Dog-human interactions

Bidirectional response to signals of affective state

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Abstract

The domestication process of dogs has made them well adapted to humans. Dog-human interactions are of increasing scientific interest and research has revealed that dogs look at humans for help when confronted with an unsolvable task, use human pointing cues to find hidden food, can discriminate between negative and positive human facial expressions, and even show contagious yawning. However, research into the more subtle aspects of dog-human interactions is limited and scientific proof is lacking that dogs can respond to their owner's affective state. Neuroticism in owners might lead to increased anxiety in dogs, facilitating the development of behavioural problems. Furthermore, research suggests humans might misinterpret dog behaviour, and could consequently further facilitate behavioural problems by responding inaccurately to the behaviour of dogs. This research investigates whether the owner's affective state influences the behaviour of the dog and if the owner's interpretation and response to dog behaviour is related to behavioural problems in the dog. To answer the first research question, a behavioural test was carried out, in which the owner's affective state was manipulated by means of experimental exposure to pictures and problem solving tasks, and the dog's response was measured by means of a lateralization test, a social referencing test, an obedience test and a two choice test. Thirty-two dog-owner combinations were tested. The manipulation of the owner's affective state had a significant effect on the owner's anxiousness in the intended direction, but in general the latter did not transfer to the dogs as evidenced by the results of the behavioural test. Only in the obedience test, dogs of owners in a negative affective state tended to eat a treat more often in the presence of the owner, whereas dogs of owners in a positive affective state tended to eat the treat more often in the absence of the owner. The results of the behaviour tests demonstrated how the dogs' responses to different stimuli and the number of stress signals displayed by the dogs corresponded to owner-reported behavioural traits of the dogs (neuroticism and separation anxiety). By means of a questionnaire, owners were asked to rate the behaviour of dogs in several movie fragments and to indicate how they would respond if their dog showed this behaviour. These results were linked to the dogs' behavioural traits, as reported by the owner in the CBARQ. A total of 100 owners completed both questionnaires and the results showed that owners of neurotic dogs scored the movies higher for fear aggressive behaviour, which falls into the category of neurotic behaviour. Owners of dogs with separation anxiety problems scored the movies relatively high on play. Seemingly, the owner's experiences with his or her own dog influences the owner's interpretation of dog behaviour. Furthermore, it was found that owners of neurotic dogs reported to respond to behaviour more often with positive reinforcement. This suggests that positively reinforcing fearful or aggressive behaviour may be rewarding to the dog, encouraging it to display this behaviour. To conclude, the owner's interpretation of, and response to, dog behaviour is related to behavioural problems in the dog, although causal mechanisms remain speculative. No proof was found for the influence of the owner's affective state on the dog's behaviour in an experimental setting. The limited sensitivity of the readout parameters or unwanted influences of the test environment may have masked such effects and, if existing, emotional contagion from dog-owner to dog may be subtle in its manifestation in the receiver or require more intense emotions in the sender.

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Introduction

Dogs are popular pet animals in many countries. In the Netherlands, the dog population is estimated to consist of approximately 1.5 million individuals, with 21 percent of the households owning a dog (Hoge School HAS Den Bosch, 2011). Having a dog gives people many benefits. The most important reason for acquiring a pet is companionship; it is the main reason for over 90% of pet owners for getting a pet (Endenburg et al., 1994). Several studies showed that dogs can improve the social contacts of their owners: Wells (2004) compared the responses of people to a person alone, accompanied by a dog or accompanied by a neutral stimulus (plant or teddy bear), and found that people smile more often and start conversations more often when they meet a person that is accompanied by a dog than a person that is alone or accompanied by a teddy bear or plant (Wells, 2004). Also, strangers are more likely to help an individual when a dog is present than when an individual is alone (Guéguen and Ciccotti, 2008). Furthermore, having a dog is shown to give health benefits. Serpell (1991) followed 2 groups of people during a 10 month period, the control group not owning a pet, and a pet-owning group that purchased a pet (dog or cat) at the start of the research. He found that the people that purchased a dog significantly increased their number of walks and had a significantly better health after purchasing a dog, while no such an increase was found in the control group (Serpell, 1991). The review of Cutt et al. (2007) suggests that dogs are a motivation for owners to exercise and give social support to stimulate exercise. The presence of a dog can also reduce responses in stressful situations: heart rate and blood pressure was much lower in subjects during a stressful situation when accompanied by a dog compared to subjects who were alone or accompanied by a friend (Allen et al., 1991). Thus, keeping a dog gives people social benefits, companionship and improved health. However, many owners experience behavioural problems with their dogs, a reason for some owners to relinquish their dog to the shelter. In the Netherlands, approximately 21,500 dogs are yearly relinquished to the shelter, of which 1000 dogs are euthanized (Hoge School HAS Den Bosch, 2011). According to Salman et al. (1998), behavioural problems are the reason for relinquishment to the shelter for 26% of the dogs in shelters. Especially aggression is a serious problem: biting is amongst the top ten of reasons for relinquishing a dog to the shelter (Salman et al., 1998). The number of dog bite incidences towards humans in the Netherlands is estimated to be 8.3 per 1000 humans annually (Cornelissen and Hopster, 2010). Thus, although people can benefit from the companionship of a dog, the high incidence of problem behaviours is an issue to be addressed.

It is suggested that the owner's behaviour and attitude may contribute to the cause of problem behaviours, and may play a role in the maintenance of problem behaviours (O'Farrell, 1997). This study used questionnaires to assess the behaviour of the dog and the attitude and personality of the owner. She found that anthropomorphic attitudes towards dogs correlated with more aggression problems. It is suggested that anthropomorphic behaviour of owners towards their dogs causes owners to behave submissively in the eyes of the dog, which might facilitate dominance aggression (O'Farrell, 1997). Furthermore, a correlation was found between the owner's neuroticism score and displacement activities in the dog. Possibly, neurotic owners behave more inconsistent towards their dogs, stimulating problem behaviour (O'Farrell, 1997). Others used similar questionnaires and found that owners of aggressive dogs were more tense, emotionally less stable, shy and undisciplined (Podberscek and Serpell, 1997). The most likely explanation for this correlation is that the unstable behaviour of owners causes dogs to become aggressive. Inconsistent communication of humans can cause frustration or anxiety, which can eventually lead to aggression (Dehasse, 1997). An alternative explanation might be that the behaviour of the dog is the cause of the behaviour of the owner: owners may become more tense due to an aggressive dog. It is even possible that there is no relationship between the attitude of the owner and the behaviour of the dog: it might be that nervous, tense people experience the behaviour of their dogs as more problematic than other owners. Unfortunately, these researches have only found correlations, and have not been able to prove that the owner's behaviour causes dog behaviour problems. However, some findings in literature did find links between the personality of the owner and the owner’s behaviour towards the dog. Owners that were more neurotic, used more commands and hand signals in an obedience test to get the dog to sit, while the dog responds later to the command (Kis et al., 2012). In another research, more neurotic owners were found to be more attached to their dogs as well (Kotrschal et al., 2009). Owners were tested with their dog in a bridge task, where the owner had to lead the dog over a bridge. Neurotic owners that were

more attached to their dog, interacted more with their dogs with positive physical contact, but their dogs took longer to cross the bridge (Kotrschal et al., 2009). Also a relationship between physiological parameters of stress in owners and dogs has been found. Jones and Josephs (2006) examined the effect of the owner's emotional state and behaviour on the dog. They researched the effect of winning or losing an agility competition on the owner's change in testosterone and behaviour, and the effect on the dog's cortisol level. They found that among losing owners, those that had a bigger decrease in testosterone, were more frustrated and were less affiliative and more punitive towards their dogs, resulting in a higher cortisol level in the dogs, suggesting that these dogs experienced more stress (Jones and Josephs, 2006). This research confirms that the inner state of the owner influences his behaviour which affects the dog's behaviour and inner state in return. These studies cannot provide evidence for the role that owners play in behavioural problems of dogs, but they do make it necessary to examine more closely how owners might influence problem behaviours in dogs.

To investigate the possible influence of owners on the behaviour of their dogs, the current knowledge on dogs' responses to human signals should be considered. Dogs have coexisted with humans for many years. During this domestication process, dogs became extremely adapted to humans and dogs became very skilled in interpreting human signals (Kaminski and Nitzschner, 2013). Dogs are very attentive towards humans and turn towards their owner for help when faced with an unsolvable problem, whereas socialized wolves continue to try to solve the problem themselves (Miklosi et al., 2003). Furthermore, they outperform both socialized wolves and apes, human's closest relatives, in following human pointing signals to find hidden food (Kaminski and Nitzschner, 2013). Moreover, when dogs are given the choice between two bowls with different quantities of food, they tend to choose the smaller amount more often when their owner pays attention to this bowl compared to when their owner is sitting neutral in between both food bowls (Prato-Previde et al., 2008). Since body language is an important component of dogs' communication, it may be expected that they are also very attentive to human body language. Although humans communicate mainly verbally, we also show a lot of non-verbal signals (facial expressions, body language and speaking tone) indicating our inner state. Several researches have shown that dogs are very responsive to human non-verbal behaviour. Vas et al. (2005) found that dogs respond differently to a stranger approaching threatening than to a stranger approaching friendly. A threatening approach elicited more avoiding or threatening behaviours, while a friendly approach elicited more passive or friendly behaviour (Vas et al., 2005). Dogs' responses to human nonverbal behaviour was also shown in an experiment on social referencing (Merola et al. 2012). Social referencing is the looking at an individual to gain information about a situation. A novel object was placed in the room, and the human was either told to behave positively about this object, showing a happy face and speaking in a positive tone, or to behave negatively, showing a fearful face and speaking in a negative tone. Most dogs were found to pay attention to their owner to get information about the novel situation. The results showed that dogs responded to the nonverbal behaviour of the humans, approaching the novel object more easy in the positive treatment than in the negative treatment (Merola et al., 2012). To investigate how dogs process these positive and negative cues of humans, Racca et al. (2012) studied dogs' gaze bias when looking at conspecific and human faces with different emotional expressions. Brain scans have shown that the right side of the brain is more activated when an individual is exposed to negative stimuli, while the left side of the brain is more activated when exposed to positive stimuli (Styliadis et al., 2013). Dogs showed a clear left gaze bias (right hemisphere brain processing) towards negative faces, and a right gaze bias towards positive faces (left hemisphere brain processing). This bias was present in dogs when looking at faces of either conspecifics or humans, although the bias was stronger when dogs looked at faces of conspecifics (Racca et al. 2012). This research shows that dogs recognize positive and negative emotions in human faces and respond appropriately through activation of different brain areas. A similar result was found when positive and negative emotional sounds of dogs and humans were played to dogs. Emotional sensitive regions in the brain were activated more when the emotional valence of the sounds became more positive (Andics et al. 2014). This result was similar when vocalizations of dogs were played to when vocalizations of humans were played, suggesting that dogs do not only recognize emotions in vocalizations of conspecifics, but also of humans (Andics et al., 2014). Not only can dogs recognize emotions in vocalizations, they also respond differently to different vocalizations of humans. In the two choice test, where dogs have to choose between two food bowls based on the pointing signal of the experimenter, dogs are more likely to choose the

correct bowl when the experimenter speaks to the dog in a friendly, high-pitched voice, and make more mistakes when the experimenter talks in a commanding, low-pitched voice (Scheider et al., 2011). Furthermore, dogs can respond to quite subtle differences in human behaviour. Dogs that were brought to a shelter and petted the first days at the shelter, had lower cortisol levels than dogs that were not petted during their first days at the shelter, but this effect was found only when the petter was a woman (Hennessy et al., 1997). A follow-up research showed that males and females apparently petted in a slightly different way. When males were given very detailed instructions on how to pet the dog, both genders were able to reduce cortisol responses of dogs (Hennessy et al., 2008). Thus, small details in petting technique can make the difference for dogs to experience petting as stress reducing or not.

Other researches focused on emotional contagion between humans and dogs. It was found that human yawning elicits a yawning response in dogs (Joly-Mascheroni et al., 2008). Custance and Mayer (2012) found that dogs are responsive to crying humans: dogs approached crying humans more often than the control group, where humans were talking or humming. Results of both researches suggest that dogs show empathic responses towards humans.

Thus, several researches have shown that dogs are very attentive to human nonverbal behaviour and respond to these signals. For a good relationship between humans and dog, it is not only useful that dogs are able to respond to human signals, it would also be useful for humans to be able to respond to dog signals. However, although owners report to be well able to interpret their dog's signals (Kerswell et al., 2009), several researches have shown that owners are not that capable of interpreting their dog's behaviour correctly. The more obvious behaviours (gross body movements, vocalizations, aggression) are recognized correctly by half of the owners, but the subtle signs like yawning, paw lifting and nose licking are only recognized as signs of stress by less than 10% of dog owners (Kerswell et al., 2009 and Mariti et al., 2012). The study of Tami and Gallagher (2009) found that the tail was used most to describe dog behaviours, focussing on tail movement more than the position of the tail. It is important for owners to be able to recognize not only the more obvious signs, but also the subtle signs, since recognizing the signals enables them to behave appropriately so that sources of stress can be removed. When a dog is insecure about the approach of humans, it may show signals of appeasement or avoidance. When humans do not respond correctly towards these signals, they may worsen the conflict in the dog and increase the dog's fear, which may eventually result in aggression. When the aggressive response is repeatedly successful, the dog can become more confident in showing this behaviour (Bradshaw et al., 2009). In wolves, aggression is highly ritualized behaviour, almost never escalating to a real fight. Warning behaviours of a dog elicit calming signals in other dogs to avoid escalation (Bradshaw and Nott, 1995; Lockwood, 1995). When the others would not respond with calming signals the interaction can escalate into a fight. Furthermore, when a dominant dog does not respond appropriately to calming behaviours, an insecure dog can attack without any warning out of fear (Bradshaw and Nott, 1995). Thus, humans not responding correctly to the signals of dogs can cause an attack. The research of Moss and Wright (1987) showed that humans approach dogs regardless of the signals shown by the dog, but based on their experience with dogs. If humans own a dog, they are more likely to approach any dog, despite its signals (Moss and Wright, 1987). Thus, the wrong interpretation of the dog’s behaviour and consequently a wrong response of humans to the dog might be a factor in the development of problem behaviour.

To summarize, although dogs are kept to improve human welfare, behavioural problems may compromise the dogs' as well as the owners' welfare. It is often suggested that the owners play a role in the causation of these problem behaviours, but the exact mechanism is still unknown. Relationships between dog behavioural problems and owner personality and behaviour are found by means of questionnaires, but a causative relationship is often unclear. This research will focus on this interaction between humans and dogs. I hope to contribute to the current knowledge by providing evidence of the influence of owners' behaviour on dogs. In this study, the following two research questions will be addressed:

1. How do dogs respond to different emotional states of their owners?
2. How might owners further facilitate problem behaviours by not recognizing or not responding correctly towards their dogs signalling their emotional state?

For the first research question, an experiment will be conducted, in which the owner's affective state will be manipulated. By this manipulation, I hope to elicit different behaviours in humans which cause a response in the dog to the emotional state of the owner. The second research question will be investigated by means of a questionnaire, in which owners are asked to interpret dogs' signals of their emotional state and to indicate their response to these signals. These results will be linked to the occurrence of problem behaviours in the dog reported by the owner.

Material and methods

For this study, both questionnaires and behaviour tests were used. The participants were dog-owners who indicated in a questionnaire from a previous study from Wageningen University that they were interested to participate in a follow-up study. Additionally, owners were recruited via social media.

Behaviour tests

The first part of this research was a behaviour test conducted at Carus, the test facility of Wageningen University. Owners were invited to come with their dog to the test facility. A total of 32 dog-owner combinations participated in the behaviour tests. Four owners were men, the remaining 28 owners were women. The participating dogs were of various breeds and had a mean age of 4.3 years (± 0.5 S.E.) ,of which 11 were females and 21 were males. To assess the effect of the owners' affective state on the dog's behaviour, two treatments were used in the experiment: in the positive treatment (PT, ~50% of owners) a relaxed, positive state was induced, in the negative treatment (NT, ~50% of owners) an aroused, negative state was induced. After the owner manipulation, several behaviour tests were conducted. The whole test procedure lasted maximum two hours. The behaviour test was approved by the Animal Experiment Committee of the Wageningen University.

Measuring affective state of dog and owner

To measure the emotional state of the owners, salivary cortisol was collected at arrival and at the end of the tests. Additionally, salivary cortisol was collected from the dogs to measure their stress level before and after the test procedure. Salivary cortisol was collected from owner and dog with cotton swabs, which were collected in salivettes. Saliva was collected in the same way for the dog and the owner. The owner was instructed to gently rotate two cotton swabs in one cheek pouch for 30 seconds. This procedure was repeated once for the other cheek pouch. To stimulate the dogs' saliva production, a piece of food was held in front of the dog's nose for 10 seconds prior to each saliva collection. Salivary cortisol was temporarily stored in the fridge (4°C) for maximum 5 days, after which it was stored at -20°C until analysis. Salivettes were centrifuged (3000 rpm, 4°C) for 10 minutes and saliva was stored in wells at -20°C for later analysis. Salivary cortisol was analysed using an enzyme immunoassay kit (Salimetrics LLC, State College, Pennsylvania).

