

Best of Friends? Investigating the Dog-Human Relationship

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Abstract

Dogs are commonly referred to as man's best friend, but the main focus of this thesis was to investigate how the dog experiences the relationship.

The first part of the thesis dealt with methodology currently used to assess the dog-human relationship: the Strange Situation Procedure (SSP) and the Monash Dog Owner Relationship Scale (MDORS). In one experiment, possible associations between the dog's bond to its owner (using the SSP) and the strength of the owner's relationship to the dog (using the MDORS) were investigated. Associations found were linked to how much the owner interacted with the dog on a daily basis, but not to the level of the owner's emotional closeness to the dog. In another experiment, the SSP was evaluated for its suitability to measure a dog's bond to a human. Findings showed that the test procedure was sensitive to order effects, but that there was variation in how the dog behaved during reunion with the person.

The second part of the thesis targeted the dog's reaction upon reunion with a human in different situations. In one study, the effect of time being separated from the owner was studied in the dog's home. While the owner was away dogs rested for most of the time, regardless of the duration of time alone. But once the owner returned, dogs initiated more physical contact and expressed higher frequencies of lip licking, body shaking and tail wagging after a longer duration of separation compared to a shorter one. In the final study, the type of interaction initiated by the human upon reunion was manipulated and endocrine measures were taken to better interpret the dog's behavioural reaction. It was found that when the person initiated both physical and verbal ('full') contact with the dog, oxytocin levels increased and stayed high for a longer time after the reunion event compared to when the person only talked to the dog or ignored it. The levels of physical contact initiated by the dog and lip licking behaviour were highest when the person interacted fully with the dog.

In summary, at reunion the dog's greeting behaviour differed according to the familiarity of the person, to the duration of the separation and to the type of interaction initiated by the person. It is proposed that this variation in dog behaviour during reunion should be the target of future studies of dog-human relationships.

Keywords: Dog-human interaction, Attachment, Strange Situation Procedure, MDORS, Greeting behaviour, Oxytocin, Dog welfare, Arousal

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Dedication

To my beloved parents

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List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

- I Rehn, T., Lindholm, U., Keeling, L.J. & Forkman, B. I like my dog, does my dog like me? (manuscript).
- II Rehn, T., McGowan, R.T.S. & Keeling, L.J. (2013). Evaluating the Strange Situation Procedure (SSP) to assess the bond between dogs and humans. *PLoS ONE* 8(2), e56938. Doi: 10.1371/journal.pone.0056938.
- III Rehn, T. & Keeling, L.J. (2011). The effect of time left alone at home on dog welfare. *Applied Animal Behaviour Science* 129, 129-135.
- IV Rehn, T., Handlin, L., Uvnäs-Moberg, K. & Keeling, L.J. Dogs' endocrine and behavioural responses at reunion are affected by how the human initiates contact. (manuscript).

Papers II-III are reproduced with the permission of the publishers.

The contribution of Therese Rehn to the papers included in this thesis was as follows:

- I Involved in planning, but more so in the performance of the experiment as well as in analysing the data. Main responsibility for writing the manuscript, with regular input from the co-authors.
- II Initiated the idea of the experiment and developed the design together with the supervisors. Involved in the planning and execution of the experiment. Main responsibility for summarising and analysing the data. Writing the manuscript together with the supervisors.
- III Involved in the planning of the experiment and did almost all of the practical work. Main responsibility for the analyses and for writing the manuscript, with support from the main supervisor.
- IV Shared responsibility for planning and executing the experiment together with co-authors. Main responsibility for analysing the behavioural data and the manuscript was written together with the co-authors.

Abbreviations

ASSP	Ainsworth's Strange Situation Procedure
SSP	Strange Situation Procedure
MDORS	Monash Dog Owner Relationship Scale
MDORS 1	Subscale of MDORS (dog-human interaction)
MDORS 2	Subscale of MDORS (perceived emotional closeness)
MDORS 3	Subscale of MDORS (perceived costs)
HR	Heart rate
HRV	Heart rate variability
SDNN	Index of HRV. Standard deviation of inter-beat intervals within a time interval
RMSSD	Index of HRV. Root mean square of all successive inter-beat-interval differences in a time interval
LF, HF band	Low frequency, high frequency band of the HRV spectrum
PNS	Parasympathetic nervous system
SNS	Sympathetic nervous system
HPA-axis	Hypothalamic-Pituitary-Adrenocortical axis
EDTA	Ethylenediaminetetraacetic acid
BS	Blood sample
FS	Treatment in study II (familiar person and stranger)
SS	Treatment in study II (stranger A and stranger B)
O	Owner
D	Dog
S	Stranger
T _{0.5}	Treatment in study III (dog alone 0.5h)
T ₂	Treatment in study III (dog alone 2h)
T ₄	Treatment in study III (dog alone 4h)
PV	Treatment in study IV (physical and verbal contact)
V	Treatment in study IV (verbal contact)
C	Treatment in study IV (control, ignoring dog)

1 Introduction

Dogs provide companionship for humans and the effects of such relationships are often associated with physical and psychological health benefits in humans (e.g. Barker & Dawson, 1998; Barker & Wolen, 2008; Dembicki & Anderson, 1996). While there is a large body of literature documenting these effects, less attention has been given to the impact humans have on the animals themselves. In many circumstances, humans are the most important factor influencing an animal's welfare. This is particularly true for companion animals, because pet and owner usually live in close association in the same environment. Hence, the main focus of this thesis lies in how the dog is affected by the dog-human relationship.

The quality of the relationship is influenced by the interactions it includes. Most research on dog-human interactions related to dog welfare has focused on negative aspects, like animal abuse or behavioural problems such as separation anxiety and aggression (e.g. Takeuchi *et al*, 2001; Yeates & Main, 2011). While some types of dog-human relationships may be predisposed to conflicts, others are characterised mainly by successful interactions. Focusing on day-to-day interactions between dogs and humans, of which the majority most likely are positive, may help us better understand in detail why some relationships are more successful than others. Such knowledge may be used as tools to improve dog welfare and to help owners optimise their relationship with their dogs. It is however difficult to observe a dog-human dyad continuously in order to measure their relationship.

Test procedures from human psychology have been adapted to quantify the dog-owner relationship. This is the approach of the first part of this thesis (study I and II), where attempts were made to assess the dog-owner relationship as well as to evaluate the most commonly used method when studying the dog's bond to its owner.

The second part of the thesis focuses on reunion behaviour in dogs (study III and IV). Reunion events are suggested to reveal much about the characteristics of a relationship between humans, because the interactions that occur in these situations may reflect how individuals view their previous time spent together.

In the following sections, an introduction will be given for each of the two parts of the thesis. The second part is followed by a short description of the work done on emotional arousal and physiological measures, since these areas are relevant when interpreting how the dog may experience their interactions with humans. Lastly, a note on the animals and approach used within this thesis is given.

1.1 PART 1: Studying the dog-human relationship

Historically, dogs and humans lived in cooperative relationships, where dogs were used to hunt, guard or herd animals (Coppinger & Schneider, 1995). Evidence from ancient burials, however, where dogs were occasionally buried together with a human, indicates also an early *emotional* relationship between dogs and humans (Morey, 2006).

Today, dogs play a significant role in their owners' lives mainly by offering companionship and affection (e.g. Robins *et al*, 1991). Many dog owners report that they are as emotionally involved with their dog as with their family members or friends (Archer, 1997; Barker & Barker, 1988; Voith, 1985). Serpell (2004) suggests that many humans develop positive feelings and behaviour while caring for dogs due to an emotional relationship similar to that created between mother and infant. It is however important to understand that these feelings are not resulting from the mere presence of the dog, but are more likely related to the type or quality of the relationship the owner has with his/her dog (Budge *et al*, 1998; Podberscek, 2006).

The difference between occasional interactions and a relationship is unclear, but a relationship is generally referred to as an association between two individuals over time (Hinde, 1976a). It usually includes some level of interdependence, i.e. that the actions of one member in the relationship have an impact on the other member (Berscheid & Peplau, 1983). Even long-term, 'stable' relationships are dynamic in the sense that they are constantly affected by the regular interactions that occur between the involved individuals (Hinde, 1976b). In other words, and perhaps not very surprising, the quality of a relationship is highly dependent on direct effects of day-to-day interactions as

well as indirectly by external factors contributing to the individual's physiological or psychological state. Not only do interactions affect the relationship, but they are also influenced by the relationship quality. It is therefore tempting to assume that the dog belonging to an owner who has a positive view of their relationship, which probably leads to a higher frequency of positive interactions, also experiences a close relationship to its owner. When categorising human relationships, Hinde *et al* (2001) emphasised the importance of studying both individual's view of the relationship. Hence, our angle of approach in study I was to study whether the owner's perception of his/her bond to the dog could be reflected in the dog's behaviour during an attachment test. In study II, this test was further investigated for its suitability to measure a dog's bond to a human.

1.1.1 Affectional bond and attachment

In the anthrozoology literature, the terms related to the quality of the relationship between humans and their pets have been used inconsistently, which has led to considerable confusion regarding their use. As an attempt to avoid such confusion in this thesis, the intended definitions of these terms are described in the next few paragraphs. Even within human literature, the definition of attachment when investigating human-human relationships is widely discussed (e.g. Goldberg *et al*, 1999; Pederson & Moran, 1999; see Rajecki *et al*, 1978 for a review) and it is out of the scope of this thesis to describe in detail the different views. This thesis deals with the relationship between dogs and humans which may share some aspects of the traditional attachment theory (see below) but perhaps not all of them (Crawford *et al*, 2006). This section takes up a large proportion of the thesis but I would like to emphasise these details since they set the foundation for my proposal of how the dog-human relationship may be studied in the future.

As mentioned above, a relationship refers to any connection between two individuals with its basic elements being interactions over time. Relationships may result from or lead to a social (affectional) bond, which is defined as “a relatively long-lasting tie in which the partner is important as a unique individual and is interchangeable with none other” (Ainsworth, 1989). The term “bond” should not be confused with the term “relationship”. In contrast to a relationship, which is dyadic, a bond refers to the characteristic of an individual, i.e. it describes one individual's bond to another individual (Ainsworth, 1989). This way, it is possible to claim that an owner is affectionally bonded to his/her dog, without having to account for how the

animal perceives their relationship. Although of course whether or not the dog has an affectional bond to its owner is an interesting question.

Attachment is defined as an affectional bond with the added experience of security and comfort obtained from the relationship (Ainsworth, 1989). Attachment could theoretically be applied to many long-lasting bonds that develop between humans, such as the bond experienced by an infant to its mother, that of a person to his/her romantic partner or to close friends (Crowell *et al*, 2008; Hazan & Shaver, 1987), but its precise definition is often ignored and it has been applied to dog-human relationships without accurate consideration of the specific criteria that must be met to be labeled an attachment. Bowlby (1969) developed attachment theory based on fundamental principles in ethology, evolutionary biology and cognitive science. He formulated the operational criteria of attachment to include the concepts proximity maintenance (including proximity seeking behaviour and separation protest), safe haven and secure base (Figure 1).

