



# The Role of the Emotional Relationship with Humans on Dog Welfare



Therese Rehn

Thesis (Licentiate)

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Therese Rehn

*Faculty of Veterinary Medicine and Animal Sciences  
Department of Animal Environment and Health  
Uppsala*

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## Abstract

The overall aim with this thesis was to identify reliable ways to assess the emotional bond between dogs and humans and to investigate the effect of length of separation from the owner on dog behaviour upon reunion.

In Study I, an evaluation was made as to whether the Ainsworth's Strange Situation Procedure (ASSP), developed in child psychology, can be reliably transferred to investigate attachment between dogs and humans. In a balanced cross-over design, 12 research dogs participated in the ASSP in two different treatments, where the target figure was either a familiar person or a stranger. Results showed that dogs clearly preferred to be in physical contact with the familiar person, indicating that the dogs discriminated between people according to their previous experience of the relationship. They also showed more intense greeting behaviour towards the familiar person. However, there was no evidence to support the earlier proposal that the emotional relationship with a familiar person is of the 'secure base' attachment type, since the results for this comparison were similar when the target figure in the ASSP was a stranger. In paper II, the behaviour and cardiac activity of privately owned dogs without separation anxiety was investigated when they were left alone at home for 0.5, 2 and 4h. Each period of separation was preceded and followed by a 10-min period during which the owner was present and could interact with the dog. It was found that dogs were inactive most of the time they were alone and that their behaviour did not change over time. However, the length of time left alone significantly influenced the dogs' behaviour when the owner returned. After longer separation periods (2 and 4 h), dogs had a higher heart rate and expressed a higher frequency of behaviours previously suggested to indicate arousal (body shaking and lip licking) during reunion with the owner. Dogs also displayed more tail wagging and initiated more contact with their owners after longer times of separation, regardless of owner behaviour. It was concluded that the ASSP is an inappropriate method to assess the emotional bond between dogs and humans due to inherent order effects in the procedure. Instead, dog behaviour upon reunion with their attachment figure is proposed as a better and more robust measure to assess the quality of the emotional bond.

*Keywords:* dog-human bond, dog-human interaction, dog welfare, attachment, greeting behaviour, positive arousal

*Author's address:* Therese Rehn, SLU, Department of Animal Environment and Health, P.O. Box 7068, 750 07 Uppsala, Sweden

*E-mail:* [Therese.Rehn@slu.se](mailto:Therese.Rehn@slu.se)

# Dedication

Till Brorsan

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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., McGowan, R.T.S & Keeling, L.J. An evaluation of the Ainsworth's Strange Situation Procedure (ASSP) to assess the emotional bond between dogs and humans. Manuscript.
- II Rehn, T. & Keeling, L.J. (2011). The effect of time left alone at home on dog welfare. *Applied Animal Behaviour Science* 129, 129-135.

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## Abbreviations

ASSP	Ainsworth's Strange Situation Procedure
HR	Heart rate
HRV	Heart rate variability
FS	Treatment FS in study I (Familiar person and Stranger)
SS	Treatment SS in study I (Stranger A and Stranger B)
F	Familiar person in study I (in treatment FS)
S	Stranger in study I (in treatment FS)
S <sub>A</sub>	Stranger A in study I (in treatment SS)
S <sub>B</sub>	Stranger B in study I (in treatment SS)
T <sub>0.5</sub>	Treatment in study II (dog left alone for 0.5h)
T <sub>2</sub>	Treatment in study II (dog left alone for 2h)
T <sub>4</sub>	Treatment in study II (dog left alone for 4h)

# 1 Introduction

There is currently an increasing interest in the positive effects that animals have on humans. Pet ownership is often associated with health benefits, including improvements in mental health status and the ability to interact with other people (e.g. Barker and Dawson, 1998; Dembicki and Anderson, 1996; Straede and Gates, 1993). It is an important area to investigate, but not much attention has been given to the effect humans have on the animals. Humans are the most important factor influencing an animal's welfare. This is particularly true for companion animals, because pet and owner are usually living in the same environment.

Most research on dog welfare has focused on negative aspects, like animal abuse or behavioural problems such as aggression and separation anxiety (e.g. Palestrini *et al*, 2010; Takeuchi *et al*, 2001; McCrave, 1991). Little work has investigated the 'average' interaction between dogs and humans, that occurs on a daily basis, and which is probably mostly positive. As a result we do not have sufficient understanding about how such regular human interaction actually influences the pet. From the dog's point of view, an increased knowledge about the relationship between dogs and humans and the behaviour of dogs during interaction could reveal features of possible underlying conflicts in the relationship linked to e.g. behavioural problems. Behavioural problems are one of the most common reasons for relinquishing dogs to shelters (Podberscek, 1997; Serpell, 1996). More knowledge about the relationship may also help to improve the situation for the increasing number of dogs used within animal assisted therapy. The above mentioned areas would also benefit the owner by maintaining a long-lasting positive relationship and also benefit society in general in that we can, by improving dog management, help dogs to cope better with the demands humans put on them by our modern way of living. Possibilities to

prevent behavioural problems are also beneficial for society because some behavioural problems, such as aggression, can put the general public at risk. It is however important to be able to evaluate an emotional relationship in a reliable way. Ethological test procedures from human psychology have been used and solid behavioural studies in combination with physiological measures can be useful. In this thesis, a commonly used method to assess the dog-human relationship was investigated.

A positive human-dog relationship may benefit the dog by influencing the way the owner takes care of it and how the dog experiences the time together in different activities. On the other hand, one of the criteria of individuals being emotionally bonded to each other is that they get distressed when separated involuntarily. In our modern society, it is impossible for most dog owners to be together with the dog during large parts of the day. A survey of Swedish dog owners showed that 73% of the respondents left the dog alone at home while working (Norling and 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 (PAW) Report, 2011). People often find this acceptable unless the dog suffers from separation anxiety. From the dog's point of view however, social contact is an highly important resource (e.g. Coppola *et al*, 2006; Wells and Hepper, 2000, 1998; Hubrecht, 1993) and humans have been found to have a greater stress relieving effect on dogs than even the company of another familiar dog (Tuber *et al*, 1996). One part of this thesis aimed to investigate the effects on dogs of being left alone at home, since a large proportion of dogs are faced with this on a daily basis.

