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Factors affecting human-animal interactions and relationships

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Synopsis

It is uniquely human to engage in social relationships with other animals (Podberscek et al., 2000; Robinson, 1995; Serpell, 1986; Turner and Bateson, 2005; Wilson 1984). Human-animal interaction is important in the lives of many people, and interest in human-pet interactions and their beneficial influence on humans has been growing. In general, individualized dyadic social relationships are a base for mutual sharing of attention, learning, and collaboration. Social partners, including animal companions, also provide both active and passive social support for each other (Aureli and de Waal, 2000; Scheiber et al., 2005), resulting in physiological benefits for the human partner (Robinson, 1995; Wilson and Turner, 1998). However, because the interests of dyadic partners are over time neither entirely stable nor symmetrical, such relationships generally fit a "valuable-relationship model", which predicts that individual positions in a relationship are dynamically negotiated in cycles of conflict and reconciliation (Aureli and de Waal, 2000). Similar hypotheses and predictions apply within-species or between-species (i.e., human-animal). In fact, relationships between humans and their companion animals may be as ridden with conflict and problems as those among humans (McCune et al., 1995).

An important factor in dyadic relationships is stress-coping (Aureli and de Waal, 2000). Depending on the characteristics of the interacting individuals and their relationships, social interactions can be powerful stressors. On the other hand, sociopositive interactions are an important component in dampening stress responses, through modulation of the oxytocin system (DeVries et al., 2003; Uvnäs-Moberg, 1998). This mechanism of “passive” social support is found in non-human animals as well as humans (Scheiber et al., 2005) and may also operate between species (see Kotrschal et al., 2010 for review). For example, a dog’s gazing at its owner can increase the owner’s urinary oxytocin concentration (Nagasawa et al., 2009). Odendaal and Meintjes (2003) investigated changes in serum oxytocin levels in humans in response to positive interaction with dogs. Some of these dogs belonged to participants and some were provided to non-owners; it was required that all human participants possess feelings of affection for dogs in general. The experiments were conducted in a designated test room. The control condition consisted of the human reading a book. Both humans and dogs showed increases in oxytocin in response to positive interaction; in humans, the oxytocin increase was higher during dog interaction than reading. Miller et al. (2009) elaborated on this study by investigating changes in owners’ serum oxytocin levels in response to interaction with their dogs after having been separated from them while at work all day. Human gender was noted and the control condition similarly entailed the owner reading. Testing was done at the participants' homes. The researchers found a greater increase in women's oxytocin levels in response to interaction with their dogs than in response to the reading condition, whereas in men, there was no significant increase in oxytocin levels, after interaction with their dogs compared with the reading condition. That is, women had an overall increase in oxytocin levels after interacting with their dogs compared to an overall decrease after the reading condition whereas in men, levels decreased in both conditions with a higher decrease in the reading condition.

Jones and Josephs (2006) found that affiliative behaviours on the part of a human (playing, petting) towards a dog might suppress elevation of the dog's cortisol levels during a stress situation. Tuber et al. (1996) found that in novel environments, dogs showed increased cortisol responses to stress both when they were alone and when they where together with an familiar dog, but that the rise in cortisol could be dampened by the presence of a familiar human. Henessy et al. (1998) found that being petted by a woman seems to more effectively dampen a dog's cortisol increase in a stress situation than does being petted by a man.

Several studies have shown gender differences in interactions with and attitudes towards animals (reviewed by Herzog, 2007; Prato-Previde et al., 2006; Ray, 1982; Rost and Hartmann, 1994). For example, women appear to have stronger emotional relationships to their pets than men (Ray, 1982; Rost and Hartmann, 1994). Mertens and Turner (1988) found that during first encounters between humans and cats, women vocalised more than men and cats tended to approach women more often than men, but detected no effect of human or cat gender in other human–cat interactions (e.g., petting or playing) or on cat behaviour. Mertens (1991) investigated human-cat interactions in cat-owning families and showed that women were more interactive (e.g., talked more) with their cats when at home than were men. She further found that the cats correspondingly approached female owners more frequently and that the total frequency of contact initiations (lifting/jumping up) was higher in dyads with women than in those with men. Notably, the duration of presence at home was greater for women in this study than for men; this difference may have weakened the effect of owner gender. Nevertheless, Mertens (1991) concluded that the female owners had more intense relationships with their cats than did the male owners.

Adamelli et al. (2005) found that level of care given to the cat, cat behaviour, and amount of time the cat spent with the owner differed according to owner gender. They also found that cat behaviour depended on features of the owner (e.g., gender) but not on those of the cat. Interactions in human-dog dyads have been shown to differ according to owner gender with respect to verbal communication but not visual contact or in playing with the dog (Prato-Previde et al., 2006).

Asendorpf and Wilpers (1998) found that human personality factors predict aspects of human social relationships such as number of peer relationships, conflict with peers, and falling in love. Phillips and Peck (2007) showed that self-assessed keeper personality (but not keeper- assessed tiger personality) was strongly connected to interactions between the two in an interactive zoo exhibit; e.g., they found that keepers scoring higher in neuroticism had fewer interactions with the tigers.

Relationships between domestic cats (*Felis silvestris catus*) and owners are considered to be complex, with contributions from both sides (Mertens, 1991; Turner, 1991). Owners often report a perfect fit with their cats (Karsh and Turner, 1988). This may be due mainly to the flexibility and variability of cat social behaviour (Mertens and Turner, 1988), which enables them to adapt to their human companions (Leyhausen, 1988). For instance, cat behaviour and time spent interacting with the owner have been found to be influenced by owner activity, mood, gender, and age (Mertens, 1991; Rieger and Turner, 1999). Turner (1991) investigated relationships between women and their cats and found that duration of interaction between owner and cat was determined by which member of the dyad initiated the interaction. The higher the proportion of all successful intends to interact on the cat's part, the longer was duration of interaction. Conversely, the more successful the human was in initiating interaction, the shorter the total interaction time. Turner (1991) further found that if the owner complies with the cat's wishes to interact, then the cat complies with the owner's wishes at other times; if the owner does not comply, then neither does the cat.

Dogs (C*anis lupus familiaris)* are widely considered to be man's closest animal companions. Much of the cultural evolution of mankind, at least during its sedentary phase over the past 10,000 years, took place in the continuous presence of wolves/dogs, with first contacts occurring either in the Near East (Schleidt and Shalter, 2003) or South China (Jun-Feng Pang et al., 2009). Voith (1985) proposes that the attachment between owners and their dogs tends to be strong because dogs fit into the parent-children attachment system. Factors affecting dog behaviour and relational potential include genetic background (Scott and Fuller, 1965), socialization during development, housing conditions, and owner attitudes (e.g. Serpell 1996, 1995). Topal et al. (1997) found that the quality of the human-dog relationship influences the dog's behaviour in an unfamiliar situation and during a problem-solving task; dogs considered to be family members ("companion relationship") exhibited more socially-dependent behaviour and did not perform as effectively in the problem-solving task as did dogs in a "working relationship". Several studies have investigated dog-human attachment using modified versions of Ainsworth's (1969) Strange Situation Test, an experimental method originally developed for studying human infant-parent attachment (Topál et al., 1998; Gácsi et al., 2001; Prato-Previde et al., 2003; Topal et al., 2005; Palmer and Custance, 2008). It has been shown that separation from the caregiver in an unfamiliar environment evokes anxiety in dogs as well as in human infants (Topál et al., 1998); this would suggest that functional analogies exist in human and dog attachment (Gácsi et al., 2001; Topál et al., 2005). Based on the SST approach, Prato-Previde et al. (2003) concluded that dog–human relationships can be strongly affective bonds, but they disputed that such bonds would meet the criteria for attachment and argued that Topal et al.'s (1998) study did not distinguish attachment from a general affective bond. Palmer and Custance (2008) used an improved SST procedure and concluded that dog–human bonds can indeed be consistent with the system of attachment known to exist between human infants and their caretakers.

Temporal structure is emerging as an important factor in human-animal interaction. Kerepesi et al. (2005) showed that in human-dog dyads, the partners' behaviours in cooperative activities are organized in interactive temporal (t-) patterns and that such patterns have a functional role for the successful completion of cooperative tasks. In this study, they used the pattern detection and analysis software Theme® (Noldus bv, The Netherlands, Magnusson, 1996, 2000), which allows analysis of the heretofore non-investigable temporal structure of behaviour and social interaction. A t-pattern is hierarchically and temporally structured (see example in Figure 1). Event types (e.g., different behaviours of cat and/or owner) in a pattern are ordered in chronological sequence, with the first event type at the top of the pattern (e.g., Figure 1: 1. cat approaches owner, 2. owner strokes cat's body, and 3. cat rubs body against owner). The upper event type is thus the behaviour that initiates the pattern (e.g., Figure 1: the initiating event type is “cat approaches owner”). Primary patterns are comprised of two closely-related events (e.g., Figure 1: events 1 (“cat approaches owner”) and 2 (“owner strokes cat’s body”)).

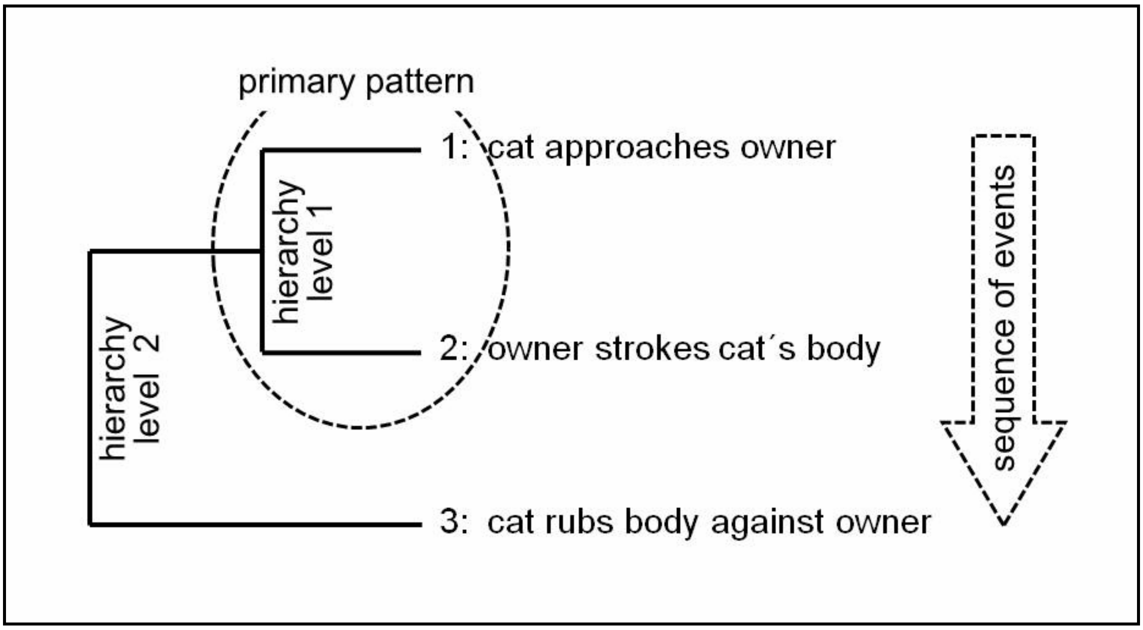

Fig. 1: Example of a simple t-pattern which could be found by Theme® (Noldus, The Netherlands), featuring 3 events and 2 levels of hierarchy. The events “cat approaches owner” and “owner strokes cat’s body” comprise a primary pattern (first order; hierarchy level 1), connected at a second hierarchy level with the event “cat rubs body against owner”. The interactive sequence of events can be read from top to bottom in order of occurrence: first the cat approaches the owner, then the owner strokes the cat’s body and finally the cat rubs its body against the owner.

As part of my diploma project, a study on animal contact in preschool children, we explored potential relationships between differential interest of children in animals and child social competence and personality; extensive further analyses and publication of the results were accomplished during my doctoral studies (Wedl and Kotrschal, 2009, see Appendix pages 91-105). We hypothesized that the presence of animals could compensate for individual deficits in social connectivity (social compensation hypothesis), or, conversely, that socially competent children would be particularly interested in animals (Paul, 2000; social competence hypothesis) and would therefore seek more contact with the rabbits. Relationships among age, sex, family background, play behaviour, personality and contact with rabbits in 50 children at a kindergarten in Lower Austria were investigated. All children had free access to the rabbits, which were kept in the kindergarten. We found that each investigated variable had significant impact on intensity of engagement with the rabbits. In general, girls, children with siblings and children without pets were more oriented towards the rabbits than were boys, children without siblings, or pet-owning children. The older the children, the less frequently they occupied themselves with the rabbits but the longer they remained with them when they did engage them. With respect to child personality (PCA factors 1-4), we found that the more “confident/respected” and less “patient/calm,” “cheerful/sociable,” and “solitary” children were, the more time they spent directly occupied with the rabbits. Most effects of the investigated variables varied between boys and girls. By and large, our findings support the “social competence” hypothesis. “Socially competent” children were indeed particularly interested in the animals.

My PhD research was based in two extensive team research projects of human-cat and human-dog dyads and centred on the study of individual and social factors affecting temporal structuring of behaviour and interaction in human-cat dyads and dog social attraction to owners. Further investigations focused on human and dog behaviour and interaction as well as stress coping in different test situations in human-dog dyads.

These interdisciplinary projects sought a better understanding of the relationships between humans and their cats and dogs, as a topic of considerable heuristic interest itself and as a model for exploring basic rules of long-tem vertebrate relationships (including human-human). We suggested that both owner and cat/dog individual features and dyadic factors affect behaviours and interactions. The effects of personality in these dyadic relationships were a central focus. We expected to find temporal structuring of dyadic behaviour and interaction in human-cat dyads and proposed that this would shed light on the nature and specificity of these dyadic relationships. Furthermore, we predicted that temporal patterns would vary among dyads depending on various factors affecting dyadic relationships, such as human and cat personalities, sex and age of partners, and duration of cohabitation. We hypothesized that the t-patterning of dyadic behaviour and interaction would differ according to owner and cat gender. Another hypothesis was that the human personality dimension neuroticism would have an especially strong impact on dyadic t-patterning, assuming that owners scoring high in neuroticism might be in particular need of social support and thus tend to consider their animal companion as a social supporter and asymmetrically seek contact with their cats (Wedl et al., 2011, see pages 19-29 of this dissertation).

The aim of our study of human-dog dyads was to investigate the effects of personality of owner and dog, owner gender, quality of owner-dog relationship and human-dog attachment on human-dog behaviours and interactions (Kotrschal et al., 2009, see pages 31-40 of this dissertation) and dog social attraction to owner (Wedl et al., 2010, see pages 41-64 of this dissertation) as well as stress-coping in both owner and dog (Schöberl et al., submitted, see pages 65-90 of this dissertation). For example, we hypothesised that owners scoring high in neuroticism would consider their dogs as social supporters, that these dyads would show low performance in a practical task and that cortisol levels in their dogs would be low. We expected that in the experimental context of our "picture viewing" test, social attraction of dog to owner would be activated by the distraction of the owner in an unfamiliar room; that is, we expected to see an increase in contact seeking behaviour and maintenance of proximity on the dog's part. Our expectation was also that individual and dyadic factors would affect dog social attraction to their owners; for example, we hypothesized that the higher an owner scored in neuroticism, the more their dogs would be attracted to them in this situation.

The projects I am discussing involved multiple investigators. Following is a description of my contributions to the research and publications included in this dissertation. For the human-cat project, I took part in devising research questions and hypotheses and in developing the coding scheme for behavioural observations. I also trained the coders, performed the reliability analyses and analyses of observed behaviours and interactions, and contributed to analysis of temporal patterns of behaviours and interactions. With the exception of the PCA, I conducted the statistical analyses for the human-cat manuscript and did much of the writing and preparation of this manuscript for publication.

In the human-dog project, I contributed to concept development and formulation of research questions and hypotheses. I also participated in designing test-situations, devising and refining data collection procedures (scheduling, preparation of detailed protocols, experimenter training), recruiting participants and in data collection. Further, I took part in preparing videos for analysis and in developing the coding scheme for behavioural observations. Again, I trained coders and conducted reliability analyses, and performed analyses of observed behaviours and interactions and the principal component analyses. I conducted the statistical analyses for the paper of which I am first author, contributed to statistical analyses in other papers, and played a substantial role in writing and preparing the human-dog manuscripts for publication.

Subjects in the dog and cat studies numbered 40 dyads in each. In the human-cat study, our subjects were 25 male and 15 female cats and 39 owners (10 men and 29 women; one woman had two cats in two different apartments). In the human-cat study, two observers visited each dyad in the owner's home four times at around the cat's feeding time. One of the observers interacted with the owner, guided the procedure, conducted interviews and explained the questionnaires; the other used a hand-held digital camcorder to video-tape cat and owner behaviours and interactions.

In the human-dog study, we arranged three observation sessions with 12 female and 10 male owners of medium- or large-sized intact male pet dogs. Two observers visited each human-dog dyad at the owner's home for the first session; the second and third were scheduled in a specially-adapted test room at the University of Vienna and were guided by one observer. In addition to those human-dog dyads that participated in the observations sessions, a further 18 dog owners completed the questionnaires we used to probe owner personality and owner-dog relationship and attachment. In both the human-cat and human-dog studies, continuous videotaping was done by camcorder. Each cat's/dog's main reference person ("owner") participated with his/her cat/dog.

In both the cat and dog studies, owner personality was assessed by the German version (Borkenau and Ostendorf, 2008) of the NEO-Five Factor Inventory (based on the Five Factor Model: Costa and McCrae, 1992; McGrae and Costa, 1987, 1989, 1992, 2003). This instrument was selected because of its empirical approach that integrates prominent dimensions of human personality (comp. Eysenck, 1990), because it is highly standardised, reliable and practicable, and because results may be compared with results of personality ratings in animals (Podberscek and Gosling, 2000; Koolhaas et al., 1999). The 60-item questionnaire is designed to measure normal adult personality in 5 domains: neuroticism, extraversion, openness, agreeableness, and conscientiousness.

In our human-dog study, we additionally designed a set of questionnaires to evaluate quality of attachment and relationship (parts translated and modified from the "Questionnaire for Anthropomorphic Attitudes" by Topal et al. (1997) and from "The Dog Attitude Scale" by

Johannson (1999)). To characterize human-dog attachment, a PCA was performed on 15 attachment items and revealed 4 main axes: 1. (dog as a) social supporter, 2. (dog as a) meaningful companion, 3. (dog as a) social partner, 4. (dog as an) understanding partner. A PCA performed on 14 owner-dog relationship items revealed 4 main axes characterizing human-dog relationship: 1. (spend) time together, 2. (take) responsibility, 3. (pay) attention, 4. (shared) activity.

Also in the human-dog study, saliva samples were taken from owner and dog by the owner at intervals of 20 minutes throughout the observation sessions to measure cortisol concentrations. To determine baseline values, saliva samples were collected on two days between the first and third sessions. On these control days, the owner took five samples from both him/herself and the dog at 20 minute intervals on two separate occasions, once in the morning and once in the afternoon. An enzyme immunoassay (EIA) was used to analyse the cortisol concentration of the owners' and the dogs' saliva samples, in collaboration with E. Möstl (Department of Biochemistry at the University of Veterinary Medicine, Vienna). The method of cortisol analysis followed that described by Palme and Möstl (1997).

Selected video-sections captured during sessions with both human-cat and human-dog dyads were continuously behaviour-coded using the software package THE OBSERVER Video Pro® (version 5.0; Noldus). In the human-cat study, these included, in each session, an unstructured period beginning five minutes before feeding the cat and ending five minutes after the cat had finished eating.

In the human-dog study, video recordings of five test situations were also coded via THE OBSERVER Video Pro® (version 5.0). These included: (1) A "picture-viewing" test in which the owner was asked to look at 15 images of dogs that had been placed on the windows and walls of the experimental room and write down three words he/she associated with each picture; the purpose of this test was to distract the owner's attention from the dog, thereby allowing us to examine the social attraction of the dog towards its owner (see Figure 2a). (2) Physical examination of the dog by the experimenter in the presence of the owner (a simulated "veterinarian check"; see Figure 2b), wherein the experimenter measured the dog's weight, length, waist and chest circumference, inspected its mouth and teeth, examined its ears and eyes, and touched its entire body, particularly the paws. (3) A "bridge" task, in which the owner was asked to lead the dog over a wood-and-wire bridge as efficiently and safely as possible (see Figure 2c). (4) A mild “threat” by the experimenter: The experimenter changed her appearance by wearing a long black coat with a hood and stood still after entering the room and silently stared at the dog, with owner present and (5) with owner absent (see Figure 2d).

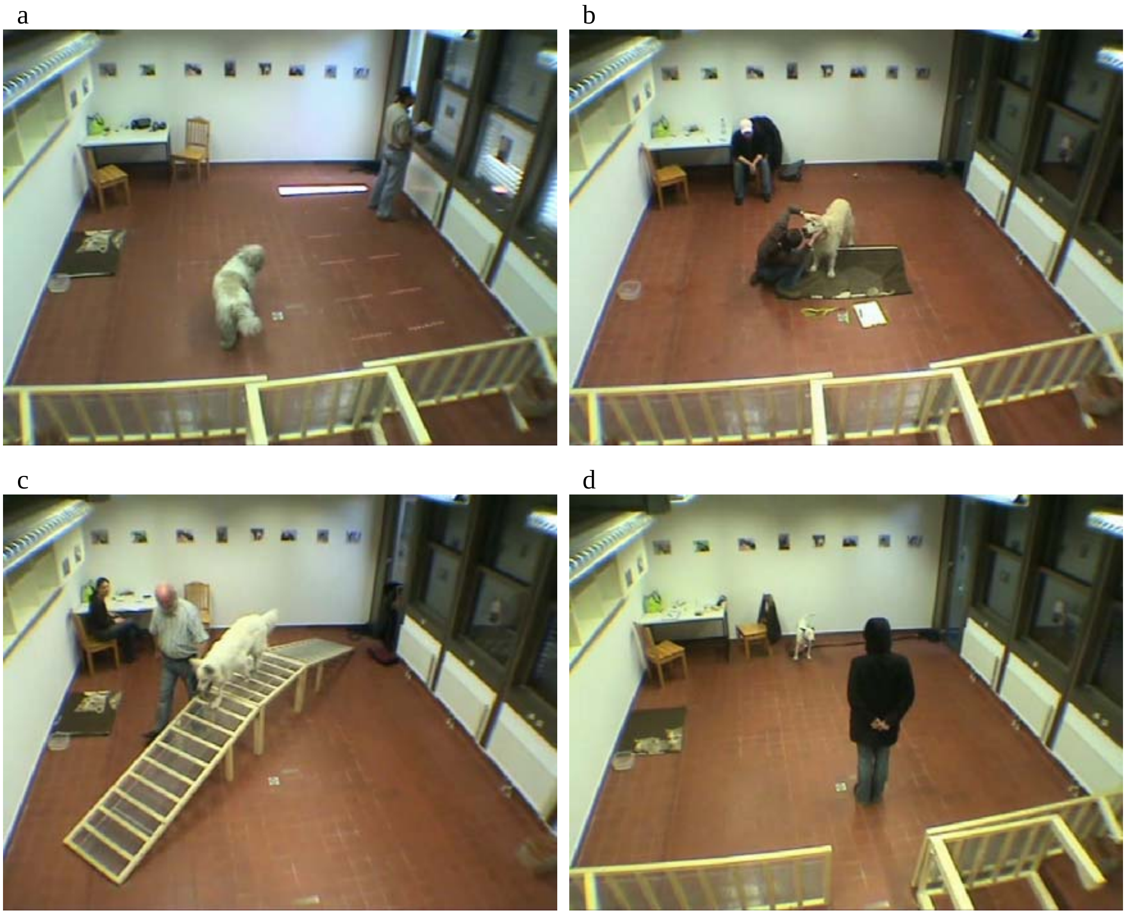

Figure 2: Observation field in the “picture viewing” test (a), “veterinarian check” (b), the “bridge” task (c) and the mild “threat” with owner absent (d) . These tasks were, along with others in this study, conducted in an adapted test room of the University of Vienna.

Cat and dog personality profiles were extracted by Principal Component Analysis based on observer-rated items (after Feaver et al., 1986), and in cats on coded behaviours as well. The PCA for cat personality (Bartlett-Test: KMO=0.625; Sphericity: $chi^2=532.6$, df=190, $p<0.001$) revealed five main axes: 1. Active, 2. Anxious, 3. Feeding, 4. Sociable, 5. Rough. The dog personality PCA resulted in four main axes: 1. Sociable and Active, 2. Unconfident and Anxious, 3. Vocal and Aggressive, 4. Clever and Attentive.

Analysis of “hidden” temporal structure of behaviour and interaction between cats and owners was initiated by importing strings of owner and cat behaviours and interactions coded via The Observer software into the Theme® software package. To enable Theme® analysis, “states” (i.e., behaviours of a certain duration) obtained from coding were then converted into “events” (frequencies). Behaviour-strings were analysed for each of the four visits, resulting in a sample size of n=4 per dyad for all Theme® parameters. For statistical analysis, we used “number of patterns”, “number of patterns per minute”, “number of non-overlapping patterns”, “number of non-overlapping patterns per minute”, and “event type complexity”. “Non-overlapping patterns” and “event type complexity” are measures of pattern complexity. “Non-overlapping patterns” are subsets of patterns whose combined occurrences account for a greater percentage of the entire observation period than any other subset. “Event type complexity” includes the top 20% most complex of all patterns in the observation period.

For example, the results of our study of human-cat dyads showed that in dyads with a female owner, the number of patterns per minute tended to be higher than in dyads with a male owner. The higher an owner scored in neuroticism (NEO-FFI-axis 1), the fewer t-patterns occurred per minute. The higher an owner scored in extraversion (NEO-FFI-axis 2), the higher was the number of non-overlapping patterns per minute. The more “active” (PCA axis 1) the cat, the fewer non-overlapping patterns occurred per minute, but the higher was event type complexity. The older the cat, the lower was dyadic event type complexity.

In our human-dog studies, we found (e.g.) that the higher owners scored in neuroticism (NEO-FFI-axis 1), the more they considered their dogs to be social supporters (human attachment PCA-axis 1). The more the owners considered their dogs social supporters, the less important it was for them to share activities with their dog (human relationship PCA-axis 4) and the longer it took the dyad to master the “bridge” task. The “picture viewing” test indicated that human attachment to dog, quality of human-dog relationship, and personality of both human and dog affected our dogs’ social attraction to their owners. A higher owner score in neuroticism, a higher tendency on an owner’s part to regard the dog as “social supporter”, and a lower owner tendency to view the dog as partner for “shared activities” were each positively correlated with higher attraction to owner on the part of the dog. The more “sociable and active” and “unconfident and anxious” but the less “vocal and aggressive” and “clever and attentive” the dogs (dog personality PCA-axes 1–4), the more they were attracted to their owners. We also found that owner personality (as well as owner attachment to and relationship with the dog) affects owner and dog basal morning cortisol levels. For example, the higher the owner’s score in neuroticism and the lower the conscientiousness score (NEO-FFI-axis 5), the higher were his/her morning salivary cortisol values and the lower were those of his/her dog. With the exception of dogs together with male owners showing elevated salivary cortisol levels during the first 20 minutes of the visit to their homes, we found that experimental challenges had little detectable effect on either dog or owner. In respect to owner-to-dog attachment we found that dogs of owners who considered them as being a “social partner” (human attachment PCA-axis 3) and a “meaningful companion” (human attachment PCA-axis 2) showed low morning salivary cortisol values.

Our findings in human-cat dyads constitute the first demonstration of the existence of temporal patterning of dyadic behaviour and interaction. To our knowledge, the only prior studies of temporal patterning in human-animal interaction involved human-dog dyads (Kerepesi et al., 2005; Kerepesi et al., 2006). These studies did not investigate factors influencing pattern number or complexity. As expected, we found not only that temporal structuring of dyadic behaviour and interaction exists in human-cat dyads, but also that features of both owner and cat affected the number and complexity of t-patterns. Important among these characteristics were owner and cat personality, owner gender, and age of cat. For example, we hypothesized that the human personality dimension neuroticism would have an especially strong impact on dyadic t-patterning; and indeed, among our findings was that the higher an owner scored in neuroticism, the fewer t-patterns occurred per minute.

Our findings on human-dog dyads indicate that owner gender, owner and dog personality, and the quality of the human-dog relationship (e.g., human attachment to dog) may all influence various human and dog behaviours and interactions, dog attraction to owner and dyadic stress-coping. An owner’s personality, for example, may affect his/her behaviour in a way that either could encourage or inhibit a dog’s social attraction to its owner; more specifically, owners scoring high in neuroticism may regard their dogs as social supporters and interact with them especially frequently, thereby reinforcing reciprocal social attraction on the dogs’ part.

In our studies of human-cat and human-dog dyads we used an interdisciplinary approach, incorporating in our data-collection methods quantitative behavioural observations, personality tests, observer ratings, questionnaires, and, in human-dog dyads, measures of cortisol. Principal Component Analyses served to condense factors of cat/dog personality, human-dog relationship, and human-to-dog attachment. For statistical analyses, we used mainly General and Generalized Linear Models. We consider the human-dog project a pilot study because the sample size was particularly low and exclusive in that only male pet dogs and their male and female owners were chosen as subjects. In a follow-up study with a larger sample size, we plan to include female dogs with their male and female owners. In this study, we also want to analyse individual and social factors that may affect temporal structure of dyadic behaviours and interactions.

My dissertation aimed towards a better understanding of relationships between humans and cats/dogs. Our integrative research, targeting both psychological and physiological aspects of social behaviour, has hopefully shed new light on factors influencing human-animal relationships and hence may prove useful in future research in human-animal interaction and also in a number of applied areas. For example, one finding from our studies of human-dog relationships indicates that dog trainers should consider the personalities of both owner and dog and the qualities of their relationship in individualizing training not just for the dog but for the dyad. Our findings on temporal patterns in human-cat dyads suggest that basic temporal structures similar to those in human-cat dyads may also be found in other complex long-term dyadic relationships, including those between humans. We hope our results can contribute to improving the social, medical and educational significance of animals -- for example, by fostering better understanding of the potential of individually tailoring interaction with pets in therapeutic settings.

References

Adamelli, S., Marinelli, L., Normando, S., Bono, G., 2005. Owner and cat features influence the quality of life of the cat. Appl. Anim. Behav. Sci. 94, 89–98.

Ainsworth, M.D.S., 1969. Object relations, dependency and attachment: a theoretical review of the infant-mother relationship. Child Dev. 40, 969-1025.

Asendorpf, J.B., Wilpers, S., 1998. Personality effects on social relationships. J. Pers. Soc. Psychol. 74, 1531–1544.

Aureli, F., de Waal, F.B.M., 2000. Natural Conflict Resolution. University of California Press, Berkeley.

Borkenau, P., Ostendorf, F., 2008. NEO-Fünf-Faktoren-Inventar nach Costa und McCrae: 2. neu normierte und vollständig überarbeitete Auflage. Hogrefe, Göttingen.

Costa, P.T., McCrae, R.R., 1992. Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional Manual: Psychological Assessment Resources, Odessa, Florida.

DeVries, A.C., Glasper, E.R., Detillion, C.E., 2003. Social modulation of stress responses. Physiol. Behav. 79, 399–407.

Eysenck, H.J., 1990. Biological dimensions of personality. In: Pervin, L.A. (Ed.), Handbook of personality: Theory and research. Guilford Press, NY, pp. 244-276.

Gácsi, M., Topál, J., Miklósi, Á., Dóka, A., Csányi, V., 2001. Attachment behaviour of adult dogs (*Canis familiaris*) living at rescue centres: Forming new bonds. J. Comp. Psychol. 115, 423–431.

Hennessy, M.B., Williams, M.T., Miller, D.D., Douglas, C.W., Voith, V.L., 1998. Influence of male and female patters on plasma cortisol and behaviour: can human interaction reduce the stress of dogs in a public animal shelter? Appl. Anim. Behav. Sci. 61, 63–77.

Herzog, H.A., 2007. Gender differences in human–animal interactions: a review. Anthrozoös 20, 7–21.

Johannson, E.E., 1999. Human–animal bonding: an investigation of attributes. PhD Thesis. University of Alberta.

Jones, A.C., Josephs, R.A., 2006. Interspecies hormonal interactions between man and the domestic dog (*Canis familiaris*). Horm. Behav. 50, 393–400.

Jun-Feng Pang, Kluetsch, C., Xiao-Ju Zou, Ai-bing Zhang, Li-Yang Luo, Angleby, H., Ardalan, A., Ekström, C., Sköllermo, A., Lundeberg, J., Matsumura, S., Leitner, T., Ya-Ping Zhang, Savolainen, P., 2009. mtDNA Data Indicates a Single Origin for Dogs South of Yangtze River, less than 16,300 Years Ago, from Numerous Wolves. Mol. Biol. Evol., 26 (12): 2849-2864.

Karsh, E.B., Turner, D.C., 1988. Die Mensch/Katze-Beziehung. In: Turner, D.C., Bateson, P. (Eds.), Die domestizierte Katze. Albert Müller Verlag, Zürich.

Kerepesi, A., Johnsson, G.K., Miklosi, A., Topàl, J., Csànyi, V., Magnusson, M.S., 2005. Detection of temporal patterns in dog–human interaction. Behav. Proc. 70, 69–79.

Kerepesi, A., Kubinyi, E., Jonsson, G.K., Magnusson, M.S., Miklósi, Á., 2006. Behavioural comparison of human–animal (dog) and human–robot (AIBO) interactions. Behav. Proc. 73, 92–99.

Koolhaas, J.M., Korte, S.M., De Boer, S.F., Van Der Vegt, B.J.,Van Reenen, C.G., Hopster, H., De Jong, I.C., Ruis, M.A.W., Blokhuis, H.J., 1999. Coping styles in animals: current status in behavior and stress-physiology. Neurosci. Biobehav. Rev. 23, 925–935.

Kotrschal, K., Scheiber, I.B.R., Hirschenhauser, K., 2010. Individual Performance in Complex Social Systems: The Greylag Goose Example. In: Kappeler, P. (Ed.), Animal Behaviour: Evolution and Mechanisms. Springer Verlag, Berlin, pp. 121-148.

Kotrschal, K., Schöberl, I., Bauer, B., Thibeaut, A.-M., Wedl, M., 2009. Dyadic relationships and operational performance of male and female owners and their male dogs. Behav. Proc. 81, 383–391.

Leyhausen, P., 1988. The tame and the wild – another just-so story? In: Turner, D.C., Bateson, P. (Eds.), The Domestic Cat: The Biology of its Behaviour. Cambridge University Press, Cambridge, pp. 57–66.

Magnusson, M., 1996. Hidden real-time patterns in intra- and inter-individual behavior: description and detection. Eur. J. Psychol. Assess. 12, 112–123.

Magnusson, M., 2000. Discovering hidden time patterns in behavior: T-patterns and their detection. Behav. Res. Methods Instrum. Comput. 32, 93–110.

McCrae, R.R., Costa, P.T., 1987. Validation of the five-factor model of personality across instruments and observers. J. Pers. Soc. Psychol. 52, 81-90.

McCrae, R.R., Costa, P.T., 1989. Rotation to maximize the construct validity of factors in the NEO Personality Inventory. Multivar. Behav. Res. 24, 107-124.

McCrae, R.R., Costa, P.T., 1992. Discriminant validity of NEO PI-R facet scales. Educational and Psychological Measurement.

McCrae, R.R., Costa, P.T., 2003. Personality in Adulthood, second edition. Guilford Press, NY.

McCune, S., McPherson, J.A., Bradshaw, J.W.S., 1995. Avoiding problems. In: Robinson, I. (Ed.), The Waltham Book of Human–Animal Interactions. Pergamon Press, Kidlington, pp. 71–86.

Mertens, C., 1991. Human–cat interactions in the home setting. Anthrozoös 4, 214–231.

Mertens, C., Turner, D.C., 1988. Experimental analysis of human–cat interactions during first encounters. Anthrozoös 2, 83–97.

Miller, S.C., Kennedy, C., DeVoe, D., Hickey, M., Nelson, T., Kogan, L., 2009. An examination of changes in oxytocin levels in men and women before and after interaction with a bonded dog. Anthrozoös, 22, 31-42.

Nagasawa, M., Kikusui, T., Onaka, T., Ohta, M., 2009. Dog’s gaze at its owner increases owner’s urinary oxytocin during social interaction. Horm. Behav. 55, 434–441.

Odendaal, J.S., Meintjes, R.A., 2003. Neurophysiological correlates of affiliative behaviour between humans and dogs. Vet. J. 165, 296–301.

Palmer, R., Custance, D., 2008. A counterbalanced version of Ainsworth’s Strange Situation Procedure reveals secure-base effects in dog–human relationships. Appl. Anim. Behav. Sci. 109, 306–319.

Palme, R., Möstl, E., 1997. Measurement of cortisol metabolites in faeces of sheep as a parameter of cortisol concentration in blood. Int. J. Mammal. Biol. 62, Suppl. II, 192-197.

Paul, E. S., 2000. Love of pets and love of people. In: Podberscek, A.L., Paul, E.S., Serpell, J.A. (Eds.), Companion Animals & Us: Exploring the Relationships between People and Pets. Cambridge University Press, Cambridge, pp.168–186.

Phillips, C., Peck, D., 2007. The effects of personality of keepers and tigers (*Panthera tigris tigris*) on their behaviour in an interactive zoo exhibit. Appl. Anim. Behav. Sci. 106, 244–258.

Podberscek, A.L., Gosling, S.D., 2000. Personality research on pets and their owners: Conceptual issues and review. In: Podberscek, A.L., Paul, E.S., Serpell, J.A. (Eds.), Companion Animals & Us: Exploring the Relationships between People and Pets. Cambridge University Press, Cambridge, pp.143-167.

Podberscek, A.L., Paul, E.S., Serpell, J.A., (Eds.), 2000. Companion animals and us. Exploring the relationships Between people & pets. Cambridge University Press, Cambridge.

Prato-Previde, E., Custance, D.M., Spiezio, C., Sabatini, F., 2003. Is the dog–human relationship an attachment bond? An observational study using Ainsworth's strange situation. Behaviour 140, 225–254.

Prato-Previde, E., Fallani, G., Valsecchi, P., 2006. Gender differences in owners interacting with pet dogs: an observational study. Ethology 112, 63–73.

Ray, J.J., 1982. Love of animals and love of people. J. Pers. Soc. Psychol. 116, 299–300.

Rieger, G., Turner, D.C., 1999. How depressive moods affect the behavior of singly living persons toward their cats. Anthrozoös 12, 224–233.