Furthermore, a questionnaire was used to assess the owner's affective state at arrival, and three times after manipulation (following each behaviour test). The questionnaire used was the State-Trait Anxiety Inventory for Adults (STAI-Y; Spielberger, C.D. et al., 1977). This questionnaire consists of two parts, the first (Y-1) measuring state anxiety (in the moment), the second (Y-2) measuring trait anxiety (in general). At arrival, the owners were given both the first and the second part, the subsequent questionnaires (after manipulation, following the social referencing test, the obedience test and the two choice test) only consisted of the first part. Several researches have proven the validity and reliability of this questionnaire (Abdel-Khalek, 1989; Fountoulakis et al., 2006; Van der Ploeg, 1982).For the aim of this study, the questionnaire was translated to Dutch and the scale was adjusted from a 4 point scale to a continuous scale, to measure the most subtle changes in anxiety (Appendix 1). The scores calculated from the questionnaire had a minimum possible value of 0 and a maximum possible value of 114. Higher scores indicate more anxious owners.

Yawning test

Before the owner manipulation, a yawning test was performed to assess how sensitive the dogs were in general to the emotional state of their owners. Yawning back as a response to human yawns is considered to be an indication of emotional contagion, which is related to empathy (Platek et al.,

2003). Before the start of the test, the dog was allowed to explore the room for 1.5 minutes. At the start of the test, the owner put the dog on a short leash attached to the wall and the owner sat down on a chair at the end of the dog's reach, facing the dog. The test consisted of two conditions, each lasting 1 minute, with a 20 seconds separation interval. The first condition was the yawning condition. During this condition, the owner yawned every time the dog was looking at the owner. When the dog was very distracted, the owner tried to get the attention of the dog in a way that the dog was familiar with. The second condition was the control condition, in which the owner made mouth-opening, non-yawning movements. Again, the owner made these movements whenever the dog was looking at him or her. This condition is included to correct for possible yawning of the dog as stress releaser in a slightly stressful situation. The two conditions were repeated once, resulting in 1 minute yawning, 1 minute control, 1 minute yawning and 1 minute control, each separated by a 20 seconds interval.

Owner manipulation

The owners were manipulated into a positive or negative state by means of pictures, sounds and mathematical tasks/intelligence questions. Owners in the PT were given pictures and sounds of positive valence, and mathematical tasks and intelligence questions that are easily solved. Owners in the NT were given pictures and sounds of negative valence, and mathematical tasks and intelligence questions that are difficult or unsolvable. The pictures were adapted from a large database where each picture is rated on the level of arousal and valence (International Affective Picture System, IAPS from Lang et al., 2008). The affective valence of these pictures has been validated by its original authors (Lang et al., 2008) and confirmed by Tok et al. (2010). The selected pictures had a mean valence of 6.18 (± 0.74) and 2.53 (± 0.52), for PT and NT respectively, and mean arousal of 3.00 (± 0.24) and 5.78 (± 0.67), for PT and NT respectively. Pictures with higher valence indicate a more positive effect on people, higher arousal indicate a bigger impact on people.

The mathematical tasks and intelligence questions were created from examples from intelligence tests and literature that used these tasks to create a similar state of mind (Krohne et al., 2002; Wang et al., 2005). These studies found that subjects that were given the more difficult mathematical tasks were less successful and experienced more negative emotions (stress, frustration, anxiety). In addition, heart rate and cortisol levels were higher in the group that received more difficult tasks. The positive group was given a relaxing, meditative background sound of a water stream and bird song, while the negative group was given an irritating background noise. Additionally, the positive group always had a clock on the screen, indicating how much time there was left to solve the mathematical tasks. The negative group did not see the time, but only heard the ticking of a clock to indicate time was running. Not knowing how much time is left makes the situation unpredictable, an aspect that is important in the regulation of emotions (Scherer, 2001).

During and after manipulating the owner, observations of dog behaviour were done and several tests were conducted. Three parts (manipulation, interaction, behaviour test) were repeatedly interchanged during this part of the experiment (See Table 1).

Table 1: Sequence of the different test phases. Manipulations and interactions were repeated several times to maintain a positive (PT) or negative (NT) affective state in the owner, and to stimulate passing on the affective state to the dog.

Test phase
Interaction 1
Manipulation 1
Interaction 2
Manipulation 2
Interaction 3
Social referencing test
Manipulation 3
Interaction 4
Obedience test
Manipulation 4
Interaction 5

In the manipulation phase, the owner is receiving the treatment behind the desk while the dog is kept on a short leash and cannot interact with the owner (Figure 1). This phase is repeated several times to maintain a positive (PT) or negative (NT) emotional state in the owner during the different behavioural tests. In the interaction phase, several actions were subsequently carried out. First, the owner released the dog from the leash. A leash system was used so that the owner could pull on a rope from behind the desk that led back via the ceiling to the point on the wall where the dog was attached, which released the dog. After releasing the dog from the leash, the owner walked to position A (Figure 1) and called the dog towards him or her. Next, the owner was instructed to walk around the room with the dog and to let the dog sit and lie down (Figure 1). This interaction phase was included to stimulate the transfer of the emotional state of the owner to the dog. Additionally, in the interaction phase a first behavioural test was conducted: the lateralization test was used here to investigate if a lateralization difference could be found between the NT and PT. Lateralization can indicate if dogs experience a stimulus as positive or negative. For this test, a fence was presented in between the dog and the owner. The fence forced the dog to choose a side from which to approach its owner. Each time the dog was allowed to interact with its owner, it had to choose the left or right side of the fence to approach its owner. A bias towards either side can give an indication of the emotions the dog is experiencing at that moment.

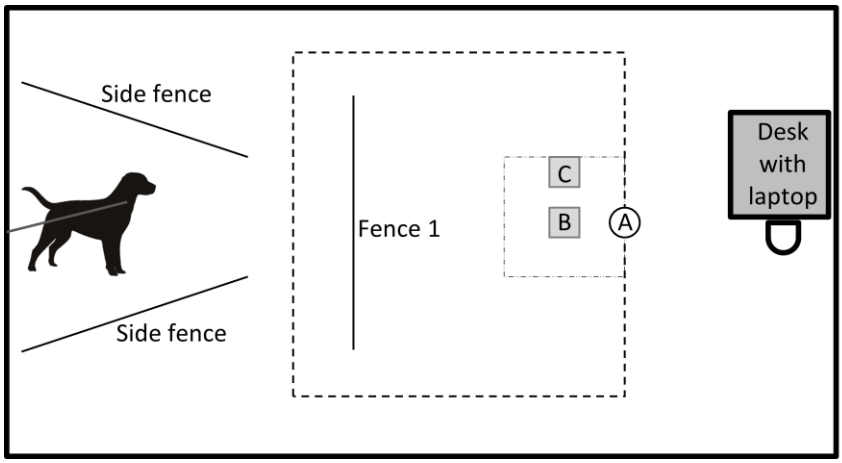

Figure 1: Schematic overview of the test room during the test phases. During the manipulation phases, the owner was sitting behind the desk (with laptop containing the pictures, sounds, mathematical tasks and intelligence questions) and the dog was kept on a short leash in between the side fences. The dog was able to look at the owner through fence 1. From behind the desk, the owner was able to unleash the dog for the interaction phases. During the interactions, the owner was standing on position A to call the dog towards him or her. The latency of the dog to approach the owner was measured at the time the dog passed the fence. The owner walked around the room with the dog following the dashed line (- - -), and returned to position A to let the dog sit and lie down. For the social referencing test, the owner was standing on position A and the object was placed on position B. The dog was unleased from behind the desk by the experimenter to allow the dog to approach the object. The dashed line (– ·· –) was used in the observations to measure the latency of the dog to cross this line in the social referencing test (line 2, as latency to pass the fence was also measured). In the obedience test, the owner was standing on position A again, with the dog on his or her left side. The box with the treat on top of it was placed on position C

During the third phase, a behavioural test was conducted. Three different tests were done. These tests will be explained in more detail below.

Social referencing test

In novel situations, dogs turn to their owner to receive information about the object (Merola et al., 2012). In this test, a novel object was presented to the dog, and its response towards this object was measured. This indicates how the dog interprets the behaviour of the owner. An object was chosen that is unfamiliar to the dog to create an ambiguous situation. The object used was a singing and dancing stuffed penguin. The owner stood on position A, right behind the object on position B (Figure 1) and was instructed to call the dogs' name once to allow the dog to approach, and subsequently stand still behind the object, looking at it without paying attention to the dog. At the start of the test, the

experimenter gave the owner a sign to remove the cover off the object and to switch it on, at the same time the experimenter stood behind the desk to release the dog from its leash from a distance. The test duration was set on 1 minute, during which the behavioural response of the dog was measured. The first 40 seconds of the test, the object was moving and making sound, the last 20 seconds, the object had ended moving and making sound.

Obedience test

When owners are in a tense state, their body language may not send out the same message as a command given, which may result in disobedience from the dog. This was tested by placing a piece of food on the ground and instructing the owner that the dog is not allowed to eat the food. The owner was allowed to give as many commands as he wanted to use. The test lasted 1,5 minutes. After 1 minute, the owner was asked to leave the room to observe the dog's behaviour when the owner was not present.

Two choice test

In this test, dogs were presented with two food bowls of which they had to choose one. The setup for this test was based on the experiments of Szetei et al. (2003), but slightly adjusted for the purpose of this study. The owner attached the dog to a long leash and stood at position D (Figure 2), keeping the dog next to him. The test required a learning phase in which one bowl was placed on position 0 (Figure 2), containing a treat. The experimenter stood behind the food bowl. The owner was instructed to let go of the leash and to stimulate the dog to approach the bowl. This was done twice to get the dog's interest in the food bowls. In the testing phase, the dog was presented with two food bowls. One bowl was put on the right side, the other on the left side (Figure 2). The experimenter showed the dog the treat went in one bowl, and after this, the owner was instructed to call the dog's name and point to the other bowl. The experimenter stood in between both bowls (position E, Figure 2) and looked down, not giving any cues to the dog. Contrary to the research of Szetei et al. (2003), both bowls were left empty so that the dog was not influenced by olfactory information. This procedure was repeated three times per dog. The experimenter always demonstrated the treat going in the same food bowl for the three repetitions. The side was counterbalanced between subjects: with ~50% of dog-owner combinations the experimenter showed the treat in the left food bowl, with the other ~50% the experimenter showed the treat in the right food bowl.

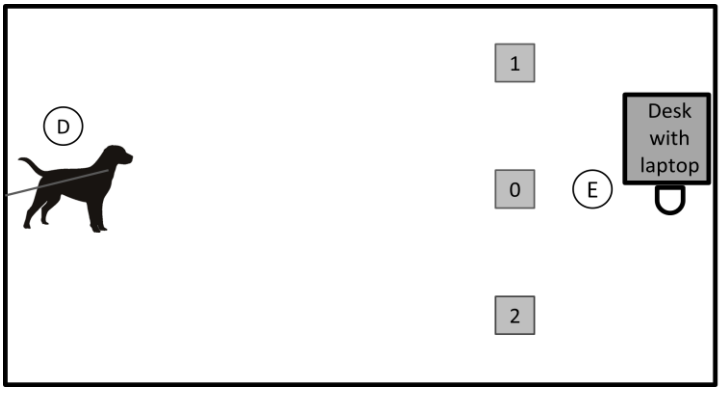

Figure 2: Schematic overview of the set up for the two choice test. The dog was attached to a long leash, with the owner standing next to the dog at position D. The experimenter was standing on the other side of the room at position E. In the learning phase, the experimenter placed one food bowl on position 0. For the test phase, the experimenter placed two food bowls, one on position 1, the other on position 2.

At the end of the whole test procedure, the goal of the experiment was explained to the owners, to ensure that the owners always returned to a relaxed state at the end of the tests.

Dog-owner relationship and personalities

After the behaviour tests, the owners were asked to fill in two questionnaires at home. Besides the dog owners that participated in the behaviour tests, additional owners were approached via mail and social media to fill in the questionnaires.

The first questionnaire aims to measure the personality of the dog, the personality of the owner and the relationship between them. This questionnaire contains three different parts. The first part is the CBARQ (Canine Behavioural Assessment and Research Questionnaire), developed and validated by Hsu and Serpell (2003). This questionnaire is used to assess the dog's personality and behavioural problems, addressing the following behaviour categories: sociability, trainability, aggression, fear and anxiety, separation-related behaviours, excitability, attachment and attention-seeking behaviours and miscellaneous behaviours. The second and third part contained the Five Factor Model (FFM) and the Monash Dog Owner Relationship Scale (MDORS) respectively. Only results of the CBARQ were analysed for the purpose of this study.

Owner's interpretation of dog signals

The second questionnaire contains 18 short movie fragments of a variety of dog behaviours and investigates how owners interpret these behaviours and how they deal with these behaviours (Appendix 2). The selected movies contain subtle stress/calming signals (nose licking, stretching, scratching, yawning, paw lifting), play signals (play bow), fear signals (shivering, barking, growling, showing teeth, lunging), as well as some long-term stress signals (tail chasing, shadow chasing) (Appendix 3).
Owners were asked for each fragment to indicate on a 5-point scale how they interpreted the behaviour, using the terms: insecure, tense, stressed, fearful, excited, playful, dominant and aggressive. Next, they were asked to indicate on a 5 point scale how they would treat their dog if it was showing this behaviour. Possible responses were structured in the following way:

- No attention for specific behaviour (treat dog no differently)
- Positive reinforcement (pet the dog, speak calming words, stimulate the dog's behaviour)
- Negative reinforcement (remove aversive stimulus causing the behaviour, take dog away from stimulus causing the behaviour)
- Positive punishment (correct the behaviour)
- Negative punishment (ignore the dog)
- Distract the dog from the behaviour

Behavioural analysis

During the behaviour tests, the dogs' behaviour was analysed during most test phases with live observation. Additionally, in several test phases, important behaviours of owners were recorded as well. These behaviours were analysed using continuous focal sampling in The Observer 5.0 (Noldus IT). Missing observations were later analysed using the video recordings of the tests. In the yawning test, observations were made on stress behaviours of the dogs, including yawning of the dog, the activity of the dog, and yawns or mouth movements of the owner. During the manipulation of the owner, the stress behaviours and the activity of the dog was observed. In the interactions, besides the stress signals, also lateralization (dog passes fence via left or right side), the latency to approach the owner (measured as the time the dog passed the fence) and the latencies to respond to the commands 'sit' and 'lie down' were measured. During the social referencing test, besides the stress signals, lateralization, the latency to pass the fence and the latency to approach the object from close distance (line 2, Figure 1) was measured, as well as play signals. In the obedience test, the dogs' latency to eat the treat was measured in addition to the stress signals. An overview of the observations during the different test phases can be found in the ethogram (Appendix 4). The ethogram consists of behaviours that were indicated as events and behaviours that were indicated as states. For events, only the frequency is scored, whereas frequency as well as duration is scored for states. Events were translated into a rate per minute for each test phase in which the behaviour was measured. States were translated into a frequency (total number of times behaviour started and a percentage of total duration for each test phase in which the behaviour was measured. Only during the last test phase (two choice test), behaviour was not recorded in The Observer. In this test phase, only the latency to approach the food bowl and the choice for following the owner or the experimenter was recorded manually.

Statistical analysis

Data was processed using Excel (Microsoft Office 2007) and Access (Microsoft Office 2007). Data was further analysed by using the programs Excel, SPSS (IBM SPSS Statistics 20) and GenStat (GenStat 7th edition). Data from the behavioural analysis was used as input for the statistical analysis. Furthermore, the statistical analysis used data on cortisol levels, anxiety scores of owners reported during the tests from the STAI questionnaire. Also results from the CBARQ and the questionnaire on the owner's interpretation of dog behaviour were used in statistical analysis.

Data reduction was carried out using Principal Component Analyses (PCAs) (Jollife, 1986), following procedures as described by Van Reenen et al. (2004). Principal components resulting from the analysis indicate co-varying variables by high absolute loadings. Correlations between variables can range between -1 and +1 for the same component (indicating respectively negative or positive relationships between variables). The percentage of variation explained by one component indicates the relative importance of this component. From this Principle Component Analysis, a component score is calculated for each record, in which multiple parameters are combined. Variables with relatively high loadings give most weight to the calculation of component scores. Thus, a principal component combines multiple correlating variables into one component score, which can be used to reduce the amount of variables. PCAs were used on behavioural data from the test observations, the behavioural traits of dogs following from the CBARQ and the ratings of owners on the interpretation of dog behaviour from the movie fragments and their response to dogs showing these behaviours. Categorical data and percentages were log-transformed for the PCAs.

Quantitative data was analysed with ANCOVAs when only 1 observation per dog-owner combination was available, or with Linear Mixed Models with Restricted Maximum Likelihood when more than 1 observation per dog-owner combination was available. Data analysed with a Mixed Model or ANCOVA were checked for a normal distribution. Raw data were preferred for the interpretation of the analysis, but if data significantly deviated from the normal distribution, data were log-transformed to investigate whether log-transformation significantly changes the results.

