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Associations between the Psychological Characteristics of the Human–Dog Relationship and Oxytocin and Cortisol Levels

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ABSTRACT The aim of the present study was to explore possible correlations between dog owners' relationships with their dogs, as measured with the Monash Dog Owner Relationship Scale (MDORS), and oxytocin and cortisol levels in both the owners and their dogs. Ten female owners of male Labrador Retrievers completed the MDORS. The scores obtained from the single items, subscales, and total score of the MDORS were calculated. Ten blood samples were collected from each dog owner and her dog during a 60-minute interaction. Blood samples were analyzed for oxytocin and cortisol by Enzyme Immuno Assay (EIA) and mean values of oxytocin and cortisol were calculated in both owners and dogs. The MDORS scores obtained were correlated with basal and mean oxytocin and cortisol levels. The correlation analysis revealed some relationships between the scores of items in the MDORS that reflect the character of the dog–owner-relationship and the owners' hormone levels. For example, higher oxytocin levels in the owners were associated with greater frequency in kissing their dogs ($r_s = 0.864$, $p = 0.001$). Lower cortisol levels in the owners were associated with their perception that it will be more traumatic when their dog dies ($r_s = –0.730$, $p = 0.025$). The correlation analysis also revealed some relationships between the scores of items in the MDORS and the dogs' hormone levels. For example, greater frequency in owners kissing their dogs was associated with higher oxytocin levels in the dogs ($r_s = 0.753$, $p = 0.029$). Six items in the subscale Perceived Costs, as well as the subscale itself, correlated significantly with the dogs' oxytocin levels ($r_s = 0.820$, $p = 0.007$), that is, the lower the perceived cost, the higher the

dogs' oxytocin levels. In addition, significant correlations between the oxytocin levels of the owners and the dogs were demonstrated. Possible mechanisms behind these correlations are discussed. In conclusion, the scores of some items and the subscales of the MDORS correlated with oxytocin, and to a lesser extent cortisol, levels in both the owners and dogs.

Keywords: cortisol, dog, dog owner, MDORS, oxytocin

The relationship between humans and animals, especially between humans and their companion dogs, can be a close emotional connection. Dogs often have the status of family members and are frequently described by owners as a source of emotional support (Walsh 2009).

Attachment, according to Bowlby and Ainsworth (Bowlby 1969; Bowlby 1973; Bowlby 1980; Ainsworth 1989), is a description of the relationship between a child and his/her mother. Bonding, on the other hand, is used to describe the positive interaction between mothers and their infants (Kennell and Klaus 1998). Both types of relationships are characterized by positive emotions in the sense that both individuals experience pleasure and security in the presence of each other, and anxiety and distress when separated. Lately, it has been suggested that the relationship between a dog owner and his/her dog might represent expressions of attachment/bonding (Topal et al. 1998; Prato-Previde, Spiezio and Sabatini 2003; Palmer and Custance 2008).

The neuropeptide oxytocin plays an important role in bonding and attachment between mother and young in all mammalian species, as well as other types of relationships such as in pair bonding (Carter 1998; Insel et al. 1998; Uvnäs-Moberg, Arn and Magnusson 2005). Oxytocin is produced in the supraoptic nucleus (SON) and paraventricular nucleus (PVN) of the hypothalamus and was originally described as a hormone released into the circulation during labor and suckling (Richard, Moos and Freund-Mercier 1991). However, oxytocin neurons from the PVN also project to important regulatory areas within the brain.

Animal studies have shown that administration of oxytocin induces different types of social behavior, including maternal behavior, bonding between mother and young, and pair bonding (Carter 1998; Insel et al. 1998). In addition, oxytocin induces anxiolytic-like, pain relieving and sedative effects (Uvnäs-Moberg et al. 1994; Amico et al. 2004); decreases cortisol levels (Petersson, Hulting and Uvnäs-Moberg 1999) and blood pressure (Petersson et al. 1996; Holst, Uvnäs-Moberg and Petersson 2002); and influences the release of gastrointestinal hormones (Petersson et al. 1999). Some of these effects have been shown to be sustained for several weeks, even months, after repeated administration of oxytocin (Uvnäs-Moberg 1998; Uvnäs-Moberg and Petersson 2010).