Duncan (1996) argued that the welfare of an animal is largely dependent on its feelings. Much work on measuring negative affective states has been made (Harding *et al*, 2004; King *et al*, 2003; Rushen, 1996) and it is widely accepted that animals can feel e.g. pain and suffering. Lately, animal welfare science has begun to focus also on how to assess positive emotions because these are suggested not only to be a main component of good welfare (Fraser and Duncan, 1998) but also to have adaptive values to the individual (Fredrickson, 2001; Panksepp, 1998). There is to date however, a lack of objective methods to measure positive emotions. When assessing the internal state of animals, behaviour, physiology and their cognitive abilities are the core targets of investigation (Yeates and Main, 2008; Boissy *et al*,

2007; Paul *et al*, 2005). In this thesis, we focused on finding behaviours that could be suggested to indicate positive arousal.

## 1.1 The dog-human relationship

Dogs have established a niche for themselves in human society during their common history with man, which has been described as a form of co-evolution (Hare *et al*, 2002; Paxton, 2000; Clutton-Brock, 1977). Historically, dogs and humans lived in a cooperative relationship, where dogs and humans were hunting together and dogs were used for guarding or herding animals (Coppinger and Schneider, 1995). Findings from ancient burials however, where dogs were occasionally buried together with a human, seem to indicate an early emotional relationship between dogs and humans.

Today, dogs occupy a significant role in their owners' lives by offering companionship, affection, friendship and by acting as social facilitators (e.g. Robins *et al*, 1991). Many dog owners report that they are as emotionally involved with their dog as with family members or friends (Barker and Barker, 1988). Serpell (2004) suggests that humans develop positive feelings and behaviour while caring for dogs because of an emotional relationship similar to that in the human mother-infant bond. A relationship is referred to as an association between two individuals. 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 and Peplau, 1983). The dog-human relationship is a complex and multi-faceted phenomenon and different categories of relationships have been described (e.g. Dotson and Hyatt, 2008; Holbrook *et al*, 2001; Veevers, 1985; Fox, 1981), ranging from including attributes such as the master-slave relationship to the infant-mother relationship. A healthy and positive relationship may develop into a social bond between two or more individuals.

## 1.2 Dog-human social interaction

Maintenance of a social bond is necessary for a stable social life (Kikusui *et al*, 2006). To uphold this social bond between group members, a mutual understanding of communicative signals is probably necessary for appropriate social interactions. During domestication, dogs have been

selected for traits that improve their adaptation to human society and their cooperative skills during social interactions with humans (Hare *et al*, 2002; Millot, 1994). Dogs are very sensitive to human actions and to their intention (e.g. Topál *et al*, 2009; Soproni *et al*, 2001; McKinley and Sambrock, 2000; Miklósi *et al*, 1998) and dogs are also able to signal their intentions back to humans without prior training of the task, e.g. direct their owner towards the location of a hidden food reward (Miklósi *et al*, 2000; Hare *et al*, 1998). It has also been shown that humans, without any previous experience of dogs, are able to classify the emotional intention of barking dogs, just by listening to the sound of the barks (Pongrácz *et al*, 2010; Molnár *et al*, 2009; Pongrácz *et al*, 2005). Comparisons of hand-raised wolf and dog pups have shown that dogs show more communicative signals towards a familiar human such as vocalisation, tail wagging and gazing (Gásci *et al*, 2005). These notable cases of interspecies communication, where dogs often outperform both their own closest relatives, wolves, as well as our closest relatives, chimpanzees, are suggested to be due to a convergent evolution of advanced social skills in response to similar social selection pressures in humans and dogs (Hare *et al*, 2010; Hare and Tomasello, 2005) or a mixture of domestication effects and early experiences in life (Udell *et al*, 2010). Evidence of dogs' ability to empathize with humans has not yet been found, but is proposed to be investigated due to their close relationship with humans and highly developed socio-cognitive skills (Silva and de Sousa, 2011).

In dog-human social interactions, observation of the dog's behaviour is one method to measure the individual's intentions and the behaviour can also reflect the internal emotional state of the individual (e.g. Boissy *et al*, 2007). Since most previous welfare research has focused on the negative side of human-animal interaction, 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. Palestini *et al*, 2010; Rooney *et al*, 2007; Beerda *et al*, 2000, 1997; Glover, 1992; Hetts *et al*, 1992).

Reunion between individuals in a healthy relationship is probably a positive experience. Greeting usually includes a number of different behaviours initiated by the dog, such as physical contact, proximity to or orientation towards the other individual and sometimes also includes lip licking behaviour and tail wagging. The intensity of the greeting session or

the duration has been measured to evaluate the response to reunion with familiar people and strangers (e.g. Prato-Previde *et al*, 2003; Topál *et al*, 1998). Both lip licking and tail wagging are often referred to as signals of active submission (Fox, 1970). Submission has a negative sound to it, but the word is actually defined as an (inferior's) intention to a friendly and harmonic social interaction (Schenkel, 1967). Lateral tail wagging is suggested to reflect emotional states in dogs (Quaranta *et al*, 2007), but such bias is difficult to identify outside a controlled laboratory environment (Paz and Escobedo, 2011). One intention was to find behavioural indicators of positive affective states in dogs by further exploring the interaction and greeting behaviour upon reunion between dogs and owners.

### 1.3 Attachment

Attachment could theoretically be applied to many long-lasting emotional bonds that develop between humans, such as the bond between infant and mother, between romantic partners and between close friends (Crowell *et al*, 2008; Hazan and Shaver, 1987). Bowlby (1969) developed the 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 behaviours and separation protest), *safe haven* and *secure base* (Fig. 1). According to Bowlby (1969), individuals are born with an innate psychobiological system (the attachment system) that motivates them to seek proximity to someone that will protect them in times of need. This attachment system 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 (providing protection) and reproduction (e.g. pair bonding/sexual mating, parental behaviour) (Belsky *et al*, 1991; Bowlby, 1958).