Categorical data (two categories) were analysed with Binomial and Chi-square tests. The Binomial test was used to investigate whether the proportion of dogs in one category significantly deviated from 0.5. The Chi-square test was used for the analysis of 2 categorical variables (2x2 table). For this analysis, also the residuals were calculated for each cell. Residuals larger than |2| were considered significant deviations from expected values.

Finally, the questionnaire where owners had to rate the behaviour of dogs and their response to these behaviours based on several movie fragments of dogs was newly developed for this study. Thus, the inter-rater reliability of this questionnaire was investigated, using the intraclass correlation coefficient (ICC). The intraclass correlation coefficient indicates the amount of agreement between observers. Values for ICC can range between 0 and 1. Higher ICC values indicate stronger agreement between observers, and thus higher inter-rater reliability. The ICC model used was the two-way random model for consistency (McGraw and Wong, 1996). This model is used when all objects (here movie fragments) are rated by the same observers, and the observers were a random selection from the population. By selecting the ICC model for consistency, the model allows systematic differences between raters, i.e. when one rater persistently rates 1 point lower than another rater, reliability is still high.

Results

1. Clustering dog behaviours in stress components

A number of stress signals and activity were observed in the tests to assess how stressed the dogs were. These observations were analysed by PCA analyses to cluster behaviours that are characteristic for stressed dogs. The components resulting from these analyses were used as input in further statistical analyses to investigate (1) how the owner's affective state influences the stress level of the dog and (2) how the behaviour of the dogs during the tests can be explained by their stress levels.

Stress behaviours were measured in all 32 dogs. Throughout the 1.5 hour-lasting test procedure, stress behaviours were scored during bouts of 0.5 - 7 minutes, specifically during the yawning test, four manipulation phases, five interactions, the social referencing test and the obedience test. In total 380 records were used for the PCA analysis. Behaviours occurring most were panting, whining and tongue flicking (

Table 2). The behaviours freezing, paw lift, yawn, stretch, scratch and urogenital check were observed less frequently. The analysis of all stress behaviours resulted in two components (

Table 2). The first one consists of the behaviours panting, tongue flick, urogenital check and whine, which are typical behaviours for a dog in a stressful situation. Therefore, this component is referred to as stress. High scores on this component indicate a stressed dog. The second component consisted of the behaviours stretch, shake, jump and these behaviours were negatively correlated with whining. High levels of stretching, shaking and jumping were mostly observed upon reunion with the owner, suggesting that these behaviours show that dogs release their stress. Therefore, this component will be referred to as stress release. High scores on this component indicate a high level of stress release.

Table 2: Stress behaviours were measured in all 32 dogs during several test phases, resulting in 380 records. For each stress behaviour, an average score (±S.E.) was calculated by taking the average of all observations, indicating the average occurrence of each behaviour. The PCA analysis resulted in two components: the first (stress) explained 13% of the variation, the second (stress release) explained 11% of the variation. Behaviours that have a loading larger than |0.4|(indicated in bold) can be considered to be parameters that explain this component.

	Average rate per minute	Stress (Component 1)	Stress release (Component 2)
Panting	2.49 (±0.23)	**0.67**	-0.08
Tongue flick	1.07 (±0.07)	**0.69**	0.34
Urogenital check	0.01 (±0.00)	**0.49**	-0.33
Whine	1.76 (±0.32)	**0.65**	**-0.47**
Stretch	0.01 (±0.01)	0.11	**0.51**
Shake	0.12 (±0.02)	0.28	**0.54**
Jump	0.16 (±0.03)	0.14	**0.52**
Freezing	0.04 (±0.02)	-0.07	-0.10
Paw lift	0.07 (±0.02)	-0.04	0.20
Yawn	0.08 (±0.01)	0.11	0.10
Scratch	0.00 (±0.00)	0.00	-0.02
Bark	0.25 (±0.08)	-0.02	-0.29
Play	0.56 (±0.15)	-0.16	0.01

Furthermore, a PCA analysis was conducted on the activity of the dog. Activity was measured on all 32 dogs during bouts of 3 - 7 minutes, specifically during the yawning test and the manipulation phase. A total of 160 records were used for the PCA analysis. Sitting, lying, standing and walking behaviour was scored and resulted in a total number of times the dog sat down, lay down, stood up, and started walking, and a percentage of the total time that the dog was sitting, lying, standing and walking. On average, dogs spent most time lying, and only little time walking. The activity results were used as input for the PCA analysis, which resulted in one component for activity. It should be noted that the used variables overlap, since for example the percentage of time walking is likely to increase when a dog switches to this behaviour more often. Consequently, the results of the PCA show a high percentage of variance explained by this component (42%), and relatively high loadings. Since the interest of this analysis is to find one component for activity, and the percentage of explained variance is of little interest, this is not considered an important issue. This component includes most of the parameters (

Table 3). High scores for this component indicate an active dog that spent a lot of time standing and walking, and switched a lot between sitting, standing and walking. Low scores indicate dogs that were very calm and spent a lot of time lying down.

Table 3: Activity was measured in 32 dogs during the yawning test and the manipulation phases, resulting in 160 records. Average values (±S.E.) are calculated from all records to indicate the average number of times dogs switched to this behaviour and the average percentage of time dogs were performing this activity. From the PCA analysis, only the first component was meaningful in explaining the data. This component (activity) explained 42% of all variation. Behaviours explaining this component are those with a loading larger than |0.4| and are indicated in bold.

	Average number/ Average %	Activity (Component 1)
Sit (Total number)	1.23 (± 0.13)	**0.53**
Sit (% of total duration)	17.80 (±2.30)	0.36
Stand (Total number)	3.06 (±0.33)	**0.87**
Stand (% of total duration)	25.75 (±2.42)	**0.58**
Lie (Total number)	1.11 (±0.09)	-0.12
Lie (% of total duration)	51.66 (±3.17)	**-0.68**
Walk (Total number)	2.36 (±0.31)	**0.85**
Walk (% of total duration)	4.27 (±0.56)	**0.82**

Thus, the PCA analyses on observations from the tests have resulted in three components. From this analysis, it seems that the behaviour of dogs relating to stress could be characterized along three dimensions: stress, stress release and activity. These components are behavioural states that vary between the different test phases. These three components are used as input in further statistical analysis.

2. Clustering dog behaviour traits

Dog behaviour in tests might vary depending on the dog's personality. Therefore, the dogs' behaviour traits were measured with the CBARQ so that these traits could be used to explain the behaviour of the dogs during the tests. Thus, the CBARQ results were analysed with a PCA to identify correlating behavioural traits. A total of 110 owners completed this questionnaire. Of the owners participating in the test, 28 completed the CBARQ. The results of the questionnaire give scores on the following behaviour traits: several types of aggression and fear, separation anxiety, attachment and chasing. The scores are presented in percentages of the maximum possible score: high percentages represent dogs with high scores for that behavioural trait. On average, the behavioural traits chasing and attachment are very common amongst dogs, while owner directed aggression was the least common behavioural trait. The PCA analysis resulted in two components combining several behaviour traits (

Table 4). The first component includes most parameters: all types of aggression and fear, and attachment. High scores for this component indicate dogs that are fearful, aggressive and attached to their owner. This component was named neuroticism, a personality trait found in both humans and dogs. Behaviour traits with a high loading in the second component are most importantly separation anxiety and attachment, which negatively correlate to dog directed aggression. This component was named separation anxiety. High scores on this component indicate dogs that are anxious when left alone and are highly attached to their owner.

Table 4: CBARQ results were used from 110 owners. Results of the questionnaire were transformed to percentages for each behaviour trait. Average values (± S.E.) are calculated from all records to indicate the average occurrence of each behaviour trait. The first component (neuroticism) explains 27% of all variation, the second one (separation anxiety) explains 16% of the variation. Behaviours indicated in bold have a loading larger than |0.4| and can be considered to be parameters that explain this component.

	Average score (%)	Neuroticism (trait)	Separation anxiety (trait)

Stranger directed aggression	5.69 (±0.92)	**0.59**	-0.38
Owner directed aggression	1.15 (±0.27)	**0.50**	-0.36
Dog directed aggression	19.86 (±1.95)	**0.59**	**-0.46**
Non social fear	12.42 (±1.20)	**0.61**	0.34
Social fear	7.02 (±1.24)	**0.60**	0.20
Dog fear	10.17 (±1.20)	**0.55**	0.03
Separation anxiety	8.21 (±1.31)	0.38	**0.71**
Attachment	37.09 (±1.77)	**0.42**	**0.46**
Chasing	39.60 (±2.53)	0.39	-0.32

Thus, the CBARQ data used for the PCA analysis have resulted in two components that both relate to the trait anxiety of the dog. From this analysis, it seems that the personality of the dog can be measured along two dimensions, namely neuroticism and separation anxiety. The scores for the neuroticism trait and the separation anxiety trait will be used in further analysis to examine their effect on the behaviour of the dogs during the tests.

3. Emotional contagion

To measure emotional contagion in dogs, a yawning test was performed, in which the owner yawned when the dog paid attention to the owner. This test was performed to investigate (1) if dogs show emotional contagion to human yawns and (2) if a higher response to human yawns can indicate a stronger emotional contagion and thus a stronger response to a negative or positive affective state in the owner. As a control, this yawning phase was alternated with a mouth movement phase, in which the owner made a mouth movement when the dog paid attention to the owner. For this test, results of 31 dog-owner combinations were used. A Chi-square test was used to test if the amount of yawns were higher during the yawning sessions than during the control (mouth movement) sessions, relative to the amount of yawns or mouth movements displayed by the owner. From the total of 277 yawns performed by owners, 11 were followed by a yawn from the dog. From the total of 382 mouth movements made by owners, 7 were followed by a yawn from the dog. The remaining 266 and 375 yawns and mouth movements respectively, were not followed by a yawn from the dog. These data are summarized in

Table 5 as input for the Chi-square test. The amount of yawns performed by dogs after an owner yawn did not differ significantly from the amount of yawns performed by dogs after a mouth movement of the owner (X^2= 2.76, df = 1, p=0.10). However, a trend can be seen for more yawns of dogs after owner yawns than after mouth movements of the owner.

Table 5: Number of yawns and mouth movements from all owners followed by a yawn from the dog, or not followed by yawn from the dog. In total 11 yawns from dogs were observed after yawns of owners, and 7 yawns from dogs were observed after mouth movements from the owners. Residuals of the Chi-square analysis are indicated between brackets. Higher residuals indicate a larger deviation from expected values, with residuals larger than |2| are considered significant deviations from expected values.

	Owner yawns	Owner mouth movements	*Total*
Yawn	11 (1.25)	7 (-1.06)	*18*
No yawn	266 (-0.21)	375 (0.18)	*641*
Total	*277*	*382*	*659*

Thus, the results from the yawning test have shown that yawning in dogs was rarely observed, but yawning in dogs tended to occur more after yawns made by the owner than after mouth movements.

4. Owners' change in emotional state

Owners were manipulated to a negative emotional state (NT) or a positive emotional state (PT) to examine the effect of the owner's emotional state on the dog's behaviour. To measure the effect of the manipulation into a negative or positive emotional state, the STAI questionnaire was used, which

measures the owner's anxiety. All owners (N=32) indicated their emotional states by means of the STAI questionnaire four times during the whole procedure (128 records). The first questionnaire was filled in at arrival, before manipulation, the following three were filled in after manipulation (after the social referencing test, the obedience test and the two choice test). Maximum possible anxiety score was 114. Average scores (±S.E.) of the STAI questionnaire were calculated and are summarized in Figure 3. The emotional state of the owners in the NT and PT was approximately similar before manipulation. On average, the emotional state increased to higher anxiousness for NT, and decreased to lower anxiousness for PT. A significant interaction was found between treatment and test phase (Mixed Model, $p<0.01$). When comparing the predicted means per treatment-test phase combination, a significant difference was found between NT and PT after social referencing, as can also be seen in Figure 3, which shows the largest difference in anxiousness score between NT and PT at social referencing. Furthermore, for NT, the increase in anxiousness score compared to the score before manipulation was only significant at social referencing. For PT, the decrease in anxiousness compared to the score before manipulation was only significant at the two choice test.

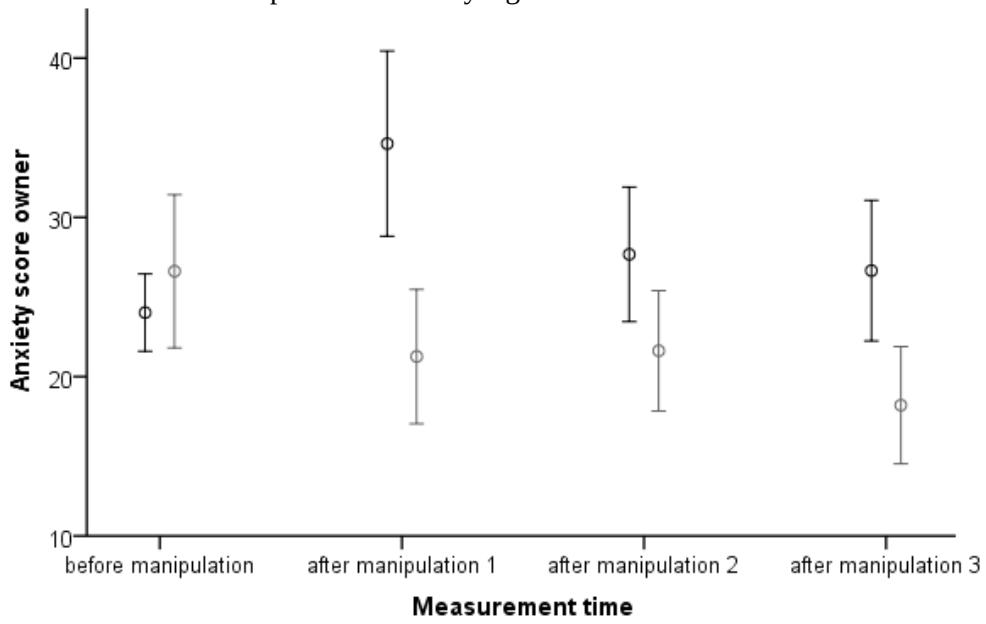

Figure 3: Average anxiety scores of owners (± S.E.) calculated from the data from the STAI-questionnaires. Higher scores indicate higher anxiousness. Owners filled in the questionnaire four times: at the beginning (before manipulation) and three times after manipulation. Anxiety scores before manipulation do not differ between owners that received the NT (black) and owners that received a PT (grey). After manipulation, anxiety scores are higher for owners in the NT than owners in the PT for all measurement times. The manipulation effect is strongest the first time after manipulation, where the difference between NT and PT is biggest.

Since this study aims to investigate the effects of an induced change in emotional state on the behaviour of the dog, the emotional state of the owner was included in the analyses in two different ways. For the Linear Mixed Models and ANCOVAs, the emotional state of the owner was included as a quantitative variable. This quantitative variable was calculated as the difference in STAI score between social referencing and before manipulation. By calculating this difference, the change in anxiety of the owner induced by the treatment was used as predictor of behaviours of the dogs. For the Chi-square tests, this difference between social referencing and before manipulation was translated to either a negative or positive effect of the treatment. Negative differences indicate a decrease in anxiousness and thus a positive effect, while positive differences indicate an increase in anxiousness and thus a negative effect.

The first questionnaire that was filled in by the owners (before manipulation) also contained the second part of the STAI questionnaire, measuring the anxiety of owners as a trait. An ANCOVA was used to analyse the effect of the owner's trait anxiety and the effect of the treatment on the owner's change in anxiety due to the treatment. Records of all 32 owners were used for this analysis. It was found that the interaction between treatment and trait anxiety has a significant effect on the change in the owner's anxiety (Figure 4, ANCOVA, $p=0.04$). Owners that are in general more anxious, showed

also a stronger increase in anxiousness in the negative treatment. This correlation was not found in the positive treatment (Figure 4).

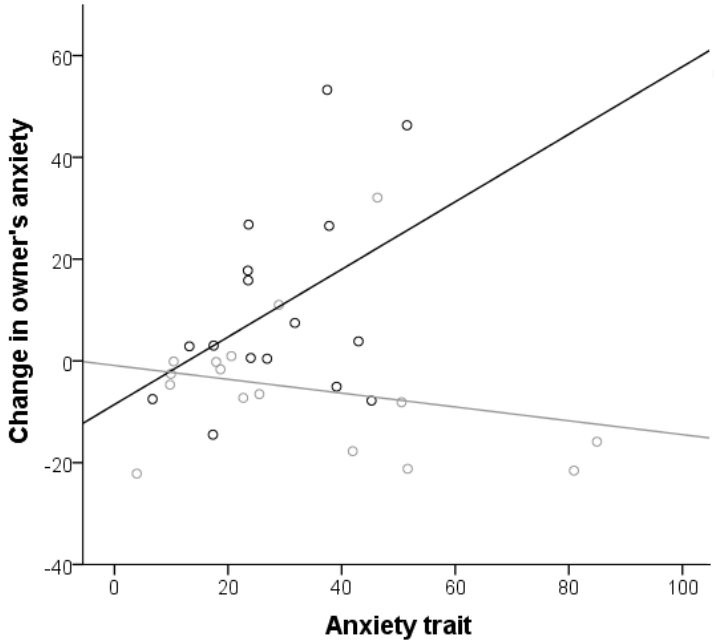

Figure 4: Change in owner's anxiety depends on anxiety trait. Change in owner's anxiety is shown separately for owners given the negative treatment (black) and the positive treatment (gray). Change in owner's anxiety is calculated as difference in anxiety score between arrival and social referencing. There is a significant interaction between trait anxiety and treatment (ANCOVA, N=32, p=0.04). The negative treatment causes a higher increase in anxiety when owners are in general more anxious. No significant relation between general anxiety score and change in anxiety was found in the positive treatment.