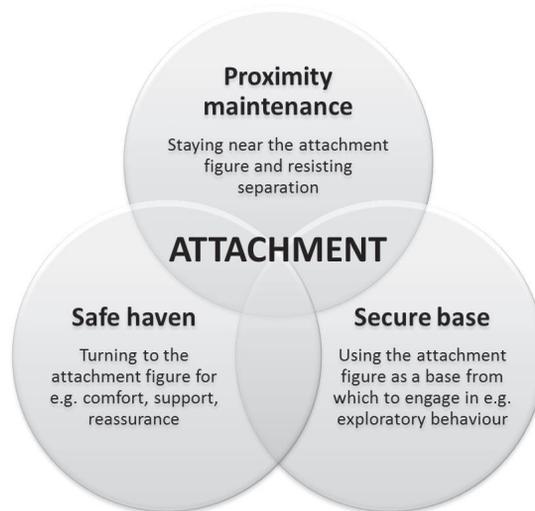


Figure 1. The defining features of attachment according to Bowlby's (1969) attachment theory. Illustration is based on a figure from Hazan & Shaver (1994).

According to Bowlby (1969), individuals are born with an innate psychobiological system (the attachment system) that motivates them to seek proximity to someone who will protect them in times of need. The child-parent attachment relationship is not symmetrical, i.e. the attached individual is less cognitively developed and benefits from being attached to a more cognitively

sophisticated individual (the attachment figure), who plays the caregiving role in their relationship (Bowlby, 1982). The caregiver is bonded also to the child, driven by a behavioural system which promotes care and protection of offspring. The attachment relationship between a dog and its owner is also a clear case of asymmetry, where the owner is taking the role as the caregiver and is presumably bonded to the dog, while the dog might or might not be attached to him/her.

Ainsworth *et al* (1978) further developed the work on attachment theory by defining different styles of attachment among children. These different styles describe the systematic patterns of relational expectations, emotions and behaviours that result from a particular history of interactions with attachment figures (Hazan & Shaver, 1987). A *secure* attachment style is characterised by the child using the attachment figure as a source of comfort and security (Bowlby, 1969). The child gets distressed during separation and greets the attachment figure with pleasure when reunited. Once comfort is gained, it uses the attachment figure as a so-called secure base, from which to engage in other 'nonattachment' behaviours, such as exploration or play. Individuals that are insecurely *avoidant* usually do not show any distress while being separated from the attachment figure and is actively avoiding or ignoring it upon reunion (Ainsworth *et al*, 1978). Insecurely *ambivalent/resistant* individuals get very distressed and show a lot of contact-seeking when separated from the attachment figure but resist comfort at reunion. *Disorganised* attachment is characterised by individuals with a chaotic and conflicting behaviour around the attachment figure, without consistent patterns (Main & Solomon, 1986). The development of these different attachment styles is affected by the individual's social experiences, especially early in life, such as the responsiveness to the child by its parents. From an evolutionary perspective, attachment is formed as a behavioural system in social species to promote behaviours that are important for survival (being protected). Most probably, all but the disorganised attachment style are adaptive in the way that they are developed as a functional strategy to fit with the parent's behaviour (Main, 1990). Later in life, the experiences during the formation of attachment styles contribute to other types of social interactions in adult relationships, such as a person's strategies for controlling emotions and communicating with other people (Bowlby, 1958; Cooper *et al*, 1998).

In human psychology, the Ainsworth's Strange Situation Procedure (ASSP) was developed to categorise human mother-infant attachment style (Ainsworth & Bell, 1970). The test is based on attachment theory and aims to activate the

attachment behavioural system by putting the attached individual in a stressful situation (being in a novel environment, meeting a stranger and being separated from the attachment figure). Upon activation of the attachment system, the first strategy of the attached individual should be to seek protection and comfort from the attachment figure (Bowlby, 1969). When comfort is gained, the attached individual should be able to move away from the attachment figure to explore the environment, i.e. using the attachment figure as a secure base. It is the balance between these two motivational systems, protection from threat and the urge to explore the surroundings, which is used for the evaluation of different attachment styles. An individual who fails to receive unconditioned support and care from its attachment figure develops alternative ways to cope with the situation, driven mainly by attempts to minimise the activation of the attachment system (Main & Solomon, 1986). This may be observed as the absence of distress at separation and avoidance of the attachment figure upon reunion, as in the insecure avoidant attachment style.

1.1.2 Methods to study the dog-human relationship

Most research on dog-human relationships has been carried out using questionnaire studies, as a method to assess the owner's way of interacting with the dog or his/her feelings about the dog (e.g. Dwyer *et al*, 2006; Johnson *et al*, 1992; Shore *et al*, 2006; Templar *et al*, 1981). In study I, the Monash Dog Owner Relationship Scale (MDORS) (Dwyer, 2004; Dwyer *et al*, 2006) was used to assess the owner's view of the relationship to his/her dog. The MDORS is based on several theoretical frameworks including exchange theory (Homans, 1958) and social support theory (Cobb, 1976). Exchange theory states that a relationship is maintained only when perceived costs and benefits are balanced or when the perceived benefits outweigh the costs. Social support theory states that the outcomes of a relationship need to include aspects of feelings of being cared for, appreciated and valued. Moreover, the MDORS was specifically developed to investigate the *dog*-human relationship. Questionnaires have been used also when evaluating the dog's behaviour towards the owner or when assessing behavioural problems (e.g. Bennett & Rohlf, 2007; Hsu & Serpell, 2003; Jagoe & Serpell, 1996). Well-designed questionnaires can give valuable information from a large sample size over a large geographic area at a low cost. However, questionnaires are subjective as they are based on the human respondent's perception of the situation rather than solid observational data. Another possible problem with questionnaires is that because surveys often rely on volunteers, the respondents may already represent a biased group of dog owners, based on the simple fact that they agree to participate.

Although behavioural studies are more costly and labour-intensive than questionnaires, the main advantages are that the observations are concrete and can provide insights to the contextual factors affecting a response. Hence, direct studies of the behaviour can teach us a lot about dog-human relationships. Hypothesizing the similarity with the child-parent relationship, the ASSP has been adapted to explore the dog-human relationship, and is generally referred to as the Strange Situation Procedure (SSP), or the Strange Situation Test (SST) (Mariti *et al*, 2013; Palestrini *et al*, 2005; Topál *et al*, 1998). This test was used in study I to investigate the affectional bond of the dog to its owner, as a measure of their relationship from the dog's point of view. Proximity seeking behaviour, and behaviours indicating secure base effects, such as increased exploration in the presence of the owner, were observed to evaluate the bond of the dog to its owner. However, the reliability of the SSP has been questioned due to possible order effects (Feldman & Ingham, 1975; Palmer & Custance, 2008). Therefore, in order to investigate the suitability of the SSP when assessing the dog-human relationship in study II, a novel treatment was included in a balanced cross-over design.

Regardless of which method is used to assess a relationship, it is equally important to consider what to measure in order to retrieve necessary information. The relationship quality is dependent on the frequency and type (quality) of interactions and how these are synchronised between the dog and the human (Hinde, 1976b). As a 'snapshot' of the relationship quality, reunion events have been suggested to be useful (Ainsworth *et al*, 1978; Main & Cassidy, 1988). That is why the second part of this thesis deals with how a dog reacts upon reunion with a person in different situations.

1.2 PART 2: Studying dog-human interactions during reunion

In social animals, reunion between individuals in a well-functioning relationship is considered a positive experience (Kalin *et al*, 1995) and greeting is important for confirmation and strengthening of the social bond between them (East *et al*, 1993; Hinde & Davies, 1972; Smith *et al*, 2011). Descriptions of greeting behaviour in dogs usually include a number of different behaviours initiated by the dog, such as physical contact and proximity to or orientation towards the other individual. The intensity or the duration of the greeting session has been measured to evaluate the response to reunion with familiar people and strangers (e.g. Konok *et al*, 2012; Prato Previde *et al*, 2003; Topál *et al*, 1998). Interestingly though, it has until now remained uninvestigated

how the duration of the separation from the owner influences the dog's greeting behaviour.

On the one hand, a strong dog-human relationship may benefit the dog by influencing the way the owner cares for it and so how the dog experiences the time together in different activities. On the other hand, a strong relationship may have negative consequences for the welfare of dogs due to the conditions of our modern way of life. For example, most adult household members work during the day and it is often impossible for dog owners to be together with the dog for large parts of the day. A survey of Swedish dog owners showed that 73% of the respondents left their dog alone at home while working (Norling & Keeling, 2010). A recent investigation performed in the UK revealed that 23% of the British dog owners left their dog alone at home for 5 hours or more on a typical weekday (PDSA Animal Wellbeing Report, 2011). Indirectly, the effects of this lifestyle pose new challenges to dog welfare which requires scientific attention. An acute example of this is dogs suffering from separation anxiety. Fortunately, such dogs represent a small proportion of the total pet dog population, but there has been little research on how dogs without these problems are affected by routine separations from their owners. Therefore, study III in this thesis targeted the question of how the dog was affected by the time being left alone at home, with emphasis on reactions upon reunion with the owner.

How the human initiates contact is another factor that most probably has an impact on how dogs react to the reunion event, although until now this has not received scientific attention. Common experiences for the dog could include an owner who greets the dog immediately upon returning home and engages fully, initiating physical contact and talking to the dog or, at other times, oversees and ignores the dog due to other duties. Dogs' skills of reading human signals have received considerable investigation during the last decades (e.g. Gácsi *et al*, 2005; Pongrácz *et al*, 2013). Among other things, this work has suggested that dogs are very sensitive to human actions and to their intentions (McKinley & Sambrock, 2000; Miklósi *et al*, 1998; Soproni *et al*, 2001; Topál *et al*, 2009). In many social species, specific behavioural patterns during greeting are important in order to maintain and re-establish the social bond between individuals (Braithwaite, 1981 (birds); East *et al*, 1993 (spotted hyenas); Kalin *et al*, 1995 (primates)). Based on this work, one can assume that reunion between dogs and humans is a crucial situation for dogs in which to evaluate the human's intention for their future interactions, as well as signalling their own intentions. While there have been investigations of the physiological

effects in dogs caused by calm, positive interaction, including tactile stimulation by the owner (Handlin *et al*, 2011; Odendaal & Meintjes, 2003), a less investigated area of dog-human interaction is the effect of the mere re-appearance of the caregiver or interactions where only verbal contact is initiated by the human. To better understand the effect of interaction type, the reactions of dogs upon reunion with a human who systematically initiated contact with them in different ways was investigated in study IV.