Similar effects as those seen in animals have also been demonstrated in humans following the administration of oxytocin as a nasal spray. Oxytocin has been shown to increase social skills, decrease anxiety and stress, and increase trust (Heinrichs et al. 2003; Kosfeld et al. 2005).

The same effects seen in both animals and humans after the administration of oxytocin can also be seen after endogenous oxytocin release in response to non-noxious stimulation, such as massage, skin-to-skin contact, breastfeeding, and after positive social interactions (Uvnäs-Moberg and Petersson 2010). For example, rats exposed to stimulation of the sciatic nerve or gentle stroking (massage) display increased oxytocin levels (Stock and Uvnäs-Moberg 1988), increased pain thresholds (Lund et al. 2002), decreased pulse and blood pressure (Lund et al. 1999; Holst, Uvnäs-Moberg and Petersson 2002), and decreased cortisol levels (Tsuchiya, Nakayama and Sato 1991).

In addition, mothers who are breastfeeding or having skin-to-skin contact with their infants display increased oxytocin levels (Nissen et al. 1996; Matthiesen et al. 2001; Jonas et al. 2009) and decreased cortisol levels and blood pressure (Liu et al. 1997; Jonas et al. 2008a; Handlin et al. 2009). They also become less anxious, calmer, and more inclined to social interactions (Uvnäs-Moberg 1996; Nissen et al. 1998; Jonas et al. 2008b). A similar effect was also observed in infants (Christensson et al. 1995; Bystrova et al. 2003; Jonas et al. 2007).

In breastfeeding mothers, the oxytocin effects are induced as an acute response to the actual interaction; but in response to the repeated interaction, and hence repeated exposure to oxytocin, these effects are also transformed into long-term effects. In addition, individual mothers have their own oxytocin levels, and mothers with higher basal oxytocin levels are more interactive with their children and more sensitive to their children's cues (Feldman et al. 2007).

Interaction between humans and dogs is followed by a release of oxytocin in both species and also by reduced cortisol levels and blood pressure (Odendaal and Meintjes 2003; Miller et al. 2009; Handlin et al. 2011). It is not known, however, whether the type of relationship a dog owner has with his/her dog is reflected in endocrine parameters. Owners with high oxytocin levels may hypothetically have a more caring and interactive character or personality and therefore a more positive attitude towards their dogs, just as mothers with high oxytocin levels are more interactive and sensitive to their infants' needs (Feldman et al. 2007). It is also possible that dogs with high oxytocin levels may be more interactive and more sensitive to their owners' physiological and mental status. Alternatively, the interaction between the dog and its owner may induce long-term, secondary endocrine changes, resulting in increased oxytocin levels.

Since oxytocin is released in response to each positive interaction between a dog and its owner, and since repeated administration of oxytocin can induce long-term, anti-stress effects, a long lasting relationship involving repeated close interaction between owners and dogs might give rise to a reduction in blood pressure and cortisol levels. In fact, interaction between dog owners and dogs has been shown to result in lower cortisol levels for the dogs. Furthermore, dogs with highly interactive owners have low cortisol levels in comparison with those with less interactive owners (Kotrschal et al. 2009).

The quality and type of relationship between dog owners and their companion dogs can be evaluated by inventories such as the Monash Dog Owner Relationship Scale (MDORS), which concerns both positive and negative aspects of the relationship with a companion dog.

In the present study, we wanted to investigate whether there are associations between the quality of the relationship between a dog and its owner and the oxytocin and cortisol levels in both owners and dogs. Ten female dog owners completed the 28-item MDORS questionnaire, and blood samples from both the owners and the dogs were collected. The answers from the MDORS questionnaire were then correlated with the owners' as well as the dogs' oxytocin and cortisol levels.

Methods

Participants

The study was conducted at the Swedish University of Agricultural Sciences in Skara, Sweden. Through information gathered at local workplaces and local veterinarian clinics, the prospective participants were informed of the study and the experimental design. As a result, ten privately owned male Labrador Retrievers and their female owners were recruited to the study. Eligible participants were middle-aged women (35–70 years) who owned a male Labrador older than 1 year, where both owner and dog did not have any current documented illnesses.