Thus, manipulating the affective state of the owners had a significant effect on the owners, the most strongest effect was observed in the first measurement after manipulation. Amongst the owners given the negative treatment, the increase in anxiety was higher when owners scored higher for anxiety as a trait.

5. Cortisol levels owners and dogs

Saliva samples were collected from the owners and the dogs to measure cortisol, which is used as physiological stress indicator. Samples were collected at the start of the tests, before manipulation, and at the end of the tests, after manipulation. Data of cortisol levels are summarized in Table 6. Average cortisol levels of owners and dogs were both around 4.5 before manipulation. After manipulation, cortisol levels of owners decreased on average to 2.86, and cortisol levels of dogs were on average 4.33.

Table 6: Summary of cortisol data. Only samples with sufficient saliva could be analysed for cortisol levels, resulting in smaller sample sizes. Average cortisol levels in nmol/L (± S.E.) are calculated as means from the data and displayed for both owners and dogs. Data was separated for samples taken before manipulation and after manipulation.

	N (before manipulation)	Cortisol level (nmol/L) before manipulation	N (after manipulation)	Cortisol level (nmol/L) after manipulation
Owner	21	4.52 (±0.45)	18	2.86 (±0.23)
Dog	21	4.58 (±0.53)	22	4.33 (±0.42)

First, saliva samples were analysed to investigate the change in cortisol levels in the owners during the test procedure. Saliva samples of 15 owners were sufficient to analyse cortisol levels both before manipulation and after manipulation. Results were analysed using a Mixed Model, in which the treatment (NT or PT), measurement time (before or after manipulation) and interaction between treatment and measurement time were used to predict cortisol levels. No significant interaction between treatment and measurement time was found (Mixed model, N=30, p=0.37). Treatment had no

significant effect on cortisol levels (N=30, p=0.11), but cortisol levels were significantly affected by measurement time (N=30, p<0.001). For both the positive and negative treatment, cortisol levels decreased during the whole procedure (Figure 5).

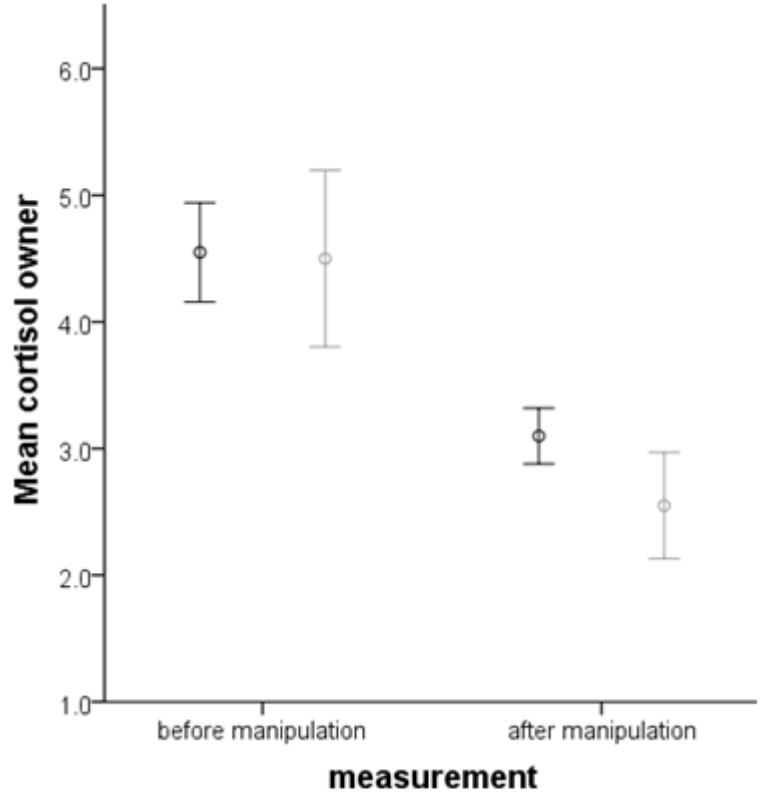

Figure 5: Average cortisol levels in nmol/L (± S.E.) calculated as means from the data of the owners before manipulation and after manipulation. Data is displayed separately for owners given the negative treatment (black) and owners given the positive treatment (gray). For both groups, cortisol levels decreased over time.

Additionally, cortisol data were analysed to investigate the effect of the owners' stress level on the dogs' stress level. From all saliva samples collected before and after the test procedure, 22 records could be used where data was available for both owner and dog at the same measurement time. A Mixed Model was used to investigate the effect of the personality of the dog (neuroticism score and separation anxiety score) and the cortisol level of the owner on the cortisol level of the dog. None of the independent variables were significant in explaining the variance in cortisol levels in dogs (neuroticism: p=0.11; separation anxiety: p=0.996; cortisol owner: p=0.13).

Thus, based on the cortisol results, owners seemed to be less stressed at the end of the experiment, and manipulating the owners affective state did not seem to influence their stress levels. Furthermore, no relation was found between the owners' and the dogs' cortisol levels.

6. Effect of owners' emotional state on dog behaviour

The manipulations were interchanged by interactions between dog and owner so that the emotional state of the owner could be transferred to the dog. During the interactions, lateralization was measured by letting dogs choose to approach their owners via the left or right side or the fence. From all interactions, 125 choices for left or right were used in the analysis. Overall, more dogs chose to approach their owner via the right side of the fence (Binomial test, p<0.001), thus approaching their owner with their left eye, which is connected to their right brain side. No significant difference was found in lateralization choice between dogs of negatively affected owners and dogs of positively affected owners after manipulation (

Table 7, X^2=1.30, df=1, p=0.25).

Table 7: Number of times dogs chose to approach their owner via the left or right side of the fence when the owner was negatively affected or positively affected. From all 32 dogs, 125 choices for left or right were made during the interactions after manipulation. Residuals of the Chi-square analysis are indicated between brackets. Higher residuals

indicate a larger deviation from expected values, with residuals larger than |2| indicating a significant deviation from expected values.

	Owner negatively affected	Owner positively affected	*Total*
Left	12 (0.79)	11 (-0.66)	*23*
Right	40 (-0.37)	62 (0.32)	*102*
Total	*52*	*73*	*125*

Lateralization was also measured during the social referencing test. Results of 31 dogs were used in the analysis. Also during the social referencing test, dogs were more likely to approach the novel object via the right side (Binomial test, p=0.01). Again, no significant difference was found in lateralization between dogs of negatively affected owners and dogs of positively affected owners (Table 8, X^2=0.01, df=1, p=0.94).

Table 8: Number of times dogs chose to approach the novel object in the social referencing test via the left or right side of the fence when the owner was negatively or positively affected. Results from 31 dogs were used for the Chi-square analysis. Residuals are indicated between brackets, where higher residuals show a higher deviation from expected values. Residuals higher than |2| are considered as a significant deviation from expected values.

	Owner negatively affected	Owner positively affected	*Total*
Left	3 (-0.05)	5 (0.04)	*8*
Right	9 (0.03)	14 (-0.03)	*23*
Total	*12*	*19*	*31*

Thus, the lateralization results from the interactions and from the social referencing test both show that dogs prefer to approach their owner or a novel object via the right side of the fence, but the owner's affective state has no effect on this choice.

In the obedience test, the owner instructed the dog not to eat the treat that was placed in front of the dog. Following a standard procedure, the owner was instructed to leave the room after one minute and the dog's behaviour was observed for half a minute longer. For each dog, it was recorded if the dog ate the treat or not, and for those who ate the treat, the latency to eat the treat was measured. Data of 31 dogs were used in the analysis. A Chi-square test was used to test for a difference between the effect of the treatment (negative or positive) in number of dogs eating the treat and not eating the treat. No significant difference was found in the distribution of the dogs eating the treat and not eating the treat between the positively and negatively affected owners (Table 9, X^2=0.18, df=1, p=0.68).

Table 9: Number of dogs observed eating the treat and not eating the treat when the owner was positively affected or negatively affected. Results of 31 dogs were used for the Chi-square analysis. Residuals of the Chi-square analysis are indicated between brackets. Higher residuals indicate a larger deviation from the expected value, with residuals larger than |2| indicating a significant deviation from expected values.

	Owner negatively affected	Owner positively affected	*Total*
Did not eat treat	4 (0.28)	5 (-0.22)	*9*
Ate treat	8 (-0.18)	14 (0.14)	*22*
Total	*12*	*19*	*31*

Furthermore, amongst the dogs that ate the treat, a distinction was made between dogs that ate the treat before the owner left the room, and dogs that ate the treat after the owner left the room. From the 22 dogs that ate the treat, 8 did so before the owner left the room, the remaining 11 dogs ate the treat after the owner left the room (Table 10). Again, a Chi-square test was used to investigate whether there was a difference in eating the treat when the owner was present or when the owner was absent between the dogs of negatively affected owners and the dogs of positively affected owners. A trend can be seen that dogs of negatively affected owners were more likely to eat the treat in the presence of

the owners, while dogs of positively affected owners were more likely to eat the treat after the owner left the room (X^2=3.71, df=1, p=0.054).

Table 10: Number of dogs observed eating the treat before the owner left the room or after the owner left the room when the owner was negatively or positively affected. 22 dogs were observed eating the treat. Residuals of the Chi-square analysis are indicated between brackets. Higher residuals indicate a higher deviation from the expected values, with residuals larger than |2| indicating a significant difference.

	Owner negatively affected	Owner positively affected	*Total*
Ate treat before owner left room	5 (1.23)	3 (-0.93)	*8*
Ate treat after owner left room	3 (-0.93)	11 (0.70)	*14*
Total	*8*	*14*	*22*

Thus, no effect of the owner's affective state can be seen on the probability to eat the treat. However, a trend was found that dogs of negatively affected owners were more likely to eat the treat in the presence of their owner, while dogs of positive affected owners were more likely to eat the treat in absence of their owner.

In the two choice test, the experimenter showed the dog the treat going in one food bowl, and subsequently asked the owner to instruct the dog to collect a treat in a different food bowl. This test was repeated three times per dog. From 31 dogs, a total of 92 choices were analysed. Overall, dogs tended to follow their own observations more often (63 times) than their owners' cues (29 times). The proportion of dogs following the experimenter was significantly higher than 0.5 (Binomial test, p<0.01). A Chi-square test was used to test for a difference in following the owner or experimenter between dogs of owners that were negatively affected by the treatment and dogs of owners that were positively affected by the treatment. No significant effect of the owners' emotional state on the choice of the dog was found (Table 11, X^2=0.22, df=1, p=0.64).

Table 11: Number of times dogs followed their owner and the experimenter in the two choice test when the owner was positively affected or negatively affected. The test was repeated three times for each dog-owner combination. Results of 31 dogs were taken into account for the analysis, resulting in 92 records. Residuals of the Chi-square test are indicated between brackets.

	Owner negatively affected	Owner positively affected	*Total*
Follow owner	13 (0.30)	16 (-0.25)	*29*
Follow experimenter	25 (-0.20)	38 (0.17)	*63*
Total	*38*	*54*	*92*

Additionally, an ANCOVA was performed to investigate if the average latency to approach the food bowl can be explained by the change in owner's anxiety, the number of times the dog followed the owner and the neuroticism and separation anxiety scores. Results of 27 dogs were used in the analysis. No significant effect of any parameters was found on latency to approach the food bowl (ANCOVA, change in owners' anxiety p=0.84; number of times followed owner p=0.74; neuroticism p=0.46; separation anxiety p=0.98).

Thus, the emotional state of the owners does not seem to affect the dogs' choice to follow the owner or the experimenter, nor does it affect the latency to approach the food bowl.

The behaviour of the dog was measured during different test phases by measuring activity, stress signals, responses to the owner and responses to stimuli presented during the different tests. Each of these response variables was analysed to examine the effect of the owner's emotional state on the behaviour of the dog. Some of these response variables were measured during several test phases; for these variables, a Mixed Model analysis was used, with the fixed effects change in owner's anxiety,

test phase, interaction between change in owner's anxiety and test phase, neuroticism and separation anxiety score (behavioural traits, resulting from the PCA analysis on the CBARQ data), and stress and stress release (states, resulting from the PCA analysis on stress behaviours observed during the tests). In these Mixed Models, the dog ID was used as a random part in the model. The results of these Mixed Model analyses are summarized in

Table 12 and will be discussed in more detail below.

Table 12: Overview results Mixed Model analyses. The response variables activity, stress, stress release and latencies to approach owner and respond to commands sit and lie were measured during several test phases. These variables were analysed with a Mixed Model using test phase, change in owner's anxiety, neuroticism, separation anxiety, stress and stress release as fixed effects. Additionally, the model contained an interaction effect between test phase and change in owner's anxiety. For each fixed effect, the p-value is given. Variables with a p-value <0.05 were considered to have a significant effect on the response variable, p-values <0.1 show a trend. Additionally, slopes are given for quantitative variables to indicate how they affect the response variable.

	Test phase		Change in owner's anxiety	Test phase* change in owner's anxiety		Neuroticism (trait)		Separation anxiety (trait)		Stress (state)		Stress release (state)	
	p-value	slope	p-value	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value
Activity[1]	0.26	-0.01	0.40	0.48	-0.24	0.06	0.37	0.05	0.55	<0.01	-0.14	0.85
Stress[2]	<0.01	<0.01	0.58	0.22	0.10	0.28	-0.12	0.32	-	-	-0.12	0.81
Stress release[2]	<0.01	0.01	0.79	0.82	0.11	0.16	0.06	0.33	-0.12	0.66	-	-
Latency to approach owner[3]	0.14	-0.11	0.03[a]	0.25	2.16	<0.01[a]	1.18	0.30	0.56	0.72	-0.58	0.44
Latency to sit[3] (obey command)	0.73	-0.02	0.40	0.96	-0.06	0.53	0.53	0.02	0.11	0.79	<0.01	0.93
Latency to lie[3] (obey command)	0.63	-0.05	0.37	0.75	0.23	0.29	-0.20	0.48	0.19	0.62	-0.36	0.21

[1]Measured during yawning phase and all four manipulations

[2]Measured during yawning phase, all four manipulations, all five interactions, social referencing, obedience

[3]Measured during all five interactions

[a]Data does not follow a normal distribution. After log-transformation, change in owner's anxiety and neuroticism are no significant predictors for latency to approach owner (p=0.50 and p=0.18 respectively).

Activity was measured during the yawning test and the manipulations. For the analysis, only the activity results from the manipulations were considered, since the owners interfered a lot with the activity during the yawning test by telling the dog to sit down, or helping the dog up when it was lying and not paying attention to the owners. The results of the PCA using all activity observations yielded a component for activity, which was used as input for the mixed model analysis. Data on 28 dogs were used for this analysis, resulting in 140 records. No significant effect was found of change in owner's anxiety score, test phase or the interaction between them (

Table 12). The Mixed Model analysis also included the level of stress and stress release measured during the test phases and the level of separation anxiety and neuroticism from the results of the CBARQ questionnaire as predictors for activity (

Table 12). Dogs that were more stressed, were more active (Figure 6, p<0.001). Furthermore, a trend can be seen that dogs with high separation anxiety scores were more active (p=0.05), whereas highly neurotic dogs were more passive (p=0.06).

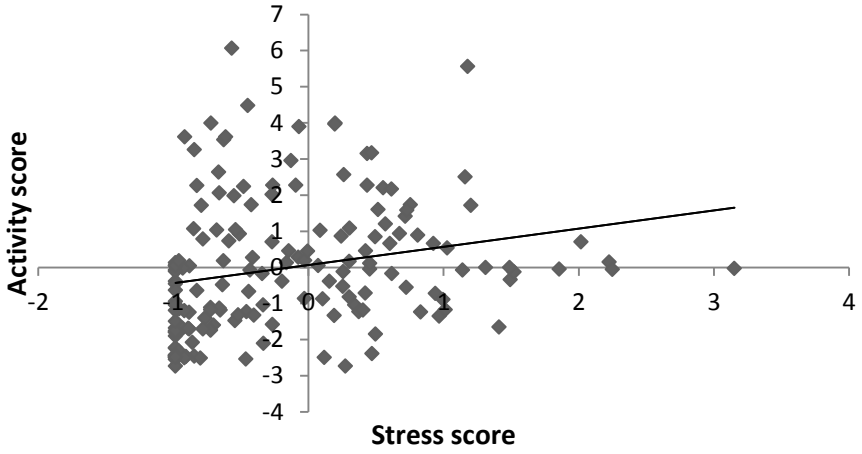

Figure 6: Relationship between stress scores and activity scores. Data of 28 dogs were used, resulting in 140 records. Stress and activity scores resulted from PCA analysis. Dogs that were more stressed, were also more active (Mixed Model, p<0.001).