Robinson, I. (Ed.),1995. The Waltham Book of Human–Animal Interaction: Benefits and Responsibilities of Pet Ownership. Pergamon Press, Kidlington.

Rost, D.H., Hartmann, A., 1994. Children and their pets. Anthrozoös 7, 242–254.

Scheiber, I.B.R.,Weiss, B.M., Frigerio, D., Kotrschal, K., 2005. Active and passive social support in families of Greylag geese (*Anser anser*). Behaviour 142, 1535–1557.

Schleidt,W.M., Shalter, M.D., 2003. Co-evolution of humans and canids. Evol. Cogn. 9, 57–71.

Schöberl, I., Wedl, M. Bauer, B., Day, J., Möstl, E., Kotrschal, K., submitted. Effects of owner-dog relationship and owner personality on cortisol modulation in human-dog dyads. Anthrozoös.

Scott, J.P., Fuller, J.L., 1965. Genetics and the Social Behavior of the Dog. Univ. Chicago Press, Chicago.

Serpell, J.A., 1986. In the Company of Animals. Basil Blackwell, Oxford.

Serpell, J.A. (Ed.), 1995. The Domestic Dog. Cambridge University Press, Cambridge.

Serpell, J.A., 1996. Evidence for association between pet behavior and owner attachment levels. Appl. Anim. Behav. Sci. 47, 49–60.

Topál, J., Gácsi, M., Miklósi, Á., Virányi, Zs., Kubinyi, E., Csányi, V., 2005. Attachment to humans: a comparative study on hand-reared wolves and differently socialized dog puppies. Anim. Behav. 70, 1367–1375.

Topàl, J., Miklòsi, À., Csànyi, V., 1997. Dog–human relationship affects problem solving behavior in the dog. Anthrozoös 10, 214–223.

Topàl, J., Miklòsi, À., Csànyi, V., Dóka, A. (1998). Attachment behavior in dogs (*Canis familiaris*): A new application of Ainsworth’s (1969) strange situation test. J. Comp. Psychol. 112, 219–229.

Tuber, D.S., Henessy, M.B., Sanders, S., Miller, J.A., 1996. Behavioural and glucocorticoid responses of adult domestic dogs (*Canis familiaris*) to companionship and social separation. J. Comp. Psychol. 110, 103–108.

Turner, D.C., 1991. The ethology of the human–cat relationship. Schweiz. Arch. Tierheilk. 133, 63–70.

Turner, D.C., Bateson, P. (Eds.), 2005. The Domestic Cat, 2nd ed. Cambridge University Press, Cambridge.

Uvnäs-Moberg, K., 1998. Oxytocin may mediate the benefits of positive social interaction and emotions. Psychoneuroendocrinology 23, 819–835.

Voith ,V.L., 1985. Attachment of people to companion animals. Vet. Clin. N. Am.: Small Anim. Pract. 15, 289-296.

Wedl, M., Bauer, B., Gracey D., Grabmayer C., Spielauer E., Day. J., Kotrschal K., 2011. Factors influencing the temporal patterns of dyadic interactions between domestic cats and their owners. Behav. Proc. 86, 58-67.

Wedl, M., Kotrschal, K., 2009. Social and individual components of animal contact in preschool children. Anthrozoös 22, 383–396.

Wedl, M., Schöberl, I., Bauer, B., Day, J., Möstl, E., Kotrschal, K., 2010. Relational factors affecting dog social attraction to human partners. Interact. Stud. 11, 482–503.

Wilson, E.O., 1984. Biophilia. Harvard University Press, Harvard.

Wilson, C.C., Turner, D.C. (Eds.), 1998. Companion Animals in Human Health. Sage, London.

Factors influencing the temporal patterns of dyadic behaviours and interactions between domestic cats and their owners

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ABSTRACT

Human–cat dyads may be similar in interaction structure to human dyads because many humans regard their cats as being social companions. Consequently, we predict that dyadic structure will be contingent on owner and cat personalities, sex, and age as well as duration of cohabitation of the partners. Forty owner–cat dyads were visited in their homes, on four occasions, during which their behaviours and interactions were video-taped. Behaviour was coded from tape and was analysed for temporal (t)-patterns using Theme® (Noldus; Magnusson, 1996). Owner personality was assessed using the NEO-FFI. Five cat personality axes were identified by Principal Component Analysis (PCA) based on observer-rated items and on coded behaviours. We found that the higher the owner in neuroticism, the fewer t-patterns occurred per minute. The higher the owner in extraversion, the higher was the number of non-overlapping patterns per minute. The more “active” the cat, the fewer non-overlapping patterns occurred per minute, but the higher was the event type complexity. The older the cat, the lower was dyadic event type complexity. We suggest that basic temporal structures similar to those of human–cat dyads may also be found in other long-term and complex dyadic relationships, including those between humans.

1. Introduction

Most household cats are regarded as being social partners by their owners (Karsh and Turner, 1988; own unpublished data). This is probably not merely a matter of anthropomorphic projection, but rather considers that vertebrates in general, and mammals in particular, share a number of “social tools” (Kotrschal, 2007). These include common brain substrates of emotions (Panksepp, 1998, 2005), instinctive socio-sexual behaviour (Goodson, 2005) and social bonding (Curley and Keverne, 2005), as well as common mechanisms for coping with stress across vertebrate species (McEwan and Wingfield, 2003; DeVries et al., 2003). Hence, socialization between humans and their companion animals appears possible on the basis of common biological grounds. In addition, domesticated animals have been selected for tameness, making them generally more attentive and cooperative towards human partners than their wild ancestors (Hare and Tomasello, 2005; Miklosi et al., 2004). In fact, companion animals, such as dogs or cats may provide social support for their owners (Podberscek et al., 1995). Contact with cats, for example, may reduce stress (Allen, 2003) and may positively affect health (Allen et al., 2002). Furthermore, human–cat dyads may be regarded as long-term valuable relationships (Kummer, 1978), probably characterized by dynamic negotiations of interests between partners. For these reasons, in the present paper, we applied the contemporary framework of evolutionary theory for dyadic social relations (Aureli and De Waal, 2000) to the study of human–cat dyads.

Relationships between cats and owners are considered to be complex, with contributions from both sides (Mertens, 1991; Turner, 1991). Owners often report a perfect fit with their cats (Karsh and Turner, 1988). This may be due mainly to the flexibility and variability of cat social behaviour (Mertens and Turner, 1988), which enables them to adapt to their human companions (Leyhausen, 1988). For instance, cat behaviour and time spent interacting with the owner has been found to be influenced by activity, mood, gender, and age of owner (Mertens, 1991; Rieger and Turner, 1999). Also, in both humans and in non-human animals, personality (an inclusive synonym for “individual behavioural phenotype”, also covering “coping style” Koolhaas et al., 1999) is a major determinant of decision making, i.e., of how

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individuals respond to environmental challenges and how they interact socially (Buss, 1999; Gosling and John, 1999; Groothuis and Carere, 2005; Kralj- Fišer et al., 2007; Sih et al., 2004). On these grounds we base our current emphasis on human and cat personality. Expanding on previous observational (e.g., Feaver et al., 1986; Turner, 1991) and questionnaire-based (e.g., Turner and Stammbach-Geering, 1990) studies we conducted a quantitative observational, and partly experimental, study in 40 owner–cat dyads in the Vienna area. Our aim was to explore the human–cat relationship as close to its social core as possible via determining regularities in the behaviours and interactions of cats and humans.

The temporal organization of behaviour is inaccessible to the human eye, necessitating special software to detect "hidden" temporal (t) patterns (Theme®, Noldus bv, The Netherlands; Magnusson, 1996, 2000). Such tools enable the investigation of the structure of behaviour through automatic detection of special relations between the time distributions of behavioural event types. A temporal pattern (t-pattern) is hierarchically and temporally structured. The number of event types (different behaviours) in a pattern is ordered in chronological sequence (for details and formal definitions of t-patterns see the Section 2.4 of this article and Magnusson, 2000).

Theme® has already been successfully applied in a number of areas (Anolli et al., 2005) that include the modulation of human hormone–behaviour (Hirschenhauser et al., 2002), behaviour in hens (Hocking et al., 2007; Merlet et al., 2005), chicks (Martaresche et al., 2000), and mice (Bonasera et al., 2008). In humans, Theme® has been used to analyse interactions and synchronies (Magnusson, 1996) in activities such as sport (Borrie et al., 2001, 2002; Jonsson et al., 2006) and dancing (Grammer et al., 1998), and also in studies of schizophrenia and mania (Lyon and Kemp, 2004). For example, Borrie et al. (2001) showed that the temporal patterning of behaviour was linked to the performance of a football team. Kerepesi et al. (2005) showed that in human–dog dyads, the behaviours exhibited during cooperative interactions are organized in interactive temporal patterns, and that such patterns have a functional role for the successful completion of the cooperative task. Kerepesi et al. (2006) compared human–dog interactions with human–robot (AIBO) interactions and found that the number of interactive t-patterns did not differ but that the structure of the t-patterns did. Given these results, we expected to find temporal structuring of dyadic interactions in human–cat dyads and that these would, to some extent, depend on the interaction style of the human partner. We proposed that these would shed light on the nature and specificity of these dyadic relationships. Furthermore, we predicted that temporal patterns would vary between dyads depending on some major factors affecting dyadic relationships, such as human and cat personalities, sex and age of partners, and duration of cohabitation. We hypothesized that the t-patterning of dyadic behaviour would vary between male and female owners and between male and female cats. We also hypothesized that the human personality dimension Neuroticism would have an especially strong impact on dyadic t-patterning, assuming that owners scoring high in neuroticism may be in particular need of social support and thus tend to consider their animal companion as a social supporter and may asymmetrically seek contact with their cats. Similar contingencies have been found in previous studies of human–dog relationships (Kotrschal et al., 2009).

2. Methods

2.1. General procedure

Data were collected between February 2005 and March 2006 in the dyads' apartments in urban Vienna. Our subjects were 40 cats (25 males and 15 females; 9–156 months; 38 domestic shorthairs, two longhairs) and 39 owners (10 men and 29 women, 21–78 years old; one woman had two cats in two different apartments). Of our dyads, 19 were same-sex (7 male owner–male cat, 12 female owner–female cat) and 21 were opposite-sex (3 male owner–female cat, 18 female owner–male cat). The cat's primary attachment figure ("owner") participated with her/his cat. All cats except two (one female, 9 months of age; one male, 7 years), were neutered. Twenty cats had limited access to outdoors (small gardens, rooftops); one cat, the single un-neutered male, ranged more widely. All of these cats still spent much of their time inside. At the beginning of our study, owners and cats had lived together from 3 to 154 months (Table 1). Cats were considered friends, members of the family or even "children" (own unpublished questionnaire data) by all participating owners, indicating strong social bonds.

Two observers visited each dyad four times at approximately weekly intervals (range: 4–14 days) at around the cat's feeding time. Visits lasted approximately 45 min; total observation time was thus approximately 120 h. One of the observers interacted with the owner, guided the procedure, conducted interviews and explained the questionnaires; the other used a hand-held digital camcorder to video-tape cat and owner behaviours and interactions. During the first visit, the owner was interviewed to obtain information concerning the dyad's history and the owner's perceptions of the cat and their relationship. This approach and the arrangement of the visit around the feeding event were chosen to provide consistency in context for the dyad's interactions. We regarded the visits, intrusive as they may have been, as experimental challenges and coded appropriate parameters (see below). Before conducting the main study, we had optimised our procedure through a pilot study with seven dyads. These pilot data were not included in the present analysis.

2.2. Personality

During our second visit, owners were asked to complete the German version (Borkenau and Ostendorf, 1993) of the NEO Five Factor Inventory of personality (NEO-FFI; Costa and McCrae, 1989). We opted for this five-factor model of human personality (FFM, "Big Five": neuroticism, extroversion, openness, agreeableness and conscientiousness; Costa and McCrae, 1989, 1992, 1999; McCrae and John, 1992), because of its empirical structure, practicability and compatibility with biological personality theory (Koolhaas et al., 1999). In our studies using this model, we have found factors other than openness not to be independent. Neuroticism correlated negatively with agreeableness, extraversion, and conscientiousness in this cat study and in a similar human–dog study that also included 40 dyads (Kotrschal et al., 2009).

In non-human animals, coping style may be defined as a coherent set of behavioural and physiological individual responses to challenging situations that is relatively constant over time (Benus et al., 1991; Hessing, 1994; Koolhaas et al., 1999; Suomi, 1991). Human observers have repeatedly and successfully used FFM-like lists of traits to assess cat personality (Feaver et al., 1986; Gosling and Bonnenburg, 1998; Gosling and John, 1998, 1999). Feaver et al. (1986) found three personality axes, "alert", "sociable" and "equable with cats". Gosling and John (1998) identified four: emotional reactivity (neuroticism), affection (agreeableness), energy (extraversion) and competence (openness). Bergler (1989) created a convergent cat "psychogram" based on owner interviews.

We evaluated cat personality by integrating observer scoring and tests. The tests included: (1) whether the cat accompanied the owner to the door when the observers arrived, (2) whether and how much the cat hid during the four visits, (3) the cat's responses to a novel object to which it was exposed once, during the third visit (a plush owlet with large glass eyes was placed on the floor so the cat would encounter it by surprise), and (4) the cat's reactions to

Table 1
Means and range of age of owner and age of cat as well as duration of living together, shown for each gender-owner and sex-cat combination and total.

Dyads	Number of dyads	Mean age of owners (years)	Age range of owners (years)	Mean age of cats (months)	Age range of cats (months)	Mean duration of living together (months)	Range of duration of living together (months)
Male owner–male cat	7	38.43	26–48	73.43	10–156	67.71	8–154
Female owner–female cat	12	49.33	25–67	70.50	12–144	45.92	3–138
Male owner–female cat	3	54.67	50–58	47.00	9–102	42.00	9–90
Female owner–male cat	18	46.00	21–78	76.27	9–144	57.44	6–120
Total	40	46.33	21–78	71.85	9–156	54.63	3–154

Table 2
Factor loadings of a Principal Components Analysis (PCA; varimax rotation; Bartlett-test: KMO = 0.625; sphericity: $chi^2 = 532.6$; df = 190; $p < 0.001$) based on observer rating and behavioural coding. Loadings of 0.500 or above are highlighted in bold text.

Original variables	Active	Anxious	Feeding	Sociable	Rough
Curious	**0.853**	−0.332	−0.115	0.147	−0.060
Active	**0.847**	−0.020	0.029	0.141	0.185
Playful	**0.842**	−0.174	0.011	0.149	0.152
Excitable	**0.794**	0.347	0.131	0.114	0.201
Vigilant	**0.725**	0.368	−0.131	0.083	−0.142
Tense	0.003	**0.916**	0.183	−0.167	−0.023
Anxious	0.137	**0.911**	0.002	−0.043	−0.136
Hiding	−0.114	**−0.722**	0.023	−0.438	0.311
Attention to visitor	0.498	**−0.688**	0.046	−0.034	0.004
Gluttonous feeder	0.004	−0.011	**−0.894**	−0.062	−0.113
Examine food	*−0.086*	*0.079*	***0.833***	*0.072*	*0.052*
Eats steadily	*−0.043*	*0.137*	***0.803***	*0.273*	*−0.087*
Playing	−0.456	0.128	**−0.566**	0.367	0.149
Vocal	−0.197	0.110	−0.095	**−0.678**	0.080
Locomotion	*−0.146*	*−0.184*	*−0.290*	***−0.636***	*−0.002*
Ears erect	*−0.154*	***0.515***	*0.352*	***0.579***	*−0.066*
Sociable	0.257	−0.386	−0.269	**0.577**	0.050
Eating hesitantly	*−0.062*	*−0.147*	*−0.023*	*−0.194*	***0.711***
Rough (in play)	*0.445*	*−0.024*	*−0.136*	*−0.043*	***0.670***
Ambivalent (pickup test)	*0.130*	*−0.108*	*0.287*	*0.269*	***0.530***

contact (uninitiated by the cat) with the owner versus an observer (during the final visit, two "pickup tests" were performed, in which the owner and then the observer-guide each picked up and held the cat in the same way, allowing us to compare the cat's responses to being handled by the owner and the visitor). In addition, observers scored 17 items of cat temperament (an appropriate subset of those used by Feaver et al. (1986); all items only applicable to cats in shelters were excluded) by ticking off along a scale between opposing attributes. Inter-observer agreement was generally better than 0.8. Mean scores from the three observers on the different items were used. A Principal Component Analysis performed on selected items coded by the observers and on selected behaviours (Bartlett-test: KMO = 0.625; sphericity: $chi^2 = 532.6$, df = 190, $p < 0.001$) revealed five cat personality axes: (1) "Active", (2) "Anxious", (3) "Feeding", (4) "Sociable" and (5) "Rough" (Table 2).

2.3. Behavioural coding

During each of the four visits, data were collected during a structured period that started 5 min before feeding of the cat and ended 5 min after the cat had finished eating.

The videos that were captured during this time were continuously coded with the aid of the software package THE OBSERVER Video Pro® (version 5.0; Noldus). For a complete list of coded variables see Table 3.

2.4. Theme® analysis

Theme® (Noldus bv, The Netherlands) was used to detect "hidden" temporal patterns of behavioural interactions ("t-patterns"; Anolli et al., 2005; Magnusson, 1996, 2000). Strings of owner and cat behaviours were analysed separately for each of the four visits, resulting in a sample size of $n = 4$ per dyad for all Theme® parameters. The main Theme® algorithm detects sets of events which follow each other non-randomly in the temporal sequence. Essentially, within a given observation period, two actions, a and b (by the individuals or specified interactions between individuals), that occur repeatedly and regularly in alternation, form a basic t-pattern (ab). Hierarchically structured t-patterns emerge via the detection of relationships of these simple, already-detected (primary or first-order) patterns (Fig. 1) through an iterative use of the algorithm scanning the string of behaviours in its temporal order. Clusters

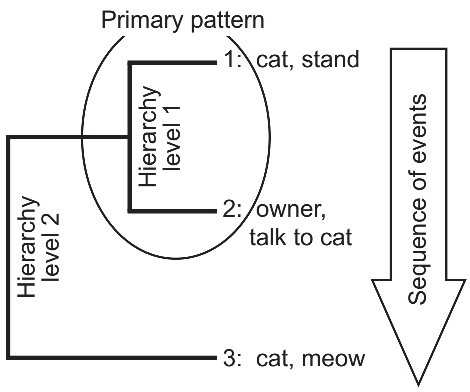

Fig. 1. Example of a hidden temporal pattern (t-pattern) featuring three events and two levels of hierarchy found by Theme®. "Cat stand" and "owner talk to cat" comprise a primary t-pattern, connected at a second hierarchy level with the event "cat meow". The interactive sequence of events from top to bottom in order of occurrence may be interpreted as: first cat stands, then owner talks to cat, followed by cat meowing. This pattern is significant at $p < 0.001$.

Table 3
Behaviour classes and behaviours used in coding via "The Observer".

Subject	Class	Behaviour	Type	Description
Division	Cut	Cut	Event	Cut in video
Division	Phases	Start phase 1	Event	5 min before the beginning of phase 2
		Start phase 2	Event	Cat's first reaction to the prospect of being fed (or, if cat does not react, when first can is opened)
		Start phase 3	Event	When the second can is opened
		Start phase 4	Event	When the owner starts preparing the cat's meal
		Start phase 5	Event	When the cat stops eating and leaves (if the cat returns and resumes eating, phase 4 continues, but ends when the cat leaves for the second time)
		End phase 5	Event	At the end of 5 min after the cat has finished the meal
Cat/owner	Approach	Approach	Event	Cat/owner moves to within-reach distance of other
		Leave	Event	Cat/owner withdraws from within-reach distance of other
Cat	Cat location	Present	State	Cat visible, in or out of room, and within visual or vocal communication range
		Absent	State	Out of room and not visible; no overt communication
		Hide	State	Cat hides inside or outside of room; is partly or fully invisible
		Location unspecified[a]	State	Unclear or undefined location
Cat	Cat tactile interactions	Head rub	Event	Cat rubs face against owner
		Body rub	Event	Cat rubs body against owner
		Tail rub	Event	Cat rubs tail against or curls tail around owner
		Head butt	Event	Cat bumps owner with forehead
		Pawing	Event	Cat reaches out with forepaw and touches owner
		Cat huddle	State	Cat in voluntary close body-contact with owner for 15 s
		Resists hold	Event	Cat struggles while being held
		Knead	State	Cat kneads owner or substrate
		Tactile interacts unspecified[a]	State	Unclear or undefined tactile interactions
		No tactile interactions	State	No cat tactile interaction with owner
Cat	Posture locomotion	Sit	State	Cat sits on a surface
		Crouch	State	Cat lowers body close to surface, legs bent
		Lie	State	Cat reclines on surface, on belly with legs curled under, on side or back, or curled up
		Roll	Event	Cat rolls over while lying
		Stand	State	Cat stands still
		Stretch	Event	Cat stretches body
		Walk	State	Cat walks forward
		Circle	State	Cat walks in tight circles near owner or around owner's legs
		Trot	State	Cat moves in rapid gait between walk and run
		Run	State	Cat moves in swift "gallop"
		Leap	Event	Cat jumps up, down, horizontally
		Reach up	Event	Cat stands on hind legs and reaches up with forelegs
		Shakes body	Event	Cat rapidly shakes body back and forth
		Sneakwalk	Event	Cat moves in rapidly gliding motion with head, body, tail lowered
		Scratch	Event	Cat scratches a surface with claws
		Scrape	Event	Cat scrapes substrate as if to dig or bury something
		Posture/locomotion unspecified[a]	State	Unclear or undefined posture or locomotion
Cat	Cat tail	Tail up	State	Tail is approximately perpendicular to back, straight up
		Tail up/tip curl	State	Tail is approximately straight up with tip curled over
		Tail up/half curve	State	Tail is approximately perpendicular to back with top half curved over
		Tail horizontal	State	Cat's tail is approximately level with back
		Tail low	State	Cat's tail is about 45° below back
		Tail flat	State	Cat's tail is flat on floor (or hanging and still)
		Tail quiver	Event	Cat rapidly quivers vertically held tail
		Tail jerk	Event	Cat abruptly jerks entire tail

Table 3 (*Continued*)

Subject	Class	Behaviour	Type	Description
		Tail tip twitch	State	Cat twitches tail tip (up to top third) once or repeatedly
		Tail flip/flop	Event	Cat flops upper half of tail over once or back and forth a few times (tail is approximately vertical)
		Tail swing	State	Cat undulates entire tail relatively slowly back and forth (tail approximately horizontal)
		Tail lash	State	Cat flails entire tail rapidly back and forth (tail approximately horizontal)
		Tail unspecified[a]	State	Unclear or undefined tail behaviour
Cat	Cat head	Head tilt	Event	Cat tilts head while watching activity or object
		Head shake	Event	Cat rapidly shakes head back and forth
		Bite-shake	Event	Cat takes food or toy in mouth and shakes it (coded by shaking episode, not by how many shakes occur within episode)
		Sniff	Event	Cat sniffs food, object, person
		Lick lips	Event	Cat lick lips/nose (including in feeding context but not while cat is in the act of eating)
Cat	Cat ears	Ears erect	State	Ears are both erect; may swivel in different directions
		Ears down/back	State	Cat's ears are flattened and drawn back
		Ears flat/side	State	Cat's ears are flattened and held sideways
		Ear flick	Event	Cat rapidly flicks one ear
		Ears unspecified[a]	State	Ear behaviour unclear or undefined
Cat	Cat eyes	Eyes open	State	Cat's eyes open
		Eyes half-closed	State	Cat's eyes approximately half-closed
		Eyes closed	State	Cat's eyes are closed
		Look at owner	State	Cat looks toward owner's face
		Slow blink	Event	Cat slowly blinks both eyes in context of making eye contact with owner
		Eyes wide open	State	Cat's eyes stretched open more widely than normal ("bug-eyed")
		Stare	State	Cat looks fixedly at owner or object with eyes fully or wide open
		Observe from distance	State	Cat gazes at owner (owner may be close to or apart from others)
		Eyes unspecified[a]	State	Unclear or undefined eye behaviour
Cat	Cat vocalisation	Meow	Event	Cat meows or mews, mouth open
		Trill/murmur	Event	Cat meows with or without trill, mouth nearly or completely closed
		Squeak	Event	Cat emits brief high-pitched, sometimes harsh sound with mouth open and lips tight
		Wack	Event	Cat emits low-pitched, shortened version of meow, lips slightly tightened
		Purr	State	Cat emits low rhythmic vibrating sound, mouth closed
		Pidgin duet with owner	State	Cat engages in exchange of nonverbal, similar sounds with owner
		Hiss/spit	Event	Cat emits hiss or abrupt spit with mouth open
		Cat vocalisation unspecified[a]	State	Unclear or undefined vocalisation
		No cat vocalisation	State	No cat vocal behaviour
Cat	Cat feeding	Looks at food	State	Cat glances or gazes at food but does not approach it
		Lick food/dish	State	Cat licks food, can, bowl
		Eat hesitantly	State	Cat eats relatively slowly with frequent pauses
		Eat steadily	State	Cat eats relatively rapidly with few pauses
		Look up	Event	Cat pauses and looks up while eating
		Reject food	Event	Cat does not taste food (may or may not sniff it)
		Ignores food	Event	Cat neither approaches, sniffs nor tastes food
		Paw in can	State	Cat probes can of food with paw
		Eats non-test food	State	Cat eats non-test food (own food left in dish or given by owner, or snack)
		Feeding bahaviour unspecified[a]	State	Unclear or undefined feeding behaviour
		No feeding	State	No cat feeding behaviour
Cat	Cat grooming	Groom lick nibble	State	Cat licks or nibbles body
		Groom paw rub	State	Cat rubs head with paw
		Groom unspecified[a]	State	Unclear or undefined grooming behaviour
		No groom	State	No cat grooming behaviour
Cat	Cat playing	Play bat	Event	Cat bats or pokes at object or owner with forepaw

Table 3 (*Continued*)

Subject	Class	Behaviour	Type	Description
		Play grab	Event	Cat grasps object or owner with forepaw
		Play grabble	State	Cat wraps forelegs around object or owner's arm or leg; may kick with hind feet
		Play bite	Event	Cat bites while grabbing or grappling
		Play run	State	Cat runs about, tail arched
		Play chase	State	Cat chases or runs from toy or owner
		Stalk	State	Cat creeps up on object or owner
		Pounce	Event	Cat jumps on object or owner after stalking or hiding
		Play fetch	State	Cat fetches or chases and plays with object thrown by owner
		Buckel stance	State	Cat stands piloerected with back and tail arched
		Play unspecified[a]	State	Unclear or undefined play behaviour
		No cat play	State	No play behaviour
Owner	Owner tactile interactions	Stroke cat's head	Event	Owner strokes top of cat's head and/or ears
		Scratch cat's head	Event	Owner scratches cat's head, ears, cheeks, and/or chin
		Stroke cat's body	Event	Owner caresses cat's body
		Stroke cat's tail	Event	Owner closes hand around cat's tail and allows cat to draw tail through or moves hand up tail till tail is released
		"Thump-pet" cat	Event	Owner pets cat vigorously on back or side
		Owner huddle	State	Owner in voluntary close contact with cat for 15 s
		Grasp cat	Event	Owner takes hold of cat
		Pickup cat	Event	Owner grasps cat and lifts him/her up
		Hold cat in arms	State	Owner hold cat in arms
		Mutual nose sniff	Event	Owner and cat reciprocally sniff noses
		Nuzzle/kiss cat	Event	Owner rubs cat with his/her face; may kiss cat
		Put cat down	Event	Owner lowers cat to substrate
		Let cat go	State	Owner releases resisting cat from hold
		Tactile behaviour unspecified[a]	State	Unclear or undefined tactile interactions
Owner	Owner vocalisation	Call cat	Event	Owner calls cat by name or nickname
		Talk to cat	State	Owner speaks to cat in conversational tone
		Whistle to cat	Event	Owner whistles to cat
		Clck/smch/sqk	Event	Owner makes nonverbal clucking, kissing, squeaking sounds to cat
		"Motherese" to cat	State	Owner talks in soft high tones to cat
		Pidgin duet with cat	State	Owner and cat engage in exchange of nonverbal, similar sounds
		Scold cat	Event	Owner rebukes cat, speaking in relatively loud or harsh or abrupt tones
		Vocalisation behaviour unspecified[a]	State	Unclear or undefined owner vocal interactions with cat
		No owner vocalisation	State	No owner vocal interactions with cat
Owner	Owner feeding related	Can-sniff cat	State	Owner holds and offers open can of food to cat
		Sniffs food	Event	Owner sniffs food
		Bowl-feed cat	Event	Owner empties chosen can into cat's bowl and gives to cat
		Encourage cat to eat	State	Owner calls or talks to cat or extends food to cat or brings cat back to food in attempt to get cat to eat
		Finger-feed cat	Event	Owner feeds cat with fingers
		Spoon-feed cat	Event	Owner feeds cat with spoon
		Owner feeding behaviour unspecified[a]	State	Unclear or undefined owner feeding behaviour
		No feeding	State	No owner feeding behaviour
Owner	Owner playing	Play body	State	Owner gestures, grabs, tickles, wrestles with cat in play context
		Play toy	State	Owner induces cat to stalk and capture toy
		Play chase	State	Owner chases or ambushes cat
		Owner play fetch	State	Owner throws object for cat to retrieve
		Owner play unspecified[a]	State	Unclear or undefined owner play behaviour
		No play	State	No owner play with cat
Cat	Cat tests	Start test[b]	Event	Observer places object on floor
		End test[b]	Event	Observer removes object from cat's access
		Ignores object	State	Cat shows no evident reaction
		Looks at object	State	Cat looks at, watches object
		Hesitates at object	Event	Cat pauses at sight of object
		Starts at object	Event	Cat shows startle reaction

Table 3 (*Continued*)

Subject	Class	Behaviour	Type	Description
		Sniffs object	Event	Cat smells novel object
		Scent-marks object	Event	Cat rubs novel object (with cheeks, sometimes also body)
		Plays with object	State	Cat bats, grapples with object
		Retreats from object	Event	Cat moves away from object after sighting or sniffing it
		Threatens object	Event	Cat hisses, piloerects
		Attacks object	Event	Cat grabs and gives object a hard bite
		No test	State	Test not done
		Accepts pickup[b]	State	Cat allows pickup with no overt objection
		Ambivalent[b]	State	Cat allows pickup but appears tense (sniff posture, ears back, staring at holder, etc.)
		Resists pickup[b]	State	Cat actively resists or rejects pickup
		No observer pickup	Event	Observer decides not to pickcat up because of concerns cat may bite or scratch

[a] Modifier class 1: not visible: behaviour cannot be coded because cat is fully or partially invisible; unclear: behaviour element not clearly discernable; unspecified: behaviour not listed in configuration; cat interaction with observer: cat interacts with observer; test: novel object test or pickup test in progress.
[b] Modifier class 2: novel object, pickup owner, pickup observer.

Table 4
Medians, minima and maxima of parameters obtained trough analysis of Theme® patterns (based on one value per dyad; $n = 40$). *Italics*: variables derived from the original Theme® variables.

Theme® – variable	Median	Minimum	Maximum
Number of patterns	65.38	23.50	126.00
Number of patterns per minute	3.14	1.28	6.66
Number of non-overlapping patterns	5.50	3.67	9.25
Percentage of non-overlapping patterns of all patterns	11.04	5.44	21.61
Number of non-overlapping patterns per minute	0.27	0.18	0.48
Number of primary t-patterns	79.63	24.75	175.67
Number of primary t-patterns with cat only	57.13	18.67	168.75
Number of primary t-patterns with owner only	5.25	1.00	37.25
Number of primary t-patterns with cat and owner	10.25	0.75	44.50
Cat-initiated primary t-pattern	6.75	0.50	23.00
Owner-initiated primary t-pattern	4.38	0.00	30.00
Only cat in pattern	41.00	17.00	118.25
Only owner in pattern	2.13	0.75	16.00
Cat and owner in pattern	14.13	1.25	57.50
Cat initiator of pattern	52.75	19.67	121.50
Owner initiator of pattern	7.79	1.25	43.00
Event type complexity	*4.45*	*3.39*	*5.91*
Percentage of cat and owner in primary patterns	*20.31*	*7.40*	*35.70*
Percentage of cat and owner in all patterns	*27.81*	*11.19*	*39.30*

of pattern pairs may thus be identified (see, for example, Kerepesi et al., 2005). Potential combinatorial hypertrophy due to redundant detection of the same patterns is dealt with by an evolution algorithm.

For Theme® analysis, "states" (i.e., behaviours of a certain duration) obtained from behavioural measurements were all converted into "events" (frequencies) after importing the 160 data files (40 dyads times four visits) from The Observer software. Theme® settings were determined empirically through pre-analysis to best suit our questions (i.e., to achieve a useful range of 15–206 patterns per visit). The following Theme® settings were used in all analyses: "minimum occurrence": 3; "significance level" = 0.001; "maximal search level": 12; "lumping factor: 0.9; "FARR: 90; no "fast free limit"; "exclude frequent event types": 2.5; "minimum sample": 100.

For each dyadic Theme® variable, a mean value was calculated over the four visits. The number of patterns per human–cat dyad varied between 23.5 and 126. Of these, dyads had 24.8–175.7 primary t-patterns (i.e., those consisting of just two behaviours; for further variables, see Table 4). The most complex patterns found showed 9 behaviours at 5 levels of hierarchy. On average, 0.8–44.5 primary t-patterns per dyad were found with both owner and cat represented. As the behaviours in t-patterns are arranged in temporal order, the initiator of an interaction, owner or cat, can be identified (Figs. 1 and 2).

The t-pattern structure as obtained by Theme® may be considered as being both a result in itself, and as a set of new variables representing the structure and complexity of the behaviour string analysed. Hence, apart from qualitative assessment of patterns, one may ask questions such as what percent of behaviours found are organized in patterns, what proportion of time the string in

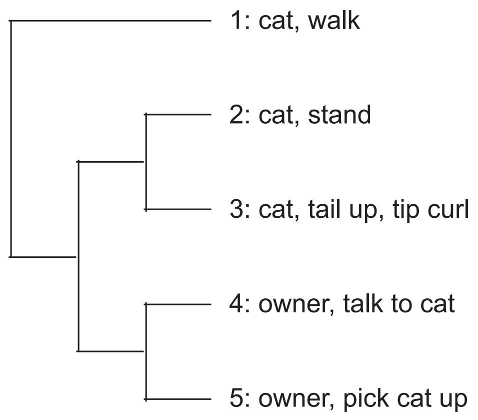

Fig. 2. Example of a t-pattern found by Theme®, featuring five events (two primary t-patterns: events 2, 3 and 4, 5) and three levels of hierarchy. The pattern can be read from top to bottom: cat walks, stands with tail up, tip curl (a sign of friendly contact), then the owner talks to the cat and finally picks the cat up. This pattern is significant at $p < 0.001$.

question is patterned, what the most abundant behaviours are in patterns, or what the proportion of higher order hierarchical patterns is of all patterns found. We used two measures of pattern complexity, “non-overlapping patterns” and “event type complexity”. “Non-overlapping patterns” are subsets of patterns whose combined occurrences account for a greater percentage of the entire observation period than any other subset. “Event type complexity” includes the most complex 20% of all patterns. In fact, dyads were differentiated by numbers of t-patterns and by a wide variety of other qualitative and quantitative parameters.

2.5. Statistical analysis

Data were generally analysed via SPSS 15.0 software. To examine whether and how the investigated factors (sex of owner and cat, age of owner, age of cat, owner and cat personality, duration of living together) influenced the “number of patterns”, we applied a general linear model (GLM). The dependent variable “number of patterns” was normally distributed when analysed with Kolmogorov–Smirnov test for normality, as were the other investigated dependent variables.

We applied one GLM with “Number of Patterns” as the dependent variable (response variable), sex of owner and sex of cat as factors, and human personality dimensions 1–5 and cat personality axes 1–5 as well as age of owner and age of cat and the duration of living together as covariates. The other four GLMs were applied with “number of patterns per minute”, “number of non-overlapping patterns”, “number of non-overlapping patterns per minute” and “event type complexity” as response variables. We made pair-wise comparisons with Bonferroni-correction to determine gender differences.

In all five models we selected the explanatory variables as main effects and removed them in the order of decreasing significance if $p > 0.1$. Only terms with $p < 0.1$ remained in the final model. Excluded terms were re-entered one by one into the final model to confirm that they did not explain a significant part of the variation (Poesel et al., 2006).

3. Results

3.1. Owner gender

In dyads with a female owner, the number of patterns per minute tended to be higher than in dyads with a male owner (tendency, GLM 2: df = 1, $F = 3.472$, $p = 0.071$, post-hoc test: $p = 0.071$).

3.2. Owner personality

The higher the owner’s score in neuroticism (NEO-FFI-axis 1), the lower was the number of patterns (tendency, GLM 1: df = 1, $F = 4.004$, $p = 0.053$) and the lower the number of patterns per minute (GLM 2: df = 1, $F = 7.244$, $p = 0.011$). The higher the owner in extraversion (NEO-FFI-axis 2), the higher the number of non-overlapping patterns (GLM 3: df = 1, $F = 6.141$, $p = 0.018$), and the higher the number of non-overlapping patterns per minute (GLM 4: df = 1, $F = 5.579$, $p = 0.024$). The more conscientious the owner (NEO-FFI-axis 5), the higher was the dyadic event type complexity (tendency, GLM 5: df = 1, $F = 3.648$, $p = 0.064$).

3.3. Age of the cat

The older the cat, the lower was the dyadic event type complexity (GLM 5: df = 1, $F = 7.499$, $p = 0.010$).

3.4. Cat personality

The more “active” the cat (PCA axis 1), the fewer non-overlapping patterns (GLM 3: df = 1, $F = 4.637$, $p = 0.038$) and non-overlapping patterns per minute occurred (GLM 4: df = 1, $F = 5.953$, $p = 0.020$), but the higher was the event type complexity (GLM 5: df = 1, $F = 6.103$, $p = 0.018$). The more “sociable” the cat (PCA axis 4), the lower was the number of patterns (GLM 1: df = 1, $F = 4.420$, $p = 0.042$) and the number of patterns per minute (GLM 2: df = 1, $F = 4.388$, $p = 0.043$). The more “sociable” the cat (PCA axis 4), the less non-overlapping patterns (GLM 3: df = 1, $F = 11.487$, $p = 0.002$) and the less non-overlapping patterns per minute (GLM 4: df = 1, $F = 12.496$, $p = 0.001$) occurred.