In order to further understand how dogs experience different reunion situations, the two following sections describe how emotional states may be measured and interpreted.

1.3 Assessing emotional states from dog behaviour

Today, it is generally accepted that the welfare of an animal is largely dependent on its feelings (Duncan, 1996). There has been much work done to assess negative affective states in animals (Harding *et al*, 2004; King *et al*, 2003; Rushen, 1996) and it is widely agreed that animals can feel e.g. pain and suffering. Lately, animal welfare science has begun to focus also on how to assess positive emotions since these are suggested not only to be a main component of good welfare (Fraser & Duncan, 1998) but also to have adaptive value for the individual (Fredrickson, 2001; Panksepp, 1998).

Dog owners often claim they are able to judge their dogs' emotional state (Kerswell *et al*, 2009). This is probably to a large extent true, but we still lack reliable scientific tools to make such judgements. In farm animals, Qualitative Behavioural Assessment (QBA) has been used to measure emotional states and welfare (Wemelsfelder *et al*, 2001). This method allows observers to use more general terms such as 'anxious', 'sociable' and 'playful' in order to evaluate the welfare or the emotional state of an individual. To my knowledge, this method has not yet been applied to assess dog welfare. Detailed and systematic studies of a dog's behaviour can also reflect the internal emotional state of the animal (e.g. Boissy *et al*, 2007). Since most previous dog welfare research has focused on the negative side of human-animal interactions, behaviours mainly linked to negative arousal are to be found in the literature. These behaviours include lip licking or other oral behaviours, body shaking, body stretching, yawning, repetitive movements, vocalisation, crouching, increased auto-grooming and paw-lifting (e.g. Beerda *et al*, 2000, 1997; Glover, 1992; Hetts *et al*, 1992; Palestrini *et al*, 2010; Rooney *et al*, 2007). Interestingly, both lip licking and tail wagging are often referred to as signals of active submission

(Fox, 1970), which is defined as an (inferior's) intention to create a friendly and harmonic social interaction (Schenkel, 1967). The submissive behavioural patterns during reunion are therefore suggested to function as reinforcers of the social bond rather than indicating a negative experience of the situation. The cumulative work on reunion behaviour of dogs in different situations within this thesis is intended to increase our understanding about their experience of the event.

In combination, solid behavioural studies and physiological measures provide useful proxy measures of the emotional experiences of animals (Boissy *et al*, 2007; Paul *et al*, 2005; Yeates & Main, 2008), and by using such an approach we aimed to find indicators of positive arousal in dogs. Emotional experiences are associated with varying degrees of physiological arousal, and a key system for generating this arousal is the automatic nervous system (Levenson, 2003).

1.4 Physiological measures

Complementary physiological measures are important tools when interpreting behavioural responses and vice versa. Behavioural reactions to external stimuli are often followed, or preceded, by changes in cardiac activity and hormone levels (e.g. Henry, 1992).

Measuring heart rate (HR) is usually done non-invasively and is often used to assess arousal levels in dogs (e.g. Beerda *et al*, 1998; Palestini *et al*, 2005). HR is affected by the sympathetic (SNS) and parasympathetic (PNS) autonomic nervous system. During resting, the PNS, where the vagus nerve plays an integral part of activation, is dominant for HR regulation, while the SNS becomes more dominant when experiencing physical or psychological stress (Hainsworth, 1995). While HR reveals something about the absolute difference in activity of these two systems, heart rate variability (HRV) gives a more detailed picture of their continuous interplay (e.g. Appelhans & Luecken, 2006). HRV measures the variation of the beat-to-beat interval between consecutive heart beats, and the variation is influenced by the level of activation of the parasympathetic *versus* the sympathetic nervous system. Because emotion regulation is dependent on adjustments of physiological arousal on a momentary basis (Gross, 1998), HRV is suggested to be a more subtle indicator of an individual's mental arousal (von Borell *et al*, 2007). Moreover, polyvagal theory (Porges, 2001), which suggests that cardiac states are coordinated with communicative behaviour through the vagus nerve, makes

HRV a promising indicator of arousal during social interactions (Appelhans & Luecken, 2006). Maros *et al* (2008) investigated HR and HRV in dogs and found a large individual variation. Nevertheless, they found that HRV seemed less influenced by physical activity than HR, and that the HRV was increased when the dog was oriented towards its favourite toy. Furthermore, Gácsi *et al* (2013) found that separation from the owner did not increase HR but affected HRV. Cardiac activity was used as a complementary measure to behavioural observations in study II and III.

Oxytocin is a hormone and neurotransmitter released in response to various tactile stimulations, such as during suckling and mating (Burbach *et al*, 2006) or massage-like stroking (Uvnäs-Moberg *et al*, 1998) as well as in response to social cues (Seltzer *et al*, 2010; Strathearn *et al*, 2009). Oxytocin has anti-stress effects by acting on several sites of the Hypothalamic-Pituitary-Adrenocortical (HPA) axis and functions, among other things, to decrease cortisol levels (Burbach *et al*, 2006; Neumann *et al*, 2000; Petersson *et al*, 2005; Windle *et al*, 1997). Social behaviour is influenced by oxytocin. It is suggested that oxytocin promotes affiliative behaviour and facilitates bonding between mother and young, as well as during pair bonding (Carter, 1998; Carter *et al*, 1992; Keverne & Kendrick, 1994; Witt *et al*, 1992). Increased levels of oxytocin have been observed during positive and calm dog-human interaction (Miller *et al*, 2009; Odendaal & Meintjes, 2003), and the effect seems to be mutual (Handlin *et al*, 2011).

Cortisol has been used extensively to measure the effect of environmental challenges in dogs (e.g. Haverbeke *et al*, 2008; Hydbring-Sandberg *et al*, 2004; Steiss *et al*, 2007). Cortisol measures have also been used to evaluate physiological responses to positive interactions, such as play activities. In play activities characterised by the owners disciplining their dogs, dogs cortisol levels were increased, while play sessions involving affiliative and affectionate behaviour expressed by the owners, had decreasing effects on cortisol levels (Horváth *et al*, 2008). Cortisol changes have also been investigated in relation to other types of positive dog-human interaction. It has been shown that cortisol levels decrease when the owner administers calm, tactile stimulation (Handlin *et al*, 2012), but even the mere presence of a human when dogs are exposed to a stressful environment has ameliorative effects on cortisol levels (e.g. Shiverdecker *et al*, 2013; Tuber *et al*, 1996). Furthermore, there seems to be a correlation between the owners' perception of the relationship to their dog and the degree to which cortisol levels in the dog decreases during a petting session (Handlin *et al*, 2012). To better interpret the behavioural responses to

different types of interactions initiated by a human upon reunion in study IV, measures of plasma oxytocin and cortisol were taken.

1.5 A word on study subjects and approach

Traditionally, research on dog-human interactions has been conducted with pet dogs and their owners. While this approach best represents the reality for most dogs, it can be difficult to control the interactions in a systematic way given the complexity of these relationships. Thus, it may be beneficial also to investigate the interactions that dogs that are kept for other purposes, with more homogenous backgrounds (e.g. research), have with their caregivers. There are advantages and disadvantages with using research dogs *versus* privately owned dogs when investigating dog-human interactions, depending on the research question. In study I, specific features of different relationships between dogs and their owners were of interest. For this reason, privately owned dogs were used. This was also the case in study III, where we wanted to investigate the effect of time left alone at home on reunion behaviour in the population of privately owned dogs in Sweden. With laboratory dogs, housed at a research facility, the experiment can be much more controlled in the sense that uniform groups of dogs matched for breed, age, earlier experiences, housing and kinship can be used. Controlling for such differences was important in study II and IV, where the aims were to evaluate a specific test procedure and to study the pure effects of interaction type initiated by a human upon reunion.

It is generally suggested that the ‘bottom up’ method (studies conducted in a very strict environment where most of the possible confounding effects can be removed) should be mixed with the ‘top down’ method (less controlled environment and subjects) to provide most information about the situation that is to be investigated (e.g. Shahzad & Loor, 2012). These methods complement each other with their advantages and disadvantages (Miklósi, 2007).

Large individual variations in behaviour and physiology of dogs subjected to the same types of stimuli have been reported (Gácsi *et al*, 2013; Palestini *et al*, 2005; Titulaer *et al*, 2013). The experimental design can be manipulated to reduce the influence of individual variation. To do this, all dogs in each study of this thesis were used as their own control.

2 Aims of the thesis

The overall aim of this thesis is to investigate how a dog experiences its relationship with humans, putting particular emphasis on the methods available to investigate the interactions involved in such a relationship. The studies described within this thesis addressed this aim by:

1. Conducting an in-depth exploration of the most common method previously used to assess the dog's bond towards a human

a. *Study I*: Investigating possible associations between the dog's bond to the owner and the strength of the owner's relationship to the dog by correlating the dog's behaviour in the Strange Situation Procedure (SSP) with the owner's score in the Monash Dog Owner Relationship Scale (MDORS) questionnaire

b. *Study II*: Evaluating the suitability of the SSP as a measure of the dog's bond to a human with particular emphasis on the potential influence of order effects inherent in the procedure

2. Examining the interaction between dog and human during different reunion situations and its effects on dog behaviour and physiology

a. *Study III*: Evaluating the effect of the duration of separation from the owner on dog welfare with specific emphasis on the dog's reaction upon reunion

b. *Study IV*: Investigating the dog's behavioural and endocrine responses to reunion according to how the person initiates contact with the dog

The studies included in the thesis set the foundation for further discussion on future methods to study the relationship between dogs and humans.

3 Materials and Methods

3.1 Subjects (all studies)

The dogs in study I and III were privately owned dogs of different breeds and ages (Table 1). The sex distribution was 50:50 in study III and close to that in study I. These dogs participated in the studies together with their owners. Participants were recruited by personal contact and advertisements, and most owners were women.

Study II and IV were performed with research beagles, housed at the dog facility at the Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden. They were all intact females and were approximately 2 years of age at the time of the studies. All of the research dogs came from the same breeder (B&K, England) and they were acquired by SLU at the age of 8-10 months. Two female researchers were involved in the studies where research dogs were used, referred to as ‘familiar persons’. These people had worked with the dogs from their arrival at the dog facility. When the dogs arrived, an intense period of socialising with the dogs took place, during which there was regular interaction with these researchers, including petting, walking and playing. Prior to the studies included in this thesis, these dogs had participated in studies on positive emotional states together with the ‘familiar persons’ and had never experienced invasive or negative treatment. Whenever a ‘familiar person’ is mentioned in the studies included in this thesis, it refers to one of these two researchers. They participated with 6 dogs each, and these were the same set of dogs in both study II and IV.