Thus, change in owner's anxiety score has no effect on the dog's activity. However, activity did increase when dogs were more stressed. Activity also seems to depend on the behaviour traits separation anxiety and neuroticism, where dogs with a lot of separation anxiety tend to be more active and highly neurotic dogs tend to be less active.

The amount of stress signals expressed by dogs was summarized into two components from the PCA analysis. From this analysis, one score for stress and one for stress release was calculated for each dog in each test phase. The relation between these results and other parameters was analysed with a Mixed Model analysis (
Table 12). Results of 28 dogs were used in the analysis (332 records). For the stress score, no significant interaction was found between test phase and change in owner's anxiety (p=0.22). The change in owner's anxiety had no significant effect on stress score (p=0.58), but a significant effect of test phase was found (p<0.001). Furthermore, neuroticism, separation anxiety and social arousal had no significant effect on stress score (Table 12). Same results were found from analyzing the social arousal score (
Table 12). The interaction between test phase and change in owner's anxiety was not significant (Mixed Model, 32 dogs, 332 records, p=0.82) and the change in owner's anxiety had no significant effect either (p=0.79). Only test phase had a significant effect on stress release score (p<0.001).

Thus, change in owner's anxiety has no predictive value for stress and stress release behaviours. Furthermore, stress and stress release scores do not seem to depend on the behaviour traits neuroticism and separation anxiety either.

During the interactions, the dog approached the owner, the owner walked around the room with the dog on leash and the interaction ended with the owner asking the dog to sit and lie down. In addition to the lateralization that was measured during the interactions, also the latency to approach the owner and the latencies to respond to the commands 'sit' and 'lie down' were measured. The latency to approach the owner can give an indication of the dog's motivation to approach it's owner. The latency to respond to the commands 'sit' and 'lie down' can give an indication of the dog's responsiveness to commands. These results were analysed with a Mixed Model analysis. For the latency to approach, results of 28 dogs were taken into account in the analysis (137 records). No interaction was found between test phase and change in owner's anxiety (Mixed Model, p=0.25) and test phase had no significant effect on the latency to approach the owner (p=0.14). The significant effect of change in owner's anxiety on the dog's latency to approach the owner (p=0.03) will not be considered here, since this result was mainly due to an outlier in the data (Figure 7), and was not significant anymore after log-transforming the data (p=0.50).

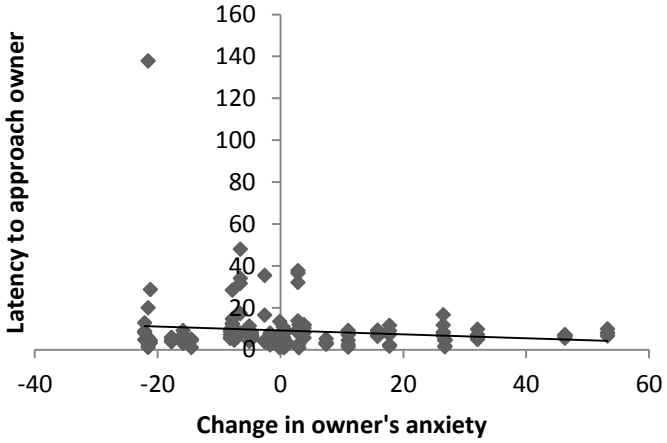

Figure 7: Relationship between change in owner's anxiety and latency to approach owner. Results of 28 dogs were used, resulting in 137 records. From the Mixed Model analysis, change in owner's anxiety had significant predictive value over the dog's latency to approach the owner (p=0.03). The significant effect found can be attributed to one outlier (left top corner). After log transformation, the effect of the change in owner's anxiety on the dog's latency to approach the owner was not significant anymore.

Furthermore, the dog's latency to approach the owner was also significantly explained by neuroticism score ($p<0.01$). Again, this finding seems to be mostly the result of one outlier in the data, and no significant result was found after log-transformation ($p=0.18$). Thus, this result will not be considered significant. Separation anxiety, stress and stress release were insignificant in explaining the variance in latency to approach the owner (

Table 12).

Results on the dog's latency to obey to the command 'sit' were available for 25 dogs (110 records). Latency to obey to the command 'sit' is not predicted by the interaction between change in owner's anxiety score and test phase, nor by the separate factors test phase and change in owner's anxiety score (Mixed Model, $p=0.96$, $p=0.73$ and $p=0.40$ respectively). Most parameters from the model were insignificant in predicting the latency to sit (

Table 12), except for the separation anxiety score ($p=0.02$). Dogs that were more attached to their owners showed a longer latency to respond to the command (Figure 8).

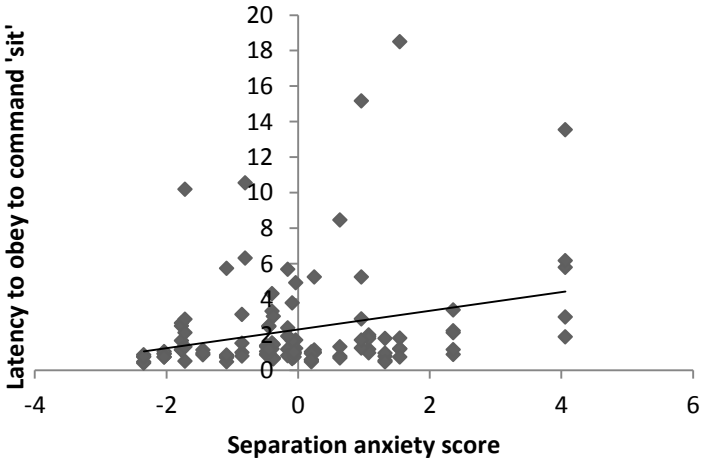

Figure 8: Relationship between the dog's separation anxiety score and the dog's latency to obey to the command 'sit'. Results of 25 dogs were used (110 records). Latency to obey to the command 'sit' significantly increased in dogs with higher separation anxiety scores (Mixed Model, p=0.02).

For the latency to respond to the command 'lie down', data was available for 25 dogs (120 records). No parameter was found to be significant in explaining the variance in latency to lie down (

Table 12).

From these results, the dog's motivation to approach its owner and the dog's responsiveness to the commands 'sit' and 'lie down' were not found to depend on the owner's affective state. Only an separation anxiety seems to affect the dog's latency to respond to the command 'sit'.

Dependent variables that were measured during only one test were analysed using an ANCOVA. The independent variables used for this analysis were owner's change in anxiety, neuroticism and separation anxiety score (behaviour traits, resulting from the PCA analysis on the CBARQ data), and stress and stress release score (states, resulting from the PCA analysis on the stress behaviours observed during the tests). The ANCOVA was used on data from the social referencing test, where the latency to approach the novel object and the rate of play was measured. Also an ANCOVA was produced for the data on the obedience test, where latency to eat treat was measured. Results of the ANCOVAs are summarized in

Table 13 and will be discussed in more detail in paragraphs below.

Table 13: Overview results ANCOVA analyses. The response variables latency to approach novel object, play rate at social referencing and latency to eat treat were analysed using an ANCOVA with the independent variables change in owner's anxiety, neuroticism, separation anxiety, stress and stress release. For each independent variable, the slope is given to indicate how the variable affects the response variable. Furthermore, the p-value is given, where independent variables with a p-value lower than 0.05 were considered to have a significant effect on the response variable.

	Change in owner's anxiety		Neuroticism (trait)		Separation anxiety (trait)		Stress (state)		Stress release (state)	
	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value
Latency to approach novel object[1]	-0.06	0.66	1.67	0.17	-0.10	0.95	4.06	0.02	-5.71	0.16
Play social referencing	0.13	0.13	-1.56	0.06	-0.82	0.44	-3.28	<0.01	5.51	0.04
Latency to eat treat	-0.43	0.30	2.73	0.54	0.83	0.88	-7.73	0.22	-22.07	0.03

[1]Data deviated from the normal distribution. Transforming the data to a log-scale resulted in different p-values, but all insignificant independent variables in the untransformed model remained insignificant in the log-transformed model. The independent variable stress turned from p=0.02 to p=0.10. Although not significant anymore, still a trend can be seen in the log-transformed model.

The response to a novel object was tested in the social referencing test by measuring the latency to approach the object and the amount of play behaviour towards the object. A faster latency to approach and more play behaviour indicate dogs with a more positive attitude towards the strange object. Results of 27 dogs were used in the analysis. Again, the statistical model included change in owner's anxiety, neuroticism, separation anxiety, stress and stress release score. The dog's latency to approach the novel object was not predicted by the change in the owner's anxiety, but was explained by the amount of stress behaviours shown by the dog (Figure 9, p=0.02). Dogs showing more stress behaviours were less secure about the novel object and approached it slower.

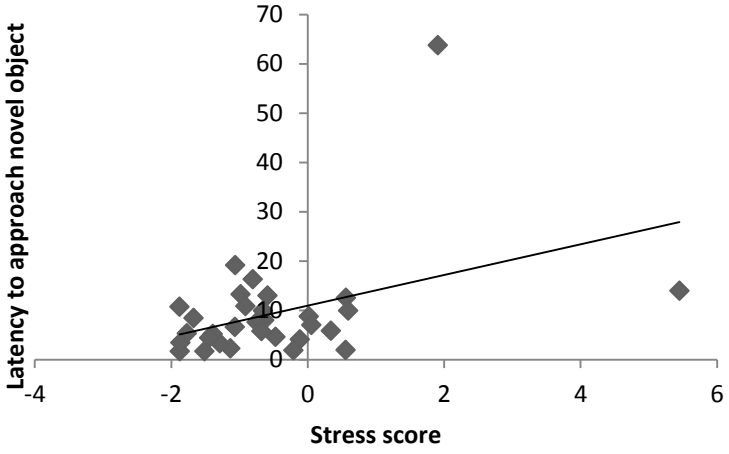

Figure 9: Relationship between the dog's latency to approach the novel object and the amount of stress behaviours shown by the dog (score resulting from the PCA). For this analysis, 27 dogs were used. Dog that were more stressed were slower in approaching the novel object (p=0.02). The result is partially influenced by the two outliers, but log-transformation still showed a trend that more stressed dogs approached the novel object slower (p=0.1)

No significant effect was found of the change in owner's anxiety on play behaviour, but stress and stress release did have a significant effect on play behaviour (Figure 10, $p<0.01$ and $p=0.04$ respectively). Play behaviour increased when dogs showed less stress behaviours and more stress release behaviour.

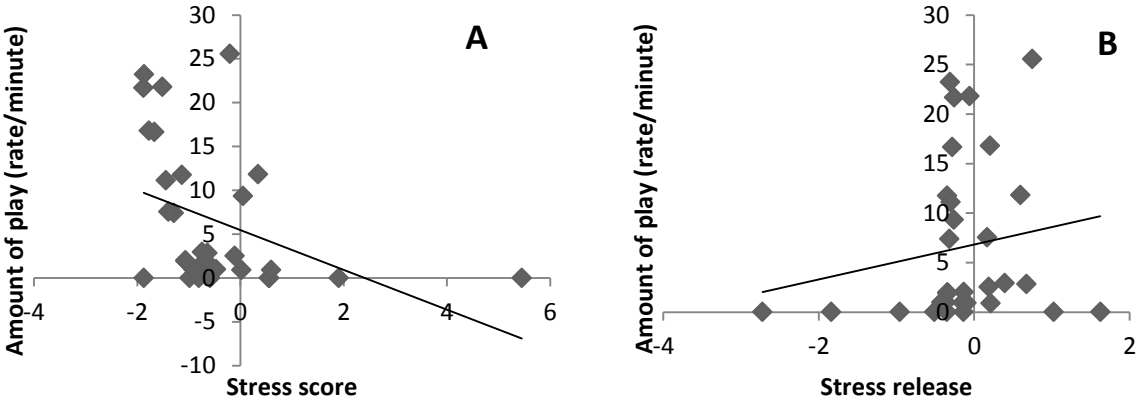

Figure 10: Relationship between amount of play (rate/minute) and stress score (A) and stress release score (B). Data of 27 dogs were used in the analysis. Dogs played more when they showed less signs of stress (p<0.01) and more signs of stress release (p=0.04).

Thus, the owner's affective state did not appear to influence the dog's response to the novel object. More stressed dogs showed less secure behaviour towards the novel object, resulting in a slower approach and less play behaviour. Dogs showing a lot of stress release behaviour were more playful towards the novel object.

Furthermore, in the obedience test, the dogs' latency to eat the treat was analysed using an ANCOVA. For this analysis, results of 27 dogs were used. Change in owner's anxiety was not significant in predicting the dog's latency to eat the treat (p=0.30). The only variable that could explain some variance in latency to eat treat was stress release (p=0.03). Dogs that showed more behaviours characteristic for stress release disobeyed their owner sooner (Figure 11).

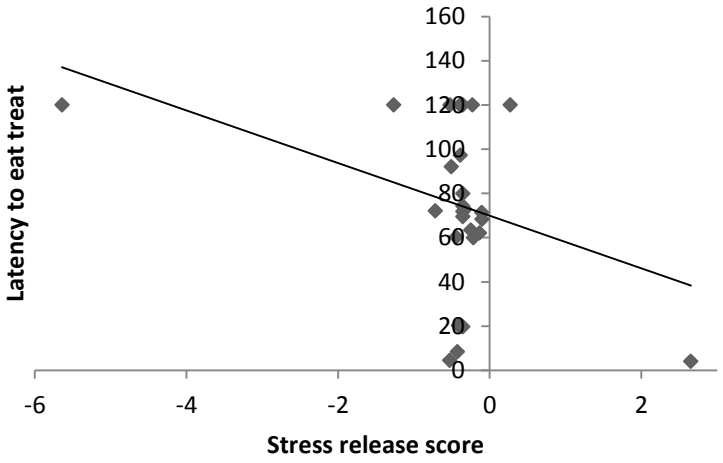

Figure 11: Relationship between the dog's latency to eat the treat in the obedience test and the amount of stress release behaviours (score resulting from the PCA) shown by the dog. For this analysis, 27 dogs were used. A significant effect was found of the amount of stress release behaviours on the dog's latency to eat the treat (p=0.03). Dogs showing more behaviours to release their stress tend to disobey sooner. Although two outliers can be seen, data was normally distributed, and same results can be found when correcting for these outliers.

Thus, the owners' affective state was not found to influence the dog's latency to disobey the owner. Dogs that showed more stress releasing behaviours disobeyed their owner sooner.

7. Interpretation of and response to dog behaviour

A total of 167 dog owners completed the questionnaire on dog behaviour. In this questionnaire, owners were asked to interpret the behaviour of dogs on 18 movie fragments and to indicate for each fragment how they would respond to this behaviour with their own dog (2679 records). Overall, the highest ratings were given to the behaviours tense and excited, whereas the lowest ratings were given to the behaviours dominant and aggressive. The results of the questionnaire were summarized with a PCA on the questions to rate the behaviour of the dog in the movie fragments, and a PCA on the questions to rate the owner's response to the dog's behaviour. The first PCA resulted in three components (

Table 14). The first component has high scores for the ratings on insecure, tense, stressed, fearful and aggressive behaviour, with low scores for playful behaviour. These behaviours represent fear aggression for this component, which explains 44% of the variance. High scores on the second component indicate high ratings for excited, dominant and aggressive behaviours. Therefore, this component can be named dominance aggression, which explains 19% of the variance. The last component yields high scores when excited and playful behaviours were rated high. This component explains 15% of the variance and is named playfulness.

Table 14: The owners' interpretation of dog behaviours was measured with a questionnaire by asking the owners to rate how much they observed different types of behaviours. Average ratings (± S.E.) were calculated as means from the data to indicate if owners interpret each type of behaviour on average low or high. Ratings ranged from 1 to 5, with 1 meaning the owners did not at all observe this behaviour, and 5 meaning they observed this behaviour very much. Data of 167 owners was used in the analysis (2679 records). Three components were found in the analysis. The first, fear aggression, explained 44% of the variance. The second component was dominance aggression and explained 19% of the variation. The last component was named playfulness and explained 15% of the variation. A loading was calculated for each behaviour to indicate its relationship to a component. Behaviours that have a loading larger than |0.4| (indicated in bold) can be considered to be parameters that explain this component.