4. Discussion

Our present findings demonstrate, for the first time, that temporal patterning of behaviours and interactions exists in human–cat dyads. Of particular interest was whether and how human and cat personality, sex and age of partners, and duration of cohabitation might influence the number and complexity of these temporal patterns. These potential effects on temporal patterns have not been previously investigated in dyadic relationships. We found that most of these factors were indeed important; notably the effects of owner and cat personality on t-patterning of dyadic behaviour. To our knowledge, we are the first to report such personality-related results in vertebrate dyads, including those of humans.

In particular, the findings of Kerepesi et al. (2005, 2006), in studies on the human–dog relationship, led us to expect that temporal structure would provide some insight into the nature of human–cat interactions. In both studies, these authors also used Theme® pattern detection and analysis software (Magnusson, 1996, 2000).

Previous research has shown that the gender of dyad members affects human–cat relations (Mertens, 1991; Rieger and Turner, 1999; Turner, 1991). Several other studies have shown gender differences in interactions with, and attitudes towards, animals (reviewed by Herzog, 2007; Kotrschal et al., 2009; Prato-Previde et al., 2006; Ray, 1982; Rost and Hartmann, 1994; Wedl and Kotrschal, 2009). We therefore also anticipated effects of cat and/or owner sex on t-patterning of dyadic behaviour. In this study we found a tendency suggesting that, in dyads with a female owner, the number of patterns per minute was higher than in dyads with a male owner. Cat sex did not have any significant or trend effect on the temporal patterning of dyadic behaviour. These results are consistent with results from other studies of the human–cat relationship. For example, Mertens (1991) showed that female owners were more active toward their cats (e.g., spoke more with them) than were male owners, that the cats likewise made more frequent approaches and withdrawals toward female owners, and concluded that female owners have a more intense relationship with their cats than male owners. Mertens and Turner (1988) found that during first encounters between humans and cats, women vocalised more than men, and cats tended to approach women more often than men, but had found no other influence of human or cat gender on other human–cat interactions (e.g., petting or playing) or cat behaviour. Adamelli et al. (2005) found that the level of care given to the cat, cat behaviour, and amount of time the cat spent with the owner were (among other factors) influenced by owner gender. They also found that cat behaviour depended mainly on features of the owner, as gender, but not of the cat.

In our human–animal research, the effect of personality in dyadic relationships is a central focus. We have previously shown that human personality is an important factor influencing interactions and relations between humans and pets (Kotrschal et al., 2009; Wedl and Kotrschal, 2009; Wedl et al., 2010). Earlier, Asendorpf and Wilpers (1998) found that human personality factors predict aspects of human social relationships such as number of peer relationships, conflict with peers, and falling in love. Phillips and Peck (2007) showed that self-assessed keeper but not keeper-assessed tiger personality was strongly connected to behaviour between the two in an interactive zoo exhibit; e.g., they found that keepers scoring higher in neuroticism had fewer interactions with the tigers.

In the present study, we found that owner personality traits affected temporal patterning of human and cat behaviour and its complexity; higher owner scores in "neuroticism" (NEO-FFI-axis 1) correlated with fewer and less frequent patterns. In another study (Kotrschal et al., 2009), we found that owners scoring high in neuroticism viewed their dogs as social supporters and spent much time with them. If this relationship also occurs in human–cat dyads, it would be likely that humans high in neuroticism would seek more contact with their cats, i.e., take the initiative in interacting with their cats. This asymmetric social interest may prompt cats to be less active contact seekers themselves. Turner (1991) investigated the relationships between female cat owners and their cats and found that duration of interaction between woman and cat was determined by which member of the dyad initiated the interaction. The higher the proportion of all successful intents to interact that were due to the cat, the longer was the duration of interactions. Thus, the more successful the human was in initiating interactions, the shorter the total interaction time with the cat. This correlation could also be linked to less frequent temporal patterns in behaviour and interaction in human–cat dyads.

Interestingly, the human personality dimensions "extraversion" (NEO-FFI-axis 2) and "conscientiousness" (NEO-FFI-axis 5) both influenced pattern complexity but not frequency; that is, dyads with "extraverted" and "conscientious" owners had a higher pattern complexity. As "conscientious" people are reliable and control their impulses, wishes and needs, another correlation Turner (1991) found could also have an effect on time patterning: if the owner complies with the cat's wishes to interact, then the cat complies with the owner's wishes at other times; if the owner does not comply, then neither does the cat. Responsive compliance could thus be related to the emergence of high complex temporal patterns in dyads with "conscientious" owners.

Hence, it seems that an important area of negotiation between the owner and cat is mutual attention and friendly tactile interactions. The cat, by its mere presence, may have an edge in this negotiation, at least with contact-seeking owners. The owners' main asset in motivating the cat to be trustful, devoted and open to contact may be in proving to be a trustworthy and dependable social companion (e.g., as may be the case particularly in highly conscientious owners). Negotiations may also include trading food for social attention, as both social behaviour and feeding can be considered central elements in the context of "allostatic load" (roughly equivalent to stress load; McEwan and Wingfield, 2003).

Because human–cat dyads are truly social at least in some of their elements, there will be asymmetry between partners in interactions such as contact seeking and conflict (e.g., over amount of social contact demanded/provided (Aureli and De Waal, 2000). Hence, depending on owner personality and need for contact, cats may have a lever in negotiating social contact with their human partners. Particularly in the case of owners high in "neuroticism", contact with the cat may be regarded an asset in the context of social support (Allen, 2003; Allen et al., 2002). In a previous study, we found that owners high in the neuroticism dimension need their dogs as emotional social supporters and are firmly attached to their dogs as a consequence (Kotrschal et al., 2009). In a test where we diverted owners' attention away from their dogs, we found that social support correlated with the dog's contact and proximity seeking behaviour, e.g., dog approaching owner more often and dog staying longer in proximity to owner in dyads with owners high in neuroticism (NEO-FFI-axis 1) and in which owner considers dog a social supporter (Wedl et al., 2010). Whether these findings may also apply to cats and how they would affect temporal patterning in human–cat dyads would be interesting to address in future studies.

Cat features also affected the temporal patterning of human and cat behaviour and its complexity. Specifically, the older the cat was, the lower the dyadic event type complexity. Furthermore, in dyads with more "active" cats (PCA axis 1), fewer non-overlapping patterns and non-overlapping patterns per minute occurred, but event type complexity was higher. Higher ratings of "sociability" in cats (PCA axis 4), coincided with lower numbers of patterns and number of patterns per minute, and with fewer non-overlapping patterns and non-overlapping patterns per minute.

Such dyadic patterning lends support to the idea that the "valuable relationship hypothesis" (Aureli and De Waal, 2000; Kummer, 1978) also applies to human–cat dyads. This might seem a surprising conclusion, because, in contrast to human–dog relationships, the human–cat companionship is not overtly operational in the sense that the partners go places and do things together. In many modern households, cats that get their food from their owners do not reciprocate by catching mice. But human–cat dyads are surely functional in a social sense. The cats in our dyads were regarded by their owners as valuable social companions and social supporters (Kotrschal et al. unpublished data). The social significance of this companionship is less clear on the cats' side, although well-socialized cats do actively seek human contact (Leyhausen, 1988; Turner, 2000). It is unlikely that cats do this just for the sake of obtaining food. Cats are clearly capable of attaching socially to "their" humans. In general, attachment in higher vertebrates is basically contingent upon, but not caused, by the provision of food (Bowlby, 1972; Curley and Keverne, 2005).

In our study, 20 cats had limited access to outdoors (small gardens, rooftops). Only one cat, the single un-neutered male, ranged more widely. Because these cats still spent much of their time inside, we did not include housing conditions of the cat as an independent variable in the present analysis. However, given that Turner (1991) found that exclusively indoor-living cats were more interactive with their owners than cats with outdoor access, it would be worthwhile to investigate in future studies whether and how cat housing conditions affect temporal patterning of cat–owner behaviours and interactions.

We would expect that in human dyads, quality and quantity of t-patterning depends on the same factors as in human–cat dyads, most notably personality traits in both partners. However, due to the potentially intrusive nature of human ethology research, human dyads could be prohibitively difficult to study. Furthermore, in human dyads, added complexities may obscure the view of such basic patterns as those we have found. Considering these issues and that the temporal patterning we found in human–cat dyads may be a relatively general phenomenon in vertebrate dyads, human–animal dyads hold promise as research models.

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References

Adamelli, S., Marinelli, L., Normando, S., Bono, G., 2005. Owner and cat features influence the quality of life of the cat. Appl. Anim. Behav. Sci. 94, 89–98.
Allen, K., 2003. Are pets a healthy pleasure? The influence of pets on blood pressure. Curr. Dir. Psychol. Sci. 12 (6), 236–239.
Allen, K., Blascovich, J., Mendes, W.B., 2002. Cardiovascular reactivity and the presence of pets, friends, and spouses: the truth about cats and dogs. Psychosom. Med. 64, 727–739.
Anolli, L., Duncan, S., Magnusson, M.S., Riva, G., 2005. The Hidden Structure of Interaction. IOS Press, Amsterdam.
Asendorpf, J.B., Wilpers, S., 1998. Personality effects on social relationships. J. Pers. Soc. Psychol. 74, 1531–1544.
Aureli, F., De Waal, F., 2000. Natural Conflict Resolution. University of California Press, Berkeley.
Benus, R.F., Bohus, B., Koolhaas, J.M., Oortmerssen, G.A., 1991. Heritable variation in aggression as a reflection of individual coping strategies. Experientia 47, 1008–1019.
Bergler, R., 1989. Mensch & Katze. Kultur - Gefühl - Persönlichkeit. Deutscher Instituts Verlag, Köln.
Bonasera, S., Schenk, A., Luxenberg, E., Tecott, L., 2008. A novel method for automatic quantification of psychostimulant-evoked route-tracing stereotypy: application to *Mus musculus*. Psychopharmacology 196, 591–602.
Borkenau, P., Ostendorf, F., 1993. NEO-Fünf-Faktoren Inventar (NEO-FFI) nach Costa und McCrae. Handanweisung. Verlag für Psychologie, Göttingen.
Borrie, A., Jonsson, G.K., Magnusson, M.S., 2001. Application of t-pattern detection and analysis in sports research. Metodol. las Ciencias del Comportamiento 3, 215–226.
Borrie, A., Jonsson, G.K., Magnusson, M.S., 2002. Temporal pattern analysis and its applicability in sport: an explanation and exemplar data. J. Sports Sci. 20, 845–852.
Bowlby, J., 1972. Attachment and loss. Attachment, vol. 1. Basic Books, New York.
Buss, D., 1999. Human nature and individual differences: the evolution of human personality. In: Pervine, L.A., John, O.P. (Eds.), Handbook of Personality: Theory and Research, 2nd ed. Guilford Press, New York, pp. 31–56.
Costa, P.T., McCrae, R.R., 1989. The NEO PI/FFI Manual Supplement. Psychological Assessment Resources. Odessa, Florida.
Costa, P.T., McCrae, R.R., 1992. Trait psychology comes of age. In: Sonderegger, T.B. (Ed.), Nebraska Symposium and Motivation: Psychology and Aging. University Nebraska Press, Lincoln, Lincoln, pp. 169–204.
Costa, P.T., McCrae, R.R., 1999. A five-factor theory of personality. In: Pervine, L.A., John, O.P. (Eds.), Handbook of Personality: Theory and Research, 2nd ed. Guilford Press, New York, pp. 139–153.
Curley, J.P., Keverne, E.B., 2005. Genes, brains and mammalian social bonds. Trend Ecol. Evol. 20, 561–567.
DeVries, A.C., Glasper, E.R., Detillion, C.E., 2003. Social modulation of stress responses. Physiol. Behav. 79, 399–407.
Feaver, J., Mendl, M., Bateson, P., 1986. A method for rating the individual distinctiveness of domestic cats. Anim. Behav. 34, 1016–1025.
Goodson, J.L., 2005. The vertebrate social behaviour network: evolutionary themes and variations. Horm. Behav. 48, 11–22.
Gosling, S.D., Bonnenburg, A.V., 1998. An integrative approach to personality research in anthrozoology: rating of six species of pets and their owners. Anthrozoös 11, 148–156.
Gosling, S.D., John, O.P., 1998. Personality dimensions in dogs, cats and hyenas. In: Annual Meeting of the American Psychological Society, Washington, DC.
Gosling, S.D., John, O.P., 1999. Personality dimensions in nonhuman animals: a cross-species review. Curr. Dir. Psychol. Sci. 8, 69–75.
Grammer, K., Kruck, K.B., Magnusson, M.S., 1998. The courtship dance: patterns of nonverbal synchronisation in opposite-sex encounters. J. Nonverbal Behav. 22, 3–29.
Groothuis, T.G.G., Carere, C., 2005. Avian personalities: characterization and epigenesis. Neurosci. Biobehav. Rev. 29, 137–150.
Hare, M., Tomasello, M., 2005. Human-like social skills in dogs? Trends Cogn. Sci. 9, 440–444.
Herzog, H.A., 2007. Gender differences in human–animal interactions: a review. Anthrozoös 20, 7–21.
Hessing, M., 1994. Individual behavioural characteristics in pigs and their consequences for pig husbandry. PhD thesis, Agricultural University, Wageningen.
Hirschenhauser, K., Frigerio, D., Grammer, K., Magnusson, M.S., 2002. Monthly patterns of testosterone and behaviour in prospective fathers. Horm. Behav. 42, 172–182.
Hocking, P.M., Rutherford, K.M.D., Picard, M., 2007. Comparison of time-based frequencies, fractal analysis and T-patterns for assessing behavioural changes in broiler breeders fed on two diets at two levels of feed restriction: a case study. Appl. Anim. Behav. Sci. 104, 37–48.
Jonsson, G.K., Anguera, M.T., Blanco-Villasenor, A., Losada, J.L., Hernandez-Mendo, A., Arda, T., Camerino, O., Castellano, J., 2006. Hidden patterns of play interaction in soccer using SOF-CODER. Behav. Res. Methods 38, 372–381.
Karsh, E.B., Turner, D.C., 1988. Die Mensch/Katze-Beziehung. In: Turner, D.C., Bateson, P. (Eds.), Die domestizierte Katze. Albert Müller Verlag, Zürich.
Kerepesi, A., Johnsson, G.K., Miklosi, A., Topál, J., Csanyi, V., Magnusson, M.S., 2005. Detection of temporal patterns in dog–human interaction. Behav. Proc. 70, 69–79.
Kerepesi, A., Kubinyi, E., Jonsson, G.K., Magnusson, M.S., Miklósi, Á., 2006. Behavioural comparison of human–animal (dog) and human–robot (AIBO) interactions. Behav. Proc. 73, 92–99.
Koolhaas, J.M., Korte, S.M., De Boer, S.F., Van Der Vegt, B.J., Wan Reenen, C.G., Hopster, H., De Jong, I.C., Ruis, M.A.W., Blokhuis, H.J., 1999. Coping styles in animals: current status in behavior and stress-physiology. Neurosci. Biobehav. Rev. 23, 925–935.
Kotrschal, K., 2007. The evolutionary base of human–animal relations. IAHAIO-Meeting Tokyo, Oct. 2007.
Kotrschal, K., Schöberl, I., Bauer, B., Thibeaut, A.-M., Wedl, M., 2009. Dyadic relationships and operational performance of male and female owners and their male dogs. Behav. Proc. 81, 383–391.
Kralj- Fišer, S., Scheiber, I.B.R., Blejec, A., Moestl, E., Kotrschal, K., 2007. Individualities in a flock of free-roaming greylag geese: behavioral and physiological consistency over time and across situations. Horm. Behav. 51, 239–248.
Kummer, H., 1978. On the value of social relationships to non-human primates. A heuristic scheme. Soc. Sci. Inf. 17, 687–705.
Leyhausen, P., 1988. The tame and the wild – another just-so story? In: Turner, D.C., Bateson, P. (Eds.), The Domestic Cat: The Biology of its Behaviour. Cambridge University Press, Cambridge, pp. 57–66.
Lyon, M., Kemp, A.S., 2004. Increased temporal patterns in choice responding and altered cognitive processes in schizophrenia and mania. Psychopharmacology 172, 211–219.
Magnusson, M., 1996. Hidden real-time patterns in intra- and inter-individual behavior: description and detection. Eur. J. Psychol. Assess. 12, 112–123.
Magnusson, M., 2000. Discovering hidden time patterns in behavior: T-patterns and their detection. Behav. Res. Methods Instrum. Comput. 32, 93–110.
Martaresche, M., Le Fur, C., Magnusson, M.S., Faure, J.M., Picard, M., 2000. Time structure of behaviour patterns related to feed pecking in chicks. Physiol. Behav. 70, 443–451.
McCrae, R.R., John, O.P., 1992. An introduction to the five-factor model and its applications. J. Pers. 60, 175–215.
McEwan, B.S., Wingfield, J.C., 2003. The concept of allostasis in biology and biomedicine. Horm. Behav. 43, 2–15.
Merlet, F., Puterflam, J., Faure, J.M., Hocking, P.M., Magnusson, M.S., Picard, M., 2005. Detection and comparison of time patterns of behaviours of two broiler breeder genotypes fed ad libitum and two levels of feed restriction. Appl. Anim. Behav. Sci. 94, 255–271.
Mertens, C., 1991. Human–cat interactions in the home setting. Anthrozoös 4, 214–231.
Mertens, C., Turner, D.C., 1988. Experimental analysis of human–cat interactions during first encounters. Anthrozoös 2, 83–97.
Miklosi, A., Topal, J., Csányi, V., 2004. Comparative social cognition: what can dogs teach us? Anim. Behav. 67, 995–1004.
Panksepp, J., 1998. Affective Neuroscience. The Foundations of Human and Animal Emotions. Oxford University Press, NY, Oxford.
Panksepp, J., 2005. Affective consciousness: core emotional feelings in animals and humans. Conscious Cogn. 14, 30–80.
Phillips, C., Peck, D., 2007. The effects of personality of keepers and tigers (*Panthera tigris tigris*) on their behaviour in an interactive zoo exhibit. Appl. Anim. Behav. Sci. 106, 244–258.
Podberscek, A.L., Paul, E.S., Serpell, J.A., 1995. Companion Animals and Us. Exploring the Relationships Between People & Pets. Cambridge University Press, Cambridge.
Poesel, A., Kunc, H.P., Foerster, K., Kempenaers, B., 2006. Early birds are sexy: male age, dawn song and extrapair paternity in blue tits, *Cyanistes* (formerly *Parus*) *caeruleus*. Anim. Behav. 72, 531–538.
Prato-Previde, E., Fallani, G., Valsecchi, P., 2006. Gender differences in owners interacting with pet dogs: an observational study. Ethology 112, 63–73.
Ray, J.J., 1982. Love of animals and love of people. J. Pers. Soc. Psychol. 116, 299–300.
Rieger, G., Turner, D.C., 1999. How depressive moods affect the behavior of singly living persons toward their cats. Anthrozoös 12, 224–233.
Rost, D.H., Hartmann, A., 1994. Children and their pets. Anthrozoös 7, 242–254.
Sih, A., Bell, A.M., Johnson, J.C., Ziemba, R.E., 2004. Behavioral syndromes: an integrative overview. Q. Rev. Biol. 79, 241–277.
Suomi, S.J., 1991. Uptight and laid-back monkeys: individual differences in the response to social challenges. In: Brauth, S.E., Hall, W.S., Dooling, R.J. (Eds.), Plasticity of Development. MIT Press, Cambridge, MA, pp. 27–56.
Turner, D.C., 1991. The ethology of the human–cat relationship. Schweiz. Arch. Tierheilk. 133, 63–70.
Turner, D.C., 2000. The human–cat relationship. In: Turner, D.C., Bateson, P. (Eds.), The Domestic Cat: The Biology of its Behaviour, 2nd ed. Cambridge University Press, Cambridge, pp. 194–206.
Turner, D.C., Stammbach-Geering, K., 1990. Owner assessment and the ethology of human–cat relationships. In: Burger, I. (Ed.), Pets, Benefits and Practice. BVA British Veterinary Association Publications, London, pp. 25–30.
Wedl, M., Kotrschal, K., 2009. Social and individual components of animal contact in preschool children. Anthrozoös 22, 383–396.
Wedl, M., Schöberl, I., Bauer, B., Day, J., Möstl, E., Kotrschal, K., 2010. Relational factors affecting dog social attraction to human partners. Interact. Stud. 11 (3), 482–503.

Dyadic relationships and operational performance of male and female owners and their male dogs

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ABSTRACT

In the paper we investigate how owner personality, attitude and gender influence dog behavior, dyadic practical functionality and the level of dog salivary cortisol. In three meetings, 12 female and 10 male owners of male dogs answered questionnaires including the Neo-FFI human personality inventory. Their dyadic behavior was video-taped in a number of test situations, and saliva samples were collected. Owners who scored highly in neuroticism (Neo-FFI dimension one) viewed their dogs as social supporters and spent much time with them. Their dogs had low baseline cortisol levels, but such dyads were less successful in the operational task. Owners who scored highly in extroversion (Neo-FFI dimension two) appreciated shared activities with their dogs which had relatively high baseline cortisol values. Dogs that had female owners were less sociable–active (dog personality axis 1) than dogs that had male owners. Therefore, it appears that owner gender and personality influences dyadic interaction style, dog behavior and dyadic practical functionality.

1. Introduction

Across history and cultures, humans engage in social relationships with other animals (Podberscek et al., 2000; Robinson, 1995; Serpell, 1986; Turner and Bateson, 2005; Wilson, 1984). Dogs are certainly the oldest and the most widespread animal companions (Serpell, 1995; Vilà et al., 1997). However, the relationships that exist between owners and their dogs, and the function of such relationships, may vary widely between dyads (Hart, 1995). Some owners regard their dogs as a close friend, whereas others considered their dogs as buddies in joint activities and for still others, dogs are merely backyard animals (Topàl et al., 1997). Some owner–dog teams perform in a highly coordinated way in complex tasks, whereas in others the dog will not even reliably return when called (Serpell, 1996, 1995). O'Farrell (1995) found a correlation between owner personality and attitudes and dog behavior problems. In the present paper, we elaborate on this idea and propose that particularly owner personality, attitude towards the dog and owner and dog sex will affect interaction styles and hence, the practical performance of a human–dog dyad (Hennessy et al., 1998; Prato-Previde et al., 2006).

Notwithstanding the recent co-evolution debate (e.g. Schleidt and Shalter, 2003), owning a dog may significantly affect human lifestyles; vice versa, dog development, behavior and performance will be shaped by the human partner(s) (Hart, 1995; Kotrschal et al., 2004), who will generally provide the socioeconomic and cultural frame for the companionship (Scott and Fuller, 1965). In a way, human–animal relationships may be more basic than human–human dyads, because they mainly operate on the emotional level, with only little contributions by those cognitive and societal components that add much complexity to the relationships between humans.

Humans and animals may engage in truly social relationships, in the sense that these do not just somehow mimic social relationships between humans, but are based on common (convergent or even homologous) biological and psychological substrates (DeVries et al., 2003; Goodson, 2005; Panksepp, 1998; Podberscek and Gosling, 2000). These include the major bonding mechanisms (Curley and Keverne, 2005) and striking parallels even in the ontogeny and expression of personality traits (Groothuis and Carere, 2005; Koolhaas et al., 1999; Sih et al., 2004; Wilson et al., 1994). The social nature of the human–animal bond is evident in the development of mutual attachment (Voith, 1985) and other features, such as the temporal patterning of human–dog dyadic interactions (Kerepesi et al., 2005) and synchronized dyadic stress hormone modulation (Jones and Josephs, 2006). Furthermore, dogs are known to stimulate social interactions between humans and to benefit the social development of children (e.g. Kotrschal and Ortbauer, 2003).

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For all these reasons, it seems appropriate to study between-species dyadic relationships and human–animal companionship using a general evolutionary theory framework developed for within-species dyadic relationships. The central tenet of such a framework is that long-term dyadic relationships are maintained because both partners benefit (Kummer, 1978). Furthermore, because the interests of partners will not always be symmetrical or stable over time, dyadic partners need to dynamically negotiate their individual interests through cycles of conflict and reconciliation (Aureli and de Waal, 2000). Both partners have their specific physical and social needs, such as the animal companion's requirement to be cared for and adequately provisioned by its human partner. In return, owners expect appropriate behavior/conduct/service from the animal (whatever the owner's perspective on this may be; Hart, 1995; Serpell, 1996). Clearly, not only material factors are important in such dyadic negotiations, but above all, partners have social needs, for example, to receive social support from their companion (Friedmann et al., 2000; Scheiber et al., 2005).

The development of complex, mutually compatible, or even rewarding human–animal relationships will depend, at least in part, on the mode and intensity of attachment (Bowlby, 1999). For example, individuals with an insecure bonding style (human or dog) may seek more intense interactions than those capable of secure bonding. Such factors may also determine whether the dyadic partners will be a source of social support (accompanied by a positive modulation of cardiovascular and other stress parameters) and consequently, a source of general well-being and good health (Friedmann et al., 2000; Robinson, 1995; Wilson and Turner, 1998). Although these are proximate mechanisms in the sense of Tinbergen (1963), they may have ultimate consequences. Via a straight link to metabolism and energy efficiency, modulation of individual stress coping by a social partner will affect individual energy balance (McEwen and Wingfield, 2003) and therefore, may have consequences for evolutionary fitness. While it would be far-fetched to imply a direct evolutionary fitness relevance for human–animal companionship (i.e. more successful reproduction when with a companion animal), it is reasonable to assume that the evolutionary bio-psychological dispositions for long-term bonding with same-species individuals also provide the base for human–animal bonding and companionship.

With this evolutionary, socio-psychological framework in mind we propose that, in general, the needs of the owner will determine the style of companionship with a particular animal (McCune et al., 1995; Serpell, 1996, 1995). For example, the ability of human partners to form attachments, their personalities, and not least, owner sex (Prato-Previde et al., 2006), will affect interaction style with the animal and determine the animal's behavior within the dyad, but also within its wider social surrounding. It is well established that the social context modulates steroid hormones (DeVries et al., 2003; Mehta et al., 2008), and we expect that interaction style will affect dog cortisol levels. We therefore predict that owners scoring high on the neuroticism dimension (NEO-FFI-axis 1; McCrae and Costa, 2003) may be in particular need of social support and hence, will tend to regard their animal as being a close social partner. Such owners may asymmetrically seek contact, giving the dog an edge in the continuous dyadic negotiation, which is driven by the owners' demand for social attention. In such socially close dyads stress loads and hence, cortisol levels of dogs may be low, but performance in practical tasks may be sub-optimal (Topàl et al., 1997; Vas et al., 2005). In contrast, we predict that owners scoring high on the NEO-FFI dimensions extraversion and conscientiousness may regard their animals as partners for activities rather than as the focus of love. These owners may have attentive animals and engage in a practically functional dyadic relationship. Finally, we expect some differences in the relationship female and male owners have with their male dogs, for example because women tend to be more emphatic and socially interested than men (reviewed in Hart, 1995; Prato-Previde et al., 2006) and because dogs may be sensitive to owner sex. In essence, this is what we found.

2. Materials and methods

2.1. Subjects and recruitment

Between January and May 2007, 22 human–dog dyads consisting of intact male dogs and their 12 female and 10 male owners were recruited via ads in local newspapers and via personal contact with owners in dog training centers. Via telephone we checked that the following criteria were met: only one intact male dog in the household, adopted as a pup, body weight at least 10 kg, age 18 months to 6 years, living in the Vienna area. All breeds including mongrels were accepted.

2.2. Data collection

Human–dog dyads were observed in standard situations with full information and consent of the owners. Three meetings with each of these dyads were scheduled, a few days apart, the first one at the owner's home, the second and third in a test room at the University of Vienna. Meetings were supervised and data were collected by two investigators (MW and IS). During the first meeting, the focus was on the behavior of the dog and owner in their familiar home, and on recording the dog's response to the visiting strangers. This initial observation period was followed by an outdoor walk during which dog and owner were video-taped. During this first visit, the owner was asked to complete most of the questionnaires including questions regarding the bond. Owner–dog relationship, owner attitudes towards the dog and a NEO-FFI personality test.

The aim of the second and third meetings was measurement of both, owner and dog behavior and their interactions in a series of test situations. Saliva samples for cortisol analysis were taken from the owner and from the dog before, during and after all meetings, in 20 min intervals. In addition, owners sampled their own and their dog's saliva in the mornings and afternoons of non-test control days. Here, only relevant information on dog cortisol is given. Eight test situations were devised to investigate the operational relationship between the dog and its owner: (1) researchers visiting the dyad at home to observe communication between the owner, the dog and strangers during the first visit; (2) saliva sampling: dog and owner behavior during saliva sampling by the owner or by one of the experimenters; (3) dog training: teaching two simple tricks to the dog chosen by the owner out of a list of 12; (4) picture viewing: the dogs' response to its distracted owner who was asked to associate freely in writing to images on the walls of the experimental room, while the dog was unrestrained; (5) bridge: as a practical task, the owner was asked to lead the dog over a wire mesh bridge (4 m long, 1 m wide, 1 m high); (6) Vet-check: a physical examination of the dog by the experimenter similar to a basic examination by a veterinarian. (7) Threatening the dog: confrontation of the dog with a mildly threatening stranger (IS entering the room disguised in a black gown and staring at the dog) at the presence, and in a second run, in the absence of the owner. (8) A retention test of the two novel commands that have been trained previously at the second meeting.

All three meetings were video-taped. All observable behaviors of dog and owner and their interactions (187 behavior items, including dog personality; Table 1) were later coded from these tapes by MW and IS by aid of the Observer Video Pro 5.0 software. Mean (±S.D.) inter-observer agreement on all items was .87 ± .03.

Table 1
The 187 variables coded/rated by the observers (mainly BB and IS). 1–161: behavioral frequencies (F) or frequencies and durations (F, D) coded via the Observer software (Noldus) in the different test situations (Material and Methods). 162–170: Variables rated by the observers over the test situations on a 5-point Likert scale. 171–187: Dog personality items rated by the observers along a continuous scale.

No.	Behavioral variables coded
1	Dog approaches the owner F
2	Dog approaches the observer F
3	Dog leaves the owner F
4	Dog leaves the observer F
5	Dog leans or rubs towards the owner F, D
6	Dog leans or rubs towards the observer F, D
7	Dog nudges the owner F
8	Dog nudges the observer F
9	Dog pawing the owner F
10	Dog pawing observer F
11	Dog resists holding by owner F, D
12	Dog resists holding by observer F, D
13	Dog avoids being held by the owner F
14	Dog avoids being held by the observer F
15	Dog tilts head towards observer F
16	Dog sniffs the owner F, D
17	Dog sniffs the observer F, D
18	Dog jumps at the owner F
19	Dog jumps at the observer F
20	Dog licks the owner F, D
21	Dog licks the observer F, D
22	Dog orientates towards the owner F, D
23	Dog orientates towards the observer F, D
24	Dog averts head towards the owner F
25	Dog averts head towards the observer F
26	Dog eats treat F
27	Dog avoids being touched/stroked by owner F
28	Dog climbs owner F
29	Dog avoids being touched/stroked by observer F
30	Dog climbs observer F
31	Dog does not interact (stopcodon) F, D
32	Dog interaction unspecified, not visible F, D
33	Dog sitting F, D
34	Dog lies head up F, D
35	Dog lies head down F, D
36	Dog lies on its side F, D
37	Dog lies on its back F, D
38	Dog rolls F
39	Dog stands F, D
40	Dog walks F, D
41	Dog trots F, D
42	Dog runs F, D
43	Dog leaps F
44	Dog standing on ist back legs F, D
45	Dog stretching F
46	Dog shakes body F
47	Dog creeps F, D
48	Dog steps on bridge F, D
49	Dog stands on bridge F, D
50	Dog walks over bridge F, D
51	Dog trot-runs over bridge F, D
52	Dog jumps onto bridge F, D
53	Dog jumps off bridge F, D
54	Dog locomotion unspecified/unclear F, D
55	Dog locomotion unspecified/not visible F, D
56	Dog tail up, wagging F, D
57	Dog tail up, not wagging F, D
58	Dog tail horizontal, wagging F, D
59	Dog tail horizontal, not wagging F, D
60	Dog tail low, wagging F, D
61	Dog tail low, not wagging F, D
62	Dog tail flat, wagging F, D
63	Dog tail flat, not wagging F, D
64	Dog tail between legs, not wagging F, D
65	Dog tail unspecified/unclear F, D
66	Dog tail unspecified/not visible F, D
67	Dog sniffs object F, D
68	Dog licks lips F
69	Dog yawns F
70	Dog pants F, D
71	Dog no sniff/pant (stopcodon) F, D
72	Dog head unspecified/not visible F, D
73	Dog barks F, D
74	Dog whimpers F, D
75	Dog growls F, D
76	Dog howls F, D
77	Dog no vocal behavior F, D
78	Dog vocal behavior unspecified/unclear F, D
79	Dog vocal behavior unspecified/not visible F, D
80	Dog feeding unspecified/excluded F, D
81	Dog groom-lick-nibble F, D
82	Dog scratches F, D
83	Dog drinks water F, D
84	Dog no groom (stopcodon) F, D
85	Dog grooming unspecified/not visible F, D
86	Dog object plays alone F, D
87	Dog play with mouth F, D
88	Dog solicits person to play F, D
89	Dog play runs F, D
90	Dog object plays with owner F, D
91	Dog no play (stopcodon) F, D
92	Owner approaches the dog F
93	Owner leaves the dog F
94	Owner sits on furniture F, D
95	Owner sit on floor F, D
96	Owner stands F, D
97	Owner walks F, D
98	Owner trots F, D
99	Owner crouches F, D
100	Owner creeps F, D
101	Owner stoops F, D
102	Owner displacement behavior F
103	Owner locomotion unspecified/excluded F, D
104	Owner strokes dog F, D
105	Owner touches dog F, D
106	Owner hugs dog F, D
107	Owner nuzzle-kisses dog F
108	Owner commands dog with hand sign F
109	Owner gesturing F, D
110	Owner orientates towards dog F, D
111	Owner muzzle-holds dog F, D
112	Owner treats dog F
113	Owner averts head F
114	Owner brings dog in position F
115	Owner no interactive behavior (stopcodon) F, D
116	Owner interactive behavior unspecified/not visible F, D
117	Owner interactive behavior unspecified/excluded F, D
118	Owner holds dog at collar F, D
119	Owner holds dog at leash F, D
120	Owner holds dog's body F, D
121	Owner picks dog up F, D
122	Owner no holding behavior (stopcodon) F, D
123	Owner holding behavior unspecified/not visible F, D
124	Owner holding behavior unspecified/excluded F, D
125	Owner calls dog F
126	Owner praises dog F
127	Owner talks to dog F, D
128	Owner issues verbal command F
129	Owner no talk (stopcodon) F, D
130	Owner vocal behavior unspecified/unclear F, D
131	Owner vocal behavior unspecified/excluded F, D
132	Owner feeding behavior unspecified/excluded F, D
133	Owner engaged in bodily play F, D
134	Owner engaged in object play F, D
135	Owner solicits dog to play F, D
136	Owner no play behavior (stopcodon) F, D
137	Owner play behavior unspecified/excluded F, D
138	Observer approaches dog F
139	Observer leaves dog F
140	Observer measuring dog body F, D
141	Observer opening dog mouth F, D
142	Observer looks dog into eyes F, D
143	Observer looks dog into ears F, D
144	Observer touched dog F, D
145	Observer strokes dog F
146	Observer walk and threatens dog F, D
147	Observer stand and threatens dog F, D
148	Observer reconciles with dog F, D
149	Observer guide no interaction (stopcodon) F, D
150	Observer guide interaction unspecified/not visible F, D
151	Observer guide interaction unspecified/excluded F, D

Table 1 (*Continued*)

No.	Behavioral variables coded
152	Observer begin test F
153	Observer ends test/owner stops test F
154	End test by time out F
155	Dog next to owner F, D
156	Dog close do owner F, D
157	Dog intermediate distance to owner F, D
158	Dog distant to owner F, D
159	Closeness to owner unspecified/not visible F, D
160	Closeness to owner unspecified/excluded F, D
161	Cut scene F
Observer-rated variables (5-point scale)	
Test situations	
162	Approach owner (1: never. 5: always)
163	Interaction style qualitative (1: harsh. 5: soft)
164	Interaction style quantitative (1: hardly. 5: intensely)
165	Reaction of dog to threat (1: ignoring. 5: intense)
166	Involvement of owner (1: not. 5: fully attentive to dog)
167	Effort of owner for bridge
168	Achievement for bridge (1: not mastered. 5: perfect)
169	Handling/approach observer (1: avoiding. 5: trusting)
170	Duration (e.g. bridge task) in s (measured)
Dog personality (continuous scale)	
171	Sociable–distant
172	Active–inactive
173	Cheerful–not cheerful
174	Interested–uninterested
175	Playful–not playful
176	Calm–hectic
177	Wild–gentle
178	Self-confident–uncertain
179	Anxious–non-anxious
180	Nervous–non-nervous
181	Dependable–unreliable
182	Calm–vocal
183	Aggressive–non-aggressive
184	Friendly–unfriendly, not relating to people
185	Balanced–unbalanced
186	Clever–stupid-stubborn
187	Attentive–inattentive

To characterize the quality of attachment and of the dyadic relationship, a questionnaire with 34 items (modified, after Topàl et al., 1997; Johannson, 1999) was answered by the owners. It consisted of six groups of questions: owner data, owner lifestyle, relationship owner–dog, dog character/temperament, upbringing, training of the dog, and dog-related attitudes of the owner. This questionnaire was answered by the 22 owners participating in full in our study and by 18 additional owners of intact male dogs, who also took personality tests but were not tested as a dyad, resulting in a total of 40 respondents. A PCA ($n = 40$, KMO = 77) performed with the 15 attachment items revealed four axes: (1) social support, (2) bond strength, (3) bond quality, and (4) cognitive component (Table 2). A PCA ($n = 40$, KMO = .72) performed with the 14 owner–dog relationship items also revealed four axes: (1) time spent together, (2) responsibility, (3) pay attention, and (4) shared activities (Table 3).

2.3. Owner personality

We used the NEO-Five Factor Inventory (Costa and McCrae, 1992; McCrae and Costa, 2003) for exploring owner personality dimensions, because this is a well established and evaluated empirical approach, revealing major and relevant human personality dimensions. This 60-item instrument measures normal adult personality in five dimensions, in the following ranked according to decreasing proportions of inter-individual variability explained: neuroticism, extroversion, openness, agreeableness, and conscientiousness (Table 4). The following descriptions follow Borkenau and Ostendorf (2008).

The neuroticism scale depicts individual differences in emotional lability/stability among healthy human subjects. Individuals high on this scale frequently experience negative emotions, are often overwhelmed by them and tend to have unrealistic ideas. In contrast, emotionally stable persons are calm and balanced even in stressful situations.