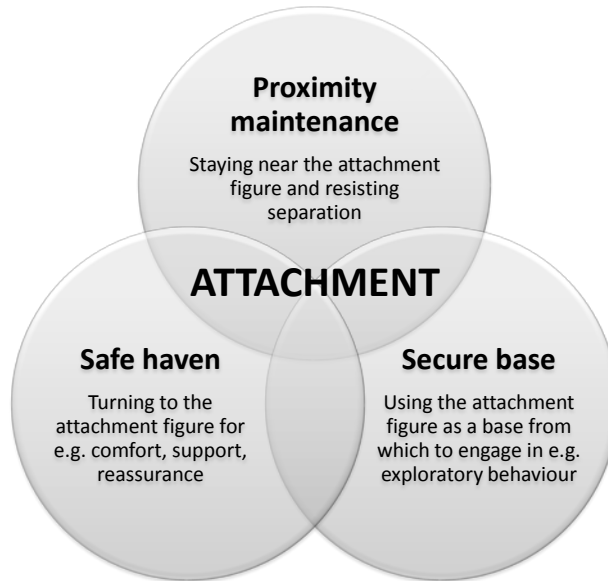


Figure 1. The defining features of attachment according to Bowlby's (1969) attachment theory. Illustration is based on figure from Hazan and Shaver (1994).

Ainsworth *et al* (1978) further developed the attachment theory by defining different patterns of attachment styles among children. They developed categories, which were based on the attachment system, originally described by Bowlby (1969). Attachment style may be defined as the systematic pattern of relational expectations, emotions and behaviours that result from a particular history of interactions with attachment figures (Hazan and Shaver, 1987). A *secure* attachment style is characterized by the child using the caregiver as a so-called secure base, from which to engage in other nonattachment behaviours, such as exploration or play. The child is also contact-seeking and happy when reunited with the caregiver. *Insecurely* attached individuals show either ambivalent behaviour patterns towards the attachment figure or even avoidance upon reunion and do not use the figure of attachment as a secure base.

The definition of attachment in relation to investigating the human-human relationships is widely discussed elsewhere (e.g. Goldberg *et al*, 1999; Pederson and Moran, 1999; Rajecki *et al*, 1978 for a review) and it is out of scope of this thesis to describe in detail the different views. As in human psychology research, when evaluating human-animal relationships the use of the term attachment has not always been consistent with the traditional definition of attachment suggested by Bowlby (1969). This thesis deals with

the relationship between dogs and humans and this may share some aspects of the traditional attachment theory applicable to children-parent relationships, but perhaps not all of them (Crawford *et al*, 2006). I will from now on generally not use the term 'attachment' to avoid possible confusion due to the lack of an existing uniform definition and the diverse interpretation of the phenomenon. The term 'affectional bond' will be used as defined by Ainsworth (1989): "a relatively long-lasting tie in which the partner is important as a unique individual and is interchangeable with none other". I will only refer to attachment in relation to the different methods used when assessing a relationship within human psychology, as well as when discussing the specific features of the affectional bond between two individuals, i.e. whether the pattern of attachment is secure or insecure (ambivalent/avoidant), which are based on the attachment theory. This thesis focuses partly on the affectional bond that can be developed between two individuals, which is one aspect of the 'emotional relationship' between dogs and humans, referred to in the title of the thesis.

#### 1.4 Methods to study the dog-human relationship

Most research on dog-human interaction has been carried out using questionnaire studies, both when assessing the owner's way of interacting with the dog or his/her feelings about the dog (e.g. Dwyer *et al*, 2006; Shore *et al*, 2006). Also, when evaluating the dog's behaviour towards the owner or when assessing behavioural problems, questionnaires have been used extensively (e.g. Bennett and Rohlf, 2007; Jagoe and Serpell, 1996). Well designed questionnaires can give valuable information from a large sample size over a large geographic area to a low cost. However, questionnaires are always based on the human respondents' perception of the situation rather than solid observational data. Another problem with questionnaires is that because surveys are relying on volunteers, the respondents may already represent a biased group of dog owners, based on the simple fact that they agree to participate.

In human psychology, the relationship between very young children (12-24 months old) and their parents has been investigated using the Ainsworth's Strange Situation Procedure (ASSP), developed by Ainsworth and Bell (1970). The ASSP is considered to be an inappropriate method to use when assessing the bond between older children and has been modified to focus more on the behaviour upon reunion between the child and the parent



(Crittenden, 1992; Cassidy, 1988; Fairchild, 2006 for a review). Waters and Dean (1985) developed the 'Attachment Q-test' as a measure of the quality of the bond between children (1-5 years old) and their parents. The Q-set test includes observations of the child's attachment behaviour in a number of different environments and is based on longer and more naturalistic observations at home. Often also interviews with the parent are included in the assessments. Among adults, the emotional bond between individuals is assessed mainly using information based on self-report questionnaires (Hazan and Shaver, 1987) and interviews (Hesse, 1999).

Taken from human psychology, the ASSP has been transferred to explore the dog-human relationship based on the similarities between the infant-mother bond and the dog-owner bond as well as the proposed equal cognitive skills between dogs and young children (1-3 year-olds) (Range *et al*, 2007; Kaminski *et al*, 2009; Topál *et al*, 2009). In the ASSP, the subject (child/dog) is presented with mildly stressful challenges according to a specific procedure. The subject is introduced to a novel environment together with its attachment figure (parent/owner), and an unfamiliar human enters and tries to interact with the subject. The subject experiences both separation and reunion with the attachment figure during the test. Proximity seeking behaviours and behaviours indicating a secure base effect, such as increased exploration in the presence of the attachment figure, are observed to evaluate the quality of the bond between the participants. The reliability of the ASSP has been questioned due to possible order effects (Palmer and Custance, 2008; Feldman and Ingham, 1975) and in study I, these were investigated by introducing a balanced cross-over design.

Behaviour studies are of great use when studying dog-human interaction. The main advantages are that direct behavioural observation is tangible and can provide insights to the contextual factors affecting a response. Behavioural studies are however time consuming and demand trained observers. Usually, the cost for implementation is higher compared to questionnaire studies and it may be more difficult to get participants to the location where the study is performed.

Complementary physiological measures are often helpful when interpreting behavioural responses. Behavioural reactions to external stimuli are often followed, or preceded, by changes in cardiac activity and hormone levels. 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; Palestrini *et al*,

2005). HR is controlled by the sympathetic and parasympathetic autonomic nervous system. Heart rate variability (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. HRV does not seem to be as influenced by physical activity as HR. Maros *et al* (2008) found that the HR in dogs increased with higher physical activity while HRV did not. In contrast, the HRV increased when the dog was oriented towards its favorite toy, indicating that HRV might indicate a mental arousal. Furthermore, Gácsi *et al* (2009) found that separation from the owner did not increase HR but affected HRV.