The mean age of the owners was 53 years (*SD* = 10) and the mean age of the dogs was 4.7 years (*SD* = 3).

Before the experiment started, the owners were informed about the study; they were given the opportunity to ask any questions regarding the experiment, and were informed that they could end their participation at any time. The owners then signed an informed consent form to participate in the study. The experimental procedure for the human participants was approved by the Local Ethics Committee in Uppsala, and the procedure for the dogs was approved by the Animal Ethics Committee in Uppsala. The use of privately owned dogs was approved by the National Board of Agriculture.

MDORS

The Monash Dog Owner Relationship Scale (MDORS) was developed by Dwyer, Bennett and Coleman in 2006 to assess the perceived relationship between dog owners and their companion dogs. The scale consists of 28 items where the dog owner selects one of five possible responses, labeled 1 to 5 for each item, with 1 representing the lowest frequency or the least positive response and 5 representing the highest frequency or the most positive response. The items can then be further arranged into sub-scales. The subscale Dog–Owner Interaction reflects both general activities related to the care of the dog and more intimate activities; this subscale indicates the amount of time spent together as well as the opportunity for shared emotional experiences and reciprocal interactions. The subscale Perceived Emotional Closeness contains items relating to social support, affectional bonding, psychological attachment, companionship, and unconditional love. The subscale Perceived Costs addresses the cost of caring for a companion dog; this subscale includes the monetary aspects and increased responsibility and restrictions placed on the owner because of the dog (Dwyer, Bennett and Coleman 2006). The MDORS score has no absolute value, so what constitutes an average, high, or low score is not known and probably varies depending on the type of dogs and groups of humans investigated.

In the present study, the item “My dog gives me a reason to get up in the morning” was excluded because some owners interpreted it as a positive statement, while others interpreted it as a negative statement. For a similar reason, the item “There are major aspects of owning a dog I don’t like” was also excluded due to owners’ different interpretations of the item as either a positive or a negative statement. The item “How often do you take your dog in the car?” was excluded because not all dog owners had a car. Therefore these three items were not included in the summarized scores for the different subscales or in the total score of the MDORS.

Experimental Setup

The owner and her dog arrived together at the testing facility. The experiment was performed in a room located on the second floor of one of the buildings in the university campus. It was an ordinary room, designed to look like a regular living room with a desk, four chairs, a book case, and a water bowl for the dog. Both the owner and the dog had a cannula inserted for blood sampling before the experiment started, according to the procedure described by Handlin et al. (2011).

The Interaction Experiment and MDORS

The owner sat in a chair during the entire experiment while the dog was let loose (i.e., off-leash), sitting or lying beside her. At time point zero, the owner sat in close contact with her dog and started to pet and stroke different parts of the dog’s body and talked to the dog for

three minutes. After three minutes of interaction, the owner remained seated in her chair and did not touch the dog for the rest of the experiment, which lasted 60 minutes. The whole experiment was videotaped.

Blood samples were collected simultaneously from both owner and dog at 0, 1, 3, 5, 15, 30, and 60 minutes after the start of interaction. According to the analysis of the video recordings, the dogs did not experience the collection of blood samples as stressful (data not shown) and the impact of the blood sampling appeared minimal.

If the dog attempted to interact with the owner during the remaining time of the experiment, the owner was instructed to ignore the dog. This resulted in the dog immediately stopping its attempt for contact. Verbal communication between the owner and the other people present in the room was allowed during the whole experiment.

During the last 30 minutes of the experiment, the owners completed the MDORS, with the dog still in the room. The MDORS had previously been translated into Swedish from Dwyer, Bennett and Coleman's original English version (2006).

Only one dog–owner pair performed the experiment at a time. In addition to the owner and the dog, four other persons were present in the room during the entire experiment: one animal caretaker, one nurse, one person preparing the blood samples for hormone analysis, and one person videotaping the experiment. The animal caretaker and the nurse were in contact with the dog or owner during cannula insertion and blood sampling. None of the other persons were in physical contact with either the dog or the owner during the experiment.