Persons high in extraversion like to be in company of others, they are self-secure, active, verbally expressive, energetic, cheerful and optimistic. Introverts (i.e. those low on the extraversion scale) are controlled, rather than unfriendly, tend to be independent and are balanced rather than phlegmatic. They enjoy being on their own.

The openness scale measures how interested individuals are in novel experiences, how intensely they seek and deal with novelty. Open persons are interested in a wide range of personal and public matters, are intellectual and creative, are interested in the arts, are ready to discuss existing norms and ethical, political or moral values and tend to think and act unconventionally. Persons with a low score in openness tend to be conventional and conservative.

Agreeableness, similar to extraversion primarily describes intrapersonal behavior. Individuals scoring high in agreeableness are altruistic, warm, understanding and emphatic and are convinced that others will respond the same way. They tend to be trustful, cooperative and forgiving and appreciate harmony in their relationships. Persons low on this dimension describe themselves as antagonistic, egocentric and distrustful towards others. They are competitive rather than cooperative.

Conscientious persons control their impulses, wishes and needs. Whereas individuals low in neuroticism are in control of their emo-

Table 2
Factor loadings of the four axes resulting from a PCA with the 15 items in the owner questionnaire relating to owner–dog attachment ($n = 40$, KMO = .77, Bartlett-Test: $chi^2 = 400.67$, d.f. = 105, $p < .01$; Varimax-rotation. Kaiser-normalization; 75.3% of the variability in the data set explained by the four axes). All loadings >.5 shown in bold.

Degree of owner agreement–disagreement to the following questions	F1: Social support	F2: Bond strength	F3: Bond quality	F4: Cognitive component
Only through being together with my dog I feel good	**.87**	.32	.13	0.02
My dogs helps me to keep in balance	**.81**	.27	.18	−.13
I improve by talking to my dog when I am sad. Angry or in discomfort	**.76**	.05	.02	.39
I like to care for my dog-the daily routines do not bother me	**.69**	.09	.28	.49
It feels good to talk to my dog	**.66**	.12	.41	.49
Would be very sad if I would loose my dog or if the dog would be injured or sick	.16	**.88**	.05	.27
I feel responsible for my dog and I like that	.24	**.85**	.13	.18
My dog means a lot to me	.17	**.73**	.52	.13
My dog is a good pal or friend	.28	**.59**	**.56**	.18
Do you consider your dog just an animal—full social partner/family animals	.22	.20	**.80**	−.19
How frequently do you talk to your dog?	.39	−.03	**.70**	.32
My dog loves me unconditionally	−.07	.25	**.69**	.38
My dog knows how I feel	−.01	.34	−.07	**.74**
I belief my dog understands me	.16	.08	.09	**.71**
I am missing my dog when we cannot be together	.19	.18	.25	**.61**

Table 3
Factor loadings of the axes resulting from a PCA with the 14 items of the owner questionnaire relating to owner–dog operational relationship ($n = 40$, KMO = .723, Bartlett-Test: $chi^2 = 307.37$, d.f. = 91, $p < .001$; Varimax-rotation. Kaiser-normalization; 70.3% of the variability in the data set explained by the four axes). All loadings >.5 shown in bold.

Degree of owner agreement–disagreement to the following questions	F1: Time together	F2: Responsibility	F3: Pay attention	F4: Shared activity
I appreciate spending much time with my dog	**.93**	.10	.16	.06
In fact I spend much time with my dog	**.83**	.27	.18	.15
I love to cuddle with my dog	**.82**	.01	.09	−.18
I walk/train my dog for extended periods of time several times per week	**.71**	.23	.01	.18
Sometimes my dog makes me laugh	**.64**	.47	.18	−.01
I make sure that my dog always has access to fresh water	**.51**	**.50**	.23	−.41
Every day it is my exclusive responsibility to feed my dog	.13	**.90**	.18	−.16
Even at the presence of other family members my dog turns to me when wanting out	.16	**.79**	−.23	.05
Of all family members. It is usually me who walks the dog	.25	**.74**	.23	.21
My dog often demands my attention	.14	.22	**.77**	−.10
Sometimes I spend time with the dog even if I should be busy with other things	.17	−.19	**.70**	.02
How often per day you play with your dog (never–very often)	.01	.11	**.53**	.13
How often do you take your dogs to work, excursions, holidays, shopping, etc.	.47	.21	.12	**.76**
I like to simply hang around with my dog and relax	.57	.24	−.10	−**.61**

tions, conscientiousness rather describes the ability of planning, organizing and performing in tasks. Persons high on the conscientiousness scale describe themselves as goal-orientated, ambitious, diligent, strong-willed, systematic, enduring, tidy and precise, but may also be compulsive.

Here we simply assume that much of the intrapersonal aspects of the five personality dimension are also relevant in the interactions of humans with their companion animals. However, it remains to be investigated whether persons approach their companion animals in a similar way as they would approach other persons.

The NEO-FFI is highly practicable and fairly compatible with biological personality theory (Koolhaas et al., 1999; Sih et al., 2004). It is known that the NEO-FFI personality dimensions are neither fully independent of each other, nor of gender (Borkenau and Ostendorf, 2008). For example, in our data set, neuroticism was negatively correlated with extroversion (Pearsons, $r = -0.57$, $n = 40$, $p < .01$), openness ($r = -.39$, $n = 40$, $p = .01$), agreeableness ($r = -.31$, $n = 40$, $p = .05$) and conscientiousness ($r = -.49$, $n = 40$, $p < .01$).

2.4. Dog personality

Dogs are known to develop consistent personality profiles (Svartberg et al., 2005) and rating of animal personalities by human observers has been shown to reveal reliable and consistent results (Gosling and John, 1999; Gosling, 2001). Therefore, dog personality was scored after completion of video analysis by the two observers (BB and IS) on a scale featuring 17 items (Table 1, items 171–187) (modified after Feaver et al., 1986) by ticking off along a line between opposing attributes. The two observers (BB and IS) rated all dogs independently from each other after observing the dog's behavior during selected situations from the video tapes (at the owner's home: experimenters entering, owner feeding the dog, owner playing with the dog; experimental room: all test situations described above, owner training the dog two new commands and presenting them to the experimenter). 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 PCA was performed on these 17 items (Table 5). This resulted in four axes: (1) sociable–active; (2) anxious–nervous; (3) vocal–aggressive; and (4) clever–attentive.

2.5. Salivary hormones

Throughout all three meetings saliva samples of the dog were taken every 20 min for measuring cortisol and androgens. In addition, saliva samples were collected during 2 days between the first and the third meeting to reveal baseline hormone levels. In dogs, these hormones hardly show episodic peaks over the day (Koyama et al., 2003). Saliva samples were taken from the dog by the owner by putting a cotton pad on a stick into the dog's cheek pouch for 30 s. Samples were stored frozen at −80 °C until analysis. Enzyme immunoassays (EIA) were used to analyze the cortisol levels from the saliva samples (Palme and Möstl, 1997). This non-invasive analysis of steroids is a long-standing routine procedure in our lab applied in much of recent research on social complexity (summarized by Hirschenhauser et al., 2005).

Data were analyzed with SPSS, employing principal component analysis (PCA) for reduction of dimensions, as appropriate. Because data were not normally distributed in most of the parameters considered, we resorted to the non-parametric Spearmans rank correlation and to the non-parametric Mann–Whitney *U*-test for comparing female owners with male owners, or for comparing owners high or low on a particular personality dimension (we split the range of NEO-FFI personality scores at its median). For dependent comparisons the Wilcoxon test was employed. We did not consider alpha correction for multiple comparisons, because this generally increases the risk of type-II error at a comparatively low potential of decreasing type-I error (Nakagawa, 2004). All significances are given two-tailed.

Table 4
Means ± standard deviations and ranges of Neo-FFI personality scores of a norm population from Austria, Germany and Switzerland (Borkenau and Ostendorf, 2008) and of the dog owners included in this study.

Populations	Neuroticism	Extraversion	Openness	Agreeableness	Conscientiousness
Population norm ($n = 11724$), range	21.95 ± 8.36, 0–48	28.38 ± 6.7, 0–48	32.10 ± 6.48, 0–48	30.23 ± 5.69, 0–48	30.87 ± 7.13, 0–48
Dog owners ($n = 22$); mean ± standard deviation, range	15.73 ± 9.21, 1–36	31.09 ± 6.98, 16–41	33.47 ± 4.85, 26–44	31.32 ± 6.95, 17–43	34.15 ± 6.33, 26–44
Female norm ($n = 7505$); mean ± standard deviation, range	23.25 ± 8.34, 0–48	28.76 ± 6.63, 0–48	32.43 ± 6.29, 0–48	30.97 ± 5.48, 0–48	31.10 ± 7.01, 0–48
Female dog owners ($n = 12$); mean ± standard deviation, range	16.92 ± 7.76, 1–31	28.92 ± 4.06, 22–35	32.95 ± 4.61, 38–42	31.34 ± 7.69, 17–43	34.65 ± 5.66, 27–44
Male norm; mean ± standard deviation, range	19.64 ± 7.86, 0–48	27.71 ± 6.77, 0–48	31.50 ± 6.75, 0–48	28.93 ± 5.81, 0–48	30.47 ± 7.30, 0–48
Male dog owners ($n = 10$); mean ± standard deviation, range	14.30 ± 10.97, 1–36	33.70 ± 8.92, 16–41	34.10 ± 5.30, 26–44	31.30 ± 6.36, 24–41	33.56 ± 7.31, 26–42

Table 5
Factor loadings of a PCA based on the 17 dog personality items obtained by observer scoring by BB and IS (Table 1; $n = 22$, KMO = .67, Bartlett-Test: $chi^2 = 374.16$, d.f. = 136, $p < .01$; Varimax-rotation. Kaiser-normalization; 85.5% of the variability in the data set explained by the four axes). All loadings >.5 shown in bold.

Dog personality items	F1: Sociable–active	F2: Anxious–nervous	F3: Vocal–aggressive	F4: Clever–attentive
Sociable	**.88**	.09	−.30	−.05
Active	**.88**	.37	.03	.07
Cheerful	**.86**	.27	.37	.10
Interested	**.85**	.19	.24	−.01
Playful	**.85**	.14	−.26	.02
Calm	**−.77**	−.49	−.14	−.02
Wild–gentle	**.60**	.40	.41	−.14
Self-confident	−.25	**−.92**	−.01	−.04
Anxious	.09	**.91**	.15	.14
Nervous	.38	**.79**	.23	−.32
Dependable	−.49	**−.73**	−.02	.31
Calm–vocal	.06	.04	**.86**	−.29
Aggressive	−.13	.23	**.81**	.14
Friendly	.55	.01	**−.76**	−.05
Balanced	.48	.53	**.53**	−.23
Clever	−.04	−.18	−.13	**.92**
Attentive	.46	.49	.09	**.61**

3. Results

3.1. Owner personalities

Those 22 owners participating in our tests with their dogs scored lower in neuroticism, but higher in extraversion and conscientiousness than the means of NEO-FFI scores of a norm population from Austria, Germany and Switzerland (Table 4). Except for the highest scores, respondents covered much of the neuroticism scale, but only occupied the upper two third of the ranges of the other four personality dimensions (Table 4). Whereas female owners showed a somewhat higher mean in neuroticism score than male owners (n.s.), the latter had higher mean score in extraversion ($t = -2.08$, $p = 0.04$) and conscientiousness (n.s.).

The higher the owners scored in neuroticism (Neo-FFI dimension one), the greater their attachment to the dog, i.e., the more they considered their dog a social supporter (attachment PCA-axis one, Table 2; Spearman rank correlation: $r_s = .37$, $n = 39$, $p = .02$). This was reflected by both dog and owner behavior, because the more owners considered their dogs as social supporters, the less time the dog spent far distant from the owner in the Picture viewing test ($r_s = -.46$, $n = 22$, $p = .03$), the less displacement behavior (scratching, yawning; Table 1, item 102) indicative of stress owners showed in this test situation ($r_s = -.54$, $n = 22$, $p = .01$) and the less aggressive ($r_s = -.43$, $n = 39$, $p = .05$) and the more friendly ($r_s = .49$, $n = 39$, $p = .02$) they rated their dogs.

However, close social relationships of owners with their dogs were linked with a low dyadic functionality: the more owners considered their dog as a social supporter, the less they engaged in shared activities with the dog (relationship PCA-axis four, Table 3; $r_s = -.33$, $n = 39$, $p = .04$), the lower their dyadic achievement was rated in the bridge task ($r_s = -.52$, $n = 22$, $p = .01$) and the longer it took the dyad to master this task ($r_s = -.57$, $n = 22$, $p = .01$). This relates to a rather tactile-friendly interaction style, because the more owners regarded their dogs as social supporters, the more often ($r_s = -.54$, $n = 22$, $p = .01$) and the longer ($r_s = -.48$, $n = 22$, $p = .03$) the owner touched and held the dog in the bridge situation and the more friendly the owner was rated by the observers in interaction with the dog in the threat situation ($r_s = .47$, $n = 19$, $p = .05$). The dogs in such socially close dyads behaved confidently and calmly. For example, the more owners considered their dog as a social supporters, the more often these dogs approached the examining observer in the Vet-check situation ($r_s = .44$, $n = 22$, $p = .04$) and the longer they lied head down in this situation ($r_s = .46$, $n = 22$, $p = .03$). This was supported by the fact that the dogs salivary cortisol in control situations was negatively correlated ($r_s = -.44$, $n = 22$, $p = .04$), the dogs salivary testosterone was positively correlated ($r_s = .65$, $n = 22$, $p = .01$) with the degree owners considered them as social supporters.

Cortisol modulation in the dog was generally related to owner gender and to a gender–personality interaction. For example, the more female owners paid attention to their dogs (questionnaire-based PCA-axis three for human–dog relationship) and the higher female owners were in neuroticism, the lower their dogs' morning cortisol values on control days (attention: Spearmans: $r_s = -.82$, $n = 12$, $p < .01$; neuroticism: $r_s = -.76$, $n = 12$, $p < .01$) and the less their dogs' cortisol increase after the threat situation (attention: $r_s = -.66$, $n = 11$, $p = .03$; neuroticism: $r_s = -.68$, $n = 19$, $p < .01$).

Male dogs behaved differently towards their social surrounding depending on whether they were with female or male owners: dogs of male owners were more sociable–active (towards other humans; dog personality axis one, Table 3) than those of female owners (Mann–Whitney $U = 27$, $Z = -2.18$, $p = .03$; Fig. 1). Also, following the Threat challenge, the dogs of male owners were higher in salivary cortisol than the dogs of female owners (Mann–Whitney

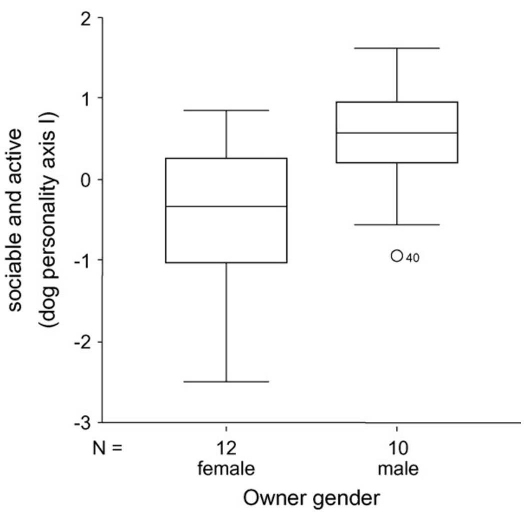

Fig. 1. Difference between factor scores of dog personality axis 1 (Table 3) between the male dogs of female and male owners (Mann–Whitney $U = 27$, $Z = -2.176$, $p = 0.03$).

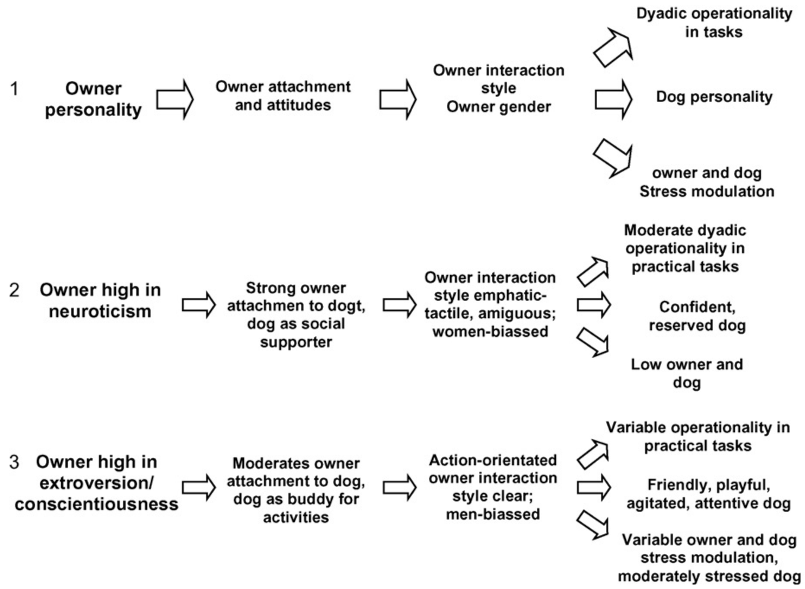

Fig. 2. Proposed contingency chain from owner personality to dyadic operationality, dog personality and owner–dog stress modulation. (1) Generalized working model of the owner–dog dyadic bio-psychological collusion. (2) Model for owners high in neuroticism as based on our present data. (3) Model for extravert/agreeable/conscientious owners as based on our present data.

$U = 17$, $Z = -2.47$, $p = .01$) Only the dogs of male owners showed a significant cortisol increase in response to the threat challenge (Mann–Whitney $U = 18$, $Z = -1.99$, $p = .05$).

3.2. Owner extroversion, agreeableness and conscientiousness

The higher owners were in extroversion, the less they tended to consider their dogs as social supporters (attachment scale, PCA-axis one; Spearmans: $r_s = -.27$, $n = 39$, $p = .09$) and the more these owners appreciated shared activities with their dogs (relationship scale, PCA-axis four; $r_s = .35$, $n = 39$, $p = .03$). Still, owner extroversion did not scale with achievement in the bridge task ($r_s = .34$, $n = 22$, n.s.), but agreeableness and conscientiousness at least produced such tendencies (FFI-axes four and five; for both dimensions: $r_s = .38$, $n = 22$, $p = .08$). The more conscientious the owner, the shorter the dog barked and growled during the mild threat situation with the owner present (Spearmans: barking: $r_s = -.47$, $n = 22$, $p = .03$; growling: $r_s = -.47$, $p = .03$). In general, the dogs growled for longer periods of time with owner present in the threat situation than with owner absent (Wilcoxons: $n = 22$, $Z = -2.5$, $p = .01$).

An analysis of dyadic behavior in the bridge test showed that the dogs of owners high in extroversion also differed from those low in that dimension by panting and trotting more (Mann–Whitney U: panting: $Z = -2.19$, $n = 22$, $p = .03$; trotting: $Z = -2.32$, $n = 22$, $p = .02$) which may be regarded as behavioral indication of stress in the dog. However, this was not confirmed by the salivary cortisol related to this task. Interestingly, the more a male owner shared activities with his dog (questionnaire-based PCA-axis four for human–dog relationship), the greater the owner's cortisol increase after the Threat challenge (Spearmans: $r_s = .92$, $n = 10$, $p < .01$). No significant differences were found between female and male owners with respect to dyadic achievement in the bridge task, although women tended to consider their dogs more as social supporters (attachment PCA-axis one, Table 2; Mann–Whitney U: $Z = -1.94$, $p = .05$) and meaningful companions (attachment PCA-axis two; Mann–Whitney U: $Z = -1.86$, $p = .06$) than men. Male owners, in contrast, like their dogs more than women for the activities they share with their dogs (relationship PCA-axis four, Table 3; Mann–Whitney U: $Z = -2.74$, $p = .01$).

4. Discussion

We found the predicted relationships between owner personality, dyadic relationship and functionality (Fig. 2), although our sample size necessitates cautious interpretation. Neuroticism and extroversion (NEO-FFI dimensions one and two) were particularly important. Owners higher in neuroticism were more closely attached and paid more attention to their dogs, which in turn, were confident-friendly, but somewhat distant to other humans when in company of a female owner. These dogs also showed low basal cortisol and hardly increased their stress hormones in response to mild challenges. Seemingly, owners scoring high in neuroticism not only considered their dogs as social supporters, but in turn, themselves seemed to be effective social supporters of their own dogs (defined as the stress-dampening effect of a social ally; Scheiber et al., 2005; DeVries et al., 2003). However, such dyads were neither greatly engaged in shared activities nor were they high achievers in a practical task. This was apparently mediated by owner interaction style.

In contrast, owners scoring high in extroversion, considered their dog mainly as a companion for shared activities, but there was no clear relationship with dyadic achievements or stress levels on in the dog. On average, women score higher in neuroticism in norm populations, whereas men are higher in extraversion (Borkenau and Ostendorf, 2008). In our limited sample, men were indeed, significantly higher in extraversion, but there was no significant difference between genders in neuroticism. We expect that with a larger sample one would indeed, find a female bias with respect to neuroticism-related attachment and a male bias towards extraverts who mainly appreciate their dogs as a partner in shared activities. Because much of the neuroticism scale is covered by our respondents (Table 4), our results with respect to this dimension may be more representative than results regarding the other four personality dimensions, where our respondents only covered parts of the ranges.

Particularly striking was our result that the male dogs of women owners were less sociable–active (dog personality axis 1; Fig. 1) than the male dogs in the company of men. Cautiously interpreted, this may mean that a more relaxed interaction style of women with their male dogs combined with the evolutionary disposition of dogs to be sex-sensitive in their social interactions with human companions (Prato-Previde et al., 2006; Zimen, 1978) prompts these dogs to assume a different social role when associated with a woman than with a man. In the wolf ancestors of dogs, positions in the hierarchy are mainly contested within the sexes and alphas tend to be socially distant and tense (Creel, 2005). There may still be social dispositions of this kind in dogs (Zimen, 1972), which they extend to their human companions. In interaction with a self-confident male owner, a male dog will assume the beta-position, but it may adopt the social alpha role in at least some contexts when with a female owner. Because of the separate female and male dominance ranks in packs, this will hardly produce a dominance conflict in women–male dog dyads, but may well be a source of friction in men–male dog dyads. With a few exceptions (Prato-Previde et al., 2006, present data), such gender aspects of human–animal companionship have not been investigated.

The interpretation of the present dog cortisol results with respect to animal welfare remains unclear. Long-term dyadic relationships undergo regular cycles of conflict and reconciliation (Aureli and de Waal, 2000); in addition, social interactions are always among the most potent stressors (McEwen and Wingfield, 2003; Von Holst, 1988). Hence, low glucocorticoid levels in the dog may also indicate a low modulation of emotionality by an over-protective owner. The interpretation of cortisol results always needs the behavioral background. In the present sample the impression was that persons needy of social support provided a particularly interactive social environment for their dogs. These partnerships may indeed be considered social symbioses, mutually satisfying the social needs of partners. In our sample, the basic dog cortisol levels and their modulation in the experimental situations seemed to be moderate, although we lack information on potential maxima (and minima), which could have been obtained by severe behavioral stress or by ACTH injection. For ethical reasons, such experiments have not been considered.

Our findings may also have practical implications. In contemporary dog training, the emphasis tends to be on methodology (i.e. how to handle and train the dog, for example, positive reinforcement, clicker training, etc.) but little on owner personality and the dyadic functionality which is a consequence thereof. Our pilot data indicate that owners higher in neuroticism may need a different approach and advice in training their dogs than owners higher in extroversion; furthermore, owner gender should be a matter of consideration in dyadic training. Hence, a purely method-centered approach in dog/team training does not do justice to the complex social nature of human–dog companionship, the more so as dogs also may share complex psychological traits with their owners, including inequity avoidance (Range et al., 2009).

Our results are preliminary and should rather be regarded as working hypotheses, not the least because of a relatively low sample size. Still, the proposed contingencies of dog behavior and dyadic performance with owner psychology and attitudes were supported. We found that owner psychology affects dog behavioral expression, dyadic functioning and the stress loads of the animal companion via interaction style. This suggests that human–animal dyads may show structural elements characteristic for higher vertebrate dyads in general. Hence, human–animal dyads, in addition to being interesting in their own right, may have a considerable potential as research models towards the basics of human dyadic relationships.

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References

Aureli, F., de Waal, F.B.N., 2000. Natural Conflict Resolution. University of California Press, Berkley, 409 pp.

Borkenau, P., Ostendorf, F., 2008. NEO-FFI. NEO-Fünf-Faktoren-Inventar nach Costa und McCrae. 2. neu normierte und vollständig überarbeitete Auflage. Manual. Hogrefe, Göttingen, 112 pp.

Bowlby, J., 1999. Attachment and Loss. Basic Books, New York, 428 pp. (reprint from 1974).

Costa, P.T., McCrae, R.R., 1992. Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional Manual: Psychological Assessment Resources, Odessa, Florida.

Creel, S., 2005. Dominance, aggression and glucocorticoid levels in social carnivores. J. Mammal. 86, 255–264.

Curley, J.P., Keverne, E.B., 2005. Genes, brains and mammalian social bonds. TREE 20, 561–567.

DeVries, C.A., Glasper, E.R., Detillion, C.E., 2003. Social modulation of stress responses. Physiol. Behav. 79, 399–407.

Feaver, J., Mendl, M., Bateson, P., 1986. A method for rating the individual distinctiveness of domestic cats. Anim. Behav. 34, 1016–1025.

Friedmann, E., Thomas, S.A., Eddy, T.J., 2000. Companion animals and human health: physical and cardiovascular influences. In: Podberscek, A.L., Paul, E., Serpell, J.A. (Eds.), Companion Animals and Us: Exploring the Relationships Between People and Pets. Cambridge University Press, Cambridge, UK, pp. 125–142.

Goodson, J.L., 2005. The vertebrate social behaviour network: evolutionary themes and variations. Horm. Behav. 48, 11–22.

Gosling, S.D., 2001. From mice to men: what can we learn about personality from animal research? Psychol. Bull. 127, 45–86.

Gosling, S.D., John, O.P., 1999. Personality dimensions in nonhuman animals: a cross-species review. Curr. Dir. Psychol. Sci. 8, 75.

Groothuis, T.G.G., Carere, C., 2005. Avian personalities: characterization and epigenesis. Neurosci. Biobehav. Rev. 29, 137–150.

Hart, L., 1995. Dogs as human companions: a review of the relationship. In: Serpell, J. (Ed.), The Domesticated Dog: Its Evolution, Behaviour and Interaction with People. Cambridge University Press, Cambridge, UK, pp. 161–178.

Hennessy, M.B., Williams, M.T., Miller, D.D., Douglas, C.W., Voith, V.L., 1998. Influence of male and female patters on plasma cortisol and behaviour: can human interaction reduce the stress of dogs in a public animal shelter? Appl. Anim. Behav. Sci. 61, 63–77.

Hirschenhauser, K., Kotrschal, K., Möstl, E., 2005. A synthesis of measuring steroid metabolites in goose feces. Ann. NY Acad. Sci. 1046, 138–153.

Johannson, E.E., 1999. Human–animal bonding: an investigation of attributes. PhD Thesis. University of Alberta.

Jones, A.C., Josephs, R.A., 2006. Interspecies hormonal interactions between man and the domestic dog (*Canis familiaris*). Horm. Behav. 50, 393–400.

Kerepesi, A., Jonsson, G.K., Miklòsi, À., Topàl, J., Csànyi, V., Magnusson, M.S., 2005. Detection of temporal patterns in dog–human interaction. Behav. Proc. 70, 69–79.

Koolhaas, J.M., Korte, S.M., Boer, S.F., Van Der Vegt, B.J., Van Reenen, C.G., Hopster, H., De Jong, I.C., Ruis, M.A.W., Blokhuis, H.J., 1999. Coping styles in animals: current status in behavior and stress-physiology. Neurosci. Biobehav. Rev. 23, 925–935.

Kotrschal, K., Bromundt, V., Föger, B., 2004. Faktor Hund. Eine sozio-ökonomische Bestandsaufnahme der Hundehaltung in Österreich. Czernin-Verlag, Wien, 96 pp.

Kotrschal, K., Ortbauer, B., 2003. Behavioural effects of the presence of a dog in the classroom. Anthrozoös 16, 147–159.

Koyama, T., Omata, Y., Saito, A., 2003. Changes in salivary cortisol concentrations during a 24-hour period in dogs. Horm. Metabol. Res. 35, 355–357.

Kummer, H., 1978. On the value of social relationships to nonhuman primates: a heuristic scheme. Soc. Sci. Inform. 17, 687–705.

McCrae, R.R., Costa, P.T., 2003. Personality in Adulthood, second edition. Guilford Press, NY, 268 pp.

McCune, S., McPherson, J.A., Bradshaw, J.W.S., 1995. Avoiding problems. In: Robinson, I. (Ed.), The Waltham Book of Human–Animal Interactions. Pergamon Press, Kidlington, pp. 71–86.

McEwen, B.S., Wingfield, J.C., 2003. The concept of allostasis in biology and biomedicine. Horm. Behav. 43, 2–15.

Mehta, P.H., Jones, A.C., Josephs, R.A., 2008. The social endocrinology of dominance: basal testosterone predicts cortisol changes and behaviour following victory and defeat. J. Person. Soc. Psychol. 94, 1078–1093.

Nakagawa, S., 2004. A farewell to Bonferroni: the problems of low statistical power and publication bias. Behav. Ecol. 15, 1044–1045.
O'Farrell, V., 1995. Effects of owner personality and attitudes on dog behaviour. In: Serpell, J. (Ed.), The Domesticated Dog its Evolution Behaviour and Interaction with People. Cambridge University Press, Cambridge, UK, pp. 151–158.
Palme, R., Möstl, E., 1997. Measurement of cortisol metabolites in faeces of sheep as a parameter of cortisol concentration in blood. Z. Säugetierkunde – Mamm. Biol. 62 (Suppl. II), 192–197.
Panksepp, J., 1998. Affective Neuroscience. The Foundations of Human and Animal Emotion. Oxford University Press, NY, 466 pp.
Podberscek, A.L., Gosling, S.D., 2000. Personality research on pets and their owners: conceptual issues and review. In: Podberscek, A.L., Paul, E., Serpell, J.A. (Eds.), Companion Animals and Us: Exploring the Relationships Between People and Pets. Cambridge University Press, Cambridge, UK, pp. 143–167.
Podberscek, A.L., Paul, E., Serpell, J.A. (Eds.), 2000. Companion Animals and Us: Exploring the Relationships Between People and Pets. Cambridge University Press, Cambridge, UK, 335 pp.
Prato-Previde, E., Fallani, G., Valsecchi, P., 2006. Gender differences in owners interacting with pet dogs: an observational study. Ethology 112, 63–73.
Range, F., Horn, L., Viranyi, Z., Huber, L., 2009. The absence of reward induces inequity aversion in dogs. Proc. Natl. Acad. Sci. USA 106, 340–345.
Robinson, I., 1995. The Waltham Book of Human–Animal Interaction: Benefits and Responsibilities of Pet Ownership. Pergamon Press, Kidlington, 148 pp.
Scheiber, I.B.R., Weiss, B.M., Frigerio, D., Kotrschal, K., 2005. Active and passive social support in families of Greylag geese (*Anser anser*). Behaviour 142, 1535–1557.
Schleidt, W.M., Shalter, M.D., 2003. Co-evolution of humans and canids. Evol. Cogn. 9, 57–71.
Scott, J.P., Fuller, J.L., 1965. Genetics and the Social Behavior of the Dog. Univ. Chicago Press, Chicago, 468 pp.
Serpell, J.A., 1986. In the Company of Animals. Basil Blackwell, Oxford, 283 pp.
Serpell, J.A. (Ed.), 1995. The Domestic Dog. Cambridge University Press, Cambridge, 268 pp.
Serpell, J.A., 1996. Evidence for association between pet behavior and owner attachment levels. Appl. Anim. Behav. Sci. 47, 49–60.
Sih, A., Bell, A.M., Johnson, J.C., Ziemba, R.E., 2004. Behavioral syndromes: an integrative overview. Quart. Rev. Biol. 79, 241–277.
Svartberg, K., Tapper, I., Temrin, H., Radesäter, T., Thorman, S., 2005. Consistency of personality traits in dogs. Anim. Behav. 69, 283–291.
Tinbergen, N., 1963. On aims and methods of ethology. Zeitschrift für Tierpsychologie 20, 410–433.
Topàl, J., Miklòsi, À., Csànyi, V., 1997. Dog–human relationship affects problem solving behavior in the dog. Anthrozoös 10, 214–223.
Turner, D.C., Bateson, P. (Eds.), 2005. The Domestic Cat, 2nd ed. Cambridge Univ. Press, Cambridge, 244 pp.
Vas, J., Topál, J., Gácsi, M., Miklósi, Á., Csányi, V., 2005. A friend or an enemy? Dogs' reaction to an unfamiliar person showing behavioural cues of threat and friendliness at different times. Appl. Anim. Behav. Sci. 94, 99–115.
Vilà, C., Savolainen, P., Maldonado, J.E., Amorim, I.R., Rice, J.E., Honeycutt, R.L., Crandall, K.A., Lundeberg, J., Wayne, R.K., 1997. Multiple and ancient origins of the domestic dog. Science 276, 1687–1689.
Voith, V.L., 1985. Attachment of people to companion animals. Vet. Clin. N. Am.: Small Anim. Pract. 15, 289–296.
Von Holst, D., 1988. The concept of stress and its relevance for animal behavior. Adv. Behav. 27, 1–131.
Wilson, E.O., 1984. Biophilia. Harvard University Press, Harvard, 157 pp.
Wilson, D.S., Clark, A.B., Coleman, K., Dearstyne, T., 1994. Shyness and boldness in humans and other animals. TREE 9, 442–446.
Wilson, C.C., Turner, D.C. (Eds.), 1998. Companion Animals in Human Health. Sage, London, 310 pp.
Zimen, E., 1972. Wölfe und Königspudel - vergleichende Verhaltensbeobachtungen. R. Piper Verlag, München, 232 pp.
Zimen, E., 1978. Der Wolf. Meyster Verlag, Wien, München, 448 pp.

Relational factors affecting dog social attraction to human partners

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Relational factors affecting dog social attraction to human partners

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We previously showed (Kotrschal et al., 2009) that owner personality and human–dog relationship predicted the performance of a human–dog dyad in a practical task. Based on the same data set we presently investigate the effects of individual and social factors on the social attraction of dogs to their owners. Twenty-two male and female owners and their intact male dogs were observed during a "picture viewing" test, where we diverted the owner's attention away from their dog whilst it was permitted to move freely around the room. Owner personality axis "neuroticism" and dog personality axis "vocal and aggressive" were, respectively, positively and negatively related to the time the dog stayed in proximity to the owner. Quality of relationship and attachment also had significant effects on this proximity. We conclude that personality and the nature of the human–dog relationship may all influence dogs' social attraction to their owners.

Keywords: companion animals; dog–human attachment; dyadic relationships; human-animal interactions; human–dog attachment; human–dog relationship; human–dog social interactions; personality; pets

1. Introduction

It seems to be uniquely human to engage in (social) relationships with other animals (Podberscek, Paul & Serpell, 2000; Robinson, 1995; Serpell, 1986; Turner & Bateson, 2005; Wilson, 1984). In addition to the wealth of practical benefits that humans may gain from such an association, there may be direct and indirect effects on human health and well-being (Kotrschal & Ortbauer, 2003; Kotrschal, Bromundt & Föger, 2004; Podberscek, Paul & Serpell, 2000; Robinson, 1995; Wilson & Turner, 1998). Companion animals are known to affect humans in a number of ways (Brickel, 1982; Bachmann, 1975; Messent, 1983;

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McNicholas & Collis, 2000; Mugford & M'Comisky, 1975), and the presence of a dog may trigger positive effects in a classroom, such as increased social integration of children (Kotrschal & Ortbauer, 2003). This is possible because cross-species socialization may be facilitated by a common "social toolbox" (Kotrschal, 2009) which includes conservatively-maintained vertebrate brain-structures and functions (i.e. for social behaviour and emotions; Goodson, 2005; Panksepp, 1998), and a conservative "social physiology" (i.e. hypothalamic-pituitary-adrenal axis and sympathico-adrenergic stress axis; Kotrschal, 2005; McEwen & Wingfield, 2003; deVries, Glasper & Detillion, 2003). In addition, vertebrates share major structural principles of social behaviour.

In dyadic social relationships, partners invest time in each other, may learn from each other, and may collaborate in various ways. For example, social partners, including companion animals, may provide active and passive (i.e. emotional) social support for each other (Aureli & de Waal, 2000; Scheiber et al., 2005), resulting in physiological and health benefits for the human partner (Robinson, 1995; Wilson & Turner, 1998), and potentially also for the animal partner. However, because interests of dyadic partners are neither entirely stable over time, nor symmetrical, dyadic relationships generally fit the "valuable-relationship model", predicting that individual positions in a relationship are dynamically negotiated in cycles of conflict and "reconciliation" (Aureli & de Waal, 2000). This may also be applicable to human–animal dyads. Indeed, relationships between humans and their companion animals are not free of conflicts (McCune, McPherson & Bradshaw, 1995) and may probably be understood in the context of this theoretical framework.

Several studies have shown gender differences in interactions with, and attitudes towards animals (reviewed by Herzog, 2007). In general, women and girls tend to form stronger emotional relationships with their pets than men and boys (Prato-Previde, Fallani & Valsecchi, 2006; Ray, 1982; Rost & Hartmann, 1994; Kotrschal et al., 2009) and girls 3 to 7 years of age seek animal contact more often than boys at the same age (Wedl & Kotrschal, 2009). It has also been shown that the performance of a human–dog dyad in a practical task is predictable from the quality of the dyadic relationship (Kotrschal et al., 2009; Topàl, Miklòsi & Csànyi, 1997). Hence, women owners should have an edge in that respect over men owners.

Topál et al. (1998) investigated dog–human attachment behaviours in a modified version of Ainsworth's (1969) Strange Situation Test (SST); essentially, separation from the caregiver in an unfamiliar environment evokes anxiety in human infants and also in dogs (Topál et al., 1998). This suggests that functional analogies exist between infant and dog attachment (Gácsi et al., 2001; Topal et al., 2005). However, we suggest that both the bio-psychological and ontogenetic mechanisms of attachment may be similar in humans and dogs, and that individual and dyadic factors will affect mutual social attraction and attachment. Based on the SST approach, Prato-Previde et al. (2003) concluded that the dog–human relationship is a strongly affective bond, but they disputed whether this would satisfy the criteria for attachment and argued that Topal et al.'s (1998) study would not distinguish attachment from a general affective bond. Palmer and Custance (2008) used an improved SST procedure and concluded that the dog–human bond is indeed, consistent with the system of attachment known to exist between human infants and their caretakers.