There are advantages and disadvantages with using research dogs versus privately owned dogs when investigating dog-human interaction, depending on the research question. With laboratory dogs, housed at a research facility, the experiment can be much more controlled in the sense that uniform groups matched for breed, age, earlier experiences, housing and kinship can be used. This was applicable in study I, where the aim was to evaluate a specific test procedure in a controlled and balanced design. In study II, we wanted to investigate the effect of time left alone at home in the population of privately owned dogs in Sweden. When using privately owned dogs outside a standardized environment, the situation may be less controlled and more complex including risk of confounding effects, but is perhaps more representative depending on the question to which the answer was sought. Also, the design of the experimental set up can reduce the influence of individual variation and in both study I and in study II, all dogs participated in all treatments to correct for this. 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, because the methods complement each other with their pros and cons (Miklósi, 2007).



## 2 Aims of the thesis

The aims of this thesis were to evaluate methods to assess the bond between dogs and humans and link this to the effects on dog welfare by,

- Evaluating a method previously used to measure the affectional bond between dogs and humans
- Proposing future methods to study the emotional relationship between dogs and humans
- Evaluating the effect of time left at home alone on dog welfare and the reaction upon reunion with the owner
- Proposing candidate behaviours to be possible indicators of positive arousal



## 3 Materials and methods

### 3.1 Subjects and testing environments

Study I was executed at the Swedish University for Agricultural Sciences (SLU) in Uppsala, Sweden. The dogs used in this study were research beagles, held in the dog facility at SLU. At the time of the study, they were approximately 2 years old and were all intact females. All dogs came from the same breeder (B&K, England) and they arrived to SLU at the age of 8–10 months.

Two female researchers acted as the familiar persons during the ASSP. They had known the dogs for over a year. They had spent a considerable amount of time with them and were well acquainted with the dogs although they were not the caretakers of the dogs. A third person always acted as the stranger in one of the treatments and two other females played the role of the strangers in the other treatment (stranger A and stranger B). The people acting as strangers had never met the dogs prior to the test.

The tests were carried out in an indoor test room, unfamiliar to the dogs. The test area consisted of two unfurnished rooms separated by a door.

Study II was performed with privately owned dogs of different breeds and ages (range: 1–12 years old, mean: 4.3). Six dogs were female and six dogs were male, all intact. They participated in the study together with their owners. Among the owners, all were women but one. Participants were recruited by personal contact and advertisements. Inclusion criteria were that the dogs did not have a history of separation related behavioural problems, that they were used to being left alone at home for at least 4

hours at a time and that they were left at home without any other animal in the home.

All recordings in study II were made in the dog's home environment. Type of household varied: most dogs lived in apartments, a few in houses and some in smaller student accommodations. Most dogs were allowed to roam free in the whole home and no dogs were kept in cages while left alone.

### 3.2 Equipment

To measure cardiac activity in study I and II, the Polar® Vantage (S810) equipment was used. The equipment consists of a flexible belt, strapped around the chest of the dog. The belt comprises two electrodes and 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 was stored in a receiver that was attached to a harness that the dogs wore. 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 studies.

Two stationary surveillance cameras (VIVOTEK network camera, PT3124) were used to monitor the dogs in both studies. These cameras were placed at roof level in two corners of the test room in study I. In study II, one camera was always monitoring the entrance area of the dog's home and the other one was placed to monitor an area which the owner believed that the dog would spend most of its time while left alone at home. In study I, an additional digital camera (SONY HDR-SR10E) was placed at a lower level (approximately 1 m height) to further monitor the dogs' behaviour.

When coding the videos from study I, the computer software programme Interact (Mangold International, version 2.4) was used. Videos from study II were scored by hand using the Vivotek software (Vivotek ST3402, version 2.0).

### 3.3 Behaviours

To investigate whether the dogs discriminated between the familiar person and the strangers in study I, proximity seeking behaviours (physical contact

with person/chair/door, orientation towards person/door, location near person/door) were observed instantaneously or recorded with one-zero sampling every 5 sec. To investigate possible secure base effects of accompanying person, exploration and play were observed using one-zero sampling. Behaviour often seen in social contexts (tail wagging, lip licking, body shaking, body stretching and yawning) were recorded either by one-zero sampling or continuously (lip licking).

In study II, main behaviours (lying, sitting, standing, walking, running) were recorded instantaneously every 15 sec. Behaviours of shorter duration (e.g. panting, tail wagging, vocalisation, yawning, lip licking, body stretching, body shaking and physical contact with owner) were scored continuously.

### 3.4 Comparisons and statistical analyses

In both studies, dogs acted as their own controls, 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 both studies. HR data followed a normal distribution and was analysed using the Mixed models. The statistical software programmes SAS® (version 9.2) and Minitab® (version 15) were used when the analyses were performed.

In study I, comparisons of behaviour and cardiac activity were made within each treatment between episodes where the familiar person was present versus where the stranger was present in treatment FS (Fig. 2). In treatment SS, equivalent episodes were compared, hence when Stranger A was present in the room versus when Stranger B was present. Also, between treatment comparisons 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. Behaviour data was dependent and Wilcoxon signed rank tests were performed. HR data were analyzed using Mixed models where ‘episode’ (1-6) or ‘treatment’ (FS/SS) was treated as fixed variables and ‘dog’ as the random variable.



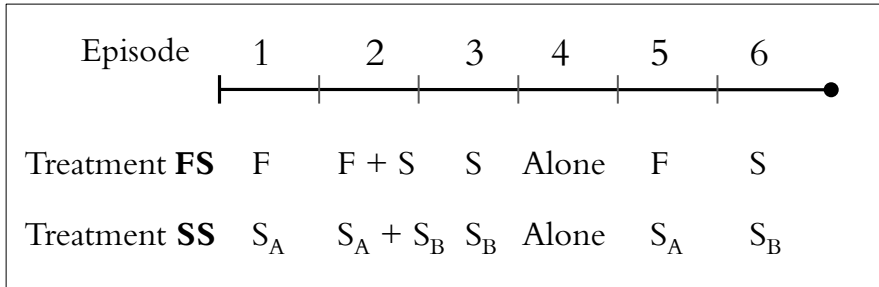


Figure 2. The ASSP consisted of 6 episodes (each lasting for 3 min). In treatment FS, the dog was accompanied by either a familiar person (F) and/or a stranger (S) or alone in the room. In treatment SS, it was accompanied by either stranger A (S<sub>A</sub>) and/or stranger B (S<sub>B</sub>) or alone, according to the description above.