Hormonal Analysis

Oxytocin and cortisol levels from both owners and dogs were analyzed by enzyme immunoassay, as described by Handlin et al. (2011).

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS/PASW) software, version 18.0 (Chicago, IL, USA).The mean scores and standard deviations were calculated for each item in the MDORS. The items were then arranged into subscales, as proposed by Dwyer, Bennett and Coleman (2006), and the mean score and standard deviation for each subscale, as well as the total mean score, were also calculated for each owner. The three excluded items were not included in any of the calculations.

For each hormone and participant, mean values with corresponding SD based on all samples collected during the experiment (0–60 minutes) were calculated. The non-parametric Spearman rank coefficient was used to calculate correlations because the number of partici–pants in the present study was relatively small and a normal distribution of data could not be assumed. Correlations were calculated between MDORS scores and the mean and basal levels of the owners' and the dogs' oxytocin and cortisol levels. Correlations were also calculated between the owners' and the dogs' oxytocin and cortisol levels at each individual time point of the interaction experiment. The statistical significance level was set at $p < 0.05$.

Results

MDORS

Owners' itemized scores of single items, the subscales, and the total MDORS score are summarized in Table 1. The scores of the three subscales, Dog–Owner Interaction (DOI), Emotional Closeness (EC), and Perceived Costs (PC), were 4.1 (*SD* = 0.4), 3.8 (*SD* = 0.4), and 3.8 (*SD* = 0.4), respectively, and the mean total MDORS score was 4.0 (*SD* = 0.4).

Table 1. The scores of the single items, subscales, and total MDORS score are presented as mean values (*SD*).

Items/Subscales	Answering Alternatives	Mean Score
1) How hard is it to look after your dog? (PC)	1 = very easy, 2 = easy, 3 = neither hard nor easy, 4 = hard, 5 = very hard	1.8 (0.8)
2) My dog gives me a reason to get up in the morning. (EC)	Excluded due to the owners' different interpretations of the item as either a positive or a negative statement	—
3) There are major aspects of owning a dog I don't like. (PC)	Excluded due to the owners' different interpretations of the item as either a positive or a negative statement	—
4) How often do you kiss your dog? (DOI)	1 = never, 2 = once a month, 3 = once a week, 4 = once every few days, 5 = at least once a day	4.1 (1.4)
5) I wish my dog and I never had to be apart. (EC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	3.3 (1.2)
6) My dog makes too much mess. (PC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	1.9 (1.0)
7) How often do you play games with your dog? (DOI)	1 = never, 2 = once a month, 3 = once a week, 4 = once every few days, 5 = at least once a day	4.4 (1.0)
8) It bothers me that my dog stops me from doing things I enjoyed before I owned it. (PC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	1.5 (0.5)
9) How often do you take your dog to visit people? (DOI)	1 = never, 2 = few times each year, 3 = once a month, 4 = once a fortnight, 5 = once a week	4.3 (0.9)
10) It is annoying that I sometimes have to change my plans because of my dog. (PC)	1 = strongly disagree , 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	2.0 (0.9)
11) My dog costs too much money. (PC)	1= strongly disagree , 2 = disagree , 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	1.6 (0.7)
12) How often do you buy your dog presents? (DOI)	1 = never , 2 = few times each year , 3 = once a month, 4 = once a fortnight, 5 = once a week	3.2 (1.1)
13) My dog is constantly attentive to me. (EC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	3.9 (0.9)
14) How often do you give your dog food treats? (DOI)	1 = never, 2 = once a month, 3 = once a week, 4 = once every few days, 5 = at least once a day	4.2 (0.6)
15) How often do you tell your dog things you don't tell anyone else? (EC)	1 = never, 2 = once a year, 3 = once a month, 4 = once a week, 5 = once a day	2.7 (0.9)
16) How often do you feel that looking after your dog is a chore? (PC)	1 = never, 2 = once a year, 3 = once a month, 4 = once a week, 5 = once a day	1.6 (1.1)
17) How often do you take your dog in the car? (DOI)	Excluded since not all dog owners had a car	—
18) How often does your dog stop you from doing things you want to? (PC)	1 = never, 2 = once a year, 3 = once a month, 4 = once a week, 5 = once a day	1.8 (0.8)
19) I would like to have my dog near me all the time. (EC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	3.3 (1.2)
20) How often do you groom your dog? (DOI)	1 = never, 2 = once a month, 3 = once a week, 4 = once every few days, 5 = at least once a day	2.4 (0.7)
21) If everyone else left me, my dog would still be there for me. (EC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	4.4 (1.0)