However, procedural problems make it difficult to apply the SST in a comparative way in animal studies. Furthermore, biologists are usually less satisfied than psychologists with "constructs" and prefer to consider "natural characters" instead (i.e. features which are open to be investigated in a coherent evolutionary frame, at all four levels of Tinbergen (1963)). From this perspective it is reasonable to doubt that "attachment" and "social attraction" label discrete categories. It may be more adequate to view them as different intensities and functional modifications, along a continuum of the brain bonding mechanism (Curley & Keverne, 2005). In an attempt to avoid the methodological problems inherent to an SST approach in its application to dogs, we chose a simple procedure to judge the social attraction of the dog to the owner. However, because this is not fully compatible with attachment theory (Ainsworth, 1969), we generally will refer to social attraction rather than attachment in the present paper. As in this experiment we distracted the owner and monitored how responsive the dog itself was to the owner, this was a test for social attraction rather than attachment.

We previously showed (Kotrschal et al., 2009) that owner personality and relationship to dog, including owner attachment to dog (as judged from questionnaire data), predicted the performance of a human–dog dyad in a practical task. Based on the same data set, we presently ask how the gender of the owner, human and dog personality, human–dog relationship and owner attachment to dog affect dog social attraction within dyads of female and male owners and their intact male dogs. In previous research it has been found that owners scoring high on the neuroticism scale tend to be closely attached to their dogs (Kotrschal et al., 2009). In the present paper, it is hypothesised that the higher an owner scores in neuroticism, the more their dogs would be attracted to them. We also included information from owner questionnaires to see how symmetrical or mutual social attraction would be in our human–dog dyads. Hence, in contrast to previous work, which focussed on the dog mainly, we try to adopt a more dyadic approach. For example, we ask whether attachment on the part of the human partner and attraction on the dog's part would be symmetrical or whether the dog, for example, might compensate for an overly attached owner by keeping its distance when given the choice. At least in human dyads, relational asymmetry is a well known phenomenon (e.g. Eagle, Pentland & Lazer, 2009). To answer this question, we investigated the relationships that exist between the personality of owner and dog, the quality of owner–dog relationship as well as the owner's sex and the behaviours and interactions of the dyad in the course of the "picture viewing" test. In this test, the owners were distracted using a defined protocol with the objective of regulating the interaction between them and their dog. In particular, we ask whether and how the investigated factors influence the proximity between dog and owner, the orientation of the dog towards its owner and the frequency of the dog's approaches towards the owner in this test situation. We expected that during the experimental conditions of the "picture viewing" test the social attraction of the dog towards its owner, is activated (e.g. proximity and contact seeking behaviours and the maintenance of proximity) by the distracted owner in an unfamiliar room. We suggest that the experimental conditions of the "picture viewing" test may be effective in activating dog distance regulation, which in turn, may be related to dog social attraction. Based on the results of a previous study (Kotrschal et al., 2009), we furthermore hypothesized that the higher an owner scores in neuroticism, the more their dogs would be oriented to their owners, the more often they would approach their owners and the longer they would stay in proximity to their owners during our test.

2. Methods

The current results are based on the same data set as used in a previous paper (Kotrschal et al., 2009). There, the basic relationship patterns were reported, in particular how owner personality affects owner–dog relationship and interactions. Here we report the results of one experiment done in this context, to investigate the social attraction of the dog to its owner. Hence, most of the methods we used were already described in detail and we only report the overall design of the study here and refer to our previous paper concerning the details. Only methods not sufficiently described elsewhere are presently explained in detail. This includes the subjects of the study, the test situations used for personality rating, the "picture viewing" test, and the description of the test room, where this test situation was scheduled.

2.1 Subject recruitment and criteria

We recruited participants by advertisements on the internet, in veterinarian clinics, at dog training facilities, in local newspapers, and by directly approaching dog owners. We checked whether our criteria were met, which were: intact male pet dog, only one dog in the household, dog adopted as pup (maximum 16 weeks), body weight 10 kg or more, age 1.5–6 years; owner aged 18 or older, only main reference person of the dog would participate, and that the dyad was living in the Vienna area. These criteria, served to control variability in the data set, which was particularly important in this case, because only a restricted number of participants could be recruited. For this reason, we consider this as a pilot study.

Owners were informed that saliva samples would be taken from themselves and their dogs (the results of the hormonal analyses will be published elsewhere), and that data collection would be conducted using video recording during three meetings. They were also informed that no one else other than the experimenters would be present during the meetings in addition to themselves and their dog. It was explained to the owner that there would be a series of test situations, mostly mimicking situations which they and their dogs might be confronted with during daily life. They were also told that they could terminate the tests at any time. However, the details of the tests or their goals were not given to the owners ahead of testing.

In addition to those dyads that participated in the full tests, a number of other dog owners were asked only to complete our questionnaires to increase our sample size in human personality, human–dog relationship and human attachment to dog. The criteria for inclusion were the same as applied to our test dyads, except that owner respondents with dogs older than 6 years were also accepted.

2.2 Subjects

Ten male and 12 female dog owners (age 23–68) participated fully in our study with their male dogs. The dogs were medium- or large-sized intact male pet dogs (age 1.5 to 6.0 years, adopted by owners between 7 and 12 weeks of age, weight between 11 and 55 kg, 4 mixed-breeds and 15 different pure breeds (Bearded Collie, Groenendael, Border Terrier, Bullterrier, Cocker Spaniel, Eurasier (2), Golden Retriever (3), Labrador Retriever, Parson Jack Russel Terrier, Pit Bull, Polish Lowland Sheepdog, Polish Tatra Sheepdog, Rough Collie, Tibet Terrier, White Swiss Shepherd Dog). Eighteen other dog owners (6 male, 12 female, age 28–55) completed our questionnaires (dog's age ranged from 1.5 to 9.0 years, dog adopted by owners between 6 and 16 weeks of age, dog weight between 20 and 37 kg, 5 mixed-breeds and 11 different pure breeds (Australian Shepherd (2), Austrian Pinscher, Border Collie, Dalmatian, Flat-Coated Retriever, Golden Retriever (3), Irish Setter, Magyar Vizsla, Nova Scotia Duck-Tolling Retriever, Rhodesian Ridgeback, Weimaraner).

2.3 General procedure

Data collection was carried out between January & May 2007. A total of three meetings were scheduled with each of the dyads, with an average of 7 days separating the meetings (range 4 to 27 days). Two observers visited each dyad at the owners' home for the first meeting. One of the observers (Iris Schöberl) interacted with the owner, guided the procedure, and explained the questionnaires; the other observer (Manuela Wedl) video-taped the behaviour of both the dog and owner using a hand-held digital camcorder with a wide-angle conversion lens. The second meeting (which included amongst other test situations the "picture viewing" test) and third meeting were scheduled in a specially adapted test room (4.7 m × 7.1 m) at the University of Vienna and were guided by one observer (Iris Schöberl). Tests were recorded by another camcorder fixed on the roof of the test room. The test room had a table, two chairs and a dog blanket. Pictures of human–dog interactions were placed on the windows and walls. Different human–dog interactions, including as well as portraits from dogs were shown in these pictures. The pictures were each located at a level of approximately 160 cm height (centre of the picture). A leash was fixed at the back side of the room, which was needed for two particular test situations. A wire mesh bridge served as room divider, whereby dog and owner stayed only in a 22.09 m^2 sized part (4.7 m × 4.7 m) of the test room during our test situations, except during one particular test situation, where the wire mesh bridge was needed.

2.4 "Picture viewing" test

The "picture viewing" test was scheduled at the beginning of the second meeting. The dog was free to explore the room (which was novel to the dog) and it could seek contact with its owner, who was not specifically instructed how to turn in any way, towards his/her dog and how to react to the dog's contact seeking behaviour before this test situation. The owner was asked to view 15 dog pictures that had been placed on the windows and walls of the experimental room and to write down three words he/she would associate with each of these pictures. The purpose of this was to distract the owner's attention from the dog and to observe the behaviour of dog and owner, particularly towards each other. The owner was allowed ten minutes to complete the task, during which the dog could move freely within the room. The experimenter was not present during this time. The test situation started when the experimenter left the room and ended 10 minutes afterwards, when the experimenter entered the room again, unless the owner had completed the task prior to that. Mean duration for completing this test situation was 9.4 min (5.5–10.3 min).

The videos that were captured during this test situation were continuously behaviour-coded with the aid of the software package THE OBSERVER Video Pro® (version 5.0, Noldus Information Technology, The Netherlands). Behaviour-coding was performed by two observers ("picture viewing" test: 12 dyads were coded by Iris Schöberl and 10 dyads by Barbara Bauer). For a complete list of coded/rated variables as well for details about the recording method used (for all test situations) see Kotrschal et al. (2009).

For analysis within this paper, three not mutually exclusive variables of the "picture viewing" test were used as dependent variables: (1) "Duration of dog orientated towards the owner" (% of time: dog's head orientated towards the owner which includes the dog sniffing owner, with or without contact), (2) "Duration of dog and owner staying close or next to each other" (% of time: dog within the same one-third sector of the room as the owner, with or without contact), and (3) "Rate of dog approaching the owner" (number per minute: dog moves into reach distance of the owner and appears oriented toward the owner; parallel movements and moving behind in same speed were excluded).

2.5 Human–dog relationship and human attachment to dog

To characterize the quality of attachment and relationship that existed between the owner and the dog, a set of questionnaires was used (translated and modified from the "Questionnaire for Anthropomorphic Attitudes" developed by Topál, Miklósi, and Csányi (1997) and from "The Dog Attitude Scale" developed by Johannson (1999)). The questionnaires were presented at the first meeting to the owners which took part in the experiment, with the request to complete them before the last meeting. These questionnaires were completed by a further 18 other dog owners, who did not participate in our test situations. We included this information in order to gain a dyadic view of the relationship, particularly because most of the previous work concentrated on the dog (see introduction).

2.5.1 *Human attachment to dog*

Principal Component Analysis (PCA; n = 40, Bartlett-Test: KMO = 0.767; Sphericity: $chi^2 = 400.674$, df = 105, $p < 0.001$; Varimax-rotation, Kaiser-normalization), performed with 15 attachment items from the questionnaires mentioned in the section above revealed four main axes: 1. (dog as a) social supporter, 2. (dog as a) meaningful companion, 3. (dog as a) social partner, 4. (dog as an) understanding partner (Table 1, also see Kotrschal et al., 2009).

Table 1. The factor loadings for human-to-dog attachment (axes 1–4) that resulted from the PCA performed with 15 items. Loadings of 0.500 or above are highlighted in bold text

Items	Principal Components			
	1: Social supporter	**2: Meaningful companion**	**3: Social partner**	**4: Understanding partner**
Just being with my dog makes me feel good	**0.866**	0.320	0.125	0.019
My dog helps to keep me in balance	**0.808**	0.272	0.177	−0.133
It makes me feel better to talk to my dog if I am sad, worried or angry	**0.764**	0.049	0.019	0.393
I like taking care of my dog, the daily routines do not annoy me	**0.685**	0.087	0.284	0.489
It feels good to talk to my dog	**0.662**	0.119	0.410	0.495
If my dog were to get lost, sick, or hurt I would feel very sad	0.157	**0.882**	0.050	0.263
I feel responsible for my dog, and that is fine	0.244	**0.851**	0.131	0.183
My dog means a lot to me	0.165	**0.734**	**0.521**	0.132
My dog is a good buddy or friend	0.276	**0.589**	**0.558**	0.181
My dog is a fully-fledged social partner/family member	0.221	0.201	**0.800**	−0.191
I have a conversation with my dog several times per day	0.397	−0.032	**0.702**	0.319
My dog loves me unconditionally	−0.069	0.249	**0.686**	0.373
My dog knows when I feel sad, worried, or angry	−0.011	0.337	−0.065	**0.743**
I think my dog understands me	0.155	0.075	0.094	**0.711**
I miss my dog whenever we cannot be together	0.195	0.180	0.247	**0.610**

2.5.2 *Human–dog relationship*

A PCA (n = 40, Bartlett-Test: KMO = 0.723, Sphericity: $chi^2 = 307.370$, df = 91, $p < 0.001$; Varimax-rotation, Kaiser-normalization) was performed with 14 owner–dog relationship items from the questionnaires mentioned in the section above and revealed four main axes: (1) (spend) time together, (2) (take) responsibility, (3) (pay) attention, (4) (shared) activity (Table 2, also see Kotrschal et al., 2009).

Table 2. The factor loadings for human–dog relationship (axes 1–4) that resulted from the PCA performed with 14 items. Loadings of 0.500 or above are highlighted in bold text

Items	Principal Components			
	1: Time together	2: Responsibility	3: Attention	4: Activity
I enjoy spending time with my dog	**0.925**	0.103	0.156	0.059
I spend quite a bit of time with my dog	**0.830**	0.268	0.178	0.146
I like cuddling my dog	**0.815**	0.002	0.094	−0.183
I go for a long walk with my dog or train/play with my dog several times per week	**0.709**	0.233	0.000	0.178
Sometimes, the performance of my dog makes me laugh	**0.641**	0.472	0.181	−0.009
I make sure my dog has water all the time	**0.514**	**0.501**	0.227	−0.411
I am responsible for feeding my dog on a daily basis	0.131	**0.899**	0.183	−0.157
Even if other family members are around, my dog lets me know when he/she wants to go outdoors	0.162	**0.793**	−0.228	0.047
I am the person in my family who usually walks my dog	0.249	**0.736**	0.225	0.207
My dog often wants my attention	0.139	0.220	**0.770**	−0.103
I sometimes look for my dog when I actually need to be doing something else	0.170	−0.186	**0.697**	0.021
I play with my dog several times per day	0.004	0.106	**0.530**	0.131
I always take my dog with me (e.g. workplace, hobbies, holidays, excursions, shopping …)	0.473	0.213	0.124	**0.759**
I like to just 'hang out' and to relax with my dog	**0.568**	0.237	−0.102	**−0.606**

2.6 Human personality

Owner personality was tested via the German version (Borkenau & Ostendorf, 1993) of the NEO-Five Factor Inventory (Costa & McCrae, 1992; McGrae & Costa, 1987, 1989, 1992, 2003), because it integrates the most important human personality features (comp. Eysenck, 1990). The 60-item instrument is designed to measure normal adult personality in five domains: neuroticism, extraversion, 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). In the present study, this personality test was completed by the owner at the first meeting (for more details see Kotrschal et al., 2009).

2.7 Dog personality

Dog personality was observer-rated (below) in a number of test situations from video tapes:

At the first meeting the researchers entered the home of the owner. Owner–dog interactions and the dog's reaction to the experimenters were observed during the first two minutes. Then the owner was asked to play with the dog for a maximum of three minutes in a way he/she usually does. Finally, the owner was asked to feed the dog as usual. While the dog was eating, the owner was asked to touch it, then to step back, then approach the dog again and take the food away just for a few seconds.

All the other test situations used for personality rating were staged at our experimental room at the University of Vienna.

During the second meeting, the owner was asked to train the dog two novel commands chosen out of a list of ten options and explained by the experimenter. The owner was permitted eight minutes for each training sessions. The experimenter was not in the same room during training. Then, the experimenter performed a "veterinarian check" on the dog in the presence of the owner whilst the dog was located on the blanket in the middle of the room. At the same time the owner was interviewed about the dog's weight, age and breed. The experimenter measured the dog's weight, length, waist and chest circumference, inspected its mouth and teeth, examined its ears and eyes, and touched its entire body, particularly the paws. The owner was asked to behave as he/she wanted, in a way he/she and the dog felt comfortable.

During the third meeting the owner was asked to do a short performance test with the dog featuring the two novel commands trained during the last meeting within the maximum of three minutes being permitted 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 using a check sheet. The same performance test was also conducted once at the second meeting, but for personality rating, only the second performance test was used, which was a repeat of the same procedure. Then a wooden bridge/ramp, 5m × 1m × 0.6m (length × width × height) with a wire mesh surface was moved into the middle of the room and assembled in preparation for the next test. The bridge was stored in three separate parts that had to be connected with screws. The owner was asked to lead the dog over the bridge as efficiently and safely as possible, within a maximum of eight minutes being permitted to complete the task. The owner was told that he/she could terminate the test at any time. Finally, two threat tests were staged. The owner was asked to tether the dog on a long leash fixed on the ground, for security of the experimenter. The experimenter told the owner that something will be done that the dog perhaps would not like, and asked the owner to behave as he/she wants to and would do if something similar happened during daily life. The experimenter did not explain what exactly would happen during this test situation. The experimenter left the room, put on a black long coat with a hood, then re-entered the room, closed the door and knocked three times onto the door to get the dog's attention. As soon as the dog looked into the experimenter's direction, the experimenter started to move towards the dog staring into the dog's eyes or, if this was not possible because the dog avoided the eye contact, staring at the dog's face and stopped moving forward at a certain point, so that the dog could not reach her. From now on the experimenter stared for a period of approximately 30 seconds into the dog's eyes or 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. Here the experimenter waited for two minutes. During this period, the next test situation ("mild threatening with owner absent") was explained to the owner. Then the owner was asked to leave the room with the experimenter and to wait quietly outside the test room. The threatening situation as described above was repeated. If the dog showed an aggressive reaction (barking and/or growling for more than four seconds and/or attacking the experimenter with moving head and/or strained leash (after Vas et al., 2005)) or showed 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 or neutral reaction (neither aggressive, nor avoidance) 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 take off the black coat and to go back into the room together with the owner. The experimenter invited the dog to play with her. After this the owner was allowed to let the dog off the leash.

These test situations formed the basis for the dog personality scoring that was conducted following the completion of quantitative behaviours by the two observers (Barbara Bauer and Iris Schöberl). Using an observer rating modified after Feaver, Mendl, and Bateson (1986) each dog was rated in a number of items between two opposing characteristics. The two observers rated all dogs independently from each other after observing the dog's behaviour from tape, during the situations described above. The position of each rating on a left-to-right scale was measured and transcribed for further analysis. Inter- and intra-observer agreement was tested before and after completion of rating and was higher than 82% for the used personality items. The mean rating given by the two observers was used in subsequent analyses. A PCA was performed on 17 items (n = 22, Bartlett-Test: KMO = 0.673, Sphericity: $chi^2 = 374.158$, df = 136, $p < 0.001$; Varimax-rotation, Kaiser-normalization). This resulted in four main axes: 1. sociable and active; 2. unconfident and anxious; 3. vocal and aggressive 4. clever and attentive (Table 3, also see Kotrschal et al., 2009).

Table 3. The dog personality factor loadings (axes 1–4) that resulted from the PCA performed with 17 items. Loadings of 0.500 or above are highlighted in bold text

Items	**Principal Components**			
	1: Sociable and active	**2: Unconfident and anxious**	**3: Vocal and aggressive**	**4: Clever and attentive**
Sociable	**0.878**	0.094	−0.298	−0.052
Active	**0.876**	0.374	0.033	0.066
Gladsome	**0.861**	0.271	−0.372	0.103
Interested	**0.852**	0.193	0.239	−0.006
Playful	**0.850**	0.141	−0.264	0.023
Calm and balanced	**−0.768**	−0.490	−0.138	−0.018
Wild	**0.603**	0.403	0.405	−0.141
Confident	−0.252	**−0.922**	−0.002	−0.039
Anxious	0.086	**0.909**	0.145	0.140
Nervous	0.383	**0.792**	0.231	−0.324
Dependable	−0.487	**−0.727**	−0.022	0.310
Vocal	0.064	0.035	**0.856**	−0.289
Aggressive	−0.125	0.234	**0.805**	0.138
Friendly	**0.554**	0.009	**−0.764**	−0.045
Excitable	0.475	**0.525**	**0.528**	−0.234
Clever/smart	−0.039	−0.179	−0.126	**0.917**
Attentive	0.462	0.485	0.088	**0.614**

2.8 Statistical analysis

Data analysis was performed using Noldus Observer 5.0. and SPSS 15.0 (Chicago, IL, USA). General linear models (GLMs) were used to explore whether and how, the investigated factors (owner gender, owner and dog personality, human–dog-relationship and human attachment to the dog) affected the "Duration of dog and owner staying close or next to each other" [% of "picture viewing" test] and the "Duration of dog orientated towards the owner" [% of "picture viewing" test]. Both dependent variables were normally distributed (Shapiro-Wilk Test for Normality; $p = 0.270$ and $p = 0.105$, respectively) and showed homoscedasticy (homogeneity of variance was tested using the Levene's Test; $p = 0.201$ and $p = 0.815$, respectively). A generalized linear model (GLM) was used to explore whether and how, the investigated factors influenced the "Rate of dog approaching the owner" [rate in "picture viewing" test], because this dependent variable was not normally distributed (Shapiro-Wilk Test for Normality; $p = 0.003$). So we transformed the values by multiplying by 100 and determined the distribution afterwards which approximated a Poisson distribution. So we could conduct a generalized linear model with a log-link function and based on Poisson distribution.

We constructed all three GLMs using the gender of the owner as a factor, and human-to-dog attachment axes 1–4, human–dog relationship axes 1–4, human personality dimensions 1–5 and dog personality axes 1–4 as covariates. We selected these explanatory variables as main effects and removed them in the order of decreasing significance if $p > 0.1$. Only terms with $p < 0.1$ remained in the final models. Excluded terms were re-entered one by one into the final model to confirm that they did not explain a significant part of the variation (Poesel et al., 2006). Although all terms with $p < 0.1$ remained in the final model (according to standard stepwise model reduction procedures) and therefore are presented in the results-section, only terms with $p < 0.05$ were considered as having a significant influence on the dependent variable. We conducted pairwise comparisons with Bonferroni-correction to determine the differences between male and female owners.

3. Results

3.1 Human attachment to dog

The more the owner considered his/her dog as a "social supporter" and as a "meaningful companion" (human attachment PCA-axes 1 and 2), the longer dog and owner were observed to be close or next to each other (Table 4). Also, the more the owner considered the dog as a "social supporter" and an "understanding partner" (human attachment PCA-axes 1 and 4), but the less he/she tended to consider the dog as a "meaningful companion" (human attachment PCA-axis 2), the more often the dog approached the owner during the "picture viewing" test (Table 4). The more the owner considered the dog as a "social partner" (human attachment PCA-axis 3), the less time the dog spent oriented towards its owner (Table 4).

Table 4. Statistics for GLMs 1–3, with 1. "Duration of dog and owner staying close or next to each other" [% of "picture viewing" test], 2. "Duration of dog orientated towards the owner" [% of "picture viewing" test] and 3. "Rate of dog approaching the owner", [rate in "picture viewing" test] as dependent variables. Of the 18 potential explanatory variables analysed using GLM, six had a significant impact on the time that dog and owner stayed close or next to each other, one had a significant impact on the time that the dog spent being orientated towards the owner and all were found to have a significant impact on the relative number of approaches the dog carried out towards its owner during the "picture viewing" test

	GLMs 1-3								
	1: "Duration of dog and owner staying close or next to each other"			**2: "Duration of dog orientated towards the owner"**			**3: "Rate of dog approaching the owner"**		
Explanatory variable	*df*	*F*	*p*	*df*	*F*	*p*	*df*	*Wald statistic*	*p*
"Social supporter" (Attachment PCA-axis 1)	1	19.661	0.001		excluded		1	46.596	< 0.001
"Meaningful companion" (Attachment PCA-axis 2)	1	7.568	0.016		excluded		1	15.684	< 0.001
"Social partner" (Attachment PCA-axis 3)		excluded		1	7.214	0.016	1	32.528	< 0.001
"Understanding partner" (Attachment PCA-axis 4)		excluded			excluded		1	31.536	< 0.001
"Time together" (Relationship PCA-axis 1)	1	31.034	< 0.001	1	3.341	0.085	1	44.157	< 0.001
"Responsibility" (Relationship PCA-axis 2)		excluded		1	4.148	0.058	1	58.056	< 0.001
"Attention" (Relationship PCA-axis 3)		excluded			excluded		1	17.408	< 0.001
"Activity" (Relationship PCA-axis 4)	1	31.127	< 0.001		excluded		1	14.851	< 0.001
Owner gender		excluded			excluded		1	21.752	< 0.001
Neuroticism (Neo-FFI dimension 1)	1	8.023	0.013		excluded		1	17.062	< 0.001
Extraversion (Neo-FFI dimension 2)		excluded			excluded		1	39.879	< 0.001
Openness (Neo-FFI dimension 3)		excluded			excluded		1	59.634	< 0.001
Agreeableness (Neo-FFI dimension 4)		excluded			excluded		1	25.818	< 0.001
Conscientiousness (Neo-FFI dimension 5)		excluded			excluded		1	24.105	< 0.001

(*Continued*)

Table 4. (Continued)

	GLMs 1-3								
	1: "Duration of dog and owner staying close or next to each other"			2: "Duration of dog orientated towards the owner"			3: "Rate of dog approaching the owner"		
Explanatory variable	*df*	*F*	*p*	*df*	*F*	*p*	*df*	*Wald statistic*	*p*
"Sociable and active" (Dog personality PCA-axis 1)		excluded			excluded		1	13.969	< 0.001
"Unconfident and anxious" (Dog personality PCA-axis 2)	1	3.391	0.087	1	3.927	0.064	1	60.505	< 0.001
"Vocal and aggressive" (Dog personality PCA-axis 3)	1	52.903	< 0.001		excluded		1	13.887	< 0.001
"Clever and attentive" (Dog personality PCA-axis 4)		excluded			excluded		1	90.404	< 0.001

3.2 Human–dog relationship

The less important it was for the owner to "spend time with his/her dogs" (relationship PCA-axis 1), to "pay attention to his/her dog" and to "share activity with his/her dog" (relationship PCA-axes 3 and 4), but the more important it was for the owner to "take responsibility" for his/her dog (relationship PCA-axis 2), the more often the dog approached the owner during the "picture viewing" test (Table 4). The more important it was for the owner to "spend time with the dog" (relationship PCA-axis 1), the longer dog and owner were observed to be close or next to each other (Table 4), and the longer the dog tended to be oriented towards the owner (tendency, Table 4). The more important it was for the owner to "take responsibility for his/her dog" (relationship PCA-axis 2), the less time the dog tended to spend being oriented towards the owner (tendency, Table 4). The more important it was for the owners to "share activity with their dog" (relationship PCA-axis 4), the less time dog and owner spent close or next to each other (see Table 4).

3.3 Owner gender and personality

Dogs owned by men approached their owners more often than dogs of female owners (Post-hoc test: $p = 0.011$, Table 4). The higher an owner scored in "neuroticism" (Neo-FFI dimension 1), the longer dog and owner spent close or next to each other (Table 4). The higher the owner scored in "neuroticism", but the lower the owner in the other four NEO-dimensions, the more often the dog approached the owner in the "picture viewing" test (Table 4).

3.4 Dog personality

The more “sociable and active” and “unconfident and anxious” and the less “vocal and aggressive” and “clever and attentive” the dog (dog personality PCA-axes 1–4), the more often the dog approached the owner during the “picture viewing” test (Table 4). The more “unconfident and anxious” the dog (dog personality PCA-axis 2), the less time dog and owner tended to spend close or next to each other (tendency, Table 4) but the longer the dog spent oriented towards the owner (tendency, Table 4). The more “vocal and aggressive” the dog (dog personality PCA-axis 3), the less time dog and owner spent close or next to each other (Table 4, also see Figure 1).

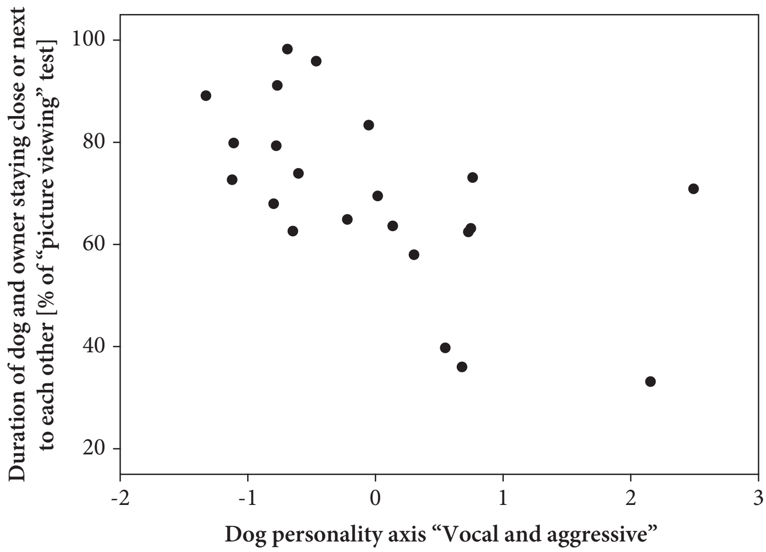

Figure 1. The relationship between the dog personality axis “Vocal and aggressive” (Dog personality PCA-axis 3) and the “Duration of dog and owner staying close or next to each other” [% of “picture viewing” test] ($n = 22$)

4. Discussion

In the present paper we investigated the effects of individual and social factors on the social attraction of dogs to their owners. These factors were the gender of the owner, human and dog personality, human–dog relationship and owner attachment to dog. In particular, we questioned whether and how, the factors influenced the proximity of the dog to its owner, the orientation of the dog towards its owner, and the frequency of the dog's approaches.

As expected, we found that the higher an owner scored in "neuroticism" (Neo-FFI dimension 1), the longer dog and owner spent in proximity to each other and the more often the dog approached his owner. This fits our previous finding that owners scoring high on the neuroticism dimension need their dogs as an emotional social supporter and, hence, are firmly attached to their dogs (Kotrschal et al., 2009). This reflects social attraction of the dog to the owner. Certainly, attachment, as judged from our questionnaire data on the side of the owner coincided with socially attracted dogs.

The other four FFI-dimensions affected the dog's approaches towards the owner in the opposite direction. However, this kind of human attachment and dog social attraction matching did not seem to arise just through a simple adjustment of dog personality to owner personality. In fact, dog personality was an important factor affecting interactions between dogs and their owners during the "picture viewing" test. This indicates that human–dog dyadic relationships are comparable to human dyads, in accordance with Asendorpf and Wilpers (1998) who demonstrated that human personality factors predict a number of aspects in human dyadic relationships.

We found that the dog approached the owner more often when the owner considered it as being a social supporter. In contrast, owners who considered their dog as being a partner and companion seemed to support independent behaviour in the dog. In fact, their dogs were less orientated towards them and approached them less often. These patterns are suggestive of the type of attachment the dogs may have as a base for the kind of social attraction behaviour it showed. Dogs which frequently approach their owners may be insecurely attached. However, it could also be argued that independent behaviour may suggest a secure attachment (Ainsworth, 1969; Topál et al., 1998). When owners considered their dog as being a partner for shared activities, their dog approached them less often and spent less time in proximity to them. This could be suggestive of secure attachment, but further work would be required to fully substantiate this assertion. Owner personality may affect owner behaviour in a way that either supports or inhibits social attraction in dogs. For example, owners scoring high on neuroticism may mainly regard their dogs as being a social supporter (Kotrschal et al., 2009) and thus, will frequently interact with them and reinforce spatial closeness with their dogs.

Based on the results of previous studies that have detected sex differences in interaction style and attitudes towards pets (Ray, 1982; Paul & Serpell, 1992; Rost & Hartmann, 1994; Prato-Previde, Fallani & Valsecchi, 2006; Herzog, 2007; Kotrschal et al., 2009; Wedl & Kotrschal, 2009), we expected that owner gender would be an important determinant of dog social attraction. Topál et al. (1998) did not find effects of gender, age, living conditions, or breed on most of the behavioural variables in a dog version of the SST. However, in our "picture viewing" test we found that owner gender can be a factor. But we only found an effect of owner gender on how often the dog approached its owner. Because this was a pilot study, we just included intact male dogs in this study. With a greater sample size and including also female dogs we would expect that on the one hand dog sex and on the other hand, the combination of owner gender and dog sex would affect dog response variables.

In conclusion, our findings indicate that owner gender, owner and dog personalities, and the nature of the human–dog relationship may all influence dog attraction to their owner. These findings are also relevant for a better understanding of the human–dog relationship and may benefit successful pet ownership. For example, dog training hitherto mainly emphasizes techniques. The message from our studies (this one and Kotrschal et al. 2009) is that dog trainers should individualize dyadic training depending on dog and owner relationship and personalities.

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References

Ainsworth, M.D.S. (1969). Object relations, dependency and attachment: a theoretical review of the infant–mother relationship. *Child Development,* 40, 969–1025.

Asendorpf, J.B. & Wilpers, S. (1998). Personality effects on social relationships. *Journal of Personality and Social Psychology,* 74, 1531–1544.

Aureli, F. & de Waal, F.B.N. (2000). *Natural conflict resolution*. Berkley: University of California Press.

Bachmann, R.W. (1975). Elementary school children perception of helpers and their characteristics. *Elementary School Guidance and Counseling,* 10, 103–109.

Borkenau, P. & Ostendorf, F. (1993). *NEO-Fünf-Faktoren Inventar (NEO-FFI) nach Costa und McCrae*. Göttingen: Hogrefe.

Brickel, C.M. (1982). Pet facilitated psychotherapy. A theoretical explanation via attention shifts. *Psychological Reports,* 50, 71–74.

Costa, P.T. & McCrae, R.R. (1992). *Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional Manual*. Lutz, Florida: Psychological Assessment Resources.

Curley, J.P. & Keverne, E.B. (2005). Genes, brains and mammalian social bonds. *Trends in Ecology and Evolution*, 20, 561–567.

DeVries, C.A., Glasper, E.R. & Detillion, C.E. (2003). Social modulation of stress responses. *Physiology and Behavior*, 79, 399–407.

Eagle, N., Pentland, A. & Lazer, D. (2009). Inferring friendship network structure by using mobile phone data. *Proceedings of the National Academy of Sciences of the United States of America*, 106, 15274–15278.

Eysenck, H.J. (1990). Biological dimensions of personality. In L.A. Pervin (Ed.), *Handbook of personality: theory and research*, (pp. 244–276). NY: Guilford Press.

Feaver, J., Mendl, M. & Bateson, P. (1986). A method for rating the individual distinctiveness of domestic cats. *Animal Behaviour*, 34, 1016–25.

Gácsi, M., Topál, J., Miklósi, Á., Dóka, A. & Csányi, V. (2001). Attachment behaviour of adult dogs (Canis familiaris) living at rescue centres: Forming new bonds. *Journal of Comparative Psychology*, 115, 423–431.

Goodson, J.L. (2005). The vertebrate social behaviour network: Evolutionary themes and variations. *Hormones and Behavior*, 48, 11–22.

Herzog, H.A. (2007). Gender differences in human–animal interactions: A review. *Anthrozoös,* 20, 7–21.

Johannson, E.E. (1999). *Human–animal bonding: an investigation of attributes*. Ph.D. Thesis, University of Alberta, Edmonton.

Koolhaas, J.M., Korte, S.M., Boer, S.F., Van Der Vegt, B.J., Van Reenen, C.G., Hopster, H., De Jong, I.C., Ruis, M.A.W. & Blokhuis, H.J. (1999). Coping styles in animals: current status in behavior and stress-physiology. *Neuroscience Biobehavior Review*, 23, 925–935.

Kotrschal, K. (2005, August). *Why and how vertebrates are social: physiology meets function*. Plenary contribution at the IEC, Budapest, Hungary.

Kotrschal, K. (2009). Die evolutionäre Theorie der Mensch-Tier-Beziehung. In C. Otterstedt & M. Rosenberger (Ed.), *Gefährten – Konkurrenten – Verwandte. Die Mensch-Tier-Beziehung im wissenschaftlichen Diskurs* (pp. 55–77). Göttingen: Vandenhoeck & Ruprecht.

Kotrschal, K., Bromundt, V. & Föger, B. (2004). *Faktor Hund. Eine sozio-ökonomische Bestandsaufnahme der Hundehaltung in Österreich*. Wien: Czernin-Verlag.

Kotrschal, K. & Ortbauer, B. (2003). Behavioral effects of the presence of a dog in a classroom. *Anthrozoös,* 16, 147–159.

Kotrschal, K., Schöberl, I., Bauer, B., Thibeaut, A.-M. & Wedl, M. (2009). Dyadic relationships and operational performance of male and female owners and their male dogs. *Behavioural Processes,* 81, 383–391.

McCrae, R.R. & Costa, P.T. (1987). Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology,* 52, 81–90.

McCrae, R.R. & Costa, P.T. (1989). Rotation to maximize the construct validity of factors in the NEO Personality Inventory. *Multivariate Behavioral Research,* 24, 107–124.

McCrae, R.R. & Costa, P.T. (1992). Discriminant validity of NEO-PIR facet scales. *Educational and Psychological Measurement*, 52, 229–237.

McCrae, R.R. & Costa, P.T. (2003). *Personality in adulthood*. Second edition. NY: Guilford Press.

McCune, S., McPherson, J.A. & Bradshaw, J.W.S. (1995). Avoiding problems. In I. Robinson (Ed.), *The Waltham Book of Human–Animal Interactions* (pp. 71–86). Kidlington: Pergamon Press.

McEwen, B.S. & Wingfield, J.C. (2003). The concept of allostasis in biology and biomedicine. *Hormones and Behavior*, 43, 2–15.

McNicholas, J. & Collis, G.M. (2000). Dogs as catalysts for social interactions: Robustness of the effect. *British Journal of Psychology,* 91, 61–70.

Messent, P.R. (1983). Facilitation social interaction by companion animals. In A.H. Katcher & A.M. Beck (Eds.), *New Perspectives on Our Lives with Companion Animals* (pp. 37–46). Philadelphia: University of Pennsylvania Press.

Mugford, R.A. & M'Comisky, J.G.M. (1975). Some recent work on the psychotherapeutic value of cage birds with old people. In R.S. Anderson (Ed.), *Pet Animals and Society* (pp. 54–65). Springfield: IL.

Palmer, R. & Custance, D. (2008). A counterbalanced version of Ainsworth's Strange Situation Procedure reveals secure-base effects in dog–human relationships. *Applied Animal Behaviour Science,* 109, 306–319.

Panksepp, J. (1998). *Affective Neuroscience. The foundations of human and animal emotion*. NY: Oxford University Press.

Paul, E.S. & Serpell, J. (1992). Why children keep pets: the influence of child and family characteristics. *Anthrozoös,* 5, 231–244.

Podberscek, A.L., Paul, E. & Serpell, J.A. (Eds.). (2000). *Companion animals and us: Exploring the relationships between people and pets*. Cambridge, UK: Cambridge University Press.

Poesel, A., Kunc, H.P., Foerster, K. & Kempenaers, B. (2006). Early birds are sexy: male age, dawn song and extrapair paternity in blue tits, Cyanistes (formerly Parus) caeruleus. *Animal Behaviour,* 72, 531–538.