	Average rating	Fear aggression	Dominance aggression	Playfulness
Insecure	2.85 (±0.03)	**0.84**	-0.25	0.14
Tense	3.27 (±0.03)	**0.88**	0.05	0.09
Stressed	2.98 (±0.03)	**0.88**	0.01	0.14
Fearful	2.29 (±0.03)	**0.85**	-0.12	0.08

Aggressive	1.73 (±0.02)	**0.48**	**0.61**	-0.38
Dominant	1.95 (±0.03)	0.00	**0.82**	-0.37
Excited	3.17 (±0.03)	0.19	**0.58**	**0.68**
Playful	2.12 (±0.03)	**-0.51**	0.29	**0.64**

In the same questionnaire, owners rated their own responses if their dog would behave like the dog in the movie fragment. Again, data of 167 owners was used (2679 records). Overall, owners were most likely to treat their dog the same way, to distract the dog, or to remove the dog from the situation (Table 15). Owners were least likely to stimulate the dog's behaviour or to pet their dog. A PCA including these questions to rate the owner's response to the dog's behaviour resulted in two components that explained the variance in the data (

Table 15). High scores on the first component indicates that owners are likely to correct their dog, distract the dog, remove the dog from the situation and/or remove the situation from the dog; these responses are typical when the dog shows unwanted behaviour that the owners want to stop. For this component, owners are not likely to treat the dog the same way or to stimulate the behaviour. This component explains 39% of the variance and is named negative response. The second component includes only two responses of the owners: High scores indicate that owners are likely to calm the dog with words and/or to pet their dog. These responses are positively reinforcing the behaviour of the dog and thus, this component was named positive reinforcement. This component explains 18% of the variation.

Table 15: The response of owners to dogs' behaviours was measured in a questionnaire by asking the owners to rate the probability of using different types of responses to their dog's behaviour. Average ratings (± S.E.) were calculated as means from the data to indicate how likely owners are on average to respond with each behaviour. Ratings range from 1 to 5, with 1 being very unlikely for owners to respond this way, and 5 being very likely for owners to respond this way. Data of 167 owners was used in the analysis (2679 records). Two components were found from the PCA analysis. The first component, negative response, explains 39% of the variation. The second component, positive reinforcement, explains 18% of the variation. Loadings larger than |0.4| are indicated in bold and show the responses of the owners that explain this component.

	Average rating	Negative response	Positive reinforcement
Treat dog the same way	3.12 (±0.03)	**-0.68**	0.24
Correct	2.34 (±0.03)	**0.60**	-0.03
Stimulate behaviour	1.58 (±0.02)	**-0.57**	0.40
Distract dog	3.11 (±0.03)	**0.84**	0.10
Remove dog from situation	3.11 (±0.03)	**0.86**	0.11
Remove situation from dog	2.94 (±0.03)	**0.80**	0.16
Calm dog with words	2.06 (±0.03)	0.31	**0.78**
Pet	1.89 (±0.02)	-0.14	**0.88**
Ignore dog	2.04 (±0.02)	-0.33	0.09

To investigate whether the owner's interpretation of dog behaviour and the owner's response to dogs are related to the dog's behavioural traits, data was analysed with ANCOVAs. The dog's behavioural traits neuroticism and separation anxiety (resulting from the PCA on CBARQ data) were used as dependent variables, and the PCA scores for the owner's interpretation of dog behaviour and the owner's response to the dogs were used as independent variables. For these analyses, the PCA scores for the owner's interpretation of dog behaviour and the owner's response to the dog's behaviour were averaged to get one score per owner for each PCA component (fear aggression, dominance aggression, playfulness, negative response and positive reinforcement). This resulted in 100 records of owners that completed both the questionnaire on dog behaviours and the CBARQ. The neuroticism of the dog was significantly explained by several factors. Owners that gave on average high scores for fear aggression and low scores for play had more neurotic dogs (ANCOVA, $p<0.01$ and $p=0.04$ respectively). Furthermore, a trend can be seen that owners giving high scores for dominance

aggression have less neurotic dogs (p=0.06). Moreover, owners of more neurotic dogs are more likely to respond to the dog's behaviour by positive reinforcement (Figure 12, p=0.01).

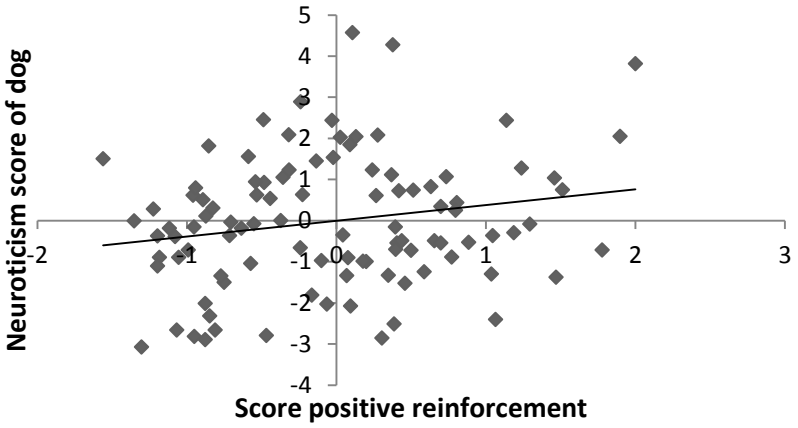

Figure 12: Relationship between owners' ratings on positive reinforcement and the dog's neuroticism score from the CBARQ. Records of 100 owners were used in the analysis. Owners that respond more with positive reinforcement to the dogs' behaviours, have more neurotic dogs. (ANCOVA, p=0.01).

Also the amount of separation anxiety shown by the dog could be significantly explained by several factors. Dogs with high separation anxiety scores have owners that give overall lower ratings for fear aggression (ANCOVA, p<0.01) and higher ratings for play (p=0.01).

Thus, the owner's interpretation of dog behaviour could be summarized in three components: fear aggression, dominance aggression and playfulness. The owner's response to the dogs' behaviours was summarized into the components negative response and positive reinforcement. When dogs are neurotic, their owners are also more likely to interpret the behaviour as neurotic (fear aggression) and to respond with positive reinforcement. When dogs show a lot of separation anxiety, their owner seems to interpret dog behaviour more positively (as play) and less negatively (as fear aggression).

The questionnaire on dog behaviour was newly developed for this study, thus the inter-rater reliability was tested as well, using ICC. The inter-rater reliability indicates the amount of agreement between owners (values ranging from 0 to 1, where higher values indicate higher reliability) and was tested separately for each type of behaviour rated by the owners and for each type of response to the behaviour rated by the owners. Each type of behaviour and each type of response was rated by all owners for 18 movie fragments. Owners that did not rate all 18 movies were excluded from the analysis, resulting in different sample sizes for each type of question (Table 16). The results of this test are displayed in Table 16. Inter-rater reliability was calculated to show both the reliability of one single rating (single measures, Table 16) and the reliability of the mean of all ratings (average measures, Table 16). Due to the high number of owners that rated the fragments of dog behaviours, the reliability of the mean of all ratings is very high (>0.9). From the reliability of a single rater, it can be seen that the reliability is higher for interpreting the dog's behaviour with ICCs ranging from 0.44 to 0.65, which is considered fair to good (Cicchetti, 1994) than for the owner's response to the dog's behaviour with ICCs ranging from 0.10 to 0.42, which is considered poor to fair (Cicchetti, 1994).

Table 16: Intraclass correlation coefficients (ICC) for each behaviour and response of the owner. ICC values can range from 0 to 1, where high intraclass correlation coefficients indicate high inter-rater reliability. ICC results are displayed for the reliability of a single rater (single measures) and for the reliability of the mean of all raters (average measures). Number of observers (N) differs for each type of question because owners that did not rate all 18 movies for a specific question were left out of the analysis.

Question	ICC (Single measures)	ICC (Average measures)	N
Insecure	0.49	0.99	94

Tense	0.49	0.99	114
Stressed	0.56	0.99	107
Fearful	0.65	0.99	94
Excited	0.49	0.99	119
Playful	0.55	0.99	101
Dominant	0.44	0.99	95
Aggressive	0.68	0.99	100
Treat dog the same way	0.39	0.99	110
Calm dog with words	0.18	0.96	121
Pet	0.22	0.97	116
Correct	0.42	0.99	117
Stimulate behaviour	0.21	0.97	111
Distract dog	0.39	0.99	118
Ignore dog	0.10	0.92	114
Remove dog from situation	0.41	0.99	111
Remove situation from dog	0.40	0.99	102

Thus, owners seem to agree most about the interpretation of dog behaviours, of which the reliability is fair to good, and least about the response to dog behaviours, of which the reliability is poor to fair. Furthermore, the reliability is very high for the mean of all ratings, due to the large sample size.

Discussion

In the process of domestication dogs have become extremely well adapted to humans and evolved to become skilled at reading human communication signals. Recent studies suggest that dogs are able to respond to the smallest signals of humans, the latter unconsciously signalling their affective state through small changes in posture, facial expressions and tone of voice. This was tested here by a behavioural test, in which the owner's affective state was manipulated, after which the dog's behavioural response to this change in owner's affective state was measured. Supposedly, the owner's interpretation and response to the dog's behaviour influences the occurrence of problem behaviours in the dog, and to investigate this a questionnaire was developed in which the owner was asked to indicate his or her interpretation of dog behaviour and the appropriate response to it. The results of this questionnaire were then linked to behavioural problems occurring in the dog.

During the behaviour tests, observations on stress signals and activity were done to find behaviours that correlate and are characteristic for stressed dogs. From the PCA analyses, three components could be identified. A component referred to as stress scored high for the behaviours panting, tongue flick, urogenital check and whine. A second component, referred to as stress release, contained the behaviours stretch, shake and jump. The behaviours associated with stress and stress release here, have also been found in other studies that investigated dog's responses to varying sources of stress (Beerda et al., 1997; Beerda et al., 1998; Dreschel and Granger, 2005; Gácsi et al., 2013; Rehn and Keeling, 2011). Some of these studies have found an association between these behaviours and physiological measures of stress, validating that these behaviours indeed indicate stress in dogs (Beerda et al., 1997; Dreschel and Granger, 2005; Gácsi et al., 2013). From these previous results, it is suggested that shaking is more a sign of relief, shown by the dog when the stressful stimulus seems to disappear (Beerda et al. 1998). Our own observations confirm this suggestion. The behaviours of the second component (stretch, shake and jump) occurred mostly in the interaction phase, when the dog was reunited with its owner after a short separation (dog and owner had no contact during the preceding manipulation phase). Thus, the reunion with the owner might be a less stressful situation than the separation from the owner in the manipulation phase, and consequently, the dog may show stress releasing signals. Therefore, the second component was called stress release. Lastly, a component of activity was found, where dogs with a high score were more active (standing and walking more often)

and switched more frequently between the locomotory states. Similar results were found in a previous study, where dogs were more active and switched more frequently between locomotions in response to aversive stimuli (Beerda et al., 1998). The influence of stress on activity was confirmed by the results showing that more active dogs also showed more stress signals. Thus, the behavioural indicators of stress found in this study seem to be valid indicators.

Furthermore, the behaviour of the dogs during the tests was explained by their behavioural traits, which were measured with the CBARQ. From this questionnaire, two components were identified, the first referred to as neuroticism (containing all types of aggression and fear), the second as separation anxiety (containing separation anxiety and attachment). The first component shows that aggressive behaviour correlates with fear. The same relation has been found in a previous study on dog behaviour traits using the CBARQ (Duffy et al., 2008). Also in behaviour tests, the aggressive behaviour is associated with fear (van der Borg et al., 2010). This component including fear and aggression, seems to be associated to neuroticism (nervous, fearful personality), a personality dimension used to describe a wide range of animals, including humans (Ley et al., 2008). From previous research, it has been shown that the dog's personality affects its performance. For example, a research in working dogs showed that dogs found to be shy in a behavioural personality test, performed worse than more secure dogs on a set of tests measuring their working performance (Svartberg, 2002). Thus, taking into account the personality of the dog might be important because it might affect their performance.

In the Mixed Model and ANCOVA analyses, the four components stress, stress release, neuroticism and separation anxiety were used as independent variables. As such, these components were able to explain some of the variance found in the dog's behaviour during the tests. However, it should be noted that the results on these independent variables found from the Mixed Models and ANCOVAs might be influenced by the correlations between the independent variables. Significant correlations were found between stress and stress release (Spearman correlation, N=28, r=0.44, p=0.01) and between stress release and neuroticism (Spearman correlation, N=28, r=0.41, p=0.03).

The yawning test was performed to investigate whether dogs show emotional contagion, and if the strength of emotional contagion can give an indication about the dog's responsiveness to their owner's affective state during consecutive tests. Research on emotional contagion in humans has shown that people with a good theory of mind performance, i.e. being able to understand the beliefs and thoughts of another, have stronger yawning responses, and thus are more empathic than others (Platek et al., 2003). Children with autism spectrum disorders, who have a disrupted social and communicative development do not show these yawning responses (Senju et al., 2007). Since the research of Joly-Mascheroni et al. (2008) found that dogs also copy human yawns, it was hypothesized that also between dogs different yawning responses could be found, explaining their sensitivity in response to the owner's affective state. The results show a trend that yawning is more likely after an owner yawn, than after a control mouth movement of the owner, and dogs might yawn contagiously to their owner yawns. However, these results are no strong evidence of contagious yawning in dogs, since a yawning response was rare and observed in only a few dogs. Due to this low response, no clear conclusions could be made about differences in dogs' responses to owners' affective states. This finding is not uncommon; although several studies found proof for contagious yawning in dogs (Joly-Mascheroni et al., 2008; Romero et al., 2013; Silva et al., 2012), other studies concluded that the number of yawns elicited was too low to prove contagious yawning in dogs (Harr et al., 2009; O'Hara and Reeve, 2011). It should be mentioned that yawns observed in the test also could have been a result of anxiety, instead of contagious yawning. Yawning is known to be an indicator of anxiety, as dogs show increased yawning in response to aversive stimuli (Beerda et al., 1998). In this study, only a control phase (mouth movements) was included to exclude this possibility, but research in macaques has shown that they showed more stress signals in response to the yawning condition than to the control condition (Paukner and Anderson, 2006). Although measures of stress were not included in the results of this yawning test, other studies have shown that the yawning response of dogs was not related to an increase in other stress related behaviours (Silva et al., 2013), nor was it related to an increase in heart rate, a physiological measure of anxiety (Romero et al., 2013). Thus, the yawning response of the dogs is most likely contagious yawning, not tension yawning.

The low yawning response in this study might be explained by several factors, like the test duration. In the study of Joly-Mascheroni et al. (2008), it took dogs on average 1 min 39 s to yawn,

whereas the test phases in this study were only one minute long. Thus, the duration of the yawning phase might simply have been too short for dogs to copy the yawn. Second, although the owners were instructed to yawn very explicitly, it was not possible to control the owners' yawns and consequently, differences in owners' yawns were seen. Many owners did not yawn with sound, whereas sound does seem to be an important feature of the yawn, since sound alone was enough to elicit a yawning response of dogs in the study of Silva et al. (2012). The sound of the yawn might be important by drawing the attention of the dog, although in chimpanzees only visual yawns were also sufficient to elicit contagious yawning (Anderson et al., 2004; Campbell et al., 2009). It is not entirely clear whether the sound is crucial in eliciting a yawning response in dogs, but it could be a factor influencing the responsiveness of dogs. Finally, also the unfamiliar environment could have decreased the dog's responsiveness to the yawning of the owner.

During the interactions between owner and dog, and during the social referencing test, the dogs had to choose to approach their owner via the left side of the fence or the right side of the fence. In both the interactions and the social referencing test, dogs showed a preference to approach their owner and the novel object via the right side of the fence, thus approaching with their left eye, which is connected to their right brain area. This right brain area is suggested to be more involved in processing negative stimuli, whereas the left brain area is more involved in the processing of positive stimuli. Previous studies have suggested that this activation of the right brain area indicates a negative perception of the dog towards the stimulus (Quaranta et al., 2007; Racca et al., 2012; Sinicalchi et al., 2010). Thus, if dogs perceive their owners as positive, they are likely to approach them with a right gaze bias. However, the study of Nagasawa et al. (2013) found that dogs showed a left gaze bias when seeing their owners after a short separation in a strange environment. Possibly, the dogs experienced both positive and negative emotions when seeing the owner, since the dogs were separated from the area where the owner appeared by a fence, they were therefore not able to reach the owner. This emotional conflict might have been present in the current study as well, since the dogs were separated from the owners during the manipulation phases, which might have been stressful for the dogs. Consequently, the conflict might have resulted in choosing to approach the owner with a left gaze bias. Indications from research on dogs' performance in detour tasks might provide another explanation for this finding. In a detour task, dogs are positioned right before a transparent V-shaped fence, and have to go around the fence to get a reward placed on the other side of the fence. The study of Pongracz et al. (2003) examined the performance of dogs on this task when a human demonstrator showed the dog how to get around the fence. Dogs that did not manage to solve the detour problem themselves in the first trial, watched a human demonstrating how to detour the fence, and chose to detour the fence along the same side of the demonstration. In the same study, a different group of dogs managed to solve the problem itself first and thereafter the detour was also demonstrated. The demonstrator always detoured along the opposite side of the side chosen by the dog. After the demonstration, approximately half of the dogs stuck to their original choice, the other half switched to the side of their demonstrator. However, in a similar study of Pongracz et al. (2001), all dogs kept detouring along the same side of their first choice. These results suggest that in the lateralization test, the experience of the dog with a particular side and the demonstration of the owner might influence the dogs' choice for left or right. Most owners were seen to pass the fence from the right side at first. Thus, the first experience of the dog was mostly to pass the fence from the right side. Although owners were instructed to switch the side to pass the fence, the first experience might have been crucial for further choices of the dog to approach from left or right. Furthermore, it should be noted that the room was not symmetrical; stimuli in the room differed on the left and the right side of the fence. All doors in the room were located on the right side of the fence, which might have had an influence on the dog's choice as well.