Items/Subscales	Answering Alternatives	Mean Score
22) How often do you feel that having a dog is more trouble than it is worth? (PC)	1 = never, 2 = once a year, 3 = once a month, 4 = once a week, 5 = once a day	1.4 (1.0)
23) My dog helps me get through tough times. (EC)	1 = strongly agree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	4.3 (0.7)
24) How often do you hug your dog? (DOI)	1 = never, 2 = once a month, 3 = once a week, 4 = once every few days, 5 = at least once a day	4.9 (0.3)
25) My dog provides me with constant companionship. (EC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	4.6 (0.7)
26) How often do you have your dog with you while relaxing, i.e., watching TV? (DOI)	1= never, 2 = once a month, 3 = once a week, 4 = once every few days, 5 = at least once a day	4.9 (0.3)
27) My dog is there whenever I need to be comforted. (EC)	1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree	4.5 (0.7)
28) How traumatic do you think it will be for you when your dog dies? (EC)	1= not traumatic at all, 2 = not traumatic, 3 = neither traumatic nor not traumatic, 4 = traumatic, 5 = very traumatic	4.7 (0.5)
Dog–Owner Interaction	1 = less interaction … 5 = much interaction	4.1 (0.4)
Emotional Closeness	1 = less emotional closeness … 5 = strong emotional closeness	3.8 (0.4)
Perceived Costs	1 = high perceived cost … 5 = low perceived cost	3.8 (0.4)
Total	1 = less positive relationship … 5 = very positive relationship	4.0 (0.4)

DOI: Dog–Owner Interaction subscale.

EC: Perceived Emotional Closeness subscale.

PC: Perceived Costs subscale.

Table 2. Mean hormone concentrations (*SD*) by time for owners and dogs dyads (n = 10).

	0 min	1 min	3 min	5 min	15 min	30 min	60 min	Mean
	Oxytocin Levels (pmol/l)							
Dogs	155.8 (80.8)	211.2 (92.0)	236.9 (116.1)	178.6 (88.7)	163.5 (103.4)	157.5 (108.0)	157.5 (123.3)	180.0 (102.1)
Owners	168.5 (109.5)	169.8 (107.8)	180.6 (108.8)	170.2 (88.1)	146.4 (104.2)	171.3 (108.3)	165.1 (83.2)	170.0 (97.4)
	Cortisol Levels (nmol/l)							
Dogs	168.4 (46.8)	169.4 (50.9)	168.1 (48.3)	180.1 (56.3)	224.1 (102.7)	202.8 (58.0)	190.2 (59.4)	186.0 (63.3)
Owners	389.8 (378.4)	382.7 (339.7)	382.7 (347.5)	387.6 (378.1)	362.1 (341.3)	331.6 (253.2)	305.2 (197.9)	363.0 (312.2)

In response to some of the items, almost all owners gave a maximal score. This resulted in mean scores of almost 5. Due to the lack of spread, the scores of these items did not allow for correlation analysis (for details, see Table 1).

Owners' and Dogs' Oxytocin and Cortisol Levels

Data on the owners' and dogs' oxytocin and cortisol levels have been described previously (Handlin et al. 2011) but are summarized in Table 2.

Correlations between the Owners' MDORS Scores and Their Oxytocin and Cortisol Levels

There was a significant correlation between the owners' oxytocin levels and how often the owners kissed their dogs ($r_s = 0.864$, $p = 0.001$), that is, more frequent kissing was associated with higher oxytocin levels in the owners. In addition, there was a tendency towards a significant negative correlation between the owners' oxytocin levels and how difficult the owners thought it was to look after their dogs ($r_s = –0.571$, $p = 0.085$).