Prato-Previde, E., Custance, D.M., Spiezio, C. & Sabatini, F. (2003). Is the dog–human relationship an attachment bond? An observational study using Ainsworth's strange situation. *Behaviour,* 140, 225–254.

Prato-Previde, E., Fallani, G. & Valsecchi, P. (2006). Gender Differences in Owners Interacting with Pet Dogs: An Observational Study. *Ethology,* 112, 63–73.

Ray, J.J. (1982). Love of animals and love of people. *Journal of Social Psychology,* 116, 299–300.

Robinson, I. (1995). *The Waltham Book of Human–Animal Interaction: Benefits and responsibilities of pet ownership*. Kidlington: Pergamon Press.

Rost, D.H. & Hartmann, A. (1994). Children and their pets. *Anthrozoös,* 7, 242–254.

Scheiber, I.B.R., Weiss, B.M., Frigerio, D. & Kotrschal, K. (2005). Active and passive social support in families of Greylag geese (*Anser anser*). *Behaviour,* 142, 1535–1557.

Serpell, J.A. (1986). *In the company of animals*. Oxford: Basil Blackwell.

Tinbergen, N. (1963). On aims and methods of ethology. *Zeitschrift für Tierpsychologie*, 20, 410–433.

Topál, J., Gácsi, M., Miklósi, Á., Virányi, Zs., Kubinyi, E. & Csányi, V. (2005). Attachment to humans: a comparative study on hand-reared wolves and differently socialized dog puppies. *Animal Behaviour*, 70, 1367–1375.

Topàl, J., Miklòsi, À. & Csànyi, V. (1997). Dog–human relationship affects problem solving behavior in the dog. *Anthrozoös,* 10, 214–223.

Topàl, J., Miklòsi, À., Csànyi, V. & Dóka, A. (1998). Attachment behavior in dogs (Canis familiaris): A new application of Ainsworth's (1969) strange situation test. *Journal of Comparative Psychology,* 112, 219–229.

Turner, D.C. & Bateson, P. (Eds.). (2005). *The Domestic Cat*: (2nd ed.). Cambridge: Cambridge Univ. Press.

Vas, J., Topál, J., Gácsi, M., Miklósi, A. & Csányi, V. (2005). A friend or an enemy? Dogs' reaction to an unfamiliar person showing behavioural cues of threat and friendliness at different times. *Applied Animal Behaviour Science*, 94, 99–115.

Wedl, M. & Kotrschal, K. (2009). Social and individual components of animal contact in preschool children. *Anthrozoös* 22, 383–396.
Wilson, C.C. & Turner, D.C. (Eds.). (1998). *Companion animals in human health*. London: Sage.
Wilson, E.O. (1984). *Biophilia*. Harvard: Harvard University Press.

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Effects of owner-dog relationship and owner personality on cortisol modulation in human-dog dyads

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Abstract

The aim of our study was to examine the influence of dyadic attachment, owner and dog personality and owner gender on stress hormone dynamics in owner-dog dyads. We hypothesized that owner personality modulates the relationship between owners and their dogs, which, in turn, affects salivary cortisol levels (which are useful to determine acute and chronic stress levels, Beerda et al. 1997). Data were collected during three meetings with 10 male and 12 female owners aged 23-68, with their medium to large intact male dogs aged 1.5-6.0 years. These owner-dog dyads were observed and video-taped in different challenge situations. The NEO-FFI test (Five-Factor Inventory; Costa and McCrae 1989) was used to determine owner personality. Questionnaires covering owner-dog relationship and attachment were also employed. Salivary cortisol levels were measured from samples collected during the dyad's daily routine and after experimental challenges. It was found that our experimental challenges had little effect on the salivary cortisol levels of either dog or owner except that dogs and male owners showed elevated levels during the first 20 minutes of our visit to their homes (first meeting). However, owner and dog morning salivary cortisol control values were related to owner personality and owner-dog relationship. The owners who scaled high in neuroticism (Neo-FFI dimension 1) or low in conscientiousness (Neo-FFI dimension 5) showed high morning salivary cortisol values (control), in contrast to their dogs, which were low in morning salivary cortisol. In general, dogs of owners who considered them as being a "social partner" (Attachment PCA axis 3) and a "meaningful companion" (Attachment PCA axis 2) showed low morning salivary cortisol values. We conclude that the strangers visiting the homes of male dogs and owners was stressful, and that the main individual factors for stress coping in owner-dog dyads were owner personality, relationship and attachment.

Keywords: dyadic challenges, human-dog attachment, human-dog interactions, personality stress coping.

Introduction

Vertebrate social systems share some phylogenetic similarities, such as evolutionary conservative brain structures and functions (Goodson 2005), physiological and psychological mechanisms including the two stress axes (hypothalamic-pituitary-adrenal axis and the sympathico-adrenomedullary system; DeVries, Glasper and Detillion 2003), and possess common rules of early socialisation, bonding, emotions (Panksepp 1998) and social learning (McEwen and Wingfield 2003; Kotrschal 2005). Hence, it is probably not mere coincidence that similar personality axes can be detected within populations of different vertebrate species (Gosling 2001; Sih et al. 2004) and particularly, within the mammalian class. A "four dimension model" of dog personality, for instance, resembles the human "Five-Factor Model" (Gosling, Kwan and John 2003). Such a common inventory of homologous and convergent vertebrate social mechanisms may also be regarded as the basis for the human ability to engage in social relationships with non-human animals (Podberscek and Gosling 2000).

Of all the companion animals, dogs seem to have been associated with humans for the longest period of time (Clutton-Brock 1995). Estimates for primary associations between humans and wolves vary between 130,000 years (Vila et al. 1997) and 15,000 years before the present day (Savolainen et al. 2002; Jun-Feng Pang et al. 2009). Comparable to human social systems, the ancestors of all dogs, wolves, live in cooperative clans (Mech 1999). The first contacts between wolves and humans may have been mutualistic (Coppinger and Coppinger 2003; Schleidt and Shalter 2003), or may have had a spiritual background (Jun-Feng Pang et al. 2009).

In the present day, it is known that dogs not only affect social interactions and social development in children (Kotrschal and Ortbauer 2003), but also may strongly affect human lifestyle (Hart, 1995; Kotrschal, Bromundt and Föger 2004), economics and society. Dogs often play an important supportive role for their owners and are often regarded and treated as full family members (Hart 1995; Allen, Blascovich and Mendes 2002; Allen 2003). Hardly any other companion animal species, with the exception of the cat, comes affectively as close to humans as dogs (Serpell 1995) and may be similarly able as human partners to provide practical assistance as well as emotional social support (Scheiber et al. 2005), resulting in benefits to the well-being, physiology and health of the human partner (Serpell 1991, 1996; Friedmann, Thomas and Eddy 2000; Allen, Blascovich and Mendes 2002¸ Beetz et al. 2011). However, little is still known about the complex human-dog relationship and associated patterns of hormones related to stress coping (DeVries, Glasper and Detillion 2003).

The “stress” response is generated to re-instate homeostasis in case of environmental and social perturbation (Cannon 1929; Selye 1950). If a certain threshold of stimulation by stressors is reached, an individuals behavior and physiology is affected to maintain “homeostasis” (Stratakis, Gold and Chrousos 1995) or also called “allostasis”, defined as the adaptive process for maintaining stability through change (McEwen and Wingfield 2003). In particular, glucocorticoids and catecholamines are known to play important roles (McEwen and Wingfield 2003; Korte et al. 2005). Furthermore, corticosteroids operate in the brain through glucocorticoid-receptors, modulating the integration of emotional arousal and cognitive performance (Brinks 2009).
Chronic over–activation of neuroendocrine systems, however, may result in immune depression and health problems (Sapolsky 1994; Koolhaas et al. 1999; Goldstein and Mc Ewen 2002; McEwen and Wingfield 2003). Even well below pathological thresholds, activation of the stress axes is always energetically costly, because glucocorticoids are central metabolic hormones, and may also invoke behavioral costs. Acute as well as chronic activation of the stress axes can be determined using salivary sampling (Beerda et al. 1997).

The corticosteroid responses of children to fear-eliciting stimuli are related to the quality of parent-child bond. For example, the cortisol levels of children with an insecure attachment to their parents tend to be higher than of children with a secure attachment to their parents (Gunnar 1998). In certain respects, such a parent-offspring attachment model may apply to human-dog dyads (Voith 1985). For example, it has been found that dogs may be more efficient emotional supporters of children with sub-optimal attachment representations than humans (Beetz et al. 2011). Hence, the strength and quality of the bond between the owner and the dog may affect the reaction to stressful situations in dogs and, possibly, also in humans. Furthermore, Weaver and De Waal (2002) found that insecure relationships between apes are characterized by unpredictability, and are inherently more tense than relationships founded on secure bonds (Weaver and De Waal 2002) and, therefore, may be associated with elevated glucocorticoid levels (Creel 2001). This also seems to apply to human-dog dyads, with the dog being the more dependent partner (Topal et al. 1998). Hence, it is not unreasonable to expect in human-dog dyads that the cortisol response to challenge (as well as basal levels) may be affected by the quality of the bond.

It has recently been shown that owner personality and gender affect dyadic interaction style, dog behavior and dyadic achievement in practical tasks (Topal, Miklosi and Csanyi 1997;

Kotrschal et al. 2009). Based on the known contingency between social behavior and stress modulation (Von Holst 1988; Sapolsky 1994; Creel 2001; DeVries, Glasper and Detillion 2003) we hypothesized that a relationship will exist between stress hormone levels in human-dog dyads, and attachment, relationship and personality of the owner and of the dog. It was previously shown that normal training situations are hardly stressful for dogs (Haubenhofer, Möstl and Kirchengast 2005). However, there is a paucity of published information concerning the factors that might link personality, attachment and relationship with the individual modulation of cortisol in human-dog dyads. Therefore, the objective of this study was to examine whether and how these parameters influence stress coping in owners and their dogs.

Individual behavioral phenotypes are considered to relate to cortisol modulation along a continuum that ranges from "proactive" to "reactive" (Koolhaas et al. 1999; Korte et al. 2005). "Proactive" individuals are characterized as being more aggressive and bold while showing higher hypothalamic-pituitary gonadal axis activity, and lower HPA-axis acitivity. "Reactive" individuals are characterized as being less aggressive and bold while showing lower hypothalamic-pituitary gonadal axis activity, and higher HPA-axis activity (Koolhaas et al. 1999). Thus, we predicted that owner personality will influence stress coping in human-dog dyads. Furthermore, the quality of dyadic relationships and attachments will affect the quality of mutual social support and thus, may be reflected in physiological parameters (Serpell 1991, 1996; Friedmann, Thomas and Eddy 2000; Allen, Blascovich and Mendes 2002) such as morning cortisol levels or after exposure to a stressor. Securely attached dyads may exhibit reduced cortisol levels (Gunnar 1998), and this may be particularly evident in the dog. Finally, because women are generally more emphatic than men (Hart 1995; Prato-Previde, Fallani and Valsecchi 2006), we also expected to find gender differences in stress coping in owners and their dogs. Within this pilot study we want to evaluate which dyadic factors influence stress coping in human-dog dyads.

Methods

The present study formed part of a pilot project that investigated owner-dog relationship. The results presented here are based on the same data set as used in two previous papers (Kotrschal et al. 2009 and Wedl et al. 2010). In Kotrschal et al. (2009) the basic relationship patterns were reported, in particular how owner personality affects owner–dog relationship, behavior and interactions. In Wedl et al. (2010) the effects of individual and social factors on the social attraction of dogs to their owners were investigated. Hence, to avoid unnecessary repetition, in the present paper we describe only those aspects of the method which are relevant to the investigation of cortisol modulation. However, we refer the reader to our previous papers for more details where applicable.

Subjects

Participants were recruited via advertisements in different newspapers, the internet, veterinarian clinics and dog training centers. We checked whether our criteria were met and the owners were informed about the general procedure via telephone. The participating owners were fully informed and gave their written consent and received full information on the purpose of this study after testing. As we did not use any invasive methods during our study there was no ethical review necessary according to Austrian law or University of Vienna rules. Also, the owners were free to abandon the test situation at any time.

Following recruitment, the subjects that were selected to participate in this study were 22 human-dog dyads, 10 male (mean age 39 years) and 12 female dog owners (mean age 46 years) and their intact male pet dogs (aged 1.5 to 6.0 years, between 11 and 55 kg). We selected only healthy dogs that had good levels of mobility. For these reasons dogs with a history of poor health and well-being (e.g. impaired breathing) were excluded. Finally we included four mongrels and 15 different pure breeds (hunting dogs, herding dogs and terrier and prototype dogs). All dogs were adopted by their owners as pups at 6 to 12 weeks of age. Participants lived in (or close to) Vienna with no other dogs in the same household. In addition, 18 owners (6 male, 12 females 28 to 55 years of age) of intact male pet dogs completed our questionnaires, but did not participate in our test situations.

General procedure

Data were collected between January and May 2007 in a series of three meetings with a mean interval of 7 days elapsing between meetings. The first meeting was conducted at the owner’s home by two experimenters. One experimenter (IS) interacted with the owner and explained the procedure and the questionnaires to be employed. The second experimenter (MW) video-taped the behavior of the dog and the owner using a hand-held digital camcorder. The second and third meetings were scheduled in a 33 m² test room at the University of Vienna and were conducted by just one experimenter (IS). The first and second meetings took approximately one hour each, and the third meeting took approximately 40 minutes.

Video recordings of the first meeting were captured using a camcorder (Sony DCR-TRV 19E) with a wide-angle conversion lens (Sony VCL-0630 S). For continuous videotaping during the second and third meeting another camcorder (Sony DCR-TRV 33E) with a wide-angle conversion lens (Hama, video objective HR 0.45 HTMC Compact) was mounted on the ceiling of the test room.

Questionnaires

We used the German version of a standard human personality test, the NEO-FFI (Five-Factor Inventory; Costa and McCrae 1989; Borkenau and Ostendorf 1993). This Inventory includes 60-items and was designed to measure normal adult personality in five domains: neuroticism, extroversion, openness, agreeableness, and conscientiousness. This personality questionnaire is empirical and is compatible with biological personality theory (Koolhaas et al. 1999; Sih et al. 2004). Our own basic questionnaire served to obtain background information about the attachment and relationship between owner and dog and included questions adapted from the "Questionnaire for Anthropomorphic Attitudes" (Topal, Miklosi and Csanyi 1997) and a scale translated and modified from "The Dog Attitude Scale" (Johannson 1999). For further details see Kotrschal et al. (2009) and Wedl et al. (2010). A sub-set of questions was used to characterize the quality of attachment and relationship. To describe human-dog attachment, Principal Components Analysis (PCA) was performed with 15 attachment items, which revealed four main axes: 1. (dog as) social supporter, 2. (dog as) meaningful companion, 3. (dog as) social partner, 4. (dog as) understanding partner (for details see Kotrschal et al. 2009 and Wedl et al. 2010).

For human-dog relationship another PCA was performed with 14 owner-dog relationship items and revealed four main axes: 1. (spend) time together, 2. (take) responsibility, 3. (pay) mutual attention, 4. (shared) activity (for details see Kotrschal et al. 2009 and Wedl et al. 2010).

Saliva samples

In each of the three meetings, the owner collected saliva samples from both themselves and their dog at 20 minutes intervals. This sampling interval was chosen on the basis of a study that indicates that canine blood-cortisol levels increase 20 minutes after the dog encounters a stressor, such as handling and venipuncture (Hennessy et al. 1998). At the beginning of the studies, owners were instructed how to collect these saliva samples according to the trial protocol. The first saliva samples were taken at the beginning each of the meetings, and then every 20 minutes throughout the meeting. The first and second meeting lasted for 60 minutes each, which resulted in the collection of four samples on each occasion (at minutes 0, 20, 40 and 60). The third meeting lasted for 40 minutes and, consequently, resulted in the collection of just three saliva samples (at minutes 0, 20 and 40). To obtain the saliva samples, the owner was asked to chew a piece of sterile polypropylene gauze (Salivette, Sarstedt) for at least 30 seconds. At the same time, the owner was requested to obtain a sample from their dog. Salivation was stimulated by showing food to the dogs, as done in other studies (Wenger-Riggenbach et al. 2010) and the resulting sample collected from the dog's buccal cavity using a safety cotton bud. The cotton part of the bud was cut off into a plastic tube (Cliklok Microcentrifuge Tube, vol 1.5 ml) and was stored at -20°C until it was subsequently analyzed. The food reward was only given after the owner had taken the samples because it is known that food particles in the mouth cross-react wit the antibodies used in salivary immunoassay (Magnano et al. 1989; Shirtcliff et al. 2001). This method was deemed appropriate because it is known that there is no handling effect within the up to 4 minutes sampling time in dogs (Kobelt et al. 2003).

For reference, saliva samples were collected on two control days from both the owner and the dog. On control days, no meetings were scheduled and the experimenters were not present. The owner was instructed to refrain from any unusual or high-intensity activities during these control days. On such days, five samples were taken in the morning (beginning at an average of 10:15 am) and five samples in the afternoon (beginning at an average of 4:25 pm) at successive intervals of 20 minutes. It is known, that humans exhibit a circadian pattern of cortisol secretion over a 24-hour period, where cortisol peaks early in the morning and decreases over the day (Van Cauter and Speigel 1999). In dogs, no similar circadian rhythm of cortisol secretion has been detected (Koyama, Omata and Saito 2003; Haubenhofer, Möstl and Kirchengast 2005; Wenger-Riggenbach et al. 2010).
Salivary cortisol concentrations were measured for both dogs and humans using an enzyme immunoassay developed by Palme and Möstl (1997).

Dog personality

Dog personality was scored using an observer rating inventory (modified after Feaver, Mendl, and Bateson 1986; see Kotrschal et al. 2009 and Wedl et al. 2010 for details) featuring 17 items (for details see Wedl et al. 2010). Inter- and Intra-observer agreement between the two raters (BB and IS) was tested before and after the completion of rating and was generally better than 82%. Observers rated all dogs independently of each other after observing the dog’s behavior from video during the following situations (for detail see data collection during three meetings): 1) at the owner's home, experimenters entering the house/flat, owner feeding the dog, owner playing with the dog, 2) at the experimental room: picture, training two new commands, veterinarian check, bridge, threat with and without owner. The mean value of the two observers per item was used. PCA was performed on the 17 items and resulted in four main dog personality axes: 1. sociable and active, 2. unconfident and anxious, 3. vocal and aggressive, 4. clever and attentive (for details see Wedl et al. 2010).

Data collection during three meetings

First Meeting

During the first meeting, the owner-dog interactions and the dog's reaction to the experimenters were observed. The procedure for saliva sampling was explained and the first samples were taken from both the owner and the dog. Subsequently, the owner was asked to complete the questionnaires, one of which was the NEO-FFI personality test. Once the owners had completed the questionnaires (which generally took 15 minutes), the second saliva samples were taken. The owner was then asked to play with the dog for a maximum of three minutes in a way he/she usually does, and then to feed the dog as usual. While the dog was eating, the owner was asked to touch it, then to step back, then approach the dog again and take the food away just for a few seconds. When the dog had finished eating, our basic questionnaire was given and explained to the owner with the request to complete it in advance of the third meeting. Saliva samples were taken for a third time. Finally, after watching and taping a 15 to 20 minute walk of the owner-dog dyad, a fourth set of saliva samples were taken from both partners.

Second Meeting

During the second meeting, tests were conducted to measure the quality of the owner-dog relationship. Upon arrival of the dyad, the first set of saliva samples was taken. Then, the owner was asked to look at 15 dog pictures that had been placed on the wall and windows and to freely associate, and write down, three words for each picture. The dog was in the same room, was unrestrained in its movement and hence, could inspect the novel room. This "picture" task took 10 minutes, with no experimenter in the room, but the scene was video taped (for more details about the "picture" situation see Wedl et al. 2010). Following this situation, a second set of saliva samples was taken.

The owner was then asked to teach the dog two novel commands that were standardized chosen by the experimenter from a list of ten options. The owner was permitted eight minutes for each command. The experimenter left the room for those training sessions. Following the training task, a third set of saliva samples was taken. After this, the experimenter performed a "veterinarian check" in the presence of the owner. This physical examination mimicked the basic examination that might be performed by a veterinarian. The experimenter measured the dog's weight, length, waist and chest circumference, inspected its mouth and teeth manually and visually, examined its ears and eyes, and touched its entire body, particularly the paws. The owner was asked to behave as he/she wanted, in a way he/she and the dog felt comfortable. Thereafter, the fourth saliva samples were taken.

Third meeting

The aim of the third meeting was to tape the owner's and the dog's reactions to two different potentially stressful contexts. Prior to either of the tasks, the first saliva samples were taken. The first task was termed the "bridge" task. This involved placing a wooden bridge covered with wire mesh into the room. The owner was asked to lead the dog over the bridge as efficiently and safely as possible, within a maximum of eight minutes. The owner was told that he/she could terminate the test at any time. Following the task, the second set of saliva samples was taken from owner and dog.

Following the completion of the "bridge" task, the owners and dogs were requested to undertake a second task which was termed the "threat" task. After the experimenter had removed the wire mesh bridge, the owner was asked to tether the dog with a leash fixed on the ground for the security of the experimenter during the next test task. The experimenter told the owner that something would happen which the dog perhaps would not like, and that they should behave as he/she wants to and how she/he would do if something similar happened somewhere else. Then the experimenter left the room and put on a black long coat with a hood and entered the room again. The experimenter closed the door and knocked 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 slowly towards the dog, staring into the dog's face. The experimenter stopped at a defined "stop-point" where it was not possible for the dog to reach the experimenter. The experimenter then stared at the dogs face for approximately 30 seconds. Irrespective of the dog's reaction, the experimenter turned away her head after 30 seconds had elapsed and moved away from the "stop-point" to the opposite corner of the room from where the dog was tethered. During next two minutes of waiting the second phase of the "threat" task was explained to the owner. For this the owner was asked to leave the room with the experimenter and to wait quietly outside. The "threat" task was repeated, but this time without the owner present. The experimenter repeated all the steps mentioned above. 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 et al. 2005) or exhibited an avoidance reaction (moving away from the experimenter into the back of the room and/or trying to hide), the experimenter moved away to the opposite corner of the room, sat down onto the ground and looked away from the dog and waited for two minutes. If the dog showed a friendly reaction (neither aggressive, nor avoidance reaction) the experimenter turned away her head, crossed the marked “stop-point” to get closer to the dog and made friendly contact with the dog through talking and reaching the hand out towards the dog. The experimenter then left the room to take off the coat and to go back into the room with the owner. The experimenter invited the dog to play with her. After this, the owner let the dog off the leash and a third set of saliva sample was taken.

Statistical analysis

SPSS (Version 15.0) was used for statistical analysis. Salivary cortisol concentrations measured during the meetings were not normally distributed, whereas the control values were generally normally distributed (Shapiro-Wilk Test). Therefore, non-parametric tests were used (Mann-Whitney-U, Wilcoxon, Friedman and Spearmans, as appropriate) to compare salivary cortisol concentrations during the meetings and to compare cortisol control values with cortisol values during the meetings. As the morning and afternoon salivary cortisol control values of owners differed, the two samples were analyzed separately. The same procedure was followed in the dogs because we could not exclude the possibility that the lack of a significant difference between the morning and afternoon values had arisen due to a type II-error.

For comparison of the control samples and the samples collected during the meetings, we used morning or afternoon control samples adjusted to the corresponding time of the meeting, because the meetings were scheduled at different times of the day. Because male and female owners differ in their cortisol levels, they were analyzed separately. To evaluate the hormone profiles of individuals over the course of the meetings, differences in salivary cortisol levels before and after the 20-minute challenge tasks were used for analysis. For this purpose, the salivary cortisol level measured before the challenge task was subtracted from the value obtained after the challenge. Four challenge tasks were considered: 1) “picture”, 2) “veterinarian check”, 3) “bridge” and 4) “threat”. In the entire data set there were two outlying data points collected from a single dog and these values were excluded from analysis.

General Linear Models (GLM) were used to evaluate whether (and how) attachment, relationship, personality, and owner gender influence stress coping in owners and in dogs. Morning salivary control values were used as dependent variables because salivary cortisol control values did not significantly differ from salivary cortisol values during the meetings. Morning salivary control values used as dependent variables were normally distributed (Shapiro-Wilk Test). One GLM was constructed with "owner salivary cortisol morning control value [ng/ml]" as the dependent variable and one GLM was calculated with "dog salivary cortisol morning control value [ng/ml]" as the dependent variable. For both general linear models "owner gender" was included as a factor and human-dog attachment axes 1-4, human-dog relationship axis 1-4, human personality dimensions 1-5, and dog personality axis 1-4 were used as covariates. We selected these explanatory variables as main effects and removed them in the order of decreasing significance if $P>0.1$. Only terms with $P<0.1$ remained in the final model. Excluded terms were re-entered one by one into the final model to confirm that they did not explain a significant proportion of the variation (Poesel et al. 2006). Although all terms with $P<0.1$ remained in the final model (according to standard stepwise model reduction procedures) and therefore are presented in the results-section, only terms with $P<0.05$ were considered as having a significant influence on the dependent variable. All significances ($P<0.05$) are given as two-tailed tests. Alpha correction for multiple comparisons was not considered, because this generally increases the risk of type-II error at a comparatively low potential of decreasing type-I-error (Nakagawa 2004).

Results

Effects of personality, attachment and relationship on stress coping

Owners high in Openness (Neo-FFI dimension 3) had higher morning salivary cortisol control values than owners low in Openness ($p<0.001$). Owners high in Conscientiousness (Neo-FFI dimension 5) tended to have lower morning salivary cortisol control values. Owners who found it important to spend much time with their dogs (Relationship PCA-axis 1), but did not engage in many shared activities with them (Relationship PCA-axis 4) had relatively higher morning cortisol control values, than owners, who engaged much in shared activities, but did not consider it important to spend time with their dog ($p=0.006$ and $p=0.001$). Also, female owners tended to have lower morning salivary cortisol than male owners (Table 1).

Dogs with owners scaling high in neuroticism (Neo-FFI dimension 1) had lower morning salivary cortisol control values, than those of owners scaling low in neuroticism ($p<0.001$) (Table 2; Fig. 1a). The same was true for dogs with owners low in Conscientiousness (Neo-FFI dimension 5, $p=0.002$; Fig. 1b).

Table 1: The effects of owner personality, attachment, and owner gender on owner morning salivary cortisol control values [ng/ml] (General linear model 1 with "owner morning salivary cortisol control values" as dependent variable).

Explanatory variable	df	F	p
Openness (Neo-FFI dimension 3)	1	19.213	<0.001
Conscientiousness (Neo-FFI dimension 5)	1	4.163	0.058
"(Spend) time together (Relationship PCA-axis 1)	1	9.864	0.006
"Shared activity" (Relationship PCA-axis 4)	1	15.172	0.001
Owner gender	1	3.063	0.099

Table 2: Effects of owner personality, attachment and owner gender on dog morning salivary cortisol control values [ng/ml] (General linear model 2 with "dog morning salivary cortisol control values" as dependent variable).

Explanatory variable	df	F	p
Neuroticism (Neo-FFI dimension 1)	1	24.765	<0.001
Conscientiousness (Neo-FFI dimension 5)	1	13.739	0.002
"Meaningful companion" (Attachment PCA axis 2)	1	4.154	0.058
"Social partner" (Attachment PCA axis 3)	1	14.560	0.002
"Shared activity" (Relationship PCA axis 4)	1	7.372	0.015

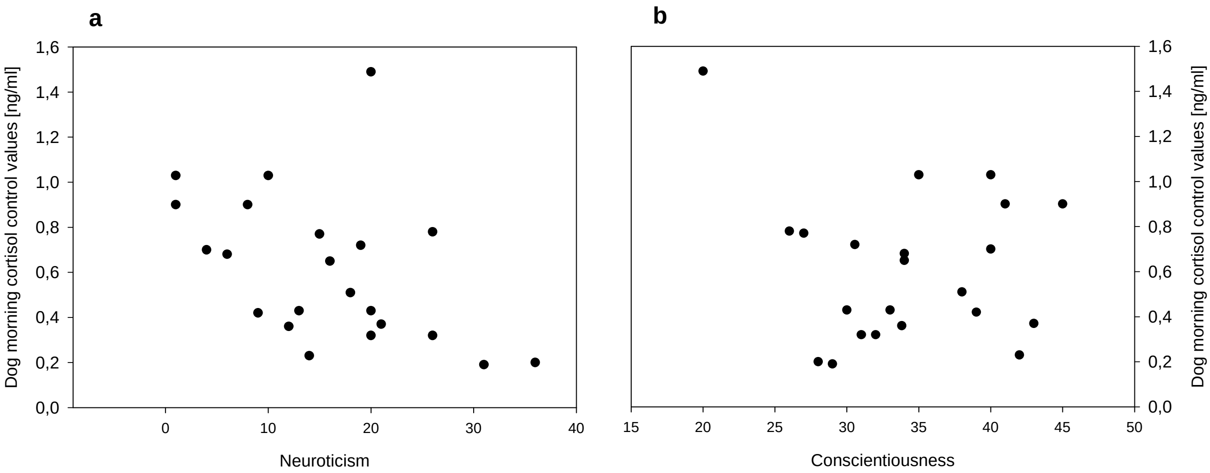

Figure 1: The relationship between owner personality: (a) “Neuroticism” (Neo-FFI dimension 1) and (b) “Conscientiousness” (Neo-FFI dimension 5) and dogs’ salivary cortisol secretion during daily life [ng/ml].

Dogs of owners who considered them as being a “social partner” (Attachment PCA axis 3) showed lower morning salivary cortisol control values than dogs of owners scaling low on this axis (p=0.002). Such a trend was also found in dogs of owners who considered them as “meaningful companion” (Attachment PCA axis 2; Table 2). The lower the morning cortisol of owners, the more important it was for them to share activities with their dogs, but in the converse was found for their dogs: the higher their morning salivary cortisol, the more important it was for their owners to share activities with them (Relationship PCA axis 4; p=0.001 and p=0.015; Table 1 and 2; Fig. 2).

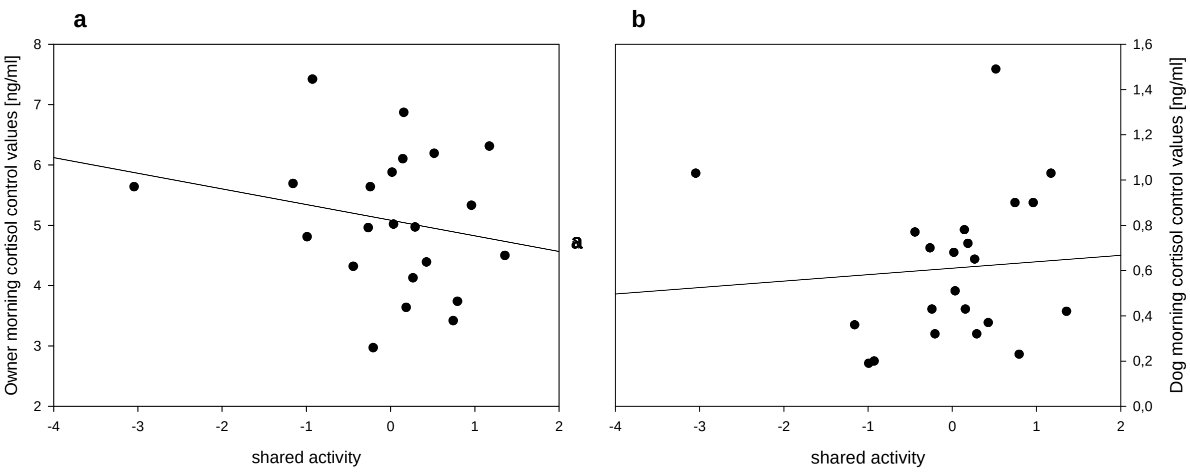

Figure 2: The relationship between “(shared) activity” and stress coping in owner-dog dyads during daily life: (a) Owners’ salivary cortisol secretion during daily life was lower the more important it was for them to share activities with their dog, (b) dogs’ salivary cortisol secretion during daily life was lower the less important it was for the owners to share activities with them.

Effects of the challenge tasks on salivary cortisol concentrations in owners and dogs

During the first visit by the two experimenters at the dyad's home, dog salivary cortisol increased initially, but decreased thereafter, to increase again during the walk (Friedman: *n*=17, χ^2=8.59, *df*=2, *P*=0.01; Fig. 3). During this home visit by the (female) experimenters, male owners showed a greater increase in salivary cortisol at the beginning of the meeting than female owners (Mann Whitney-U: *n*=22, *Z*=-2.05, *P*=0.04; Fig. 4). Actually, 8 of 12 female owners even showed a decrease in this situation, while this was the case in just three of 10 male owners. During the other two meetings no differences in the dogs' or owners' salivary cortisol levels were detected.

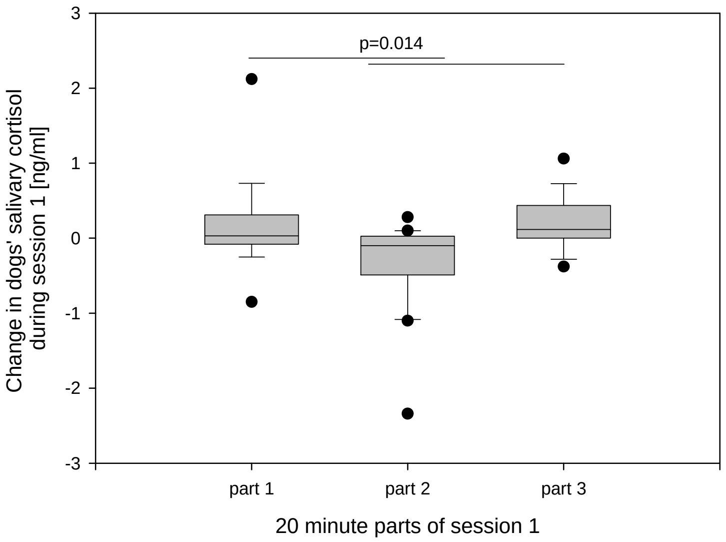

Figure 3: The changes in dog's salivary cortisol during the first meeting at the owner's home. During the initial period of the first meeting (strangers entering the dyad´s home, part 1) the dogs' cortisol increased, but decreased after 20 minutes (part 2) and increased again during the walk (part 3) (Friedman: *n*=17, χ^2=8.59, *df*=2, *P*=0.01).

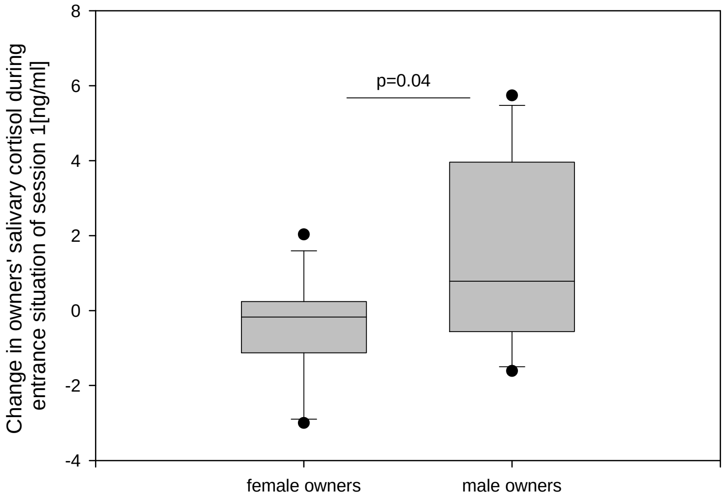

Figure 4: The changes in owner salivary cortisol during the first meeting at the owner's home. Comparison of male and female owners' salivary cortisol secretion during the initial period of the first meeting (strangers entering the dyad's home) male owners had a greater increase in salivary cortisol than female owners. Mann Whitney-U: n=22, Z=-2.05, P=0.04.

Control salivary cortisol levels did not differ significantly from the initial salivary cortisol levels at the start of the three meetings both among owners and among dogs (Wilcoxon: owner meeting 1: n=22, Z=-0.47, P=0.64; dog meeting 1: n=21, Z=-1.17, P=0.24; owner meeting 2: n=22, Z=-0.15, P=0.88; dog meeting 2: n=19, Z=-1.51, P=0.13; owner meeting 3: n=22, Z=-0.13, P=0.9; dog meeting 3: n=20, Z=-0.97, P=0.33).

There were no significant differences in salivary cortisol values before and after the four challenge tasks ("picture", "veterinarian check", "bridge" and "threat") in dogs as well as their owners (Friedman: owners: n=22, χ^2=0.93, df=3, P=0.82, dogs: n=16, χ^2=1.23, df=3, P=0.75). In addition, owners and their dogs did not react differently to these four test situations (Mann Whitney-U: "Pictures": n=41, Z=-0.44, P=0.66; "Vet Check": n=42, Z=-0.01, P=0.99; "Bridge": n=41, Z=-0.01, P=0.99; "Threat": n=40, Z=-0.11, P=0.91). During control days, no correlations between owner and dog morning salivary cortisol values were found (Spearmans: n=22, r_s=0.18, P=0.43).

Owner gender had no significant effect on salivary cortisol secretion during the four different main test situations in owners as well as in dogs (Mann Whitney-U: owners: n=22 "Picture": Z=-0.46, P=0.64; "Vet Check": Z=-1.39, P=0.17; "Bridge": Z=-0.63, P=0.53; "Threat": Z=-0.2, P=0.84; dogs: "Picture": n=19, Z=-0.45, P=0.65; "Vet Check": n=20, Z=-0.2, P=0.85; "Bridge": n=19, Z=-0.12, P=0.9; "Threat": n=18, Z=-0.71, P=0.48).

Discussion

In the present paper we investigated the effects of owner gender, owner and dog personality, relationship and attachment on cortisol modulation in human-dog dyads. We asked whether and how these factors influence cortisol values after different challenges and during daily life. In accordance with our predictions, we found significant effects of owner personality as well as owner attachment and relationship with the dog on morning salivary cortisol levels in both owners and dogs. But contrary to expectation, we found no effects of our challenges on owner or dog salivary cortisol, with the exception of the home visit. This is in alignment with previous findings that mild challenges, for instance, training situations, will not greatly affect dog cortisol levels (Haubenhofer, Möstl and Kirchengast 2005).