In the social referencing test, the dogs were presented with a novel object. The purpose of this ambiguous object was to create a situation of which the dog was not sure whether the object was safe to approach or not. In such a situation, dogs have been found to look to their owner for information on this object, and are more hesitant to approach the object when the owner is giving negative cues (Merola et al., 2012). For this test, it was expected that negatively affected owners gave more negative signals about the object, which might increase the dog's latency to approach the object. However, no effect of the owner's affective state was found on the dog's latency to approach the object. An

explanation for this result could be the nature of the novel object. Possibly, the novel object that was presented, a dancing and singing stuffed penguin, was not scary enough for dogs to look for information from their owners about the object. The research of Merola et al. (2012) used an object that elicited a cautious, mildly fearful response from the dogs. The object used in this study might not have been suitable for this test, since almost all dogs approached the penguin to a close distance, and more than half of the dogs played with the penguin. Thus, the dogs might not have used information from their owner about the novel object because the object was familiar enough to the dogs to approach it. Although no effect was found of the owner's affective state on the latency to approach the novel object and the amount of play with the novel object, some relations were found with stress parameters. Dogs showing more stress release signs, played more with the novel object. From previous research, stress release signals were observed together with increased activity and tail wagging (Rehn and Keeling, 2011). As mentioned before, stress release signals are most likely shown by dogs when the stressful situation is gone, and might coincide with more excitement, expressed by higher activity and tail wagging. Another behaviour that might be shown be excited dogs is play. Thus, dogs showing more signals of stress release might have been more excited and therefore more playful. Furthermore, dogs that approached the novel object fast and played with it more, showed less signals of stress. Possibly, the dogs that were more fearful of the novel object, showed this by expressing more signs of stress, and were therefore more cautious in approaching the novel object and playing with it. Similar results were found in the study of King et al. (2003), who found that dogs with a higher cortisol level approached the novel object slower and spent less time close to the novel object. Thus, the variation in latency to approach the novel object and play with the novel object could be explained by the amount of stress signals, reflecting the dog's fear for this object.

The dog's obedience was tested by placing a treat in front of the dog, which the dog was not allowed to eat. According to the theory of Dehasse (1997), when owners give a command with anxious nonverbal communication, the owner sends a conflicting message, which may create a conflict in the dog. This conflict can lead to more anxiety in the dog and disobeying the command. The results of the test showed that there was no difference in disobeying between the dogs of negatively affected owners and positively affected owners. However, there seemed to be a difference in when dogs disobeyed. Dogs of positively affected owners ate the treat more often when the owner was absent, whereas dogs of negatively affected owners ate the treat more often in the presence of the owner. It should be noted that these results should be interpreted with caution, since the sample size was relatively small. These results might be explained by findings of Call et al. (2003), who found in a similar test that most dog obeyed when the owner was looking at the dog, while almost all dogs ate the treat when the owner left the room. Most likely, dogs respond to the attentional state of their owner, and the absence of the owner is noticed by the dogs as indication that eating the treat will not be corrected by the owner (Call et al., 2003). Thus, perhaps the affective state of the owner only influences the obedience of the dog when the owner is actually present and sending signals to the dog. The obedience of the dogs was also measured during the interaction phases, by measuring the dog's latency to respond to the commands 'sit' and 'lie down'. The results did not show an effect of the owner's change in emotional state on the latency to respond to the commands. This is somewhat contradictory to previous research, in which the owner's personality was linked to the dog's response to the command 'sit'. Kis et al. (2012) found that more neurotic owners used more commands and hand signals to get the dog to sit. Furthermore, they found that dogs of these neurotic owners took longer to respond to the command 'sit'. Possibly, using more commands and hand signals is typical neurotic behaviour, triggering anxiety in the dog and a slower response to the command. Thus, it was also expected here that dogs of owners with a more negative emotional state would respond to the command later. Possibly, other confounding variables might have influenced the results in such a way that the effect of the owner's affective state was not measurable. One of these confounding variables may be the stress the dog is experiencing. A relation was found between the amount of stress release signals and the latency to eat the treat. Also a relation was found between the latency to sit and the behavioural trait separation anxiety. Since the dog was separated from the owner several times during the whole test procedure (during the manipulations), it is likely that dogs with high scores for separation anxiety were stressed during the test procedure. Possibly, both stress release signals and separation anxiety indicate that the dog was stressed and as a consequence of the stress, the dogs might

have been less responsive to the owners, resulting in a less obedient dog. This will be discussed in more detail later.

The dogs' response to the owner's affective state was tested by the two choice test. In this test, two food bowls were presented to the dog. The experimenter showed a piece of food going in one food bowl, and the owner pointed at the other food bowl. Thus, the dog chose between its own observation that the piece of food entered the first bowl, or its owner's cue that the piece of food was in the second bowl. It was expected that dogs rely less on their owners when they are in a negative affective state and are therefore more likely to follow their own observation. However, no effect was found of the owner's affective state on the dog's choice for the first or second food bowl. Overall, dogs followed their own observation more often than their owner's pointing cue. This result is somewhat conflicting with the results of Szetei et al. (2003), who found in a similar test that there was an equal chance that dogs chose the food bowl where the treat was shown in as that they chose the food bowl that was pointed at. Possibly, the different outcome might be explained by the difference in set up of the experiment. In Szetei et al. (2003), the experimenter both showed that the treat went in the first bowl, and pointed at the second bowl. Thus, the dog got the information of the same person, while in this experiment, the pointing was done by the owner. Possibly, the dog can relate the person giving the cues to who is in charge of the food, and therefore the dog might consider the experimenter as a more reliable source when pointing to the second bowl than the owner.

Overall, the only indication that dogs respond to the affective state of the owner was found in the obedience test, where dogs of owners in a negative emotional state tended to disobey more often in the presence of their owner, while dogs of owners in a positive emotional state tended to disobey more often in the absence of the owner. Other analyses did not show an effect of the owner's affective state on the behaviour of the dog. This result can be interpreted in two ways. First, it is possible that the dog's behaviour is not influenced by the affective state of the owner. Alternatively, there might be an effect of the affective state of the owner on the dog's behaviour, but due to other confounding variables, the influence of the owner's affective state was too small to be detected in this research. Several confounding variables might have influenced the result.

Possibly, the behaviour of the dogs was affected by the unfamiliar environment, which can cause anxiety in the dogs. Entering a new environment has been found to be stressful for dogs, indicated by an increase in cortisol levels (Hiby et al., 2006; Rooney et al., 2007; Vial et al., 1979). Thus, unfamiliar environments can be stressful for dogs, and consequently might affect their behavioural response to their owner. A new environment subjects an animal to all kinds of novel stimuli that are being processed in the animal's brain. Consequently, attention to additional stimuli may be impaired. A study in rats found that exposing rats to a new environment inhibits a behavioural response to an additional auditory stimulus (Richardson et al., 1988). Thus, also in dogs, the unfamiliar environment might have decreased the dog's attention to the owner. An indication of how stressful the unfamiliar environment was to the dogs, could be seen from their salivary cortisol levels. Average cortisol levels were 4.6 and 4.3 nmol/L (before and after the test procedure, respectively). From a previous study, the average base line salivary cortisol level in privately-owned dogs was 2.7 nmol/L (Van der Borg et al., 2010). Salivary cortisol levels of shelter dogs can increase to 20.4 nmol/L when dogs are presented with aversive stimuli (Beerda et al., 1998). Thus, the dogs in this study were most likely not highly stressed, but might have been mildly stressed. Furthermore, there might have been a lot of variance in the dog's responses to the different tests due to effects of breed and personality. Several studies have found differences in dog's performance in behaviour tests based on their personality or breed. For example, dogs that turned out to be more sociable when testing the dog's interaction with a unfamiliar human, were more persistent in gazing towards the experimenter to achieve a food reward (Jakovcevic et al. 2012). Between dog breeds, hunting and herding dogs show more gazing towards humans when facing an unsolvable task compared to primitive and molossoid dogs (Passalacqua et al., 2011). Similar results were found by Gácsi et al. (2009), who studied the performance of independent and cooperative working dog breeds and mongrels in using the human pointing gesture. Breeds selected for cooperative working performed significantly better than the other groups (Gácsi et al., 2009). Furthermore, there also seems to be a difference in performance depending on body size. Results of Helton and Helton (2010) suggest that larger dogs respond better to human pointing cues than smaller

dogs. These breed differences can be due to genetic differences or environmental differences, but either way these results do show variance in dogs' performance based on their breed or personality. Also age is likely to influence the dog's response to different stimuli. In the current study, one old dog was reported to have arthrosis, which seemed to affect its locomotion and the dog's latency to approach the owner and the novel object. Previous research in Beagles found that younger dogs are more exploratory and are interacting more with novel stimuli than older dogs (Siwak et al., 2001). These studies show that there is variability in behaviour of dogs in response to different stimuli, which might overrule the effects of the owner's affective state on the dog's behaviour. By using the CBARQ, differences in personality could be partially accounted for, but cognitive performance of dogs was not included in this study, and due to the small sample size, the number of dogs per breed and age category was too small to account for breed and age effects. Possibly the use of a selection of breeds of similar age and raised in similar environments, can control for this variation and detect the effects of the owner's affective state on dog behaviour more sensitively. A different approach could be to test each dog-owner combination twice, so that each owner is given the positive treatment once and the negative treatment once and the responses of the dogs can be compared for the treatments. However, it is important to note that there is a risk that both the dogs and humans habituate to the test facility and the test procedures in this research design.

Another factor that might explain the lack of response of the dogs to their owners' affective state could be the manipulation of the owner. The manipulation to a negative (NT) or positive (PT) affective state did result in an overall trend that the owners in the NT were more anxious than the owners in the PT, but this difference was only significant the first measurement after manipulation. Also in the cortisol levels, no effect of the manipulation could be seen on the owner's stress levels. A possible explanation for this result is the effect that dogs can have on their owners' stress level. Earlier findings demonstrated how the presence of a dog can decrease owners' physiological responses to stress (Allen et al., 1991; Allen et al., 2001). Possibly, the contact with their dogs in between the manipulations had a anxiety decreasing effect. Measuring the owner's anxiety with the questionnaire and the cortisol was each time done after behaviour tests, when owners had just been interacting with the dogs. Additionally, the change in the owners' affective state was found to depend on the trait anxiety of the owner. Thus, owners that were in general more anxious, also showed a higher increase in anxiety during the test. In previous research, the anxiety trait of owners has been linked to cortisol levels of dogs in response to mildly stressful stimuli (Kotrschal et al., 2009). This study found that dogs of more neurotic owners showed a smaller increase in cortisol levels in response to mild stressors (Kotrschal et al., 2009). The authors suggest that this relation can be explained by the attachment between dogs and owners. More neurotic owners were also more attached to their dogs, and the dogs were also more attached to the owners. Consequently, the owner might function more as a social supporter for the dog, which can moderate the dog's stress (Kotrschal et al., 2009). Alternatively, dogs of owners with high scores for neuroticism, or trait anxiety, might be more used to anxious behaviour of their owner and might therefore respond less strongly to their owner. The dog's response to the owner's anxiety is possibly a combination of response to the owner's state and trait anxiety, which should be taken into account when interpreting the influence of the owner's affective state on the behaviour of the dog.

Further research is necessary to investigate the possible response of dogs to the owner's affective state. Factors mentioned above that might have suppressed the influence of the owner's affective state on the dog's behaviour should be taken into account in a follow-up research.

Owner's interpretations of dog behaviour and how to respond to it was assessed with a questionnaire developed for this study, which contained several short movie fragments on dog behaviour. Owners were asked for each movie to interpret the behaviour of the dog and to indicate how they would respond to these behaviours if it was their dog showing the behaviour. The answers to the interpretation of dog behaviour and to the response to the behaviour were analysed with PCAs and resulted in several components. Owners interpreted the behaviour of the dogs on three components: fear aggression, dominance aggression and playfulness. The owner's response to the behaviour was summarized in the components negative response and positive reinforcement. The purpose of this questionnaire was to investigate whether the owner's interpretation of the movie fragments and the owner's response to the dog's behaviours relate to behavioural problems in the dogs of these owners.

Several relations were found in the analysis. Owners with dogs scoring high for separation anxiety gave overall higher ratings for playfulness and lower on fear aggression. Previous research has shown a relation between the owner's interpretation of their dog's behaviour and the attachment between the owner and the dog (Kotrschal et al. 2009). In their study, Kotrschal et al. (2009) found that owners that were more attached to their dog, also had dogs that were more attached to their owner. These owners interpreted the behaviour of their dogs as more positive and also behaved more positively towards their dog. Possibly, the relation found here between separation anxiety of the dog and owner's high interpretation of playfulness, reflects the same pattern. Dogs with high separation anxiety were also more attached to their owner, and the owners were thus also likely to be more attached to their dog. These dog-human bonds with high attachment might reflect a more positive relationship, and consequently the owners might consider the behaviour of the dog more as play. Also a relationship was found between the dog's neuroticism and the owner's interpretation of dog behaviour. Owners of neurotic dogs rated the dog behaviours overall higher on fear aggression and lower on dominance aggression and playfulness. Possibly, owners with more experience with fear aggression are better able to interpret the behaviour of fear aggressive dogs correctly. An alternative explanation could be that these owners simply rate dog behaviour high for fear aggression, and consequently also get high ratings for neuroticism (similar to fear aggression) for their own dog. However, according to the research of Hsu and Serpell (2003), the questionnaire measuring the behavioural traits of dogs (CBARQ) is valid, and high scores for a particular behavioural trait coincide with higher observations of the trait in question when examined by behavioural experts. Although the results are only correlational, not causative, it is likely that owners' interpretation of dog behaviour is related to the types of behavioural problems experienced by the owners. Furthermore, owners of neurotic dogs were more likely to use positive reinforcement as response to the behaviours shown by the dogs. From a theoretical perspective, positive reinforcement is used to reinforce the behaviour shown by the dog. Talking to a dog in positive tone or petting the dog can be seen as rewarding for the dog, which will increase the frequency the dog expresses the behaviour that is rewarded by positive talking or petting. When these responses are used for unwanted behaviours like fear or aggression, positive reinforcement will also stimulate these behaviours and dog might show more fear or aggressive behaviour. However, the correlation found here cannot prove this cause and effect mechanism. Thus, behavioural problems in dogs were found to relate to the owner's interpretation of dog behaviour, and the owner's response to dog behaviour, but the mechanisms behind these relations remain unclear. Studies using behavioural tests are necessary to further investigate causal mechanisms for the relations found here.

The questionnaire rating owner's interpretation and response to dog behaviour was newly developed for this study. Therefore, also the inter-rater reliability was investigated. The ICC values found for single ratings ranged from 0.44 to 0.65 for the interpretation of dog behaviours, and from 0.10 to 0.42 for the owner's response to the behaviours. Apparently, owners tend to disagree more about how to respond to behaviours than about the interpretation of the behaviours. However, also the values found for the interpretation of the behaviour of dogs is lower than found in another study where owners rated their dog's personality (ICCs >0.73, Ley et al., 2009). Earlier studies investigating owner's interpretation of dog behaviour also concluded that owners are not very skilled at interpreting dog behaviour (Kerswell et al., 2009; Mariti et al., 2012; Tami and Gallagher, 2009). However, the results of these studies are not directly comparable to the current study. Where this research has focused on owner's interpretation of dog signals using terms as insecure, playful and excited, the previous researches mainly asked the owners what signals of dogs they use to interpret their behaviour. From previous research, it was found that less than 10% of the owners is able to recognize the subtle stress signs (Kerswell et al., 2009; Mariti et al., 2012). Although the ICC values found here are not directly comparable to this percentage, ICC values of >0.4 have been reported as fair, indicating that the owner's interpretation of dog behaviour in this study was slightly better than previous studies. The main reason for this could be that it is easier for owners to interpret the whole behaviour as being fearful, or excited etc., while it is more difficult to recognize which signs are actually indicating the emotional state of the dog. Thus, owners' agreement is higher for the interpretation of dog behaviour than for the response to dog behaviour. Furthermore, owners seem to perform better in rating the behaviour in terms of emotional states (fearful, aggressive etc.) than in terms of behavioural signals. Overall, the inter-rater reliability of this questionnaire seems acceptable.