Table 1. Distribution of dog participants in the studies, their age and sex and the treatments they were involved in. Dogs within a study participated in all treatments

Study	Dogs	Mean age in years (range)	Sex distribution (M:F)	Number of treatments
I	20 private dogs	4.0 (2.0-8.0)	(60:40)*	1 (SSP ^a)
II	12 research beagles	2.1 (2.0-2.2)	(0:100)	2 (SSP ^a : FS ^b , SS ^b)
III	12 private dogs	4.3 (1.0-12.0)	(50:50)	3 (Alone ^c : T _{0.5} , T ₂ , T ₄)
IV	12 research beagles	1.7 (1.6-1.8)	(0:100)	3 (Interaction ^d : PV, V, C)

*of which 2 males and 1 female were neutered

^aStrange Situation Procedure

^bTreatments: FS=Familiar person and Stranger; SS=Stranger A and Stranger B

^cTreatments: Dog home alone for T_{0.5}=0.5 h; T₂=2 h; T₄=4 h

^dTreatments: Human initiating PV=Physical and Verbal contact; V=Verbal contact; C=no contact (ignoring the dog)

The requirements for participating in study I were that the dog was between 2 and 8 years old and had been living with the current owner for at least 6 months. In study III, dogs were only allowed to participate if they did not have a history of separation related behavioural problems, if they were used to being left alone at home for at least 4 hours at a time and if they were left alone at home without any other animals.

3.2 Test environment, equipment and test methods

3.2.1 Study I and II: Investigating the methodology around assessment of the relationship between dogs and humans

Studies I and II were conducted at SLU in Uppsala, Sweden. The SSP was carried out in an indoor test area, novel to the dogs. The area consisted of two unfurnished rooms, separated by a door. The owner participated in the SSP together with their dog in study I, and a female researcher acted as the stranger in all tests. In study II, where research beagles were subjected to the SSP twice, two female researchers acted as the familiar persons during the tests. Three different women, who had never met the dogs prior to the test, played the role of the strangers in study II.

Two stationary surveillance cameras (VIVOTEK network camera, PT3124) were used to monitor the dogs. These cameras were placed at roof level in two corners of the test room. An additional digital camera (SONY HDR-SR10E) was placed at a lower level (approximately 1 m height) to further monitor the dogs' behaviour. To measure cardiac activity in study II, the Polar® Vantage (S810) equipment was used. The equipment consists of a flexible belt, strapped

around the chest of the dog. The belt is comprised of two electrodes. A gel (Cefar Blågel®) was applied between the dog and the belt to enhance the contact between the skin and the electrodes. The heart rate data were stored in a receiver that was attached to a harness worn by the dogs. The harness also helped to keep the belt in the appropriate place during the tests. All dogs were habituated to the equipment before the start of the study.

The SSP consisted of 6 episodes each lasting for 3 min and aimed to activate the attachment behavioural system. In study 1, the test provided an opportunity to observe the variation in the dogs' responses to mentally challenging situations such as being in a novel environment, meeting a stranger and being separated from the owner. It also allowed for studies of greeting behaviour directed to the owner as well as to the stranger. The test set up is presented in Figure 2.

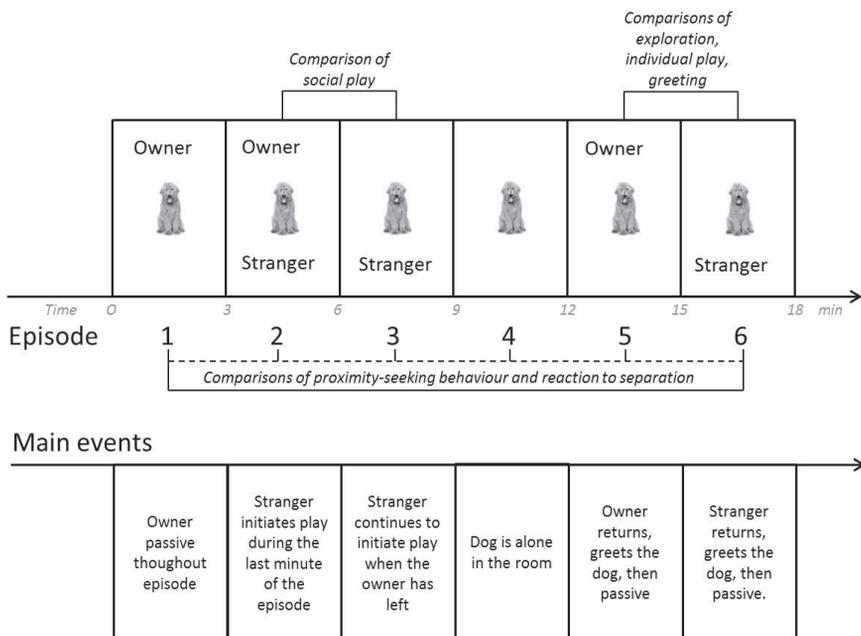


Figure 2. The SSP consisted of 6 episodes (each lasting for 3 min). The person (owner, stranger or both) who accompanied the dog in each episode is illustrated in the figure. The main events in each episode of the SSP are described in the boxes below in the illustration. For a more detailed description of the episodes, see papers I and II. In order to evaluate the relationship with the owner, the behaviour of the dog was compared between episodes where the owner was present and not. The duration of social play was compared between the last minute of episode 2 and the first minute of episode 3. The comparisons of the level of exploration and independent play were based on data from episode 5 and 6. Greeting scores were investigated during the first minute of

episode 5 and 6. Proximity-seeking behaviour was compared throughout the whole procedure. These comparisons are illustrated on the figure.

To investigate whether or not the dogs discriminated between the owner and the stranger, proximity seeking behaviour (physical contact with person/chair/door, orientation towards person/door and location near person/door) were observed instantaneously or recorded with one-zero sampling every 5 s. To investigate possible secure base effects of the owner, exploration and play were observed using one-zero sampling every 5 s. Other behaviour often seen in social contexts was recorded either by one-zero sampling every 5 s (tail wagging, body shaking, body stretching and yawning) or continuously (lip licking).

As an index of the owners' view of their relationship to the dog in study I, the MDORS questionnaire was used (Appendix 1). It consists of three subscales; 1) dog-owner interaction, 2) perceived emotional closeness, and 3) perceived costs. The answers to the questions in each subscale are given on a likert scale, indicating to which degree the owner agrees with a statement or how often he/she interacts with the dog in a certain way. The strength of the owner's view of the relationship to his/her dog was evaluated by the sum of scores gathered from the total MDORS as well as from each subscale. Correlations between owner's response (cumulative counts of scores in MDORS) and the dog's reactions in the SSP (attachment variables, see next paragraph) were tested.

In order to examine if the dogs showed attachment behaviour exclusively towards their owners in study I, comparisons of the dogs' behaviour were made between episodes where the owners was present (episode 1, 2, 5) *versus* absent (episode 3, 4, 6). Attachment variables, which were used as a measure of the individual dog's bond to its owner, were created based on the magnitude of changes in the dogs' behaviour with regards to whether the owner was present in the room or not. The attachment variables were then tested for correlations with the owners' scores gained in the MDORS.

In study II, the aim was to evaluate possible order effects of the SSP test procedure. The same test set up as in study I was used (Figure 2). All dogs were subjected to two treatments with half of the dogs beginning with each of the treatments. In treatment FS (familiar person and stranger) a familiar person took the role of the owner. In addition, a novel treatment was added to the study design referred to as treatment SS (stranger A and stranger B). In this treatment, a familiar person was never present in the SSP, but two strangers

participated in the test with the dog according to the same protocol, where stranger A followed the same procedure as the familiar person.

In order to investigate the dogs' attachment behaviour towards the familiar person, the same comparisons as in study I (see above) were made within treatment FS. In treatment SS, data from equivalent episodes were compared, hence when stranger A was present in the room *versus* when stranger B was present. Moreover, this study design allowed for comparisons of the dog's behaviour between treatments, and these were made between episodes where the familiar person was accompanying the dog in treatment FS *versus* the same episodes in treatment SS, where stranger A accompanied the dog.

3.2.2 Study III: The effect of separation length from the owner on dog's reunion behaviour

For study III, all of the video recordings from which data were collected were made in the dog's home environment. The same type of surveillance cameras as described in study I and II were used to monitor the behaviour of the dogs. One camera always covered the entrance area of the dog's home and the other one was placed to monitor an area where the owner believed that the dog would spend most of its time while left alone at home. Data for cardiac activity were collected using the same type of equipment as described for study II.

To investigate the effect of time left alone at home, dogs were left alone on three different occasions and the separation time altered; the dog was left alone for 30 min, 2 h or 4 h. Treatment order was balanced between dogs in a Latin square design.

Behaviour of longer duration (lying, sitting, standing, walking, running) was recorded instantaneously every 15 s. Behaviours of shorter duration (e.g. tail wagging, vocalising, yawning, lip licking, body stretching, body shaking and physical contact with owner) were scored continuously.

Comparisons of behaviour between treatments were made in the 10 min interval immediately following owner departure and the last 10 min before the owner returned (each split into two 5 min intervals). Also, an interval of 10 min before the owner left the home was compared between treatments as well as the 10 min interval after the owner had returned home. With regards to cardiac activity, the same intervals were compared during the separation period, but for the period before the owner departed and after they returned, comparisons of HR and HRV were made for each minute. As indices of the

HRV, the SDNN (standard deviation of all inter-beat intervals within each time interval) and RMSSD (root mean square of all successive inter-beat-interval differences in one time interval) were calculated.

3.2.3 Study IV: Effect of interaction type upon reunion with a familiar person on dog behaviour and physiology

This study was carried out at the dog facility at SLU in a test room to which all dogs were accustomed before the study. The test arena was monitored by one digital camera and one surveillance camera, placed at opposite sides of the test arena in order to cover the whole area. A veterinary assistant was always present in the arena with the dog and, with the exception of blood sampling required (see below), never interacted with the dog during the tests.

Dogs were observed in three different treatments where the type of contact initiated by the familiar person varied. The order of these was balanced between dogs according to a Latin square design. In treatment PV, the person initiated both physical and verbal contact with the dog at reunion, treatment V included verbal contact only and in treatment C, the dog was ignored by the person upon reunion.

Blood samples were collected from the dogs in this study. In order to prepare the dog for the blood sampling procedure, an anesthetic cream (EMLA®, AstraZeneca) was applied on the dog's front leg before the application of a permanent catheter. Blood samples were collected in EDTA tubes. For the hormone analyses, oxytocin levels were determined using Correlate-EIATM Oxytocin Enzyme Immunoassay Kit (Assay Designs, Inc. Ann Arbor, USA) and cortisol levels measured using DSL-10-2000 ACTIVE® Cortisol Enzyme Immunoassay Kit (Diagnostic Systems Laboratories, Inc. Texas, USA). Washing procedures were performed with an Anthos Fluido microplate washer, and the absorbance calculated using a Multiskan Ex microplate photometer (Thermo Electron Corporation). To further create standard curves, curve fitting and concentration calculation, the Ascent software (Ascent software, version 2.6 for iEMS Reader MF and multiscan) was used.