Significant correlations were also observed between the scores of some items of the MDORS and the owners' cortisol levels. Lower cortisol levels in the owners were related to the following: being less bothered about their dog stopping them from doing things, increased frequency in bringing their dogs to visit people, and the increased perception of trauma in the event that the dog dies ($r_s = 0.661$, $p = 0.037$; $r_s = –0.645$, $p = 0.044$; and $r_s = –0.730$, $p = 0.025$, respectively) (Table 3).

Correlations between the Owners' MDORS Scores and the Dogs' Oxytocin and Cortisol Levels

The dogs' mean oxytocin levels correlated significantly with three items indicating the intensity of the dog–owner relationship. The higher the dogs' oxytocin levels, the greater the frequency of owners kissing their dogs, the lower the frequency in giving food treats to their dog, and the stronger was the perceived bond with the dog ($r_s = 0.753$, $p = 0.019$; $r_s = –0.757$, $p = 0.018$; and $r_s = 0.708$, $p = 0.033$, respectively) (Table 3).

In addition, significant negative correlations and tendencies towards significant correlations were observed between scores obtained in several items of the Perceived Costs subscale and the dogs' oxytocin levels. Higher oxytocin levels in the dogs were associated with the owners having a perception of the dog being less difficult to look after and less thought of as making a mess ($r_s = –0.846$, $p = 0.004$ and $r_s = –0.763$, $p = 0.017$, respectively). In addition, higher oxytocin levels in the dogs were associated with the owners having a perception of becoming less annoyed that they sometimes had to change plans because of their dog, a lower frequency among the owners in feeling that looking after their dog was a chore, and a perception of there being less trouble in having a dog ($r_s = –0.647$, $p = 0.059$; $r_s = –0.614$, $p = 0.079$; and $r_s = –0.639$, $p = 0.064$, respectively) (Table 3). One item in the PC subscale also correlated significantly with the dogs' mean cortisol levels ($r = –0.701$, $p = 0.024$): higher cortisol levels in the dogs were associated with greater perception in owners that there was less trouble in having a dog (Table 3).

The dogs' mean oxytocin levels also correlated significantly with the entire PC subscale ($r_s = –0.820$, $p = 0.007$) and, additionally, the dogs' mean oxytocin levels correlated significantly with the mean total MDORS score ($r_s = 0.753$, $p = 0.019$), that is, the higher the dogs' oxytocin levels, the lower the owners' perceived cost, and the higher the mean total score. This indicates a more positive evaluation of the relationship in total (Table 4).

Correlations between the Dog Owners' and the Dogs' Hormone Levels

The owners' mean oxytocin levels at each time point (0, 1, 3, 5, 15, 30, and 60 minutes) and their mean oxytocin level between 0 and 60 minutes correlated positively, some of which were statistically significant, with the mean oxytocin level of the dogs at 60 minutes. The higher the owners' oxytocin levels were during the interaction experiment, the higher the dogs' oxytocin levels were at the end of the experiment (for r_s- and p-values, see Table 5). In addition, there was a significant positive correlation between the dogs' and the owners' oxytocin levels at 15

minutes (r_s = 0.857, p = 0.007) (Table 5). No significant correlations were found between the owners' and the dogs' cortisol levels.

Table 3. Correlations of single item scores from the MDORS with owner and dog hormone levels. Only significant correlations ($p < 0.05$) and those that tended towards significance ($p < 0.10$) are shown.