We found that owner personality parameters were connected to human-dog dyadic stress coping. For example, owners scaling high in neuroticism had dogs with low morning salivary cortisol control values. Dyads with conscientious owners showed the opposite effect. This is in accordance with our previous results showing that owners high in neuroticism consider, and actually need, their dogs as emotional social supporters (Kotrschal et al. 2009). Furthermore these dogs spent more time in proximity to their owners and approached their owners more often in our “picture viewing” situation (Wedl et al 2010). These findings support the idea that dogs in a close personal relationship with their owners show relatively low cortisol reactivity (Gunnar 1998). Interestingly, the practical functionality of dyads with owners high in neuroticism in the “bridge” task was rather low (Kotrschal et al. 2009), paralleling our present results that dogs of owners appreciating their dogs for shared activities had relatively high morning salivary cortisol. Both owner personality and owner-dog relationship patterns indicate that personality and relationship is correlated with proximity within the dyad. This may, in turn, influence stress modulation in dogs. This observation is in agreement with Topal, Miklosi and Csanyi (1997) who found that that the quality of human-dog relationship affects the dog's behavior in a practical task.

The fact that dogs considered as being a “social partner” and as a “meaningful companion” showed low morning salivary cortisol control values confirms that the quality of the relationship in human-dog dyads is reflected in physiological parameters as is the case in human-human dyads (Serpell 1991, 1996; Friedmann, Thomas and Eddy 2000; Allen, Blascovich and Mendes 2002) and that a close relationship is related to low salivary cortisol levels (Gunnar 1998). This also supports the idea, that the owner-dog bond generally fits a human-human model, or more specifically, the parent-offspring attachment model (Voith

1985) and that the human-dog bond may even be comparable with the attachment known to exist between human infants and their caretakers (Palmer and Custance 2008). Separation from the caregiver in an unfamiliar environment evokes anxiety in human infants and also in dogs (Topál et al. 1998), suggesting that functional analogies exist between infant and dog attachment (Gácsi et al. 2001; Topal et al. 2005).

During the first meeting, male owners appeared to be less relaxed than female owners during the visit of the two female experimenters and, in contrast to female owners, showed a significant increase in salivary cortisol. However, during the staged challenges no sex differences were found. We speculate that either men are more responsive than women with regards to the intrusion of strangers into their home, or that the presence of unknown female experimenters caused this initial response in men. The male dogs in our study also consistently showed a salivary cortisol increase during the first 20 minutes of this home visit, which was followed by a decrease during the next 20 minutes. We suggest that strangers entering the home may be considered a challenge for both the male dogs and for their male owners. In case of the dog, this may be interpreted as a territorial response, whereas in the male owners there may also have been a socio-sexual component, related to the female experimenters. Notwithstanding the exact motivational background, this supports the idea that social stressors are among the most effective stressors in vertebrates (Von Holst 1988; McEwen and Wingfield 2003; Wascher, Arnold and Kotrschal 2008).

Most of our experimental challenges did not elicit detectable cortisol responses in the participants, probably because they were not sufficiently intense. Even the “threat” challenges, which should have been rather unpredictable und uncontrollable by the dog, did not elicit a detectable salivary cortisol response. This is particularly surprising given that, in some cases, the challenge triggered marked behavioral reactions in the dog. It was found that salivary cortisol even decreased during the meetings. It is possible that the dyads used in our study were atypical of the general population and responded in a relatively relaxed manner to the challenge tasks. However, we believe this to be unlikely and favour an explanation that our challenge tasks too closely mimicked daily-life situations to which our dyads may have been used to handle. In addition, we cannot exclude the possibility that dyadic partners may have viewed the challenge tasks as being “staged”. It is known that difficult conditions may not trigger a physiological stress response unless they are unpredictable (Creel 2001). This theory is in accordance with a study that found that even during collection of saliva samples in a clinical setting there were no correlations between physiological stress of dog and excitement of dog (Dreschel and Granger 2009).

Due to the relatively small sample size, the interpretation of our pilot study needs to be accordingly cautious. Conclusions have to be restricted to only male dogs, the range of dog and owner ages recruited, and the few variables that were included in the statistical analysis. One could also criticize that different dog breeds participated within this pilot study, but the effect of the dog breed on the quality of the human-dog relationship seems to be overestimated (Wechsung 2009). In subsequent research it will become possible to recruit larger numbers of owner-dog dyads and all possible owner-dog sex combinations can be studied. It will also be possible to include behavioral parameters to extend the knowledge of how the owner-dog relationship influences stress coping.

Being mindful of these cautions, we conclude that the intrusion of strangers into the home of a dog and owner was the most stressful of our test situations, and that the main individual factors for stress coping in owner-dog dyads were owner personality, relationship and attachment. Besides providing some insights into the nature of dyadic relationships (inter- and intra-specific), our results also suggest that it may be important to employ a systemic/dyadic approach in owner-dog coaching and to consider owner personality and the nature of the human-dog relationship.

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References

Allen, K. 2003. Are pets a healthy pleasure? The influence of pets on blood pressure. *Current Directions in Psychological Science* 12 (6), 236-239.

Allen, K., Blascovich J. and Mendes, W. B. 2002. Cardiovascular reactivity and the presence of pets, friends, and spouses: The truth about cats and dogs. *Psychosomatic Medicine* 64, 727-739.

Beetz, A., Kotrschal, K., Turner, D., Hediger, K., Uvnäs-Moberg and K., Julius, H. 2011. The effect of social support by a dog in insecurely attached children: An exploratory study. *Anthrozoös*, in press.

Beerda, B., Schilder, M. B., Van Hoff, J. A. and De Vries, H. W. 1997. Manifestation of chronic and acute stress in dogs. *Appl. Anim. Behav. Sci., 52*, 307-319.

Borkenau, P. and Ostendorf, F. 1993. NEO-Fünf-Faktoren Inventar (NEO-FFI) nach Costa und McCrae, Göttingen, Hogrefe.

Brinks, V. 2009. Stress, emotion and cognition; role of mineralo and glucocorticoid receptors. Department of Medical Pharmacology, Gorlaeus Laboratories, Leiden University-LACDR, Leiden, The Netherlands.

Cannon, W. B. 1929. *Bodily Changes in Pain, Hunger, Fear and Rage*. Appleton, New York.

Clutton-Brock, J. 1995. In: *The domestic dog: Its evolution, behaviour and interaction with people*, 7-20, ed. J. Serpell. Cambrige University Press: Cambridge,

Coppinger, L. and Coppinger, R. 2003. *Hunde.* Animal learn Verlag.

Costa, P. T. and McCrae, R. R. 1989. The NEO PI/FFI manual supplement. Odessa, Florida: *Psychological Assessment Resources.*

Creel, S. 2001. Social dominance and stress hormones. *Trends in Ecology and Evolution* 16 (9), 491-497.

DeVries, C. A., Glasper, E. R. and Detillion, C. E. 2003. Social modulation of stress responses. *Physiology and Behavior* 79, 399-407.

Dreschel, N., A. and Granger, D., A. 2009. Methods of collection for salivary cortisol measurement in dogs. *Hormones and Behavior* 55, 163–168

Feaver, J., Mendl, M. and Bateson, P. 1986. A method for rating the individual distinctiveness of domestic cats. *Animal Behaviour* 34, 1016-25.

Friedmann, E., Thomas, S. A. and Eddy, T. J. 2000. Companion animals and human health: physical and cardiovascular influences. In: *Companion animals and us: Exploring the relationships between people and pets*, 125-142, ed. A.L. Podberscek, E. Paul and J.A. Serpell. Cambridge University Press, Cambridge UK.

Gácsi, M., Topál, J., Miklósi, Á., Dóka, A. and Csányi, V. 2001. Attachment behaviour of adult dogs (Canis familiaris) living at rescue centres: Forming new bonds. *Journal of Comparative Psychology*, 115, 423–431.

Goodson, J. L. 2005. The vertebrate social behaviour network: Evolutionary themes and variations. *Hormones and Behavior* 48, 11-22.

Goldstein, D. S. and McEwen, B. 2002. Allostasis, Homeostasis, and the Nature of Stress. *Stress* 5 (1), 55-58.

Gosling, S. D., Kwan, V. S. Y. and John, O. P. 2003. A Dog's Got personality: A Cross-Species Comparative Approach to Personality Judgements in Dogs and Humans. *Journal of Personality and Social Psychology* 85 (6), 1161-1169.

Gosling, S. D. 2001. From mice to men: What can we learn about personality from animal research? *Psychological Bulletin* 127, 45-86.

Gunnar, M. R. 1998. Quality of early care und buffering of neuroendocrine stress reactions: Potential effects on the developing human brain. *Preventative Medicine* 27, 208-211.

Hart, L. 1995. Dogs as human companions: a review of the relationship. In: *The domesticated dog its evolution behaviour and interaction with people,* 161-178, ed. J. Serpell. Cambridge University Press, Cambridge UK.

Haubenhofer, D., Möstl, E. and Kirchengast, S. 2005. From the Institute for Anthropology at the University Vienna1 and the Institute for Biochemistry, Department for Natural Sciences, at the University of Veterinary Medicine, Vienna. Cortisol concentrations in saliva of humans and their dogs during intensive training courses in animal assisted therapy. Vet. Med. Austria / Wien. *Tierärztliche Monatsschrift* 92, 66 – 73.

Hennessy, M. B., Williams, M. T., Miller, D. D., Douglas, C. W. and Voith, V. L.1998. Influence of male and female petters on plasma cortisol and behaviour: can human interaction reduce the stress of dogs in a public animal shelter? *Appl. Anim. Behav. Sci.* 61, 63–77.

Johannson, E. E. 1999. Human-Animal Bonding: An Investigation of Attributes. University of Alberta PhD.

Jun-Feng Pang, Kluetsch, C., Xiao-Ju Zou, Ai-bing Zhang, Li-Yang Luo, Angleby, H., Ardalan, A., Ekström, C., Sköllermo, A., Lundeberg, J., Matsumura, S., Leitner, T., Ya-Ping Zhang and Savolainen, P. 2009. mtDNA Data Indicates a Single Origin for Dogs South of Yangtze River, less than 16,300 Years Ago, from Numerous Wolves. *Molecular Biology and Evolution*, 26 (12): 2849-2864.

Kobelt A. J., Hemsworth P. H., Barnett J. L. and Butler K. L. 2003. Sources of sampling variation in saliva cortisol in Dogs. *Research in Veterinary Science Volume* 75, Issue 2, Pages 157-161.

Koolhaas, J. M., Korte, S. M., De Boer, S. F., Van Der Vegt, B. J., Wan Reenen, C. G., Hopster, H., De Jong, I. C., Ruis, M. A. W. and Blokhuis, H. J. 1999. Coping styles in animals: current status in behavior and stress-physiology. *Neuroscience and Biobehavioral Reviews* 23, 925–935.

Korte, S. M., Koolhaas, J. M., Wingfield, J. C. and McEwen, B. S. 2005. The Darwinian concept of stress: benefits of allostasis and costs of allostatic load and the trade-offs in health and disease. *Neuroscience and Biobehavioral Reviews* 29, 3-38.

Kotrschal, K., Schöberl, I., Bauer, B., Thibeaut, A.-M. and Wedl, M. 2009. Dyadic relationships and operational performance of male and female owners and their male dogs. *Behavioral Processes* 81, 383 - 391.

Kotrschal, K. 2005. Why and how vertebrates are social: physiology meets function. Plenary contribution IEC Budapest, Aug. 2005.

Kotrschal, K., Bromundt, V. and Föger, B. 2004. *Faktor Hund. Eine sozio-ökonomische Bestandsaufnahme der Hundehaltung in Österreich*. Czernin-Verlag, Wien.

Kotrschal, K. and Ortbauer, B. 2003. Behavioural effects to the presence of a dog in the classroom. *Anthrozoös* 16, 147-159.

Koyama, T., Omata, Y. and Saito, A. 2003. Changes in salivary cortisol concentrations during a 24-hour period in dogs. *Horm Metab Res., 35*(6), 355-7.

Magnano, C. L., Diamond, E. J. and Gardner, J. M. 1989. Use of salivary cortisol measurements in young infants: a note of caution. *Child Dev.* 60, 1099–1101.

McEwen, B. S. and Wingfield, J. C. 2003. The concept of allostasis in biology and biomedicine. *Hormones and Behavior* 43, 2-15.

Mech, L. D. 1999. Alpha status, dominance and division of labor in wolf packs. *Canadian Journal of Zoology* 77, 1196-1203.

Nakagawa, S. 2004. A farewell to Bonferroni: the problems of low statistical power and publication bias. *Behavioural Ecology* 15, 1044–1045.

Palme, R. and Möstl, E. 1997. Measurement of cortisol metabolites in faeces of sheep as a parameter of cortisol concentration in blood. Zeitschrift für Säugetierkunde - *International Journal of Mammalogy. Biol.* 62, 192-197, Suppl. 2.

Palmer, R. and Custance, D. 2008. A counterbalanced version of Ainsworth's Strange Situation Procedure reveals secure-base effects in dog–human relationships. *Applied Animal Behaviour Science*, 109, 306–319.

Panksepp, J. 1998. *Affective Neuroscience. The foundations of human and animal emotion.* Oxford University Press, New York.

Poesel, A., Kunc, H. P., Foerster, K., Johnsen, A. and Kempenaers, B. 2006. Early birds are sexy: male age, dawn song and extrapair paternity in blue tits, Cyanistes (formerly Parus) caeruleus. *Animal Behaviour* 72, 531-538.

Podberscek, A. L. and Gosling, S. D. 2000. Personality research on pets and their owners: Conceptual issues and review. In: *Companion animals and us: Exploring the relationships between people and pets,* 143-167, ed. A. L. Podberscek, E. Paul, J. A. Serpell, Cambridge University Press, Cambridge, UK.

Prato-Previde, E., Fallani, G. and Valsecchi, P. 2006. Gender Differences in Owners Interacting with Pet Dogs: An Observational Study. *Ethology* 112, 63-73.

Sapolsky, R. M. 1994. *Why zebras don't get ulcers: A guide to stress, stress-related diseases and coping*. Freeman, W. H., New York.

Savolainen, P., Zhang, Y., Luo, J., Lundeberg, J. and Leitner, T. 2002. Genetic evidence for an East Asian Origin of Domestic Dogs. *Science* 298, 1610-1613.

Scheiber, I. B. R., Weiss, B. M., Frigerio, D. and Kotrschal, K. 2005. Active and passive social support in families of Greylag geese (Anser anser). *Behaviour* 142, 1535-1557.

Schleidt, W. M. and Shalter, M. D. 2003. Co-evolution of humans and canids. An alternative view of dog domestication: Homo Homini Lupus? *Evolution and Cognition* 9(1).

Selye, H. 1951. The general-adaptation-syndrome. *Annual Review of Medicine* 2, 327-342.

Serpell, J. A. 1996. Evidence for association between pet behavior and owner attachment levels. *Applied Animal Behavior Science* 47, 49-60.

Serpell J. A. (Ed.) 1995. *The domestic dog: Its evolution, behaviour and interaction with people.* Cambridge University Press, Cambridge, pp. 245-255.

Serpell, J. A. 1991. Beneficial effects of pet ownership on some aspects of human health and behaviour. *Journal of Royal Society of Medicine* 84, 717-720.

Shirtcliff, E. A., Granger, D. A., Schwartz, E. and Curran, M. 2001. Use of salivary biomarkers in biobehavioral research: cotton based sample collection methods can interfere with salivary immunoassay results. *Psychoneuroendocrinology* 26, 165–173.

Sih, A., Bell, A. M., Johnson, J. C. and Ziemba, R. E. 2004. Behavioral syndromes: an integrative overview. *Quarterly Reviews of Biology* 79, 241–277.

Stratakis, C. A., Gold, P. W. and Chrousos, G. P. 1995. Neuroendocrinology of stress: implications for growth and development. *Hormone research, 43*(4), 162-7.

Topál, J., Gácsi, M., Miklósi, Á., Virányi, Z., Kubinyi, E. and Csányi, V. 2005. Attachment to humans: a comparative study on hand-reared wolves and differently socialized dog puppies. *Animal Behaviour*, 70, 1367–1375.

Topal, J., Miklosi, A. and Csanyi, V. 1997. Dog-human relationship affects problem solving behaviour in the dog. *Anthrozoös* 10 (4), 214-223.

Topàl, J., Miklòsi, À., Csànyi, V., and Dóka, A. 1998. Attachment behavior in dogs (Canis familiaris): A new application of Ainsworth's (1969) strange situation test. *Journal of Comparative Psychology,* 112, 219-229.

Van Cauter, E. and Speigel, K. 1999. Circadian and sleep control of endocrine secretions. In: F.W. Turek & P.C. Zee (Eds.), *Neurobiology of sleep and circadian rhythms*. New York: Marcel Dekker.

Vas, J., Topal, J., Gacsi, M., Miklosi, A. and Csanyi, V. 2005. A friend or an enemy? Dogs' reaction to an unfamiliar person showing behavioural cues of threat and friendliness at different times. *Applied Animal Behaviour Science* 94, 99-115.

Vila, C., Savolainen, P., Maldonado, J. W., Amorim, I. R., Rice, J. E., Honeycutt, R. L., Crandall, K. A., Lundenberg, J. and Wayne, R. K. 1997. Multiple and ancient origins of the domestic dog. *Science* 276 (5319), 1687-1689.

Voith, V. L. 1985. Attachment of people to companion animals. Veterinary Clinicians of North America: *Small Animal Practice* 15, 289-296.

Von Holst, D. 1988. The concept of stress and its relevance for animal behavior. *Advances in Behaviour* 27, 1–131.

Wascher, C.A.F., Arnold, W. and Kotrschal, K. 2008. Heart rate modulation by social contexts in greylag geese (*Anser anser*). *Journal of Comparative Psychology* 122, 100-107.

Weaver, A. and De Waal, F. B. M. 2002. An Index of Relationship Quality Based on Attachment Theory. *Journal of Comparative Psychology* 116, 93-10.

Wechsung S. 2009. *Mensch und Hund. Beziehungsqualität und Beziehungsverhalten*. Roderer Verlag.

Wedl, M., Schöberl I., Bauer B., Day J. and Kotrschal K. 2010. Relational factors affecting dog social attraction to human partners. *Interaction Studies*, 11 (3), 482-503.

Wenger-Riggenbach B., Boretti F. S., Quante S., Schellenberg S., Reusch C. E. and Sieber-Ruckstuhl N. S. 2010. Salivary Cortisol Concentrations in Healthy Dogs and Dogs with Hypercortisolism. *Journal of Veterinary Internal Medicine*, Volume 24, Issue 3, pages 551–556.

Appendix

Social and individual components of animal contact in preschool children

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Social and Individual Components of Animal Contact in Preschool Children

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ABSTRACT Humans are generally biophilic. Still, for unknown reasons, interest in animals varies substantially among individuals. Our goal was to investigate how differential interest of children towards animals might be related to social competence and personality. We proposed two alternatives: 1) Children may compensate for potential deficits in social competence by resorting to animals, and 2) Socially well-connected children may show a particular interest in animals. We focused on relationships between age, gender, family background, play behavior, personality components, and contact with rabbits in 50 children (22 boys/28 girls; 3 to 7 years of age) at a preschool in Krems/Austria. Data were analyzed using GLM. We found that each one of these variables had significant impact on intensity of engagement with the rabbits. In general, girls, children with siblings, and children without pets were more oriented towards the rabbits than were boys, children without siblings, or pet-owning children. The older the children, the less frequently they occupied themselves with the rabbits but the longer they remained when they did engage them. Furthermore, we found that the more "Confident/Respected" (PCA factor 1) and less "Patient/Calm," "Cheerful/Sociable," and "Solitary" (PCA factors 2–4) the children, the more time they spent in direct occupation with rabbits. Most effects of the investigated variables varied between boys and girls. By and large, our findings support the hypothesis that the "socially competent" children were particularly interested in the animals. Also, children's social styles, as evinced in interactions with peers, were generally reflected in how they interacted with the rabbits.

Keywords: companion animals, human–animal interactions, personality, pets, rabbits

Contact with animals may positively affect human health and well-being (e.g., Katcher and Beck 1985; Collis and McNicholas 1998; Friedmann 2000), notably through the ability of animals to provide social support, to physically activate their human companions (Bachmann 1975; Brickel 1982), and to increase their social contact with

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other humans (Mugford and M'Comisky 1975; Messent 1983; McNicholas and Collis 2000). Companion animals also may increase the social status of children within their peer groups (Guttmann, Predovic and Zemanek 1985). The presence of a dog in a classroom increased children's attentiveness and social cohesion (Kotrschal and Ortbauer 2003), and children in a classroom with a dog present were shown to have developed greater self-confidence and social competence than children in a control group without a dog (Hergovich et al. 2002). Such results support pedagogical common sense that animal contact benefits child development. In fact, an increasing number of institutions have been integrating animals into their programs.

This was the case in a preschool in Krems (Austria), where 50 children between 3 and 7 years of age had free access to rabbits during a specified period every day. This situation allowed us to tackle the question: Why, despite the general human tendency toward biophilia (Wilson 1984), does interest in animals vary quantitatively and qualitatively among individuals? Whether, and to what extent, humans enjoy the company of animals is a complex matter (Serpell 1986). Although animal lovers are sometimes seen as indulging their interest at the expense of their regard for fellow humans, this does not actually seem to be the case (Paul 1995; 2000). Our present study of preschool children may have the potential to shed more light onto the question of how interest in animals is related to social and individual parameters. Our goal was to investigate whether and how differential demonstration of interest in animals could be related to age, gender, family background, play behavior, and personality components—variables we considered to be the most important factors in children of this age group.

We hypothesized that the presence of animals could compensate for individual deficits in social connectivity (social compensation hypothesis), or, conversely, that socially competent children would be particularly interested in animals (Paul 2000; social competence hypothesis) and would therefore seek more contact with the rabbits.

Methods

Participants

We studied 50 children (28 girls and 22 boys, 3 to 7 years of age; Table 1) at a preschool in Krems/Austria, operated by a staff of seven female teachers and assistants. Children were not divided into groups assigned to specific rooms or spaces; all were able to utilize the entire premises, which offered a range of possibilities for group play and solitary play.

Table 1. Gender and age of children as related to year of attendance at the preschool.

Year of Attendance at the Preschool	Number of Children	Gender (*n* female/*n* male)	Mean Age (years)	Age Range (years)
1st	17	9/8	4.17	3.3–4.6
2nd	17	10/7	5.15	4.8–5.6
3rd	16	9/7	6.19	5.7–7.0

Setting

During the observation period, one large, adult, male rabbit occupied a cage in the garden and two smaller adult, female rabbits along with three young were housed in two hutches in the preschool building's entrance area. The male rabbit was regularly released into a larger enclosure in the garden and the other rabbits were allowed to move freely in the entrance area. All children had free, ad libitum access to the rabbits during free playtime from 0700 until 1200 hours, except during daily programs (generally 0830–0845 hours, 1000–1100 hours). They had been instructed how to treat the rabbits appropriately and mutual social control enforced these rules. No serious mishandling or abuse of rabbits was ever observed.

Procedure

As a matter of principle, our research was as "minimally invasive" as possible; that is, none of the usual routines in the preschool was changed or significantly adapted for data collection. Parents were informed about the study in a parent–teacher conference and were given the opportunity to discuss our research plan and to contribute to it. Consent from all parents was obtained, as were permissions from the relevant governmental offices. A pilot study, conducted from February through April 2004, served to test and improve our procedures and to habituate the children to the observer's (first author) presence, to videotaping, and direct observation. No data from this pilot were used in the current analysis; the primary data were collected in May and June 2004. When the preschool's schedule differed from the usual daily routine, no data were taken (e.g., because of special activities, birthdays and other celebrations, visits from external preschool teachers or children, visits from trainees, trips, "open house," etc.).

Child–Animal Interactions

In the entrance area, one video camera (Sony DCR-TRV 19 E) equipped with a wide-angle lens was installed on the wall. In the garden, a second video camera (JVC GR-DVL 145) was placed on a tripod at a distance of approximately 10 meters from the rabbit enclosure. Video recordings were conducted in the mornings between 0700 and 1200 hours. Child–rabbit interactions during 9 days distributed between May 24 and June 23, 2004 were coded from these videotapes. Inter-coder reliability was tested in several video sections throughout the coding process. The percentage of agreement (duration; The Observer 5.0 software, Noldus Information Technology, The Netherlands) was 80%; as measured by calculating Cohen´s Kappa, inter-coder reliability was 0.72.

Tapes were behavior-coded by the first author using The Observer 5.0. Because many children passed through the foyer observation area for reasons unrelated to interest in the rabbits, we included only those children who were occupied with the animals at least once while in the observation field. Coding started when the child entered the field and ended when he/she left. During the 9 days coded, each of the 50 children attended preschool for 4 to 9 mornings. The male rabbit was released into the garden enclosure on 7 of the 9 days, and one or more of the rabbits housed in the entrance area were taken out of their hutches on 5 of the 9 days.

All relevant behaviors shown by the children while focused on, and interacting with, the rabbits were coded via continuous recording. For statistical analysis, the behaviors (Table 2) were later grouped into the following categories: "direct occupation with rabbits" (one or more rabbits directly at the focus of attention/action) and "indirect occupation with rabbits" (focus of occupation is only indirectly related to rabbits). The category "proximity to rabbits" (child's presence apparently unrelated to rabbits but in connection with prior or subsequent occupation with them) was also used for analysis. We used the terms "occupy" and "occupation" to encompass the various ways children were observed to exhibit and act on their interest in rabbits. Because not all children were present in the preschool during all observation days, data were standardized with respect to observation effort (per observation day). The frequency of being occupied with rabbits and the duration of the three categories of occupation (direct and indirect occupation with rabbits and proximity to rabbits) were used for statistical analysis.

Table 2. Specific behaviors constituting direct and indirect occupation with rabbits and definitions.

Behavior	Definition
Watch Rabbits [a]	Child observes one or more rabbits without direct or indirect engagement with them.
Watch Persons in Contact with Rabbits [a]	Child observes interaction between one or more persons and one or more rabbits without being directly engaged.
Stroke Rabbit [a]	Child passes one or both hands over a rabbit's fur.
Hold Rabbit [a]	Child holds a rabbit in his/her arms or on lap.
Feed Rabbits [a]	Child places food into rabbit enclosure or hutch or feeds rabbit(s) by hand.
Reach into Hutch [a]	Child reaches into rabbit hutch without touching a rabbit.
Open or Close Hutch Door [a]	Child handles hutch in the act of opening or closing the door.
Follow Rabbits [a]	Child moves after one or more rabbits.
Look for Rabbits [a]	Child looks around or behind furniture in entrance area or enclosure.
Talk to Rabbit [a]	Child speaks to rabbit while simultaneously orienting his/her face toward rabbit.
Take Rabbit Out of, or Puts into, Cage [a]	Child picks up rabbit and removes it from or puts it into cage.
Touch Rabbit [a]	Child contacts rabbit but does not stroke or hold rabbit.
Chase Rabbit [a]	Child rapidly pursues rabbit.
Drop Rabbit [a]	Child lets rabbit fall or pushes it.
Talk about Rabbits [b]	Child participates in a conversation about rabbits.
Look through Rabbit Books [b]	Child looks through one or more rabbit books.
Pick Fresh Fodder [b]	Child forages, picking greens for the rabbit in the garden.
Handle Rabbit Cage/ Enclosure Material [b]	Child touches or works with a cage, the enclosure fence or ladder, or the water trough.
Imitate Rabbit [b]	Child copies behavior of rabbit.
Clean Cage Area [b]	Child assists preschool staff in cleaning; e.g., helps with dustpan or broom.
Watch Cleaning of Cage Area [b]	Child watches someone cleaning the area around a cage.

[a] Denotes direct occupation with rabbits. [b] Denotes indirect occupation with rabbits.

Social Interactions with Other Children and Personality

Data on child play behavior were scored via direct observation during free playtime (~ 0815 to 0845 hours) throughout the entire premises, except entrance area and garden, for a total of 17 days between May 3 and June 9, 2004. At 10-minute intervals, the observer (first author) moved in a designated order through all the rooms to which children had access. Observations were conducted by visually scanning from right to left. Check sheets were used to record whether a child was playing in a group, playing in parallel to other children, playing alone, or watching the activities of other children (after Grammer 1995). Each child was observed 12 to 38 times during this period (a total of 1,413 play events). The number of children observed per scan varied because not all children were present on all days and because not all children present were visible in each scan. Therefore, percentages (from the total number of observations) of group play, parallel play, solitary play, and watching other children were calculated for each child. Inter-observer reliability was tested using sections from video recordings made with a hand-held video camera during the pilot study. Only events in which the children were fairly visible and/or audible were selected. Observations were conducted from the selected video sections by use of check sheets. Inter-observer agreement on observed child play behavior was 97.9%.

Two preschool teachers independently rated the children on 12 personality items (5-point Likert scale, modified after Seabrook 1984 and Waiblinger 1996). Also, on a 5-point scale (from high to low), they rated the children's social status according to how respected each child was by their peers. We used a list of criteria, modified from Hold (1976), as a guide for rating the children on this scale. In most cases, we calculated the mean value of the independent personality ratings of the two preschool teachers. For items where the difference between the ratings of the two observers was greater than 2 on the 5-point scale (in only 12 out of 650 cases), we discarded the rating and substituted it with the rating of the first author and used the mean of this and the retained rating. In other questionnaires, we asked about pet ownership and sibling status of the children.

A Principal Component Analysis (PCA; Bartlett-Test: KMO = 0.726; Sphericity: $\chi^2 = 732.695$, $df = 136$, $p < 0.001$) with varimax rotation of data on child play behavior and on the rated personality items revealed four major components: "Confident/Respected," "Patient/Calm," "Cheerful/Sociable," and "Solitary" (Table 3, p. 388). These explained 77% of the variance.

Analysis

Data analysis was carried out with the aid of The Observer 5.0. and SPSS 15.0 (Chicago, IL, USA). We conducted four generalized linear models (GLMs) with a log-link function and based on Poisson distribution.

The first GLM was constructed with "frequency of occupation with rabbits" as the response variable (dependent variable); "gender," "siblings yes/no," "pets yes/no" as factors; and "age," "PCA factor 1," PCA factor 2," PCA factor 3" and "PCA factor 4" as covariates. We selected these explanatory variables as main effects and included interactions between gender and each of the other explanatory variables. These interactions were chosen because other studies have reported gender differences in human–animal relationships (e.g., Ray 1982; Paul and Serpell 1992; Rost and Hartmann 1994; Herzog 2007), and we expected that the other explanatory variables would have different effects on the intensity of occupation with rabbits, depending on whether the child involved was a boy or a girl. We conducted pairwise comparisons with Bonferroni-correction to determine the differences between boys with siblings and without, between boys with pets at home and without, and the same for girls. The other three GLMs were constructed with "duration of direct occupation with rabbits," "duration of indirect occupation with rabbits," and "duration of proximity to rabbits" as response variables.

In all four models, we removed explanatory variables in order of decreasing significance (if $p > 0.1$). Only terms with $p < 0.1$ remained in the final model. Excluded terms were re-entered one by one into the final model to confirm that they did not explain a significant part of the variation (Poesel et al. 2006). Non-significant terms are not presented below. For the significant terms, we present Wald statistics.

Results

Gender Effects

Girls were occupied with the rabbits more often, and spent more time with them (direct and indirect occupation with rabbits and staying in proximity to rabbits), than the boys (Table 4 and Figure 1a–d).

Table 3. Results of Principal Component Analysis on data of child play behavior and personality items. The values represent the loading of each variable on the factors. Loadings of 0.500 or above are in bold.

	Principal Components			
Items Scored by Preschool Teachers on a 5-Point Scale and Data on Play Behavior	**1: Confident/ Respected**	**2: Patient/ Calm**	**3: Cheerful/ Sociable**	**4: Solitary**
Meek–Not Meek	**0.844**	–0.184	0.034	–0.023
Lacking Confidence–Confident	**0.843**	0.085	0.340	–0.074
Low Social Status Among Peers–High Social Status Among Peers	**0.810**	0.093	0.131	–0.195
Suspicious of Change–Liking Change	**0.800**	0.099	0.421	–0.029
One Who Keeps Quiet–One Who Speaks One's Mind	**0.794**	–0.288	0.323	0.021
Giving in Easily–Forceful	**0.792**	–0.346	0.111	0.095
Unsociable–Sociable	**0.673**	–0.092	**0.579**	–0.138
Giving up Easily–Persevering	**0.642**	**0.534**	0.096	0.171
Not Talkative–Talkative	**0.600**	–0.336	**0.514**	0.126
Impatient–Patient	–0.113	**0.887**	0.039	–0.017
A Worrier–Not a Worrier	–0.276	**0.858**	–0.025	–0.055
Difficult to Get on with–Easy-Going	0.423	**0.566**	**0.565**	0.114
Grumpy–Cheerful	0.315	0.121	**0.851**	–0.074
% of Group Play	0.000	–0.043	–0.034	**–0.989**
% of Watching Other Children	–0.255	–0.144	–0.176	**0.722**
% of Parallel Play	0.481	0.315	0.031	**0.534**
% of Solitary Play	0.020	–0.021	0.476	**0.533**

Children with Siblings

In general, children with siblings were occupied with the rabbits significantly more often, and spent more time with them (direct and indirect occupation with rabbits and staying in proximity to rabbits), than were only-children (Table 4 and Table 5). Three models revealed significant interactions with gender (Table 4). Both boys and girls with siblings were more often occupied with the rabbits, and were directly occupied with them for longer periods of time, than were only-children (Post-hoc test: all $p < 0.001$), but the difference in frequency was greater between boys with and without siblings, whereas the difference in duration of direct occupation was greater between girls with and without siblings (Table 5). Furthermore, girls with siblings spent significantly longer periods of time in proximity to the rabbits than girls without, whereas there was no significant difference between boys with siblings and without (Post-hoc test: girls: $p < 0.001$, boys: $p = 1.000$; Table 5).

Children with Pets of Their Own

Children without pets at home were in general significantly more often occupied with the rabbits, and spent significantly more time with them (direct and indirect occupation with the rabbits and staying in proximity to the rabbits), than were pet-owning children (Table 4 and Table 6). All four models revealed significant interactions with gender (Table 4). Girls without pets were occupied with the rabbits more often, and spent more time directly occupied with them, than were pet-owning girls, but no such differences were found in boys (Post-hoc test:

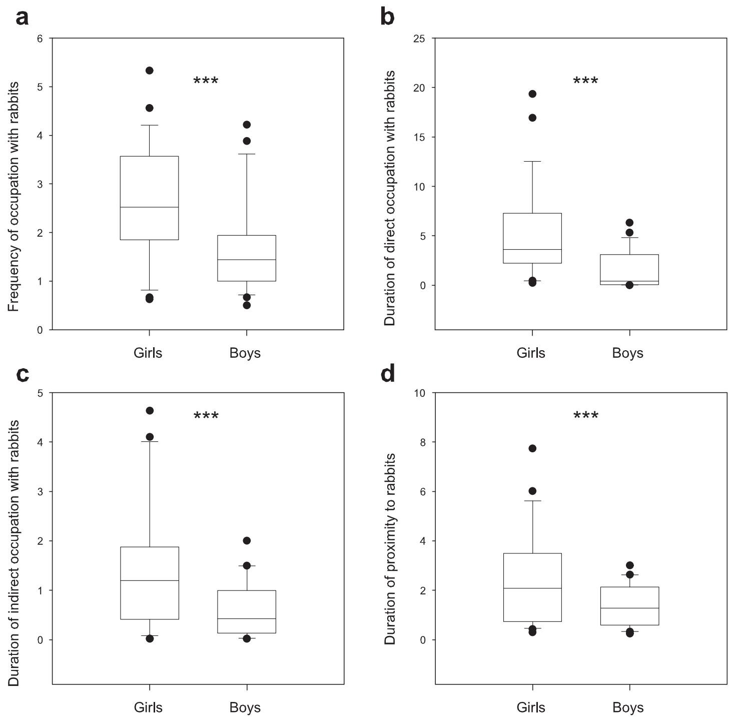

Figure 1. Gender differences in (a) mean frequency of occupation with rabbits (mean number of entrances into observation range followed by engagement with rabbits) per child per day, (b) mean duration of direct, (c) indirect occupation with rabbits, and (d) proximity to rabbits [min/child/day]; girls: $n = 28$, boys: $n = 22$. Box and whisker plots represent medians, upper and lower quartiles, and maximum and minimum scores. Dots indicate outliers. Asterisks mark significant differences, $^{***}p < 0.001$.

frequency: girls: $p < 0.001$, boys: $p = 1.000$; direct occupation: girls: $p < 0.001$, boys: $p = 0.824$; Table 6). In both boys and girls, children without pets at home spent more time indirectly occupied with the rabbits, and in proximity to them, than did pet-owning children (Post-hoc test: all $p < 0.001$), but the difference was greater in girls (Table 6).

Age Effects

In general, the older the children, the less often they were occupied with the rabbits (Table 4 and Figure 2a) and the less time they spent in proximity to the rabbits (Table 4 and Figure 2d), but the more time they spent in direct occupation with them (Table 4 and Figure 2b). Two models also revealed significant interactions with gender (Table 4): the decrease of time spent in proximity with age (Figure 2d) and the increase of time spent in direct occupation with age (Figure 2b) were both more pronounced in girls than in boys.

Effects of Social Interactions with Other Children and Child Personality

"Confident/Respected": The more "confident/respected" children (PCA factor 1; Table 3) spent proportionately more time in direct (Table 4 and Figure 3b) and indirect occupation with the rabbits (Table 4 and Figure 3c), and less time in proximity to them (tendency; Table 4 and

Table 4. Wald statistics for generalized linear models (GLMs) 1–4, with 1. "Frequency of occupation with rabbits" (mean number of entrances into observation range followed by engagement with rabbits), 2. "Duration of direct occupation with rabbits," 3. "Duration of indirect occupation with rabbits," and 4. "Duration of proximity to rabbits" (mean duration of categories [min/child/day]) as response variables.