The experiment lasted for 2 h in total, divided in 5 different phases (Table 2). In total, 7 blood samples (BS1-7) were collected before, during and after reunion with the familiar person.

Behaviour related to physical activity (e.g. lying, standing, walking) was recorded instantaneously every 30 s throughout the whole experiment to better

interpret the physiological findings. To further examine the effect of interaction type upon reunion, a more detailed ethogram with shorter observation intervals (5 s) was applied for the period from 2 min before until 2 min after the reunion phase. During this period, behaviour of longer durations was recorded instantaneously every 5 s (e.g. lying, standing, sitting), while behaviour of shorter duration (e.g. body shaking, body stretching and tail wagging) was recorded using one-zero sampling every 5 s. The frequency of lip licking was recorded continuously during this period.

Table 2. *Test set up in study IV*

Phase	Duration	Main event	Blood samples (BS)
Basal	35 min	Passive phase. The dog was in the test arena together with the familiar person, who did not interact with the dog	BS-1, BS-2
Separation	25 min	Dog 'alone' ¹ . The familiar person were no longer in the room	None
Approach	15 s	The familiar person approached the test arena, visible for the dog	None
Reunion	4 min	The familiar person entered the arena and interacted with the dog according to the treatment ²	BS-3, BS-4
Relaxation	56 min	Passive phase. The familiar person was in the arena but did not interact with the dog	BS-5, BS-6, BS-7

¹The veterinary assistant was always in the arena without interacting with the dog.

²Treatment PV: The person initiated both physical and verbal contact with the dog, treatment V: the person initiated verbal contact only, treatment C: the person ignored the dog.

Dogs' behavioural responses to the returning person were compared between treatments during the reunion phase, which was divided into stage 1 (initial response), stage 2 (continued response following the first blood sample collected during this phase) and stage 3 (the first 2 min of the relaxation phase, i.e. immediately after the interaction had ended). The physiological responses were compared within treatment, using the second sample taken in the basal phase (BS-2) as a reference value. In order to investigate the effects of interaction type, the maximum values of plasma oxytocin (for each dog) of the two samples collected during the reunion phase and the maximum value of the three samples collected during the relaxation phase were compared to the reference value. The minimum values of plasma cortisol of the samples collected during the reunion phase and relaxation phase were compared to the reference sample.

3.3 Statistical analyses (all studies)

In all studies, dogs acted as their own control, i.e. all dogs participated in the different treatments and data were treated as dependent. Behavioural data were not normally distributed and non-parametric tests were used throughout all studies. The plasma oxytocin data did not follow a normal curve so the physiological data in study IV were analysed also using non-parametric tests (if nothing else stated: Friedman's test followed by post-hoc Wilcoxon signed rank tests). For the correlation tests in study I, the Spearman rank-order correlation test was used. HR data followed a normal distribution and were analysed using the Mixed models. In study II, HR data were analysed using Mixed models where 'episode' (1-6), 'minute' or 'treatment' (FS/SS) was treated as fixed effects and 'dog' as the random effect. In study III, HR data were compared using the Mixed models, where 'treatment' was considered as a fixed effect and 'dog' was regarded as a random effect. All analyses were performed using either SAS® (version 9.1, 9.2) or Minitab® (version 15, version 16) where appropriate.

3.4 Hypotheses

Study I: If there is a positive association between how strongly bonded the dog is to its owner and the perceived strength of the relationship from the owner to the dog, the dog's responses during the SSP should reveal signs of a strong affectional bond and its owner should score high in the total MDORS or in one of the MDORS subscales. This would be shown by large differences in behaviour towards, or in the presence of, the owner *versus* the stranger. High scores in MDORS would indicate an owner who spends a lot of time with and is often engaged in physical contact with the dog (MDORS 1), is highly emotionally involved with the dog (MDORS 2), or an owner who is not concerned about possible drawbacks of having a dog (MDORS 3).

Study II: If the SSP is a reliable indicator of attachment to use when studying the dog-human relationship, dogs should show more proximity-seeking behaviour towards the familiar person than towards any of the strangers involved in the two treatments included in this study. They should also explore and play more in the presence of the familiar person in order to fulfill all the criteria of being securely attached. An additional treatment SS (where there were two strangers) allowed for an investigation of these behavioural responses in relation to possible inherent order effects, i.e. if there is an effect of which person enters the unfamiliar room with the dog rather than the quality of the relationship to this person. If the SSP is reliable, dogs will not show differences

in attachment behaviours towards the two strangers in treatment SS. Lastly, during periods where physical activities are similar, we hypothesize that HR is lower in the company of the familiar person compared to when accompanied by any of the strangers in the SSP.

Study III: If dogs are affected by the time they are left alone at home, behavioural and cardiac differences should be observed between the three treatments. It is hypothesized that dogs will show behaviour previously associated with negative arousal (e.g. lip licking and panting) during the longer separations. One might also expect that dogs will express a higher (positive) arousal (tail wagging, physical contact) upon reunion with their owner after a longer duration of separation.

Study IV: If the type of interaction initiated by a human upon reunion with a dog affects the behavioural and physiological responses of the dog, we hypothesize that the 'full' interaction initiated by the familiar person including both physical and verbal (PV) is experienced as most positive for the dogs. This should be indicated by higher oxytocin levels, decreased cortisol levels and behavioural arousal (tail wagging and physical contact). The treatment with only verbal contact (V) should be less positive and the treatment where the person ignores the dog (C) should be least positive for the dogs. However, it may also be that the more common types of interactions (PV and C), are experienced as more positive than V, due to the novelty of the latter interaction type.

4 Summary of results and brief discussion

These sections summarise the results of study I-IV, and each section is followed by a short description of the interpretations of the main findings. More detailed information can be found in the individual papers. A more general discussion about the findings from all studies is presented after this results section.

4.1 Study I – Associations between how the dog and the owner view their relationship

Marked differences between the dog's behaviour in the presence of the owner and the stranger in the SSP suggest that dogs discriminated between their owner and the stranger. Dogs greeted their owners more intensely, were more often oriented towards their owner and tended to initiate more physical contact with their owner compared to the stranger. When greeting their owner, dogs also showed more tail wagging and higher frequencies of lip licking than when greeting the stranger. In the presence of their owner, the dogs explored more and engaged in social play with the stranger more often than when the owner was absent. According to previous interpretation of these measures, in general dogs seemed to be securely attached to their owner.

The results of the owner's scores in MDORS showed variation between individual owners in total MDORS score and within all subscales. When looking at the individual variation of the dog's behaviour in the SSP and owner assessments based on MDORS scores in each dog-owner dyad, results revealed that dogs who discriminated most clearly between the owner and the stranger upon reunion, i.e. those which initiated much more contact with their owner than the stranger, had owners who reported that they interacted a lot with their dogs on a daily basis (i.e. had a high score in MDORS subscale 1). The

increased level of physical contact initiated by these dogs may also be explained by the possibility of them having been reinforced by their owners for this behaviour, as indicated by the higher levels of interactions reported by their owners.

Dogs belonging to these owners did not engage much in play even if their owner was present, or at least they did not play more in the presence of their owner compared to when only the stranger was present. The latter could be interpreted as they did not use their owner as a secure base. Rather, their strategy was to stay in close proximity to their owner and they did not seem to gain enough security to be able to play on their own after the slightly stressful event of being alone in the test area. This behavioural pattern resembles that of insecurely (ambivalent) attached children (Ainsworth *et al*, 1978). So, even if the initial analyses of the whole group of dogs indicated that they were securely attached to their owners, these results suggest this may not be the case for all dogs. This further underlines previous concerns about assessing reactions at group level, without taking into consideration that reactions vary at the individual level (e.g. Gácsi *et al*, 2013). Interestingly though, these variations seemed to be related to their day-to-day type of interactions with their owners rather than to how the owner feels for the dog, since no correlations were found between the dog's behaviour in the SSP and the owner's score in the subscale describing the owner's emotional closeness to the dog (MDORS 2). This is discussed in more detail later.

Overall, the owner's view of his/her strength of the relationship to the dog had little effect on how the dog behaved during the SSP. This may indicate that such associations are few, or that the rather limited number of subjects included in this study was not enough to reveal more details about reciprocity in the relationship, or that the methods chosen to investigate this were inappropriate.

4.2 Study II – Evaluation of the SSP as a method to study the dog's affectional bond to humans

The main findings from comparisons made within treatments are presented initially. These results are based on the same type of comparisons made in previous SSP studies (Palmer & Custance, 2008; Prato Previde *et al*, 2003), only that in treatment SS, two strangers were present. This is followed by a presentation of the results from comparisons between treatments, which gave the added benefit for further investigation of possible order effects in the SSP.

Dogs initiated more physical contact with the familiar person than with the stranger in treatment FS. Results also showed that the dogs used the familiar person as a secure base, as they explored more in the presence of the familiar person than of the stranger. Mean HR decreased over time, although HR was higher during episodes where the familiar person was present.

In treatment SS, dogs did not initiate more physical contact with either stranger A or stranger B, i.e. they did not seem to discriminate between the two strangers with regards to their level of proximity-seeking. Interestingly though, results revealed that dogs explored more in episodes where stranger A (who took the 'role' of the familiar person) was present. These results indicate that exploration is sensitive to order effects in the SSP and supports previous concerns (e.g. Palmer & Custance, 2008). HR was higher during episodes when the dog was accompanied by stranger A, but the overall decline along the test procedure in treatments FS and SS indicates an order effect that probably accounts for this difference in HR with the different people. This is in line with previous studies on HR activity during the SSP (e.g. Palestini *et al*, 2005).

When comparing the dogs' behaviour in equivalent episodes between treatments, dogs reliably initiated more physical contact with the familiar person (FS) compared to with stranger A (SS). However, no difference in exploratory behaviour was found according to the accompanying person (familiar person or stranger A), further indicating an effect of the sequence of the episodes in the test.

The dogs' behaviour upon reunion with the familiar person in treatment FS differed in comparison to when they were reunited with stranger A in treatment SS. Dogs tended to express more lip licking, tail wagging, body shaking and vocalising when the familiar person returned. Moreover, dogs initiated significantly more physical contact upon reunion with the familiar person compared to when they were reunited with stranger A.