Items	Owners' Mean Oxytocin (pmol/l)	Owners' Mean Cortisol (nmol/l)	Owners' Basal Cortisol (nmol/l)	Dogs' Mean Oxytocin (pmol/l)	Dogs' Mean Cortisol (nmol/l)
Dog–Owner Interaction					
4) How often do you kiss your dog?	r_s = 0.864 p = 0.001	ns	ns	r_s = 0.753 p = 0.019	ns
9) How often do you take your dog to visit people?	ns	ns	r = –0.645 p = 0.044	ns	ns
14) How often do you give your dog food treats?	ns	ns	ns	r_s = –0.757 p = 0.018	ns
Emotional Closeness					
21) If everyone else left me, my dog would still be there for me.	ns	ns	ns	r_s = 0.708 p = 0.033	ns
28) How traumatic do you think it will be for you when your dog dies?	ns	r = –0.730 p = 0.025	ns	ns	ns
Perceived Costs					
1) How hard is it to look after your dog?	r_s = –0.571 p = 0.085	ns	ns	r_s = –0.846 p = 0.004	ns
6) My dog makes too much mess.	ns	ns	ns	r_s = –0.763 p = 0.017	ns
8) It bothers me that my dog stops me from doing things I enjoyed before I owned it.	ns	ns	r_s = 0.661 p = 0.037	ns	ns
10) It is annoying that I sometimes have to change my plans because of my dog.	ns	ns	ns	r_s = –0.647 p = 0.059	ns
16) How often do you feel that looking after your dog is a chore?	ns	ns	ns	r_s = –0.614 p = 0.079	ns
22) How often do you feel that having a dog is more trouble than it is worth?	ns	ns	ns	r_s = –0.639 p = 0.064	r_s = –0.701 p = 0.024
Perceived Costs Total Score	ns	ns	ns	r_s = –0.820 p = 0.007	ns
Total MDORS Score	ns	ns	ns	r_s = 0.753 p = 0.019	ns

ns = non significant.

Table 4. Correlations of subscales and total MDORS scores with owner and dog hormone levels. Significant correlations ($p < 0.05$) are in bold.

Subscale	Owners' Mean Oxytocin (pmol/l)	Owners' Mean Cortisol (nmol/l)	Owners' Basal Cortisol (nmol/l)	Dogs' Mean Oxytocin (pmol/l)	Dogs' Mean Cortisol (nmol/l)
Dog–Owner Interaction	$r_S = 0.299$ $p = 0.402$	$r_S = -0.218$ $p = 0.572$	$r_S = -0.195$ $p = 0.589$	$r_S = -0.135$ $p = 0.729$	$r_S = -0.135$ $p = 0.711$
Emotional Closeness	$r_S = 0.391$ $p = 0.263$	$r_S = -0.035$ $p = 0.930$	$r_S = 0.130$ $p = 0.719$	$r_S = 0.519$ $p = 0.152$	$r_S = -0.391$ $p = 0.263$
Perceived Costs	$r_S = 0.238$ $p = 0.508$	$r_S = -0.301$ $p = 0.431$	$r_S = -0.341$ $p = 0.334$	**$r_S = 0.820$** **$p = 0.007$**	$r_S = 0.177$ $p = 0.625$
Total MDORS Score	$r_S = 0.472$ $p = 0.168$	$r_S = -0.356$ $p = 0.347$	$r_S = -0.313$ $p = 0.379$	**$r_S = 0.753$** **$p = 0.019$**	$r_S = -0.092$ $p = 0.800$

Table 5. Significant correlations ($p < 0.05$) between the owners' and the dogs' oxytocin levels during the interaction experiment.

Owners' Oxytocin Levels at	Dogs' Oxytocin Levels at	r_S	p
0 min	60 min	0.733	0.025
1 min	60 min	0.800	0.010
3 min	60 min	0.683	0.042
5 min	60 min	0.900	0.001
30 min	60 min	0.700	0.036
60 min	60 min	0.700	0.036
15 min	15 min	0.857	0.007
Mean (0–60 min)	60 min	0.783	0.013

Discussion

Given that oxytocin levels have been demonstrated to correlate with some maternal physiological and behavioral variables, including the level of maternal interaction and sensitivity to the infant's cues, this study explored whether the scores obtained on the MDORS correlated with oxytocin and cortisol levels in dogs and their owners. In the present study, we demonstrated that the scores of some items and subscales in the MDORS, describing the quality of the relationship between dog owners and their dogs, correlated significantly with the owners' as well as their dogs' oxytocin and cortisol levels.