	Generalized Linear Models (GLMs) 1–4											
	1: Frequency of Occupation with Rabbits			2: Duration of Direct Occupation with Rabbits			3: Duration of Indirect Occupation with Rabbits			4: Duration of Proximity to Rabbits		
Model Term	**Wald Statistic**	***df***	***p***	**Wald Statistic**	***df***	***p***	**Wald Statistic**	***df***	***p***	**Wald Statistic**	***df***	***p***
Gender	522.922	1	< 0.001	39.233	1	< 0.001	682.817	1	< 0.001	125.389	1	< 0.001
Siblings (yes/no)	167.926	1	< 0.001	2048.388	1	< 0.001	322.349	1	< 0.001	47.788	1	< 0.001
Pets (yes/no)	37.589	1	< 0.001	436.365	1	< 0.001	290.152	1	< 0.001	341.513	1	< 0.001
Age	322.581	1	< 0.001	10.031	1	0.002		Excluded		552.346	1	< 0.001
Confident/Respected		Excluded		163.977	1	< 0.001	92.544	1	< 0.001	3.352	1	0.067
Patient/Calm	247.900	1	< 0.001	857.640	1	< 0.001	169.487	1	< 0.001	64.902	1	< 0.001
Cheerful/Sociable		Excluded		121.046	1	< 0.001	31.689	1	< 0.001	11.749	1	0.001
Solitary		Excluded		39.671	1	< 0.001	32.703	1	< 0.001	143.415	1	< 0.001
Gender * Siblings (yes/no)	21.494	1	< 0.001	314.681	1	< 0.001		Excluded		30.677	1	< 0.001
Gender * Pets (yes/no)	45.407	1	< 0.001	339.195	1	< 0.001	4.329	1	0.037	136.028	1	< 0.001
Gender * Age		Excluded		11.124	1	0.001		Excluded		55.430	1	< 0.001
Gender * Confident/Respected	130.381	2	< 0.001	18.646	1	< 0.001	20.097	1	< 0.001	136.091	1	< 0.001
Gender * Patient/Calm	251.550	1	< 0.001	1066.446	1	< 0.001		Excluded		10.217	1	0.001
Gender * Cheerful/Sociable	26.634	2	< 0.001	1044.577	1	< 0.001	7.397	1	0.007	5.267	1	0.022
Gender * Solitary	36.524	2	< 0.001	27.467	1	< 0.001		Excluded		49.651	1	< 0.001

Excluded = term was excluded from this final model because $p > 0.1$; * = interaction.

Table 5. Median frequencies (range) of occupation with rabbits (number of entrances into observation range followed by engagement with rabbits) per child per day and median duration (range) of occupation categories [min/child/day], per groupings of children according to sibling status and gender. Significant differences are shown in bold.

	Girls (n = 28)		Boys (n = 22)		Total (n = 50)	
Response Variable	**W/ Siblings (n = 20)**	**W/O Siblings (n = 8)**	**W/ Siblings (n = 16)**	**W/O Siblings (n = 6)**	**W/ Siblings (n = 36)**	**W/O Siblings (n = 14)**
Frequency of Occupation with Rabbits	**2.53 (1.33–5.33)**	**2.63 (0.63–3.57)**	**1.44 (0.50–4.22)**	**1.44 (0.83–2.11)**	**2.06 (0.50–5.33)**	**1.47 (0.63–3.57)**
Duration of Direct Occupation with Rabbits	**4.81 (0.78–19.36)**	**2.37 (0.23–9.16)**	**2.36 (0.55–12.37)**	**0.52 (0.41–3.67)**	**3.37 (0.55–19.36)**	**1.27 (0.23–9.16)**
Duration of Indirect Occupation with Rabbits	1.43 (0.19–4.63)	0.71 (0.02–2.27)	0.53 (0.02–2.00)	0.13 (0.02–1.50)	**0.84 (0.02–4.63)**	**0.35 (0.02–2.27)**
Duration of Proximity to Rabbits	**2.08 (0.46–7.74)**	**1.86 (0.30–4.05)**	1.26 (0.24–3.01)	1.49 (0.50–2.60)	**1.32 (0.24–7.74)**	**1.49 (0.30–4.05)**

Table 6. Median frequencies (range) of occupation with rabbits (number of entrances into observation range followed by engagement with rabbits) per child per day and median duration (range) of occupation categories [min/child/day], per groupings of children according to whether or not they had pets of their own and gender. Significant differences are shown in bold.

	Girls (n = 28)		Boys (n = 22)		Total (n = 50)	
Response Variable	**W/ Pets (n = 16)**	**W/O Pets (n = 12)**	**W/ Pets (n = 6)**	**W/O Pets (n = 16)**	**W/ Pets (n = 22)**	**W/O Pets (n = 28)**
Frequency of Occupation with Rabbits	**2.22 (0.67–4.00)**	**3.06 (0.63–5.33)**	1.55 (0.83–3.00)	1.44 (0.50–4.22)	**2.00 (0.67–4.00)**	**1.95 (0.50–5.33)**
Duration of Direct Occupation with Rabbits	**2.70 (0.45–10.04)**	**4.81 (0.23–19.36)**	2.36 (1.70–5.32)	1.43 (0.41–12.37)	**2.55 (0.45–10.04)**	**3.06 (0.23–19.36)**
Duration of Indirect Occupation with Rabbits	**0.79 (0.02–3.19)**	**1.73 (0.02–4.63)**	**0.46 (0.14–0.87)**	**0.43 (0.02–2.00)**	**0.74 (0.02–3.19)**	**0.96 (0.02–4.63)**
Duration of Proximity to Rabbits	**0.89 (0.43–3.59)**	**3.14 (0.30–7.74)**	**1.00 (0.35–2.13)**	**1.34 (0.24–3.01)**	**0.89 (0.35–3.59)**	**1.66 (0.24–7.74)**

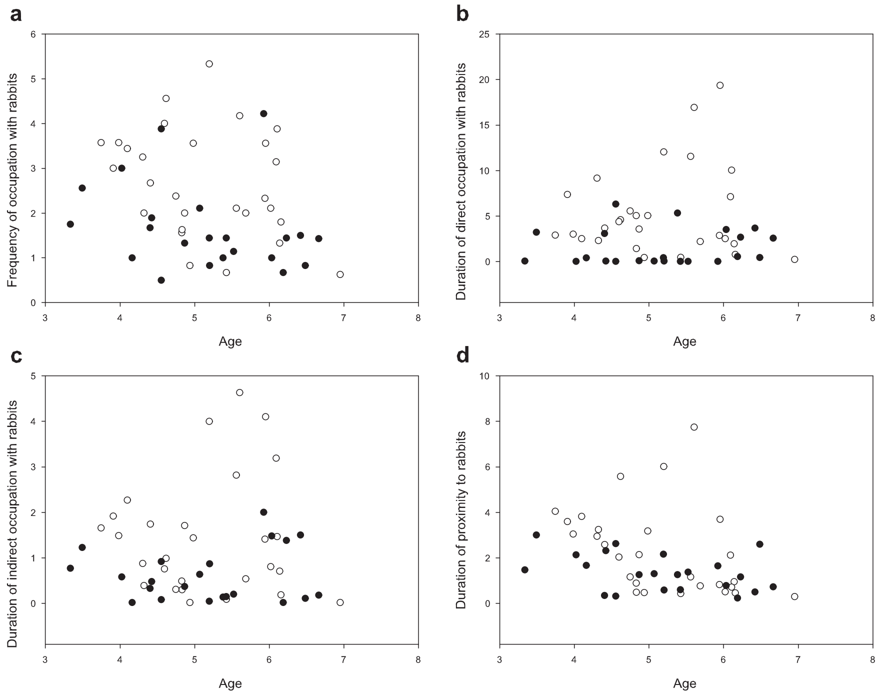

Figure 2. The relationship between age of child (years), and (a) mean frequency of occupation with rabbits (mean number of entrances into observation range followed by engagement with rabbits) per child per day and (b) mean duration of direct, (c) indirect occupation with rabbits, and (d) proximity to rabbits [min/child/day]; ❍ girls (n = 28), ● boys (n = 22).

Figure 3d). All four models revealed significant interactions with gender (Table 4). The more "confident/respected" the boys, the less often they were occupied with the rabbits (Figure 3a), but the longer they were directly occupied with them (Figure 3b); this was not the case in girls. The more "confident/respected" the girls and boys, the longer they were indirectly occupied with the rabbits (Figure 3c), and the less time they spent in proximity to them (Figure 3d), but in boys these relationships were more pronounced.

"Patient/Calm": In general, the more "patient/calm" the children (PCA factor 2; Table 3), the less often they were occupied with the rabbits (Table 4) and the less time they spent with them (direct and indirect occupation and proximity to the rabbits; Table 4). However, three models revealed significant interactions with gender (Table 4). The more "patient/calm" the boys, the less often they were occupied with the rabbits and the less time they spent directly occupied with them, but in girls these relationships were not found. The more "patient/calm" the girls and boys, the less time they spent in proximity to the rabbits, but this relationship was more pronounced in boys.

"Cheerful/Sociable": The more "cheerful/sociable" the children (PCA factor 3; Table 3), the less time they spent in direct occupation with the rabbits (Table 4), but the more time they spent in indirect occupation with them (Table 4) and in proximity to them (Table 4). All four models revealed significant interactions with gender (Table 4). The more "cheerful/sociable" the boys,

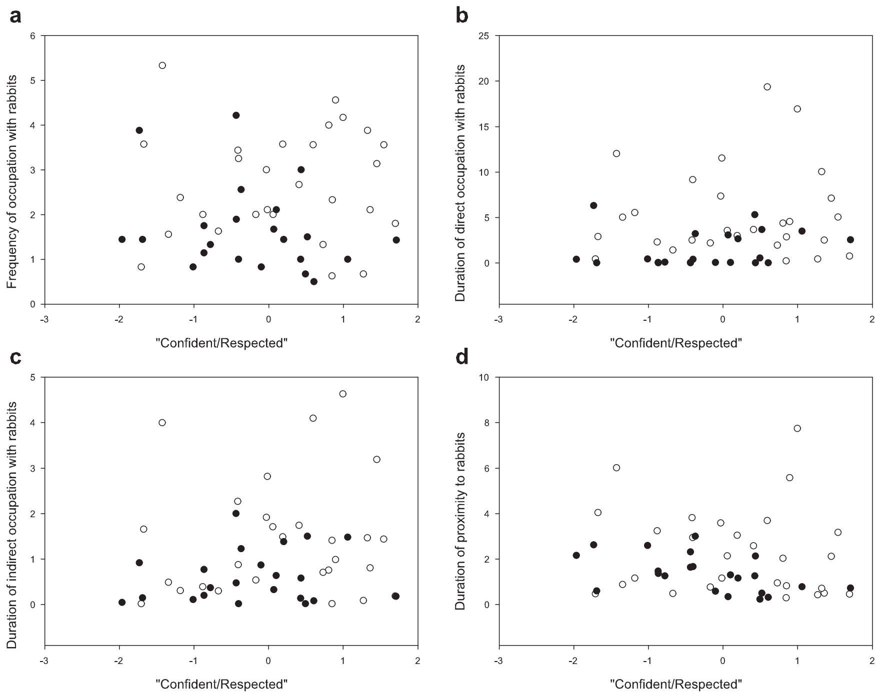

Figure 3. The relationship between the PCA factor 1 "Confident/Respected," and (a) mean frequency of occupation with rabbits (mean number of entrances into observation range followed by engagement with rabbits) per child per day and (b) mean duration of direct, (c) indirect occupation with rabbits, and (d) proximity to rabbits [min/child/day]; ❍ girls (*n* = 28), ● boys (*n* = 22).

the less often they were occupied with the rabbits (vague relationship) and the less time they spent in direct occupation with them, but in girls there were no such relationships. The more "cheerful/sociable" the girls, the more time they spent in indirect occupation with the rabbits and in proximity to them, but in boys we did not find such relationships.

"Solitary": The more "solitary" (PCA factor 4; Table 3) the children, the less time they spent in direct and indirect occupation with the rabbits (Table 4), but the more time they spent in proximity to them (Table 4). Three models revealed significant interactions with gender (Table 4). The more "solitary" the boys and girls, the more often they were occupied with the rabbits, but in boys this relationship was more pronounced. The more "solitary" the boys, the more time they spent in direct occupation with the rabbits, while more "solitary" girls, spent proportionately less time in direct occupation with them; furthermore, the relationship in boys was more pronounced. The more "solitary" the boys, the more time they spent in proximity to the rabbits, but in girls we did not find this relationship.

Discussion

We found that the girls were generally more engaged with the rabbits than the boys. This result is consistent with those of a number of previous studies. For example, Paul and Serpell (1992) and Rost and Hartmann (1994) showed that girls were more likely to desire a pet than

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boys and maintained stronger emotional relationships with their pets (Ray 1982). Kotrschal and Ortbauer (2003) found no gender differences in interacting with a dog in a classroom of children aged 10 years, but behavior changes in the presence of the dog were more pronounced in the boys than in the girls.

Overall, our findings support the "social competence" hypothesis. In concurrence with findings that a strong bond between a child and a companion animal is contingent upon social competence and empathy (Poresky and Hendrix 1990; Poresky 1996), children high on the "confident/respected" and low on the "solitary" factors (Table 3) were particularly engaged in directly interacting with the rabbits. In contrast, less "confident/respected" and more "solitary" children spent greater amounts of time in proximity to, but less time directly occupied with, rabbits. The fact that these children, who often watched others play without joining in, also spent much time near the rabbits without directly or indirectly becoming occupied with them may indicate that they were shy or socially reluctant. However, they were not isolated or "socially incompetent." Perhaps some insecure, relatively low-ranking children are not especially interested in rabbits themselves, but benefit from them by getting into contact with other children in their area. Indeed, a "social lubricant effect" of animals has been reported by a number of researchers (e.g., Messent 1983; McNicholas and Collis 2000; Hergovich et al. 2002; Kotrschal and Ortbauer 2003). Animals seem to be excellent vehicles for conversation (Endenburg 2003).

Interestingly, children with pets of their own have been found to be more integrated in their class, embedded within more extended social networks, and generally more popular among their classmates (Endenburg and Baarda 1995) than children without pets. Taking care of a pet may indeed enhance self-confidence, social acceptance, and communication with humans (Messent 1983; Hunt, Hart and Gomulkiewicz 1992; Poresky 1996; McNicholas and Collis 2000; Endenburg 2003). Alternatively, it may well be that families that allow pet-keeping may provide a different social environment than families that don't. In the present study, children without pets were significantly more often occupied with the rabbits and spent significantly greater amounts of time directly and indirectly engaged with, and in proximity to, them than pet-owning children. Children with siblings were generally more intensely occupied with the rabbits than children without siblings (frequency of occupation with rabbits and duration of direct and indirect occupation with rabbits and staying in proximity to rabbits). These differences parallel previous findings that family composition affects attitudes towards animals (Godwin 1975; Franti et al. 1980; Melson 1988; Kidd and Kidd 1989; Endenburg, Hart and de Vries 1990). Generally, in the present study, pet-owning and having siblings had significant effects on frequency and duration of occupation with rabbits. In girls, both pet-owning and having siblings had significant effects on frequency and duration of occupation with rabbits. In boys, however, the intensity of direct occupation with the rabbits was not related to having a pet at home but was by having siblings.

We investigated whether and how differential demonstration of interest in animals could be related to age, gender, family background, play behavior, and personality components—we considered these variables to be the most important factors in children of this age group. We did not investigate the influence of other factors such as self-esteem, social anxiety, stress level, emotional competence, self-concept, or peer group influences, primarily because of the low sample size. These factors would be interesting to address in future studies and are necessary to further our understanding of interest in contact and occupation with animals. Also, mainly because of the low sample size, we could not include exploration of pet personality features or more information about family background (e.g., age and gender of siblings; kinds of, and relationship to, pets at home; and parent's attitudes towards pets). Also, in future studies other pet animals should be considered.

Because in this preschool many children passed through the observation areas for reasons unrelated to interest in the rabbits, we included only those children who were occupied at least once with the animals while in the observation field. To investigate the idea that socially "incompetent" children may spend time near the animals without being occupied with them at all, a study with more controlled conditions should be conducted, in which the animals are kept in an area that children would approach only to spend time around them or be occupied with them.

Longitudinal studies would provide a better understanding of the role of animals in different stages of a child's development. Because starting preschool constitutes an important change in a child's life, a study focusing on the first year of attendance would provide opportunity to examine the potential influence of interest in animals on children's stress levels and the development of, and changes in, friendships and social structure.

In conclusion, our findings indicate that girls are more interested in rabbits than are boys. Children low in social status and children who watch others play rather than playing actively with others themselves tended to linger in proximity to the rabbits, rather than interacting actively with them. In contrast, the high-status, socially interactive children actively interacted with the rabbits. Hence, the social styles of these children were reflected in the way they interacted with the animals.

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References

Bachmann, R. W. 1975. Elementary school children perception of helpers and their characteristics. *Elementary School Guidance and Counseling* 10: 103–109.

Brickel, C. M. 1982. Pet facilitated psychotherapy. A theoretical explanation via attention shifts. *Psychological Reports* 50: 71–74.

Collis, G. M. and McNicholas, J. 1998. A theoretical basis for health benefits of pet ownership: Attachment versus psychological support. In *Companion Animals in Human Health*, 105–122, ed. C. C. Wilson and D. C. Turner. Thousand Oaks, CA: Sage Publications.

Endenburg, N. 2003. Tiere in der Entwicklung und Psychotherapie: Der Einfluss von Tieren auf die Frühentwicklung von Kindern als Vorraussetzung für tiergestützte Psychotherapie. In *Menschen brauchen Tiere: Grundlagen und Praxis der tiergestützten Pädagogik und Therapie,* 121–130, ed. E. Olbrich and C. Otterstedt. Stuttgart: Franckh-Kosmos.

Endenburg, N. and Baarda, B. 1995. The role of pets in enhancing human well-being: Effects on child development. In *The Waltham Book of Human–Animal Interaction: Benefits and Responsibilities of Pet Ownership*, 7–17, ed. I. H. Robinson. Exeter: Pergamon.

Endenburg, N., Hart, H. and de Vries, H. W. 1990. Differences between owners and non-owners of companion animals. *Anthrozoös* 4: 120–127.

Franti, C. E., Kraus, J. F., Borhani, N. O., Johnson, S. L. and Tucker, S. D. 1980. Pet ownership in rural northern California (El Dorado County). *Journal of the American Veterinary Medical Association* 176: 143–209.

Friedmann, E. 2000. The animal–human bond: Health and wellness. In *Handbook on Animal-Assisted Therapy. Theoretical Foundations and Guidelines for Practice,* 41–58, ed. A. H. Fine. San Diego: Academic Press.

Godwin, R. D. 1975. Trends in the ownership of domestic pets in Great Britain. In *Pet Animals and Society,* 96–102, ed. R. S. Anderson. London: Baillière Tindall.

Grammer, K. 1995. *Biologische Grundlagen des Sozialverhaltens: Verhaltensforschung in Kindergruppen.* Darmstadt: Wissenschaftliche Buchgesellschaft.

Guttman, G., Predovic, M. and Zemanek, M. 1985. The influence of pet ownership in non-verbal communication and social competence in children. In *The Human–Pet Relationship: Proceeding of the International Symposium on the Occasion of the 80th Birthday of Nobel Prize Winner Prof. DDr. Konrad Lorenz, October 27–28, 1983*, 58–63. Vienna: IEMT.

Hergovich, A., Monshi, B., Semmler, G. and Ziegler, V. 2002. The effects of the presence of a dog in the classroom. *Anthrozoös* 15: 37–50.

Herzog, H. A. 2007. Gender differences in human–animal interactions: A review. *Anthrozoös* 20: 7–21.

Hold, B. 1976. *Rangordnungsverhalten bei Vorschulkindern*. *Homo* 25: 252–267.

Hunt, S. J., Hart, L. A. and Gomulkiewicz, R. 1992. Role of small animals in social interactions between strangers. *The Journal of Social Psychology* 132: 245–256.

Katcher, A. H. and Beck, A. M. 1985. Sicherheit und Vertrautheit. Physiologische und Verhaltensreaktionen auf die Interaktion mit Haustieren. In *Die Mensch-Tier-Beziehung: Dokumentation des Internationalen Symposiums aus Anlass des 80. Geburtstages von Nobelpreisträgers Prof. DDr. Konrad Lorenz, 27. und 28. Oktober 1983,* 131–138. Wien: IEMT.

Kidd, A. H. and Kidd, R. M. 1989. Factors in adults' attitudes towards pets. *Psychological Reports* 65: 903–910.

Kotrschal, K. and Ortbauer, B. 2003. Behavioral effects of the presence of a dog in a classroom. *Anthrozoös* 16: 147–159.

McNicholas, J. and Collis, G. 2000. Dogs as catalysts for social interactions: Robustness of the effect. *British Journal of Psychology* 91: 61–70.

Melson, G. F. 1988. Availability and involvement with pets by children: Determinants and correlates. *Anthrozoös* 2: 45–52.

Messent, P. R. 1983. Facilitation social interaction by companion animals. In *New Perspectives on Our Lives with Companion Animals*, 37–46, ed. A. H. Katcher and A. M. Beck. Philadelphia: University of Pennsylvania Press.

Mugford, R. A. and M'Comisky, J. G. M. 1975. Some recent work on the psychotherapeutic value of cage birds with old people. In *Pet Animals and Society*, 54–65, ed. R. S. Anderson. London: Baillière Tindall.

Paul, E. S. 1995. Us and them: Scientists' and animal rights campaigners' views of the animal experimentation debate. *Society & Animals* 3: 1–21.

Paul, E. S. 2000. Love of pets and love of people. In *Companion Animals & Us: Exploring the Relationships between People and Pets*, 168–186, ed. A. L. Podberscek, E. S. Paul and J. A. Serpell. Cambridge: Cambridge University Press.

Paul, E. S. and Serpell, J. 1992. Why children keep pets: the influence of child and family characteristics. *Anthrozoös* 5: 231–244.

Poesel, A., Kunc, H. P., Foerster, K. and Kempenaers, B. 2006. Early birds are sexy: Male age, dawn song and extrapair paternity in blue tits, *Cyanistes* (formerly *Parus*) *caeruleus*. *Animal Behaviour* 72: 531–538.

Poresky, R. H. 1996. Companion animals and other factors affecting young children's development. *Anthrozoös* 9: 159–168.

Poresky, R. H. and Hendrix, C. 1990. Differential effects of pet presence and pet bonding on young children. *Psychological Reports* 67: 51–54.

Ray, J. J. 1982. Love of animals and love of people. *Journal of Social Psychology* 116: 299–300.

Rost, D. H. and Hartmann, A. 1994. Children and their pets. *Anthrozoös* 7: 242–254.

Seabrook, M. F. 1984. The psychological interaction between the stockman and his animals and its influence on performance of pigs and dairy cows. *The Veterinary Record* 115: 84–87.

Serpell, J. 1986. *In the Company of Animals: A Study of Human–Animal Relationships.* Oxford: Basil Blackwell.

Waiblinger, S. 1996. Die Mensch-Tier-Beziehung bei der Laufstallhaltung von behornten Milchkühen. *Tierhaltung* 24, Ökologie, Ethologie, Gesundheit, Universität/Gesamthochschule Kassel.

Wilson, E. O. 1984. *Biophilia*. Cambridge, MA: Harvard University Press.

Zusammenfassung

In meiner Dissertation untersuchte ich, welche individuellen und sozialen Faktoren die zeitlichen Strukturen von Verhalten und Interaktionen von Mensch-Katze-Dyaden und die Aufmerksamkeit von Hunden ihren Besitzern gegenüber bestimmen. Zudem wurden Verhalten, Interaktionen und Stressmanagement von Mensch-Hund-Dyaden in verschiedenen Testsituationen untersucht. Meine Dissertation war ein Teil von zwei umfangreichen Studien (Team-Forschungsprojekten). 40 Mensch-Katze-Dyaden wurden je viermal zuhause besucht, 22 Mensch-Hund-Dyaden wurden je einmal zuhause besucht, und wurden je zweimal gebeten, in unseren Testraum an der Universität Wien zu einem Treffen zu kommen. Dort wurde zum Beispiel der „Bilder"-Test durchgeführt, wo der Besitzer durch die Aufgabe, Bilder im Raum zu betrachten und zu bewerten, in seiner Aufmerksamkeit vom Hund abgelenkt wurde. Der Hund konnte sich währenddessen im Raum frei bewegen. Fragebögen wurden von insgesamt 40 Hundebesitzern ausgefüllt. In beiden Studien wurden Verhalten und Interaktionen der Dyaden während aller Treffen gefilmt. Ausgewählte Video-Ausschnitte wurden mit Hilfe der Software THE OBSERVER® kodiert und das Verhalten der Mensch-Katze-Dyaden zusätzlich auf zeitlich organisierte Muster (T-Patterns) mittels der Software Theme® analysiert. In beiden Studien wurde die Persönlichkeit des Besitzers mit Hilfe des NEO-FFI erhoben; die Persönlichkeit der Tiere wurde über Beobachter-Bewertungen ermittelt, die der Katzen zusätzlich über kodierte Verhaltensweisen. Dies bildete jeweils die Basis für Hauptkomponentenanalysen (PCAs). Ebenfalls mittels PCAs wurden die Mensch-Hund-Bindung und -Beziehung charakterisiert, wofür Fragebögen die Grundlage bildeten. Die Ergebnisse zeigten, dass in Mensch-Katze-Dyaden Verhalten und Interaktionen in zeitlich organisierte Muster gegliedert ist und dass sowohl Besitzer- und Katzenmerkmale die Anzahl und die Komplexität dieser Muster beeinflussen; die wichtigsten waren die Persönlichkeit von Besitzer und Katze, das Geschlecht des Besitzers und das Alter der Katze. Die Persönlichkeit von Besitzer und Hund, die Mensch-Hund-Bindung und -Beziehung, sowie das Geschlecht des Besitzers sind wichtige Einflussfaktoren der Aufmerksamkeit des Hundes seinem Besitzer gegenüber. Diese Ergebnisse sind für eine besseres Verständnis von Mensch-Tier-Beziehungen und -Interaktionen von Bedeutung.

Abstract

My PhD centred on the study of individual and social factors affecting temporal structuring of behaviours and interactions in human-cat dyads and dog social attraction to owners. Further investigations focused on human and dog behaviours and interactions as well as stress coping in different test situations in human-dog dyads. My PhD was part of two extensive studies (team research projects) of human-cat and human-dog dyads. Forty human-cat dyads were visited in their homes, on four occasions, 22 human-dog dyads were visited once at home, and twice were asked to attend in a specially adapted test room at the University of Vienna, where for example a “picture viewing” test was scheduled, where we diverted the owner’s attention away from their dog whilst it was permitted to move freely around the room. Eighteen other dog owners completed our questionnaires. Dyads were observed and video-taped throughout the meetings. Selected video-sections were coded using THE OBSERVER® and in human-cat dyads further analysed for temporal (t)-patterns using Theme®. In both studies owners were asked to complete the NEO-FFI; cat and dog personalities were extracted by PCA based on observer-rated items, and in cats also on coded behaviours. To characterize the quality of human-to-dog attachment and relationship, a set of questionnaires was used; two PCAs were performed, one with owner-dog relationship items and one with owner-dog attachment items. The results showed that temporal patterning of behaviours and interactions exists in human-cat dyads and that both, owner and cat features affect the number and complexity of t-patterns, especially owner and cat personality, owner gender, and age of the cat. Human attachment to dog, the quality of human-dog relationship, owner gender and personality of both owner and dog, all influence dogs´ social attraction to their owners. These findings are relevant for a better understanding of human-animal relationships and interactions.

Curriculum Vitae

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Publications

Kotrschal, K., Bauer, B., Schöberl, I. & Wedl, M. (2009): Towards the Nature of the Human-Dog Social Bond. *Journal of Veterinary Behavior: Clinical Applications and Research* 4 (2), 91-92. Publ. Abstract.

Kotrschal, K., Schöberl, I., Bauer, B., Thibeaut, A.-M. & Wedl, M. (2009): Dyadic relationships and operational performance of male and female owners and their male dogs. *Behavioural Processes* 81, 383 - 391.

Schöberl, I., Bauer, B., Dittami, J., Möstl, E., Wedl, M. & Kotrschal, K. (2009): Effects of Owner Gender and Interaction Style on Stress Coping in Human-Dog Dyads. *Journal of Veterinary Behavior: Clinical Applications and Research* 4 (2), 91. Publ. Abstract.

Wedl, M., Bauer, B., Dittami, J., Schöberl, I. & Kotrschal, K. (2009): Effects of Personality and Sex on Behavioral Patterns in Human-Dog Dyads. *Journal of Veterinary Behavior: Clinical Applications and Research* 4 (2), 88-89. Publ. Abstract.

Wedl, M. & Kotrschal, K. (2009): Social and individual components of animal contact in preschool children. *Anthrozoös* 22 (4), 383-396.

Wedl, M., Schöberl, I., Bauer, B., Day, J. & Kotrschal, K. (2010): Relational Factors Affecting Dog Social Attraction to Human Partners. *Interaction Studies* 11 (3), 482-503.

Aliabadi, I., Wedl, M., Schöberl, I., Bauer, B. & Kotrschal, K. (2011): Effects of gender on performance in human-dog dyads in an agility parcours. *Journal of Veterinary Behavior: Clinical Applications and Research* 6 (1), 57. Publ. Abstract.

Auer, M., Wedl, M., Range, F., Virányi, Z., Belényi, B. & Kotrschal, K. (2011): Leash walking as a model for cooperation between humans and wolves: the effects of personality and intensity of contact. *Journal of Veterinary Behavior: Clinical Applications and Research* 6 (1), 100-101. Publ. Abstract.

Wedl, M., Bauer, B., Grabmayer, C., Gracey, D., Spielauer, E., Day, J. & Kotrschal K. (2011): Factors influencing the temporal patterns of dyadic behaviours and interactions between domestic cats and their owners. *Behavioural Processes;* 86, 58–67.

Aliabadi, I., Wedl, M., Schöberl, I., Bauer, B. & Kotrschal, K. (in prep.): Effects of gender and personality on performance in human-dog dyads in an agility parcours.

Auer, M., Wedl, M., Range, F., Virányi, Z., Belényi, B. & Kotrschal, K. (in prep.): Leash walking as a model for cooperation between humans and wolves: the effects of personality and intensity of contact.

Sandler, G., Wedl, M., Beetz, A., Julius, H., Uvnäs-Moberg, K., & Kotrschal, K. (in prep.): Stress related behaviours in children and the impact of therapy dogs on stress coping.

Kotrschal, K., Bauer, B., Grabmayer, C., Spielauer, E., Wedl, M., Day, J. & Gracey, D. (in revision): The effects of cat sex, owner gender and owner personality on dyadic behaviour and interactions in relation to the provision of food. *Anthrozoös.*

Schöberl, I., Wedl, M., Bauer, B., Day, J., Möstl, E. & Kotrschal, K. (subm.): Effects of owner-dog relationship and owner personality on cortisol modulation in human-dog dyads. *Anthrozoös.*

Conference Contributions

Kotrschal, K. & Wedl, M.: Persönliche und soziale Komponenten der Tierbeziehung von Kindern. 2. D.A.CH.-Symposium zur Mensch-Heimtier-Beziehung, 5.5.–6.5.2006, Ismaning, Oral presentation.

Gracey, D., Bauer, B., Grabmeyer, C., Spielauer, E., Wedl, M. & Kotrschal, K.: Soziale Unterstützung: Katzen als aktive Teilnehmer. Kongress Mensch und Tier – Tiere in Prävention und Therapie, 17.5.–19.5.2007, Berlin, Oral presentation.

Kotrschal, K. & Wedl, M.: Warum und welche Kinder sich für Tiere besonders interessieren. Kongress Mensch und Tier – Tiere in Prävention und Therapie, 17.5.–19.5.2007, Berlin, Oral presentation.

Wedl, M., Schöberl, I. & Kotrschal, K.: Persönlichkeitskomponenten der Mensch-Hund-Beziehung. Kongress Mensch und Tier – Tiere in Prävention und Therapie, 17.5.–19.5.2007, Berlin, Oral presentation.

Bauer, B., Gracey, D., Grabmayer, C., Spielauer, E., Wedl, M. & Kotrschal, K.: Temporal Patterns in Human-Cat Interaction. First Central European Behavioural Biologists meeting, 22.5.2007, Vienna, Oral presentation.

Wedl, M., Schöberl, I. & Kotrschal, K.: Personality in human-dog interactions. First Central European Behavioural Biologists meeting, 22.5.2007, Vienna, Oral presentation.

Bauer, B., Gracey, D., Spielauer, E., Wedl, M. & Kotrschal, K.: Dyadic temporal interaction structure between owners and cats depends on age, sex and personalities of both, owners and cats. 30th International Ethological Conference, 15.8.-23.8.2007, Halifax, Poster.

Kotrschal, K, Schöberl, I. & Wedl, M.: Personality matching in dog-owner dyads. 30th International Ethological Conference, 15.8.-23.8.2007, Halifax, Poster.

Wedl, M., Scheiber, I. B. R. & Kotrschal, K.: Social competence parallels interest in animals in preschool children. 30th International Ethological Conference, 15.8.-23.8.2007, Halifax, Poster.

Kotrschal, K., Gracey, D., Spielauer, E., Wedl, M. & Bauer, B.: Dyadic temporal interaction structure between owners and cats as revealed by THEME. Fifth Meeting of the European Research Group on Methodology for the Analysis of Social Interaction, 8.9.-9.9.2007 Budapest, Oral presentation.

Bauer, B., Gracey, D., Spielauer, E., Wedl, M. & Kotrschal, K.: Dyadic temporal interaction structure between owners and cats depends on age, sex and personalities of both, owners and cats. 11th International Conference on Human-Animal Interactions, 5.10.-8.10.2007, Tokyo, Poster.

Kotrschal, K, Schöberl, I. & Wedl, M.: Personality matching in dog-owner dyads. 11th International Conference on Human-Animal Interactions, 5.10.-8.10.2007, Tokyo, Oral presentation.

Wedl, M. & Kotrschal, K.: Social competence parallels interest in animals in preschool children. 11th International Conference on Human-Animal Interactions, 5.10.-8.10.2007, Tokyo, Poster.

Schöberl, I., Wedl, M. & Kotrschal, K.: Effects of personality and sex on the interaction style and stress management in human-dog dyads. Meeting of Ethologische Gesellschaft, 20.2.-22.2.2008, Regensburg, Poster.

Wedl, M. & Kotrschal, K.: Social and individual components of children's contact with rabbits. Meeting of Ethologische Gesellschaft, 20.2.-22.2.2008, Regensburg, Poster.

Kotrschal, K., Bauer, B., Schöberl, I. & Wedl, M.: Towards the nature of the human-dog social bond. Canine Science Forum 2008, 5.-9.7.2008, Budapest, Oral presentation.

Schöberl, I., Bauer, B., Dittami, J., Möstl, E., Wedl, M. & Kotrschal, K.: Effects of owner sex and interaction style on stress coping in human-dog dyads. Canine Science Forum 2008, 5.-9.7.2008, Budapest, Oral presentation.

Wedl, M., Bauer, B., Dittami, J., Schöberl, I. & Kotrschal, K.: Effects of personality and sex on behavioural patterns in human-dog dyads. Canine Science Forum 2008, 5.-9.7.2008, Budapest, Oral presentation.

Kotrschal, K., Bauer, B., Gracey, D., Schöberl, I. & Wedl, M.: Towards the nature of the relationship between humans and their companion animals. 4th European Conference on Behavioural Biology, 18.-20.7.2008, Dijon, Oral presentation.

Wedl, M., Bauer, B., Dittami, J., Möstl, E., Schöberl, I. & Kotrschal, K.: Effects of personality and sex on behavioural patterns and stress coping in human-dog dyads. 4th European Conference on Behavioural Biology, 18.-20.7.2008, Dijon, Oral presentation.

Schöberl, I., Bauer, B., Dittami, J., Möstl, E., Wedl, M. & Kotrschal, K.: Effects of owner sex and interaction style on stress coping in human-dog dyads. 42nd Congress of the International Society for Applied Ethology, 5.-9.8.2008, Dublin, Poster.

Wedl, M., Bauer, B., Dittami, J., Schöberl, I. & Kotrschal, K.: Personality factors affecting human-canine interactions. 42nd Congress of the International Society for Applied Ethology, 5.-9.8.2008, Dublin, Oral presentation.

Schöberl, I., Bauer, B., Dittami, J., Möstl, E., Wedl, M. & Kotrschal, K.: Auswirkungen von Interaktionsstil und Geschlecht des Besitzers auf das Stress-Management in Mensch-Hund Dyaden. 2. Kongress Mensch und Tier, 25.-27.9.2008, Berlin, Oral presentation.

Wedl, M., Bauer, B., Dittami, J., Schöberl, I. & Kotrschal, K.: Eine verhaltensbiologisch-psychologische Untersuchung zur Qualität der Mensch-Hund-Beziehung. 2. Kongress Mensch und Tier, 25.-27.9.2008, Berlin, Oral presentation.

Kotrschal, K., Day, J. & Wedl, M.: Effects of human personality on relational patterns with companion dogs and cats. ISAZ 2010 Conference - Cross Cultural Perspectives on Human-Animal Interaction, 30.6.2010, Oral presentation.

Aliabadi, I., Wedl, M., Schöberl, I., Bauer, B. & Kotrschal, K.: Effects of gender and personality on performance in human-dog dyads in an agility parcours. 12th International

IAHAIO Conference on Human-Animal Interactions, 1.7.-4.7.2010, Stockholm, Oral presentation.

Wedl, M., Schöberl, I., Bauer, B., Day, J. & Kotrschal, K.: Relational factors affecting dog attachment to human partners. 12th International IAHAIO Conference on Human-Animal Interactions, 1.7.-4.7.2010, Stockholm, Oral presentation.

Aliabadi, I., Wedl, M., Schöberl, I., Bauer, B. & Kotrschal, K.: Effects of gender on performance in human-dog dyads in an agility parcours. Canine Science Forum 2010, 25.-28.7.2010, Vienna, Poster.

Auer, M., Wedl, M., Range, F., Virányi, Z., Belényi, B. & Kotrschal, K.: Leash walking as a model for cooperation between humans and wolves: the effects of personality and intensity of contact. Canine Science Forum 2010, 25.-28.7.2010, Vienna, Poster.

Schöberl, I., Wedl, M., Bauer, B., Day, J., Möstl, E. & Kotrschal, K.: Stress coping in human-dog dyads. Canine Science Forum 2010, 25.-28.7.2010, Vienna, Oral presentation.

Wedl, M., Schöberl, I., Bauer, B., Day, J. & Kotrschal, K.: Dog social attraction to human partners: A pilot study. Canine Science Forum 2010, 25.-28.7.2010, Vienna, Poster.

Auer, M., Wedl, M., Range, F., Virányi, Z., Belényi, B. & Kotrschal, K.: Leash walking as a model for cooperation between humans and wolves: the effects of personality and intensity of contact. KLF Anniversary Symposium: Frontiers in Behavioural Biology, 24.-25.9.2010, Vienna, Poster.

Wedl, M., Schöberl, I., Bauer, B., Day, J. & Kotrschal, K.: Dog social attraction to human partners: A pilot study in male and female owners and their male dogs. KLF Anniversary Symposium: Frontiers in Behavioural Biology, 24.-25.9.2010, Vienna, Poster.

Kotrschal, K. & Wedl, M.: Zum Einfluss der Persönlichkeit von Hund und Halter auf ihre soziale Interaktion. 47. Kongress der Deutschen Gesellschaft für Psychologie, 26.-30.9.2010, Bremen, Oral presentation.

Application for funds

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