Unfortunately, the level of social play among these dogs was too low in order to analyse this aspect of the secure base. This may reflect an effect of being less often subjected to play with humans in these research dogs, compared to many privately owned dogs. The level of independent play was slightly higher and comparisons between treatments showed that dogs played more independently in the presence of the familiar person than stranger A. No such difference was found in the within treatment comparisons though. Taken

together, these results should be interpreted cautiously due to the low levels of play and the absence of significant differences within treatments.

In conclusion, the only aspect where dogs reliably behaved differently according to whom the accompanying person was (hence acting as a measure of the quality of their relationship), was the level of physical contact initiated towards the person when they returned. Order effects in the SSP can explain the other results. Moreover, results from detailed observations of the dogs greeting behaviour in this study suggest that future studies on attachment behaviour in dogs should focus more on reunion events.

4.3 Study III – Reunion behaviour according to separation duration

Dogs were lying down most of the time (92-97 %) while left at home alone, regardless of the length of time separated from the owner. No differences between treatments concerning behaviour or cardiac activity were observed before and during separation.

However, there were clear treatment differences in the way dogs responded when the owner returned. After longer durations of separation (2 and 4 h *versus* 30 min), dogs reacted with increased physical activity and a higher frequency of body shaking as soon as they could hear or see the owner approaching the home. Once reunited with the owner, dogs expressed more tail wagging, lip licking and body shaking when they had been left alone for 2 or 4 h compared to 30 min.

Dogs were also more physically active, showed a higher frequency of attentive behaviour and initiated more physical contact with their owners when they had been separated for a longer period of time. HR tended to be higher during the first and second minute after reunion when they had been alone for 2 h compared to when left alone for 30 min. Data on HR were not available following the 4 h of separation due to technical difficulties with the equipment. These changes in HR could however be explained by the dog's increased physical activity. No differences in HRV (SDNN and RMSSD) were found between treatments. Further interpretations of physiological measures in relation to mental states are discussed later.

Dogs were affected by the time they were separated from their owners as was evident by the fact that their behaviour upon reunion differed according to the

separation length. The increases in physical contact, tail wagging, lip licking and body shaking were not affected by how the owner interacted with the dog, since no differences in owner behaviour upon reunion were found between the treatments. Rather, these behaviours seem to reflect an increase in arousal after a longer duration of separation. Dogs did not, however, demonstrate that they were ‘missing’ their owners while separated (up to 4h of separation) since they were inactive most of the time in all treatments. In a previous study (Aslaksen & Aukrust, 2003) it was found that dogs were inactive most of the time throughout separation durations lasting up to 9.5 h. The effect of regular and longer durations of separation should be investigated to be able to better understand what impact separation from their owner has on the welfare of dogs without separation problems. Such studies should specifically target the effects of long durations of inactivity and absence of social contact.

4.4 Study IV – Effect of interaction type initiated by a human upon reunion on dogs’ endocrine and behavioural responses

When both physical and verbal contact were initiated by a familiar person upon reunion, dogs initiated more physical contact and expressed higher frequencies of lip licking compared to in the other treatments. Oxytocin levels were higher during and after this type of interaction compared to pre-reunion reference values. Cortisol levels were lower after the interaction had ended compared to reference values. An additional effect on cortisol of this interaction compared to the other types was the decrease in cortisol levels from the reunion phase to the relaxation phase, possibly as a result of the higher oxytocin release (e.g. Petersson *et al*, 1999).

The initial response to reunion when a familiar person only talked to the dog (verbal contact) was increased tail wagging and vocalising. Oxytocin levels tended to increase during interaction compared to reference values and there was no difference after the interaction had ended. Cortisol levels were lower after the interaction had ended compared to reference values.

When dogs were ignored upon reunion with a familiar person, they initially explored the environment or directed their attention to the veterinary assistant, but soon became inactive. Their oxytocin levels were higher when the familiar person had just returned, compared to reference values, but no such differences were observed later. Cortisol levels were, however, lower in the relaxation phase compared to reference levels.

In summary, the mere return of a familiar person seemed to have positive effects on the dogs, as evidenced by increased oxytocin levels and decreased cortisol levels in all treatments. Importantly though, oxytocin levels continued to stay higher for a longer time when the person initiated both physical and verbal contact. This suggests that this treatment was the most positive for the dogs and therefore physical contact and lip licking may be behavioural indicators of positive arousal in dogs. A situation that perhaps was a bit unusual to the dogs was when the familiar person only talked to them upon reunion. In this treatment, dogs showed more tail wagging and vocalised more. These behaviours may therefore reflect contact-seeking, since they were also shown most after the interaction had ended in the treatment where both physical and verbal contact was administered. In conclusion, the way the human interacts with the dog when reunited with it had effects on both endocrine and behavioural responses of the dog and physical contact had an additive value with regards to how positive this experience was for the dogs, as measured by endocrine responses in the dogs.

5 General discussion

Referring back to the aims of this thesis, in the following sections I will discuss the use and appropriateness of two commonly used methods to assess the dog-human relationship: the MDORS and the SSP, based on the results from study I and II, with emphasis on the SSP. Next, I will pool my findings from all studies to discuss more specifically the dogs' greeting behaviour in relation to familiarity with the person, the duration of separation and the type of interaction initiated by the human. I will then evaluate my results to discuss candidate behaviours indicative of positive emotional states in dogs. Finally, I will suggest future approaches to assess the dog-human relationship.

5.1 Associations between the owners' view of the relationship and the dog's behaviour towards the owner

Reciprocal interaction is an important factor for the creation and maintenance of the bond between individuals (Voith, 1985). If the dog greets the owner with tail wagging and by showing affiliative behaviour, the owner is likely to increase friendly interactions with the dog in return. This is a 'cyclic' pattern that reinforces the relationship. Going back to the development of a human child-parent relationship (Bowlby, 1969), expressions made by the infant are not related to the parent's behaviour initially, but they gradually become tailored to the parent's willingness to respond. This is the result of conditioning, where the experience from previous interactions also influences future interactions (Hinde, 1976b). As also dogs rapidly learn to express behaviours that are reinforced (Reid, 2009), this might explain the finding in study I; dogs who expressed a higher level of physical contact upon reunion in the SSP had owners who interacted with them frequently on a daily basis. This result may also indicate a well-functioning relationship, as it reflects a synchrony of interaction patterns between the owner and the dog, something

that is considered to be important for relationships between humans (Hinde, 1976a).

Perhaps surprisingly, no correlations were found between the dogs' behaviour in the SSP and the owners' scores of perceived emotional closeness in study I. This suggests that, in contrast to the amount of interaction, the owner's level of emotional closeness to the dog does *not* mirror how the dog experiences the relationship. One would perhaps expect that the level of emotional closeness reported by an owner would be related to how much the owner actually interacts with the dog, but previous findings actually report the opposite. A few studies have investigated correlations between the owners' reported emotional closeness, their interactions with the dog and the dogs' behaviour. Kotschal *et al* (2009) found that the higher the 'attachment' to the dog (using the dog as a 'social support'), the less time the owner spent together with the dog on a daily basis. Furthermore, these dog-owner dyads took longer to complete a task together, which is perhaps explained by a less synchronised interaction pattern between these dogs and their owners. In another study (Wedl *et al*, 2010) it was found that owners who viewed their dog as a 'social support' had dogs who stayed close to their owner for a longer time when the dyad was observed undisturbed in a novel environment. The opposite was observed when owners spent a lot of time in shared activities with the dog on a regular basis. In the light of this, it is interesting to note that much research on the dog-human relationship relies on attitudinal or 'attachment' questionnaires, where the owners' emotional involvement in their dogs is evaluated in relation to demographic variables or their own mental well-being (e.g. Garrity *et al*, 1989; Poresky *et al*, 1987; Templer *et al*, 1981). Findings from such studies do suggest that a dog can provide social support for humans with limited social networks, as these owners reported stronger emotional bonds to their dogs (Johnson *et al*, 1992). But the aspects related to how emotionally involved the owner is probably have limited influence on the dog's perception of the relationship as the two factors, emotional closeness and level of shared activities, might counteract each other.

These results are promising as future studies of the dog-human relationship could focus on the level and types of interactions the owners engage in with their dog, rather than on the owners' emotional involvement. The latter probably serves as a suitable indicator of how the relationship is experienced from the human side, but says less about how the dog experiences the relationship.

5.2 Evaluation of the SSP when assessing dog-human relationships

Looking at the relationship from the dogs' point of view, the SSP is by far the most common method used. Assessments are based on how attachment behaviours (those related to proximity maintenance, safe haven and secure base, see Figure 1) are expressed by the dogs towards or in the presence of their owner. The findings from study II confirmed previous concerns regarding limitations of this test, due to the sequence of episodes. On group level, dogs expressed exploratory behaviour indicative of a secure attachment style towards their owners (study I) and to a familiar person (study II, treatment FS). However, the same type of responses with regards to exploration, which has been a key feature when assessing secure base effects in dogs, were found in the SSP even when two strangers participated with the dogs in the test (study II, treatment SS). These findings bring up an important point to discuss; whether or not the SSP is an appropriate method to use when studying dog-human relationships, even if a counter-balanced design is used to deal with the issue of order effects. The SSP was originally developed to investigate attachment behaviours in very young children (<2 years of age). In order to assess the SSP's suitability for investigation of dogs' attachment behaviours towards humans, below I will highlight a few important differences in the characteristics of children and well-socialised, adult dogs in the view of the events included in the SSP.

Firstly, I raise the question whether or not the SSP is a strong enough stressor to fully activate the attachment system in dogs? Most adult dogs have been exposed to novel environments and are used to being separated from their owners, especially if comparing the dog's experience of such situations with those of a very young child. Stranger wariness, which is high in children at the age during which they are subjected to the SSP (e.g. Waters *et al*, 1975), is generally low in adult dogs. Dogs rarely show avoidance behaviour towards a stranger during the SSP or in similar test settings (e.g. Nagasawa *et al*, 2013; Palmer & Custance, 2008).

Secondly, if the SSP *does* activate the attachment system in dogs, are we using the correct indicators of possible secure base effects? Even though the urge to explore an environment may be higher in dogs in the sense of investigating and claiming a territorial area (Miklósi, 2007) compared to children, their interest quickly decreases during the SSP (e.g. Palmer & Custance, 2008; Prato Previde *et al*, 2003). Dogs can probably scan and assess the environment much faster than children considering their advantages in physical and sensory skills.

Perhaps the environment in the SSP is too barren for a dog to maintain its interest in exploring. Therefore, I recommend investigating attachment behaviours in a more complex and interesting environment for the dog, including hidden areas and different odours. Tóth *et al* (2008) observed a high level of individual variation in play behaviour in dogs, which they suggested to be related to differences in early experience and learning. The low level of play behaviour performed by the research dogs in study II seems to support this statement. Moreover, it seems like the degree of compatibility during play between dogs and humans is important for the dog's level of engagement during play sessions (Mitchell & Thompson, 1991). In the SSP, this may pose a bias in some individuals if these dogs are relatively familiar with the standardised type of play initiated by the strangers. The only way to partly overcome this problem would be that the stranger is instructed by the owner how to initiate play with the dog. Such an adaptation, however, could make it more difficult to compare findings between different studies.