The characteristics of the relationship between humans and dogs can be described by inventories such as the MDORS. The items in this scale address both the positive and the negative aspects of the dog–owner relationship and they have been arranged into three subscales: Dog–Owner Interaction, Perceived Emotional Closeness, and Perceived Costs (Dwyer, Bennett and Coleman 2006). There are no normative values for the MDORS and so the results obtained in the present study cannot be compared with those obtained in other studies.

In general, the owners participating in the present study described their relationship with their dogs in very positive terms. In response to some of the items, almost all owners gave a maximal score. For example, "How often do you hug your dog?" and "How often do you have

your dog with you while relaxing, i.e., watching TV?" (mean of 4.9 out of 5 for both items), supporting the premise that these owners had a close relationship with their dogs.

The correlation analysis showed that higher oxytocin levels in the owners were associated with greater frequency in kissing their dogs and a perception that looking after their dog was not difficult. It also showed that lower cortisol levels in the owners were associated with a perception of being less bothered about the dog stopping them from doing things, a greater frequency in bringing their dogs when visiting people, and a perception that the dog's death would be traumatic. Taken together, these results indicate that high levels of oxytocin and low levels of cortisol in dog owners are related to owners having a perception of the relationship with their dogs as pleasant and interactive and associated with few problems.

The scores obtained from the MDORS were also correlated with the dogs' oxytocin and cortisol levels. The correlation analysis showed that higher oxytocin levels in the dogs were associated with greater frequency in being kissed by their owners and lower frequency in getting food treats from their owners. In addition, the strength of the perceived bond correlated with the dogs' oxytocin levels. Higher oxytocin levels in the dogs were associated with lower perceived cost by the owners and a more positive overall evaluation of the relationship by the owners. These results indicate that high levels of oxytocin in the dogs are related to increased interaction with the owner and with the owners seeing their dog as a positive and pleasant companion.

The previous findings of positive correlations between maternal oxytocin levels and mothers being more interactive with their children and also more sensitive to their children's cues (Feldman et al. 2007) give support to the idea that owners with high oxytocin levels may interact more with their dogs. The positive relationships between the owners' and the dogs' oxytocin levels indicate that there is a mutual relationship between dog owners and their dogs and that this relationship influences their oxytocin levels, and perhaps also their cortisol levels. However, due to the correlational nature of this study, it cannot be concluded whether it is the high oxytocin levels that generate the close and frequent interaction between owners and their dogs or if it is the close and frequent interaction that generates the increased oxytocin levels.

While statistically significant positive relationships existed between the owner's and the dog's oxytocin levels, no significant relationships were identified for cortisol. The reason why no correlations were found for their cortisol levels is not known. However, cortisol levels are easily affected by various kinds of stimuli, such as movement and activity, which might be the case in this study.

Oxytocin is released not only in response to interactions between humans but also in response to interactions between dogs and their owners (Odendaal and Meintjes 2003; Miller et al. 2009; Handlin et al. 2011). Since cortisol levels are lowered by oxytocin, the correlations between the MDORS scores and oxytocin and cortisol levels may both reflect the interaction between dogs and their owners.

In the present study, we chose to study middle-aged (35–70 years) women and their male Labrador Retriever, in order to keep variation due to gender, sex -steroid levels, and breed to a minimum. Labradors are one of the most common companion dogs and are considered friendly and easy to work with. In future studies, it would be interesting to study other breeds, as well as to study both female and male owners, to see if the results differ. Future studies should also include a larger number of participants compared with the present study, in order to further evaluate the role of oxytocin and other hormones in the quality of the human–dog relationship.

If the MDORS continues to be used as a tool to evaluate the relationship between dog owners and their companion dogs, it would be helpful to validate it across cultures and to evaluate the effects of excluding single items.

In conclusion, the results from the present study suggest that owners' perceptions of their relationship with their dogs are related to the oxytocin, and to lesser extent cortisol, levels in both owners and dogs. Whether the responses identified are innate or acquired over time through the interaction with the dog cannot be determined by a correlational study and requires further investigation.

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