In study II, comparisons of behaviour and HR between treatments were made at equivalent time intervals after owner departure and before the owner returned. 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. Kruskal-Wallis tests were used, since more than two treatments were compared simultaneously. HR and HRV were compared using the Mixed models, where ‘treatment’ was considered as fixed variables and ‘dog’ was regarded as a random variable. The same intervals were compared during the separation period, but before the owner departed, comparisons of HR and HRV were made for each minute. This comparison was also made for each minute after reunion with the owner.

### 3.5 Hypotheses

In order for the ASSP to be a reliable method to use when studying the dog-human relationship, dogs should explore and play more in the presence of the familiar person. They should also show more proximity seeking behaviour towards the familiar person than towards any of the strangers involved. In study I, the additional treatment SS (where there were two strangers rather than one stranger and one familiar person) allowed an investigation of these behavioural responses in relation to who was the accompanying person and possible inherent order effects.

If dogs were affected by the time they were left alone at home, behavioural and cardiac differences would be observed between the three treatments in study II. It was hypothesized that dogs would show more indicators of negative arousal during longer separation. It was also expected

that dogs would express a more positive reaction upon the reunion with the owner after a longer time of separation.



## 4 Summary of results and main conclusions

These sections summarize the main results of study I and II. More detailed information can be found in the individual papers.

### 4.1 Study I

Results of comparisons between episodes within treatment FS showed that dogs explored more in the presence of a familiar person than when with a stranger, indicating a secure base effect. Also, dogs initiated more physical contact with the familiar person than with the stranger.

However, comparisons between the same episodes within treatment SS, where a familiar person was never present, showed that dogs also explored more in episodes where stranger A was present. These results indicate either 1) that stranger A, who walked into the room together with the dog at the start of the test, acted as a secure base, or rather 2) that there is an order effect in the ASSP. Dogs did not initiate more physical contact with either stranger A or stranger B, i.e. they did not seem to discriminate between them in regard to the level of physical contact.

When comparing episodes where the familiar person was accompanying the dog in treatment FS with the equivalent episodes where the dog was accompanied by stranger A in treatment SS, no difference in exploratory behaviour was found, further indicating that dogs did not see the familiar person as a stronger secure base. Dogs however, initiated more physical contact with the familiar person compared to with stranger A.

Mean HR decreased over time in both treatments. Comparisons within treatment FS showed that HR was higher during episodes where the familiar person was present. Equivalent comparisons within treatment SS demonstrated that HR was higher during episodes where the dog was accompanied by stranger A. The overall decline along the test procedure indicates an order effect and probably accounts for this difference in HR with the different people. No differences in HR were found when comparing the same episodes between treatments.

The behaviour upon reunion with the familiar person in treatment FS tended to differ compared to when reunited with stranger A in treatment SS regarding lip licking, tail wagging, body shaking and vocalizing. Dogs initiated more physical contact upon reunion with the familiar person compared to with stranger A.

In conclusion, the only aspect where dogs behaved differently according to who was the accompanying person (hence acting as a measure of the quality of their previously acquired relationship), was the level of physical contact initiated towards the person. Order effects in the ASSP can explain the other results.

## 4.2 Study II

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 differences in the way dogs responded upon reunion with the owner according to the time they had been left alone at home. After longer times of separation (2 h and 4 h), 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. When reunited, dogs expressed more tail wagging, lip licking and body shaking when they had been left for 2 h or 4 h compared to 30 min (Fig. 3).

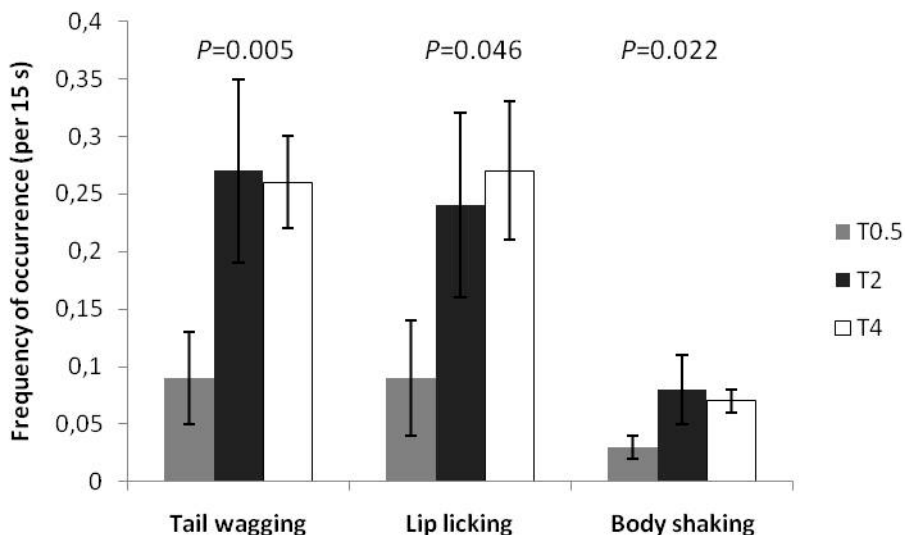


Figure 3. Frequencies (mean  $\pm$  SE) of tail wagging, lip licking and body shaking observed among dogs after owner's return in treatments  $T_{0.5}$ ,  $T_2$  and  $T_4$ .

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.

It was concluded that dogs were affected by the time they were separated from their owners by the fact that their behaviour upon reunion differed according to the separation length. They did however, not demonstrate that they were 'missing' their owners while separated (up until 4 h of separation) since they were inactive most of the time in all treatments. The effect of regular and longer times of separation should be investigated to be able to ensure a good welfare of dogs.