It is important to remember that in humans, the attachment style of an individual is not characterised simply by whether the attached individual explores and plays more in the presence of the attachment figure. Rather, the central element of attachment theory is the balance between proximity-seeking behaviour towards the attachment figure (initial response to stressor) and the propensity to move away from the attachment figure to explore a potential threat (delayed response to stressor) (Bowlby, 1958). The pattern of these two motivational systems serves as a measure of attachment style. The assessment of attachment style is mainly based on observations upon reunion with the attachment figure (Ainsworth *et al*, 1978). This calls for a more focused discussion around the findings related to the dogs' responses during reunion from the studies included in this thesis.

5.3 Dogs' reaction to reunion with a human

A number of findings in the studies included in this thesis support the need for a more thorough discussion of reunion situations. Upon reunion with a human, the frequencies of initiating physical contact, tail wagging, lip licking, body shaking and vocalising were expressed differently by the dogs according to the familiarity of the person, the duration of separation and to the type of interaction initiated by the person. While some authors suggest that greeting is a positive experience (Kalin *et al*, 1995; Armitage, 1977), some may argue that it is a ritualised behaviour including signals that mainly serve to clarify the rank between individuals (Schenkel, 1967; Wittig & Boesch, 2003). These two

arguments are however not mutually exclusive: important signals probably have become ritualised, but nevertheless the system that activates these behaviours could be emotionally triggered. The dogs' approach behaviour (initiating physical contact) was always more pronounced in response to the owner (or a familiar person), which I argue would be experienced by the dogs as more positive than the reappearance of a stranger. Moreover, the approach behaviour was observed along with strong tendencies for dogs to express higher frequencies of lip licking, tail wagging and body shaking when reunited with a familiar person compared to a stranger. The fact that increased approach behaviour and higher frequencies of lip licking and body shaking were observed after longer times of separation could be explained either by an increased positive arousal, or that a longer separation may demand a more intense effort to re-establish the relationship. These responses were also affected by how the human initiated contact upon reunion. The highest levels of physical contact and lip licking were observed when a familiar person initiated both physical and verbal contact. This type of full interaction also had greatest effects on dogs' endocrine responses, as observed by a higher level of oxytocin sustained for longer after the reunion event was over and a more pronounced decrease in cortisol levels. When dogs were ignored upon reunion in study IV, they initially redirected their behaviour to the surroundings or to the veterinary assistant who was always present in the test room, before becoming inactive. This supports the idea about intentional behaviour only being expressed when knowing that the receiver is attentive to your actions (Tomasello *et al*, 2005). Interestingly though, when the familiar person talked to the dog but did not initiate any physical contact, the dog intensified its contact-seeking behaviour (tail wagging and vocalisations), reflecting its willingness to interact. Taken together, the variation of the level on which these behaviours were expressed in response to these different situations, suggests that dogs perform a more complex evaluation of the reunion situation rather than merely express a ritualised behavioural pattern.

Variation in reunion behaviour is the foundation for studying different attachment styles in humans, and may serve as a tool also for investigating different attachment styles in dogs. While most research on attachment behaviour in dogs has focused on the *secure* type of attachment, it does not seem reasonable to believe that all dogs share the same attachment style. This is further discussed in the last section of this general discussion.

5.4 Towards measuring emotional states in dogs

It is widely accepted that animals are sentient beings capable of experiencing subjective feelings, such as distress and fear (Désiré *et al*, 2002; Duncan, 1996). Lately, there has been increased interest in investigating positive affective states in animals, e.g. pleasure and contentment (Boissy *et al*, 2007). From an evolutionary perspective, positive feelings promote survival and reproduction, because they encourage approach behaviours towards stimuli that are rewarding, like food resources, affiliative social interactions and shelter (Cabanac, 1971). The recent accumulation of evidence towards possible indicators of positive emotional states in animals has revealed complexities in the interpretations of behavioural expressions since arousal as such can elicit similar behavioural responses in different (negative or positive) contexts (Dawkins, 2004).

Owners often claim they are able to judge their dog's emotional state (Kerswell *et al*, 2009), but when asked about more subtle behavioural expressions, previously suggested to indicate negative stress (lip licking, paw lifting and yawning), owners did not list these as indicators of negative stress (Mariti *et al*, 2012). The reason for this could be that these behaviours are less obvious than e.g. vocalisations or trembling. It could also be that these behaviours simply do indicate a higher arousal and that they are expressed also during positive experiences. Due to the latter, owners may not judge them as purely indicative of 'negative' stress responses.

If we assume that reunion with a familiar human generally is experienced as positive by the dog, then increased physical contact, higher frequencies of lip licking, tail wagging and body shaking are all candidate behaviours to be considered as indicators of positive arousal in dogs. However, considering results from previous studies on negative emotions, it seems as though some of these behaviours are also displayed in situations that are characterised by negative arousal. Increased frequencies of lip licking, tail wagging and body shaking have been reported in situations where dogs were presented with a frightening stimulus (e.g. Beerda *et al*, 1998; Horváth *et al*, 2007). Lip licking has also been observed in crated dogs with separation anxiety while they were left alone at home (Palestrini *et al*, 2010) and in puppies left alone (Cannas *et al*, 2010). Only recently, Kemp & Kaplan (2013) observed lip licking behaviour in marmosets when exposed both to positive and negative stimuli. However, they identified slight differences in the way the lip licking was performed: a repetitive licking with slightly parted mouth was observed in response to positive stimuli, as compared to a singular movement, showing

only the tip of the tongue through a tightly closed mouth in response to negative stimuli. Moreover, detailed analyses of dogs' responses to different types of positive stimuli showed a higher frequency of lip licking when the stimulus was a familiar human compared to a regular food pellet (Norling *et al*, 2012). This warrants future investigation of more subtle differences in lip licking behaviour in dogs, in relation to positive and negative stimuli.

Body shaking has been observed during stressful situations and described as an indicator of relief (Beerda *et al*, 1998). However, in early descriptions of the dog ethogram, the *head* shake in particular, was described as a play facilitating signal in dogs (Fox, 1970). Therefore, it would be interesting to explore specifically with which part of the body the dog is performing these shaking movements in order to increase our understanding of this expression.

Lateralisation of behavioural expressions has received increasing attention in the study of emotional reaction to different stimuli (e.g. see Rogers, 2010 for a review). For example, detailed studies of tail wagging have shown that a positive stimulus (seeing its owner) made dogs wag their tail more to the right, while a threatening stimulus (dominant unfamiliar dog) made them wag their tails more to the left (Quaranta *et al*, 2007). Identification of these kinds of lateralised biases, however, requires studies in very controlled laboratory settings (Paz & Escobedo, 2011). A simpler approach when interpreting the valence of arousal is to include intentional behaviour, such as approach or avoidance during such assessments.

The same complexities arise when interpreting other physiological parameters of arousal, such as cortisol or HR (Mendl *et al*, 2009). When arousal is increased, the HPA axis is activated, resulting in release of e.g. cortisol. Cortisol measures are often used as an indicator of negative arousal, but a typical situation where cortisol may increase during positive contexts is during play (Carrier *et al*, 2013). HR generally increases when an individual is being emotionally and physically aroused, regardless of the valence of the experience. In humans, HR is increased for a longer time after a negative emotional experience than following a positive experience (Brosschot & Thayer, 2003), and it may be that the latency for the HR to return to normal after being presented with a specific stimulus could be a useful indicator also of positive *versus* negative arousal in dogs.

HRV is suggested to be a promising tool for measuring mental states in animals (von Borell *et al*, 2007). Nevertheless, HRV is affected by many

different physiological factors and in order for it to serve as a valuable measure of psychological arousal, the choice of index of the HRV is important. The time domain indices (e.g. SDNN and RMSSD) are easiest to calculate and are of clinical use, but does not serve as very good measures of mental arousal (Appelhans & Luecken, 2006). Rather, focus should be on different frequencies of the HRV spectrum (e.g. the high frequency (HF) band, low frequency (LF) band and the ratio between them) in future studies on mental arousal, since these can better specify the physiological reactions underlying changes in PNS and SNS activity.

A challenge when it comes to measures of oxytocin as an indicator of 'pleasant' states is the ongoing discussion about whether or not peripheral oxytocin measures reflect central levels of oxytocin. This is important as oxytocin exerts its effects on e.g. social behaviour in the brain. Although still much debated (Churchland & Winkielman, 2012; Meyer-Lindenberg *et al*, 2011), evidence of a coordinated release of central and peripheral oxytocin is emerging (Carter *et al*, 2007; Ross *et al*, 2009).

5.5 Future studies of different attachment styles in dogs and the quality of the dog-owner relationship

Most research on attachment behaviour in dogs has focused on the secure style of attachment. But why should we assume that the majority of dogs develop such a style towards their owner? When Ainsworth *et al* (1978) first defined the different attachment styles in infants (based on their behaviour in the ASSP) they used Western middle-class infant-parent dyads, where the majority of children were classified as securely attached. This was considered the most successful strategy in terms of competence in social abilities and emotional control later in life. More lately, however, light has been shed on the adaptive values of the other styles of attachment (insecure ambivalent and insecure avoidant), arguing that these are alternative conditional strategies (Main, 1990). Conditional strategies are equal in terms of adaptive value in those conditions in which they are required. Under some circumstances it may be more beneficial for the caregiver to prolong the dependence of the attached individual in order to safeguard its survival, while in others it may be a better strategy to promote independency. The attached individual adapts its behaviour according to the caregiving strategy to maximise its survival under these conditions. These variations in caregiving behaviour may be present also among dog owners, suggesting the formation of different attachment styles in the dogs cared for. It may also be that different breeds are predisposed to

different styles of attachment as a result of intensive selective breeding. It is tempting to speculate that such biases may be seen between different types of working dogs, where some breeds are supposed to perform their tasks with minimal guidance from a handler, while others work in close contact, constantly attentive to their handlers' signals. Whether or not such biases exist, the influence of early experience and the owner's behaviour is crucial for the social development of the dog. Hence, the ability of the dog to adapt to different caregiving behaviour may have implications to its welfare in the relationship with its owner. For example a dog may have developed its attachment style with a previous owner and this style is no longer adaptive with a new owner.

To categorise a relationship fully we need to know not only the content and quality of the interactions, but also how they are patterned (when they occur with respect to each other and how they affect each other). Since it would be impossible to observe a single dog-owner dyad continuously to 'catch' all types of different interactions that occur in different circumstances, we need a specific situation where a 'snap-shot' of important interactions can be taken. Studies of the more complex attachment behaviour in older children (>2 years of age) focuses on unstructured reunion sessions with the attachment figure in other laboratory settings than the SSP. Given the variation in reunion behaviour in dogs found in the work within this thesis, I suggest future studies should focus on reunion behaviour in dogs, with the aim of finding proper categorisations of dogs based on their individual responses during these events. This has a promising potential to reveal underlying mechanisms to why some dog-human relationships are more successful than others.

6 Conclusions

- The view that if a person has a strong relationship to their dog, the dog would also be strongly bonded to the person, was not supported by the results in study I. The correlations found were linked to how the owner interacted with the dog on a daily basis, but no associations were found between the dog's bond and the level of the owner's perceived emotional closeness to the dog.
- When evaluating the SSP in study II, dogs reliably behaved differently towards familiar people and strangers upon reunion in the SSP. But, no differences were found in the levels of exploration according to the familiarity of the accompanying person, indicating that this important feature of the secure base assessment was sensitive to order effects in the procedure. Evidence from the work within this thesis and pitfalls discussed in the literature suggest that without counterbalancing for order effects, the SSP is not an appropriate method to study the dog's affectional bond to its owner.
- Although dogs did not show that they were affected by the duration of time (≤ 4 h) while separated from their owners in study III, behaviour upon reunion differed according to the length of the separation. This was indicated by increased levels of physical contact, lip licking, body shaking and tail wagging after longer durations of separation from the owner.
- Regardless of how the person interacted with the dog in study IV, reunion with a familiar person increased plasma oxytocin levels and decreased cortisol levels in the dog. These endocrine effects were however most apparent when the familiar person initiated both

physical and verbal contact with the dog during reunion. During this type of interaction, dogs showed higher levels of physical contact and lip licking.

In combination, the results suggest that physical contact, lip licking, body shaking and tail wagging are indicators of arousal in dogs. In order to determine the valence of arousal, additional indicators of emotional state including approach/avoidance behaviour, body postures, and preferably also physiological measures, must be considered in future studies.

Based on findings gathered from all studies in this thesis, it was evident that dogs adapted their greeting behaviour towards humans according to the familiarity of the person, the duration of separation and the type of interaction initiated by the person. Therefore, to better understand how dogs experience their relationship with a particular human, measures should focus on the dog's reunion behaviour. These variations in the different components of reunion behaviour may also make it possible to identify different attachment styles in dogs.

7 Svensk sammanfattning

Hunden spelar en viktig roll i människans liv, och vi i deras. Inom forskningen har man hittills främst fokuserat på de effekter som denna relation har för oss människor, medan man vet mindre om hur hundarna upplever relationen. Det huvudsakliga syftet i denna avhandling är att undersöka just detta; hur hundarna uppfattar relationen och hur man kan mäta detta på ett tillförlitligt sätt.

I den första studien undersökte vi om styrkan av det känslomässiga band som hunden har till sin ägare kan återspeglas i ägarens syn på deras relation. För att värdera hur starkt bunden varje hund var till sin ägare fick hundarna tillsammans med sina ägare genomgå ett beteendetest; Strange Situation Procedure (SSP). SSP utförs i en främmande miljö och består av en kedja olika episoder, under vilka hunden har sällskap av antingen ägaren, en främling, eller är lämnad ensam i ett rum. Styrkan av hundens band till sin ägare värderades genom att titta på hur mycket hundens beteende skiljde sig när ägaren fanns till hands i denna mildt stressande situation, jämfört med om denne inte fanns i rummet. Ägarnas syn på relationen mättes med hjälp av ett frågeformulär som belyser tre aspekter av hundägandet: vardagliga interaktioner med hunden, det känslomässiga bandet till hunden och de saker som eventuellt kan uppfattas som jobbiga med att vara hundägare. Utifrån ägarens svar värderades även hans/hennes relation till hunden som svagare eller starkare för hela, samt för varje del av frågeformuläret. Därefter jämförde vi hundens och ägarens mått och undersökte om det fanns ett samband mellan hur starkt bunden hunden var och hur stark relationen uppfattades som av ägaren. Det visade sig att ju mer tid ägaren tillbringade i närheten av sin hund till vardags, desto mer fysisk kontakt tog hunden vid återförening i beteendetestet. I motsats till vad vi förväntat oss, hittades inga samband mellan hur starkt ägaren kände emotionellt för hunden och hur hunden betedde sig under testet. Därmed drogs

slutsatsen att det är vad ägaren gör med hunden som i högre grad påverkar hur hunden uppfattar relationen snarare än hur känslomässigt involverad ägaren är i sitt hundägarskap. Metoden (SSP) som vi använde för att titta på hundens band till sin ägare har till viss del ifrågasatts för sin lämplighet när man tittar på relationen mellan hund och människa. Därför ville vi titta närmare på just detta i nästa studie.

SSP är ett test ursprungligen utformat för att undersöka bandet mellan unga barn (1-2 år gamla) och deras föräldrar, men modifierade versioner av testet har i stor utsträckning använts även för att studera bandet mellan hund och ägare, då detta har liknats vid bandet mellan ett barn och dess förälder. Målet med SSP är att man genom att försätta hunden i en stressande situation vill trigga igång ett behov av trygghet som eventuellt skulle kunna tillgodoses av ägaren. Under testet tittar man bland annat på hur hunden reagerar när ägaren inte längre finns där som en trygghet att vända sig till, och huruvida hunden i närheten av sin ägare blir mer säker i sig själv och vågar utforska sin omgivning. Det har dock funnits en misstanke om att det är turordningen av händelserna i testet som framkallar effekter på hunden snarare än relationen till den närvarande personen.

För att undersöka detta fick hundar i den andra studien delta i SSP två gånger. Den ena gången deltog hunden i testet tillsammans med en välbekant person och en främling. Den andra gången, som utgjorde en kontrollbehandling, deltog hunden tillsammans med två främlingar. Jämförelser av hundens beteende tillsammans med en välbekant person eller total främling visade att hundarna utforskade sin omgivning lika mycket oberoende av relationen till den som var närvarande i rummet. Detta pekar mot att det snarare var turordningen av de händelser som hunden utsattes för som påverkade hundens utforskandebeteende. Hundarna föredrog dock att vara i fysisk kontakt med den välbekanta personen framför någon av främlingarna och det fanns belägg för att de reagerade starkare på återseendet med den välbekanta personen, vilket uttrycktes bland annat genom att de viftade mer på svansen och ville ha nära kontakt. Sammanfattningsvis visade resultaten att SSP troligen inte är en bra metod att använda för att utvärdera detaljer i bandet mellan hund och människa, utan att fokus istället bör läggas på att observera hundens beteende vid återförening med ägaren. I resten av avhandlingen gick vi därför in i detalj på hur hunden reagerar på återförening med en person under olika förhållanden.

I den tredje studien studerade vi hur hundar påverkades av att vara separerade från ägaren under olika tidslängder, med fokus på hälsningsbeteende vid återförening. Beteende och hjärtaktivitet observerades hos hundar vid tre olika tillfällen: när de var ensamma hemma i 0,5, 2 och 4 timmar. Varje separation följdes av en 10-minuters period där vi i detalj kunde studera hur hundarna interagerade med sina ägare när de återförenades. Det visade sig att hundarna var inaktiva större delen av tiden då de var ensamma (92-97% av tiden) oberoende av tidslängd, men i deras beteende då ägaren kom tillbaka hem sågs däremot skillnader. Efter de två längre separationstiderna tog hundarna initiativ till mer fysisk kontakt, viftade mer på svansen, slickade sig mer om munnen mer och ruskade mer på kroppen. Det bekräftades således att det spelade roll hur lång tid de varit ensamma hemma, och detta återspeglades i deras hälsningsbeteende.

Spelar det då roll för hunden hur den blir bemött vid en återförening? I den sista studien varierade en person sitt sätt att ta kontakt med hunden, genom att antingen både tala till och klappa hunden, att endast tala till den eller att ignorera den. För att bättre kunna tolka hundarnas beteende mättes även hundens kortisol- och oxytocinnivåer under detta experiment. Oxytocin är ett hormon som frisätts bland annat vid lugn positiv beröring och kallas ofta för ett ”lycko-hormon”. Vi kunde se att återseendet med personen, oavsett hur denna tog kontakt med hunden, frisatte detta hormon bland hundarna. Denna effekt var dock starkast (varade längre) om personen initierade både fysisk och verbal kontakt, vid en jämförelse med de andra sätten. Vid denna typ av full kontakt tog hunden även mest initiativ till fysisk kontakt och slickade sig mest om munnen. Det verkade som att hundarna mest uppskattade den typen av återförening som inkluderade både fysisk och verbal kontakt.

Sammanfattningsvis kunde vi se skillnader i hur hunden betedde sig vid återförening med avseende på hur välbekant personen var, hur lång tid de hade varit åtskilda och på vilket sätt personen tog kontakt med hunden. För framtida studier av olika typer av relationer mellan hund och ägare föreslår vi att variationer i beteende under återförening ska ligga i fokus. Återföreningen kan fungera som en ögonblicksbild av relationen, där man kan plocka upp viktiga detaljer som återspeglar deras tidigare interaktioner.

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So at last, here it is - the *thesis*..., and you've all contributed to it.

PS. I forgot to thank **Mr Deadline**. D.S.

Appendix 1. The MDORS questionnaire's three subscales and the questions included in each of them (from Dwyer et al., 2006)

Subscale 1: 'Dog-Owner interaction'	Subscale 2: 'Perceived Emotional Closeness'	Subscale 3: 'Perceived costs'
How often do you play games with your dog?	My dog helps me get through tough times.	How often do you feel that looking after your dog is a chore?
How often do you take your dog to visit people?	My dog is there whenever I need to be comforted.	It is annoying that I sometimes have to change my plans because of my dog.
How often do you give your dog food treats?	I would like to have my dog near me all the time.	It bothers me that my dog stops me doing things I enjoyed doing before I owned it.
How often do you kiss your dog?	My dog provides me with constant companionship.	There are major aspects of owning a dog I don't like.
How often do you take your dog in the car?	If everyone else left me my dog would still be there for me.	How often does your dog stop you doing things you want to?
How often do you hug your dog?	My dog gives me a reason to get up in the morning.	My dog makes too much mess.
How often do you buy your dog presents?	I wish my dog and I never had to be apart.	My dog costs too much money.
How often do you have your dog with you while relaxing, i.e. watching TV?	My dog is constantly attentive to me.	How hard is it to look after your dog?
How often do you groom your dog?	How often do you tell your dog things you don't tell anyone else? How traumatic do you think it will be for you when your dog dies?	How often do you feel that having a dog is more trouble than it is worth?