## 5 General discussion

Coming back to the aims of this thesis, in the following sections I briefly discuss the reliability of the ASSP as a method to study the dog-human relationship based on the results from study I, as well as give a suggestion for future methods to assess the relationship. I further discuss how dogs were affected by the time left alone at home and link results from both studies to propose candidate behaviours to assess positive arousal in dogs. Finally, a discussion about the consequences of the quality of the emotional bond on dog welfare follows.

### 5.1 Study I: Evaluation of the ASSP when assessing the dog-human relationship

Humans play an important role on the welfare of dogs and the quality of the relationship probably has effects on the positive/negative outcomes from that relationship. The dog-human relationship has previously been studied in various ways and it is important that we have correct tools to use when assessing it. The ASSP has been used, but the findings in study I indicated severe limitations in the test, due to the sequence of episodes in the test procedure. We found that the company of a stranger influenced the dogs in the same way as a familiar person regarding exploratory behaviour which, according to the attachment theory, would indicate a secure attachment between two individuals.

Dogs however, seemed to discriminate between a familiar person and a stranger in another aspect which could be reliably identified in the ASSP; dogs always initiated more physical contact with, and they tended to show



more greeting behaviour (tail wagging, lip licking) and body shaking upon reunion with the familiar person than when reunited with the stranger. These results regarding greeting behaviour are similar also in other studies where the dog-human relationship has been evaluated using the ASSP (Valsecchi *et al*, 2010; Palmer and Custance, 2008; Fallani *et al*, 2006; Topál *et al*, 2005; Prato-Previde *et al*, 2003; Topál *et al*, 1998). The pattern of attachment (secure versus insecure) is characterized not only by whether the attached individual explores and plays more in the presence of the attachment figure, but also on the reaction upon reunion (Ainsworth *et al*, 1978). Hence, future studies should focus on a detailed description of the behaviour upon reunion to identify possible differences in attachment style. Other methods to investigate the secure base effect of a familiar person could also be reflected upon, since dogs perhaps feel security by means other than increased exploration or play in presence of the attachment figure. Gácsi *et al* (2009) looked at the effect of the presence of the owner on dogs' reaction to a threatening stranger and found some evidence of a secure base effect. But they also found that the test order, whether the dog met the stranger first with or without its owner, was important. Indications of a supportive owner could also be found in for example problem solving tasks (Topál *et al*, 1997).

HR also seemed to be influenced by order effects in the ASSP and the general trend was that HR decreased over time in both treatments. In other studies, HR during the ASSP has been correlated to the level of physical activity (Palestrini *et al*, 2005) as was probably the case also in this current study, where a low HR was accompanied by a longer duration of lying behaviour. At reunion, dogs greeted both the familiar person and the stranger and no differences in HR were observed during these sessions according to who was entering the room. These results support previous findings regarding HR responses during the ASSP (Valsecchi *et al*, 2010; Palestrini *et al*, 2005).

## 5.2 Study II: The effect of time left alone at home on dog welfare

It was found that dogs were inactive most of the time while they were left alone at home, regardless of the duration of separation. This result is in line with previous studies of dogs without any separation related behaviour problems, where they were resting most of the time when being left alone

between 4 h and 9.5 h (Aslaksen and Aukrust, 2003). That there were no differences in the behaviour over the 0.5 h, 2 h and 4 h treatments may imply that the dogs were not aware of the length of time alone. This is discussed in more detail later.

No differences in HR or HRV were observed while the dogs were left alone. Although HR measures are broadly used as an indicator of negative arousal in animals (e.g. Loijens *et al*, 2002; Boissy and Le Neindre, 1997), separation in itself does not seem to have effects on HR in dogs, even in a novel environment (Gácsi *et al*, 2009; Maros *et al*, 2008). HRV however has been observed to change in dogs when left alone in an unfamiliar place (Gácsi *et al*, 2009). The fact that these dogs were in their home environment during testing could explain why we did not observe any physiological reaction in response to being alone.

The reaction upon reunion with the owner however, was affected by the separation time. After longer times of separation (2 h and 4 h), dogs initiated more physical contact with their owners and showed more greeting behaviour (tail wagging, lip licking) and body shaking. HR was higher immediately upon reunion with the owner after 2 h compared to after 30 min of separation (due to storage limits in the receiver, HR data from the interval following reunion in the 4 h treatment were unavailable). No differences in HRV according to time separated were observed at reunion. That reunion with the owner is followed by alterations in HR has been shown previously (Nagasawa *et al*, 2009; Palestrini *et al*, 2005), but so is the reunion with a friendly stranger (Palestrini *et al*, 2005). Increased HR levels might be linked to positive arousal and excitement or related to fear reactions (Beerda *et al*, 1998). Behaviour, such as approaching/avoidance or possible freezing responses should be observed simultaneously when interpreting the HR changes at reunion. In our study, dogs approached and initiated high levels of contact with the owner after being separated for longer periods of time, supporting a positive emotional reaction.

### 5.3 Indicators of positive arousal

Given that behaviour (physical contact, lip licking and body shaking) upon reunion was different towards a familiar person compared to a stranger in study I, observing reunion seems to be a useful method when evaluating the dog-human relationship. The reaction upon reunion with the owner in

study II, also differed according to the time they had been separated. Actually, some of these behaviours overlapped (physical contact, lip licking and body shaking) and were observed at different levels in both studies, according to the treatment. The reunion with a familiar person is probably more positive than the reunion with a stranger, as well as the longer two individuals have been separated the more positive is probably the reunion. Therefore, increased physical contact, higher frequency of lip licking, tail wagging and body shaking are suggested to be candidate behaviours as indicators of positive arousal. However, considering results from previous studies of negative emotions, it seems as some of these behaviours (lip licking, body shaking and tail wagging) may be shown also in situations that are characterized by negative arousal. An increased frequency of lip licking and body shaking is related to situations where dogs were presented with a frightening stimulus (e.g. Beerda *et al*, 1998). Lip licking has also been observed in caged dogs with separation anxiety while they were left alone at home (Palestrini *et al*, 2010). Tail wagging and lip licking have often been referred to as signals of active submission in wolves (McLeod and Fentress, 1997; Schenkel, 1967) and in a study by Gácsi *et al* (2005) dog puppies expressed tail wagging in a social context with humans, while wolf puppies did not. Tail wagging has also been seen to increase in foxes selected for tameness (Belyaev, 1978), suggesting that tail wagging in the domestic dog is used as a mean of communicative signaling to facilitate positive dog-human interaction (Gácsi *et al*, 2005).

Arousal as such (negative or positive) could elicit similar behavioural response in different contexts. A dog can, for example, wag its tail as a response to a positive event (McLeod, 1996) as well as when feeling anxious or aggressive (Horváth *et al*, 2007). More 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). The same problem arises when interpreting HR, which is generally increased when being emotionally and physically aroused, regardless of the valence (positive or negative) of the experience. In humans, HR is increased for a longer time after a negative emotional experience compared to following a positive experience (Brosschot and Thayer, 2003), and it may be that latency for the HR to return to normal after being presented with a specific stimulus could also be a useful indicator of positive versus negative arousal in dogs. Intentional behaviour, such as approach or avoidance behaviour is probably also helpful when interpreting the valence of arousal.

## 5.4 Implications for welfare

The underlying reasons to the different attachment styles are suggested to be related to the responsiveness shown by the caregiver (Ainsworth *et al*, 1978) and in the dog-human relationship, this would be reflected by the owner's interactions with the dog. Attachment as such is not equal to a needy, dependent individual, but rather a description of a competent and motivated individual using the primary caregiver as a secure base from which to explore and when necessary use as a haven of safety and source of comfort (Waters and Cummings, 2000). Some patterns of attachment could cause conflicts in the relationship, due to previous experience of a caregiver not being available in times of need. Other authors have tested the idea that 'hyper-attachment behaviour' might be related to separation anxiety disorder in dogs (Appelby and Pluijmakers, 2003), but no correlations between proximity seeking behaviours shown during the ASSP and separation anxiety have been found (Parthasarathy and Crowell-Davis, 2006). 'Hyper-attachment behaviour' has been suggested to include behaviours such as constantly following the owner around in the house and showing distress upon the departure of the owner (King *et al*, 2000). The pattern of attachment could perhaps be worthwhile investigating in relation to separation anxiety. In this case it should include individual scoring of behaviours related to the secure base effects, something which was not reported by Parthasarathy and Crowell-Davis (2006). Rooney and Bradshaw (2003) identified different patterns of attachment in an attachment test performed in the dog's home environment, including features similar to those situations implied in the ASSP, and they underlined the multi-dimensional aspects of attachment. Neither have other authors neglected the importance of these dimensional patterns of attachment (Marinelli *et al*, 2007; Topál *et al*, 1998). But these studies were also based on the ASSP, and hence perhaps not valid measures, plus they lack a link to other aspects of the dogs' behaviour and possible effects of different attachment styles.

A significant welfare issue is the fact that so many dogs are surrendered to animal shelters, often due to behaviour problems (Marston *et al*, 2004; Patronek *et al*, 1996). Aspects of the quality of the relationship between dogs and humans are probably the foundation to the outcomes of these conflicts. But this is not an easy subject to investigate and the nature of a good relationship is far from described in detail even among humans (Kelley *et al*,

1983). Freedman (1978) however, stated that almost everyone believes that a satisfying and close relationship is crucial for their well-being and happiness. Close relationships can arouse emotion (e.g. at separation and reunion) but also the other way around, in that the relationship is built on successful mutual interactions which in turn affect the quality of the relationship. Thus, emotion and cognition are important characteristics of close relationships in humans (Mikulincer and Shaver, 2005) and this is very likely to be the case also in the dog-human relationship.

One aspect of cognition that was indirectly assessed in the second study is the concept of time. In study II, we could not say that the dogs were aware of the exact passing of time while they were left alone, but the reaction upon reunion with the owner indicated that they were affected by the separation time. There was no evidence that the dogs reflected over the time that had gone since the owner left the home and there is still, to my knowledge, no evidence that dogs have an episodic memory, which is the ability to connect a specific event to a certain place and time (Tulving, 1983). Episode-like memory has been observed in chimpanzees, rats and scrub jays (Martin-Ordas *et al*, 2010; Babb and Crystal, 2006; Clayton *et al*, 2003) but there is no evidence that these animals consciously reflect over these memories, since they cannot verbally declare this. Due to this obvious limitation in verbal communication in animals, Morris (2001) has challenged the definition of an episodic memory wanting it also to be applicable to non-linguistic animals, and stressed the need for new methods to study this phenomenon in animals. Although we still do not know whether or not dogs were 'thinking' about their owner's absence while being separated, there are other consequences of decreased social contact with the owner. Kobelt *et al* (2003) found that more time spent together with the dog on a regular basis was linked to lower levels of reported behavioural problems and Bennett and Rolfh (2007) identified that a low number of shared activities with the dog was associated with higher scores of problematic behaviours. An accompanying human has been shown to have even more stress relieving effects than the company of another familiar dog in a novel environment (Tuber *et al*, 1996), which also points to the importance of humans in the social lives of dogs.

## 6 Conclusion

There is evidence of a strong dog-human relationship, but it is not yet clear how to evaluate the quality of this relationship. In study I, we identified order effects in the ASSP, which supports findings from validation studies in human psychology. Behaviours that were not affected by the order effects in the ASSP concerned those expressed upon the reunion with a familiar person and these also support previous results regarding selective greeting behaviour directed towards the owner. It is therefore suggested that future studies of the dog-human relationship should focus on behaviour expressed upon reunion. The behaviour during reunion with the owner was also affected by the time left alone at home, which further supports the relevance of these specific behaviours in relation to an established relationship between dogs and owners. Furthermore, given that the reunion between dogs and humans in a healthy relationship is positive, we suggest that the level of affiliative physical contact, tail wagging, lip licking and body shaking could be indicators of positive arousal in dogs.



## 7 Svensk sammanfattning

Hundar har en stor inverkan på människan och att förstå det känslomässiga bandet mellan hund och människa är viktigt för de val vi gör gällande hur vi håller hundar idag och hur våra vardagliga interaktioner med dem kan påverka deras välfärd. Ett starkt band mellan människa och djur kan vara till fördel för djuret genom att det påverkar hur ägaren tar hand om det och hur hunden upplever de olika aktiviteter som människa och hund utför tillsammans. En av grunderna till beteendeproblem hos hundar kan troligen ligga i att relationen mellan hund och ägare är konfliktfull. Ökad kunskap och förståelse för olika typer av hund-ägare-förhållanden och vad som karakteriserar dessa skulle möjligen hjälpa till att identifiera orsaker till dessa konflikter. Kan vi dessutom förhindra konflikter i relationen kan vi bidra till en ökad livskvalitet för både hund och ägare. För att utvärdera relationen mellan hund och ägare måste man ha tillgång till pålitliga metoder för att mäta detta. Ainsworth's Strange Situation Procedure (ASSP) är ett test utformat för att undersöka bandet mellan unga barn (1–2 år gamla) och deras föräldrar. Detta test har tidigare använts i flera studier för att värdera relationen mellan hundar och deras ägare, då bandet mellan hund och ägare har liknats vid bandet mellan ett barn och dess förälder. Ett av syftena med denna avhandling var att granska ASSP som ett redskap för att uppskatta bandet mellan hund och människa (artikel I).

Ett av kriterierna för att två individer ska kallas känslomässigt bundna till varandra, är att de känner obehag vid en ofrivillig separation. Detta skulle kunna orsaka problem för hundar, då vi i vårt moderna samhälle oftast inte har möjlighet att vara tillsammans med hunden stora delar av dagen. Detta anses ofta vara godtagbart så länge hunden inte har separationsproblem. Det saknas dock forskning om hur hundar utan separationsångest påverkas



genom regelbunden separation från sin ägare. Ett annat mål i denna avhandling var att undersöka hur dessa s k ”problemfria” hundar påverkas av tidlängden de lämnas ensamma hemma (artikel II). Beteendet vid återseende efter separation har dessutom föreslagits vara relevant för utvärderingen av bandet mellan människa och hund. Därför undersökte vi också specifikt hundens beteende när den återförenades med sin ägare efter ensamhetstiden.

I artikel I ville vi utvärdera om Ainsworth’s Strange Situation Procedure (ASSP) kan användas för att på ett tillförlitligt sätt undersöka det känslomässiga bandet mellan hund och ägare. ASSP baseras på anknytningsteorin, som innebär att en individ som är anknuten känslomässigt (barnet/hunden) till en annan individ (föräldern/ägaren) strävar efter att upprätthålla närhet till denna, blir stressad om de ofrivilligt separeras och upplever glädje när de återförenas. En annan del av anknytningsteorin säger att om anknytningen är ”säker”, d v s återspeglas av en harmonisk relation där föräldern/ägaren är lyhörd för hundens/barnets behov, så fungerar denna person som en säker bas från vilken den anknutna individen (barnet/hunden) vågar distansera sig från för att t ex utforska omgivningen. Målet med ASSP är att utsätta barnet/hunden för mildt påfrestande situationer där man kan identifiera tecken på att barnet/hunden är knuten till föräldern/ägaren genom att titta t ex på hur närhetssökande hunden/barnet är vid separation och återseende. Man vill också urskilja huruvida föräldern/ägaren utgör en säker bas, genom att titta på hur mycket barnet/hunden utforskar med eller utan föräldern/ägaren i närheten. ASSP utförs i en främmande miljö och består av en på rad följande episoder, under vilka barnet/hunden har sällskap av antingen föräldern/ägaren, en främmande person eller är lämnad ensam i rummet.

I försöket fick försökshundar delta i ASSP under två olika förhållanden för att undersöka om eventuella effekter av den sekvens som händelserna infaller under testet kunde påverka hundens beteende snarare än relationen till närvarande person. I den ena situationen deltog hunden i ASSP tillsammans med en välbekant person och en främling. I den andra situationen, som fungerade som en kontrollbehandling, deltog hunden tillsammans med två främlingar. Jämförelser av hundens beteende gjordes med avseende på huruvida målpersonen för hundens beteende var välbekant eller en total främling. Resultaten visade att hundarna utforskade lika mycket oberoende av relationen till den som var närvarande i rummet, vilket indikerar att sekvensen av de händelser som hunden utsattes för snarare påverkade hundens beteende. Hundarna föredrog dock att vara i fysisk

kontakt med den välbekanta personen jämfört med någon av främlingarna och det fanns belägg för att de reagerade starkare på återseendet med den välbekanta personen. Sammanfattningsvis så visade resultaten att ASSP troligen inte är en bra metod att använda för att utvärdera detaljer gällande bandet mellan hund och människa, utan att fokus istället skall läggas på observationer av hundens beteende vid återförening med ägaren.

I artikel II, ville vi undersöka hur hundar utan påvisade separationsproblem påverkas av tiden de lämnas ensamma hemma. Därför undersökte vi beteende och hjärtaktivitet hos privatägda hundar vid tre olika tillfällen; när de var ensamma hemma i 0,5, 2 och 4 timmar. Varje behandling föregicks och följdes av en 10-min period när ägaren var närvarande och kunde interagera med hunden. Detta tillät oss också att i detalj studera hur hundarna interagerade med sina ägare när de återförenades. Analys av hundarnas beteende visade att hundarna var inaktiva större delen av tiden då de var ensamma (92-97% av tiden), och deras beteende förändrades inte över tid. Däremot uppvisade hundarna olika beteende beroende på tidslängden när ägaren kom hem. Efter de två längre separationsperioderna var hundarna mer fysiskt aktiva och uppmärksamma vid återseendet, hade en högre hjärtfrekvens och utförde högre andel beteenden som tidigare har föreslagits vara tecken på positiv eller negativ stress (t.ex. skaka på sig och slicka sig runt läpparna). Hundarna viftade också mer på svansen och var mer kontaktsökande efter de längre separationsperioderna oavsett ägarens beteende. I den här artikeln diskuteras huruvida dessa uppvisade beteenden (slicka sig runt läpparna, skaka sig och svansviftning) kan vara en indikation på ett positivt känslotillstånd hos hundar och om hundar har någon tidsuppfattning.

Sammanfattningsvis påvisades att återseende med ägaren troligen är en bättre metod att använda för att utvärdera bandet mellan hund och ägare, då reaktioner under ASSP påverkas av den ordning som händelserna kommer i under testet. Hundar påverkas av hur länge de lämnas ensamma hemma då de reagerade starkare vid återföreningen med ägaren efter längre separationstid, men det fanns inga tecken på att de "reflekterade" över detta under själva separationstiden. Beteenden intressanta för vidare forskning om hur hundar kan uppvisa positiva känslotillstånd har föreslagits och diskuteras i avhandlingen.



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