Conclusions

The effect of the owner's affective state on the dog's behaviour was tested in several behaviour tests after the owner had been manipulated into a positive or negative affective state and had interacted with the dog. Four tests were carried out to measure the dog's response to the owner's affective state: the lateralization test, the social referencing test, the obedience test and the two choice test. Owners manipulated to a negative emotional state were significantly more anxious than owners manipulated to a positive emotional state, although this was not confirmed by changes in cortisol levels, an established physiological indication of stress. Overall, the behaviour tests found no proof that the owner's affective state influences the dog's behaviour. Variables, such as the dog's anxiety as response to the unfamiliar environment and variation in the dog's response to humans as a consequence of breed and personality, may have obscured the dog's response to the owner's affective state. Stress seemed to be an important factor influencing the dog's behaviour; relations existed between the number of stress signals shown by the dog and the dog's response to different stimuli. Furthermore, a questionnaire was used to investigate the owner's interpretation of, and response to, dog behaviour. The results of this questionnaire were linked to behavioural traits of the dog. A relation was found between the owner's interpretation of dog behaviour and behavioural traits of his / her dog and the owner's experiences with the own dog likely influenced the interpretation of dog behaviour in general. Furthermore, owners of neurotic dogs seemed to opt for positive reinforcement when dealing with dogs. There is reason to belief that positively reinforcing fearful or aggressive behaviours increases the frequency of these behaviours.

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References

Abdel-Khalek, A.M. 1989. The development and validation of an Arabic form of the STAI: Egyptian results. *Personality and Individual Differences* 10 (3): 277 - 285.

Allen, K.M., Blascovich, J., Tomaka, J., Kelsey, R.M. 1991. Presence of human friends and pet dogs as moderators of autonomic responses to stress in women. *Journal of Personality and Social Psychology* 61 (4): 582 -589.

Allen, K., Shykoff, B.E., Izzo Jr., J.L. 2001. Pet ownership, but not ACE inhibitor therapy, blunts home blood pressure responses to mental stress. Hypertension 38 (4): 815 - 820.

Anderson, J.R., Myowa-Yamakoshi, M., Matsuzawa, T. 2004. Contagious yawning in chimpanzees. *Proceedings of the Royal Society B: Biological Sciences* 271 (6): S468 - S470.

Andics, A., Gácsi, M., Faragó, Kis, A., Miklósi, A. 2014. Voice-sensitive regions in the dog and human brain are revealed by comparative fMRI. *Current Biology*: http://dx.doi.org/10.1016/j.cub.2014.01.058

Beerda B., Schilder, M.B.H., van Hooff, J.A.R.A.M., de Vries, H.W. 1997. Manifestations of chronic and acute stress in dogs. *Applied Animal Behaviour Science* 52: 307 - 319.

Beerda, B., Schilder, M.B.H., van Hooff, J.A.R.A.M., de Vries, H.W., Mol, J.A. 1998. Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Applied Animal Behaviour Science* 58: 365 - 381.

Bergamasco, L., Osella, M.C., Savarino, P., Larosa, G., Ozella, L., Manassero, M., Badino, P., Odore, R., Barbero, R., Re, G. 2010. Heart rate variability and saliva cortisol assessment in shelter dog: Human-animal interaction effects. *Applied Animal Behaviour Science* 125: 56 - 68.

Bradshaw, J.W.S, Blackwell, E.J., Casey, R.A. 2009. Dominance in domestic dogs - useful construct or bad habit? *Journal of Veterinary Behaviour* 4: 135 - 144.

Bradshaw, J.W.S., Nott, H.M.R. 1995. Social and communication behaviour. In: *The domestic dog: Its evolution, behaviour and interactions with people*, ed. J. Serpell, pp. 115 - 130. Cambridge University Press, Cambridge.

Call, J., Bräuer, J., Kaminski, J., Tomasello, M. 2003. Domestic dogs (*Canis familiaris*) are sensitive to the attentional state of humans. *Journal of Comparative Psychology* 117 (3): 257 - 263.

Campbell, M.W., Carter, J.D., Proctor, D., Eisenberg, M.L., de Waal, F.B.M. 2009. Computer animations stimulate contagious yawning in chimpanzees. *Proceedings of the Royal Society B: Biological Sciences* 276 (1676): 4255 - 4259.

Cicchetti, D.V. 1994. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment* 6 (4): 284 - 290.

Cornelissen, J.M.R., Hopster, H. 2010. Dog bites in The Netherlands: A study of victims, injuries, circumstances and aggressors to support evaluation of breed specific legislation. *The Veterinary Journal* 186: 292 - 298.

Custance, D., Mayer, J. 2012. Empathic-like responding by domestic dogs (Canis familiaris) to distress in humans: an exploratory study. *Animal Cognition* 15: 851 - 859.

Cutt, H., Giles-Corti, B., Knuiman, M., Burke, V. 2007. Dog ownership, health and physical activity: A critical review of the literature. *Health & Place* 13: 261 - 272.

Dehasse, J. 1997. The role of paradoxical inter-specific communication in the development of family-pack hierarchical instabilities. *Proceedings of the First International Conference on Veterinary Behavioural Medicine, ESVCE & CABTSG*, Birmingham, UK. pp. 52 - 57.

Dreschel, N.A., Granger, D.A. 2005. Physiological and behavioral reactivity to stress in thunderstorm-phobic dogs and their caregivers. *Applied Animal Behaviour Science* 95: 153 - 168.

Duffy, D.L., Hsu, Y., Serpell, J.A. 2008. Breed differences in canine aggression. *Applied Animal Behaviour Science* 114: 441 - 460.

Endenburg, N., 't Hart, H., Bouw, J. 1994. Motives for acquiring companion animals. *Journal of Economic Psychology* 15: 191 - 206.

Fountoulakis, K.N., Papadopoulou, M., Kleanthous, S., Papadopoulou, A., Bizeli, V., Nimatoudis, I., Iacovides, A., Kaprinis, G.S. 2006. Reliability and psychometric properties of the Greek translation of the State-Trait Anxiety Inventory form Y: Preliminary data. *Annals of General Psychiatry* 5: 2.

Gácsi, M., Maros, K., Sernkvist, S., Faragó, T., Miklósi, A. 2013. Human analogue save haven effect of the owner: behavioural and heart rate response to stressful social stimuli in dogs. *PLoS ONE* 8 (3): e58475. doi:10.1371/journal.pone.0058475

Gácsi, M., McGreevy, P., Kara, E., Miklósi, A. 2009. Effects of selection for cooperation and attention in dogs. *Behavioral and Brain Functions* 5: 31 - 38.

Guéguen, N., Ciccotti, S. 2008. Domestic dogs as facilitators in social interaction: An evaluation of helping and courtship behaviours. *Anthrozoös* 21 (4): 339 - 349.

Harr, A.L., Gilbert, V.R., Phillips, K.A. 2009. Do dogs (*Canis familiaris*) show contagious yawning? *Animal Cognition* 12: 833 - 837.

Helton, W.S., Helton, N.D. 2010. Physical size matters in the domestic dog's (*Canis lupus familiaris*) ability to use human pointing cues. *Behavioural Processes* 85: 77 - 79.

Hennessy, M.B., Davis, H.N., Williams, M.T., Mellot, C., Douglas, C.W. 1997. Plasma cortisol levels of dogs at a county animal shelter. *Physiology & Behaviour* 62 (3): 485 - 490.

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

Hiby, E.F., Rooney, N.J., Bradshaw, J.W.S. 2006. Behavioural and physiological responses of dogs entering re-homing kennels. *Physiology & Behavior* 89: 385 - 391.

Hoge School HAS Den Bosch. 2011. Feiten & Cijfers Gezelschapsdierensector 2011. HAS Kennis transfer, 2e druk.

Hsu, Y., Serpell, J.A. 2003. Development and validation of a questionnaire for measuring behavior and temperament traits in pet dogs. *Journal of the American Veterinary Medical Association* 223: 1293 - 1300.

Jakovcevic, A., Mustaca, A., Bentosela, M. 2012. Do more sociable dogs gaze longer to the human face than less sociable ones? *Behavioural Processes* 90: 217 - 222.

Jolliffe, I.T. 1986. Principle Components Analysis. Springer-Verlag, New York, NY.

Joly-Mascheroni, R.M., Senju, A., Shepherd, A.J. 2008. Dogs catch human yawns. *Biology Letters* 4: 446 - 448.

Jones, A.C., Josephs, R.A. 2006. Interspecies hormonal interactions between man and the domestic dog (*Canis familiaris*). *Hormones and Behaviour* 50: 393 - 400.
Kaminski, J., Nitzschner, M. 2013. Do dogs get the point? A review of dog-human communication ability. *Learning and Motivation* (in press): 9 pp.
King, T., Hemsworth, P.H., Coleman, G.J. 2003. Fear of novel and startling stimuli in domestic dogs. *Applied Animal Behaviour Science* 82: 45 - 64.
Kis, A., Turcsán, B., Miklósi, A., Gácsi, M. 2012. The effect of the owner's personality on the behaviour of owner-dog dyads. *Interaction Studies* 13 (3): 373 - 385.
Kotrschal, K., Schöberl, I., Bauer, B., Thibeaut, A., Wedl, M. 2009. Dyadic relationships and operational performance of male and female owners and their male dogs. *Behavioural Processes* 81: 383 - 391.
Krohne, H.W., Pieper, M., Knoll, N., Breimer, N. 2002. The cognitive regulation of emotions: The role of success versus failure experience and coping dispositions. *Cognition & Emotion* 16 (2): 217 - 243.
Lang, P.J., Bradley, M.M., Cuthbert, B.N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. *Technical Report A-8*. University of Florida, Gainesville, FL.
Ley, J., Bennett, P., Coleman, G. 2008. Personality dimensions that emerge in companion canines. *Applied Animal Behaviour Science* 110: 305 - 317.
Lockwood, R. 1995. The ethology and epidemiology of canine aggression. In: *The domestic dog: Its evolution, behaviour and interactions with people*, ed. J. Serpell, pp. 131 - 138. Cambridge University Press, Cambridge.
McGraw, K.O., Wong, S.P. 1996. Forming inferences about some intraclass correlation coefficients. *Psychological Methods* 1 (1): 30 - 46.
Merola, I., Prato-Previde, E., Marshall-Pescini, S. 2012. Social referencing in dog owner dyads? *Animal Cognition* 15: 175 - 185.
Miklosi, A., Kubini, E., Topal, J., Gacsi, M., Viranyi, Z., Csani, V. 2003. A simple reason for a big difference: Wolves do not look back at humans, but dogs do. *Current Biology* 13: 763 - 766.
Nagasawa, M., Kawai, E., Mogi, K., Kikusui, T. 2013. Dogs show left facial lateralization upon reunion with their owners. *Behavioural Processes* 98: 112 - 116.
O'Farrell, V. 1997. Owner attitudes and dog behaviour problems. *Applied Animal Behaviour Science* 52: 205 - 213.
O'Hara, S.J., Reeve, A.V. 2011. A test of the yawning contagion and emotional connectedness hypothesis in dogs, *Canis familiaris*. *Animal Behaviour* 81: 335 - 340.
Passalacqua, C., Marshall-Pescini, S., Barnard, S., Lakatos, G., Valsecchi, P., Prato Previde, E. 2011. Human-directed gazing behaviour in puppies and adult dogs, *Canis lupus familiaris*. *Animal Behaviour* 82: 1043 - 1050.
Paukner, A., Anderson, J.R. 2006. Video-induced yawning in stumptail macaques (*Macaca arctoides*). *Biology Letters* 2: 36 - 38.
Platek, S.M., Critton, S.R., Myers, T.E., Gallup Jr., G.G. 2003. Contagious yawning: the role of self-awareness and mental state attribution. *Cognitive Brain Research* 17: 223 - 227.
Podberscek, A.L., Serpell, J.A. 1997. Aggressive behaviour in English cocker spaniels and the personality of their owners. *Veterinary Record* 141: 73 - 76.
Pongrácz, P., Miklósi, A., Kubinyi, E., Gurobi, K., Topál, J., Csányi, V. 2001. Social learning in dogs: the effect of a human demonstrator on the performance of dogs in a detour task. *Animal Behaviour* 62: 1109 - 1117.
Pongrácz, P., Miklósi, A., Timár-Geng, K., Csanyi, V. 2003. Preference for copying unambiguous demonstrations in dogs (*Canis familiaris*). *Journal of Comparative Psychology* 117 (3): 337 - 343.
Prato-Previde, E., Marshal-Pescini, S., Valsecchi, P. 2008. Is your choice my choice? The owners' effect on pet dogs' (*Canis lupus familiaris*) performance in a food choice task. *Animal cognition* 11: 167 - 174.
Quaranta, A., Siniscalchi, M., Vallortigara, G. 2007. Asymmetric tail-wagging responses by dogs to different emotive stimuli. *Current Biology* 17 (6): R199 - R201.

Racca, A., Guo, K., Meints, K., Mills, D.S. 2012. Reading faces: Differential lateral gaze bias in processing canine and human facial expressions in dogs and 4-year-old children. *PLoS ONE* 7 (4): e36076. doi:10.1371/journal.pone.0036076

Rehn, T., Keeling, L.J. 2011. The effect of time left alone at home on dog welfare. *Applied Animal Behaviour Science* 129: 129 - 135.

Richardson, R., Siegel, M.A., Campbell, B.A. 1988. Unfamiliar environments impair information processing as measured by behavioural and cardiac orienting responses to auditory stimuli in preweanling and adult rats. *Developmental Psychobiology* 21 (5): 491 - 503.

Romero, T., Konno, A., Hasegawa, T. 2013. Familiarity bias and physiological responses in contagious yawning by dogs support link to empathy. *PLoS ONE* 8 (8): e71365. doi:10.1371/journal.pone.0071365

Rooney, N.J., Gaines, S.A., Bradshaw, J.W.S. 2007. Behavioural and glucocorticoid responses of dogs (*Canis familiaris*) to kennelling: Investigating mitigation of stress by prior habituation. *Physiology and Behavior* 92: 847 - 854.

Salman, M.D., New, J.G. Jr. , Scarlett, J.M., Kass, P.H., Ruch-Gallie, R., Hetts, S. 1998. Human and animal factors related to relinquishment of dogs and cats in 12 selected animal shelters in the United States. *Journal of Applied Welfare Science* 1 (3): 207 - 226.

Scheider, L., Grassmann, S., Kaminski, J., Tomasello, M. 2011. Domestic dogs use contexual information and tone of voice when folling a human pointing gesture. *PLos ONE* 6 (7): e21676. doi:10.1371/journal.pone.0021676

Scherer, K.R. 2001. Appraisal considered as a process of multilevel sequential checking. In: Scherer, K.R., Schorr, A. and Johnstone, T. (eds) *Appraisal Processes in Emotion: Theory, Methods, Research* pp 92-120. Oxford University Press: Oxford, UK

Senju, A., Maeda, M., Kikuchi, Y., Hasegawa, T., Tojo, Y., Osanai, H. 2007. Absence of contagious yawning in children with autism spectrum disorder. *Biology letters* 3: 706 - 708.

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

Silva, K., Bessa, J., de Sousa, L. 2012. Auditory contagious yawning in domestic dogs (*Canis familiaris*): first evidence for social modulation. *Animal Cognition* 15: 721 - 724.

Silva, K., Bessa, J., de Sousa, L. 2013. Familiarity-connected or stress-based contagious yawning in domestic dogs (*Canis familiaris*)? Some additional data. *Animal Cognition* 16: 1007 - 1009.

Siniscalchi, M., Sasso, R., Pepe, A.M., Vallortigara, G., Quaranta, A. 2010. Dogs turn left to emotional stimuli. *Behavioural Brain Research* 208: 516 - 521.

Siwak, C.T., Tapp, P.D., Milgram, N.W. 2001. Effect of age and level of cognitive function on spontaneous and exploratory behaviors in the Beagle dog. *Learning & memory* 8: 317 - 325.

Spielberger, C.D., Gorsuch, R.L., Lushene, R., Vagg, P.R., Jacobs, G.A. 1977. *State-Trait Anxiety Inventory for Adults*. Redwood City, California, Mindgarden.

Styliadis, C., Ioannides, A.A., Bamidis, P.D., Papadelis, C. 2013. Amygdala responses to valence and its interaction by arousal revealed by MEG. *International Journal of Psychophysiology* (in press): http://dx.doi.org/10.1016/j.ijpsycho.2013.05.006

Svatberg, K. 2002. Shyness-boldness predicts performance in working dogs. *Applied Animal Behaviour Science* 79: 157 - 174.

Szetei, V., Miklósi, Á., Topál, J., Csányi, V. 2003. When dogs seem to lose their nose: an investigation on the use of visual and olfactory cues in communicative context between dog and owner. *Applied Animal Behaviour Science* 83: 141 - 152.

Tami, G., Gallagher, A. 2009. Description of the behaviour of domestic dog (*Canis familiaris*) by experienced and inexperienced people. *Applied Animal Behaviour Science* 120: 159 - 169.

Tok, S., Koyuncu, M., Dural, S., Catikkas, F. 2010. Evaluation of International Affective Picture System (IAPS) ratings in an athlete population and its relations to personality. *Personality and Individual differences* 49: 461 - 466.

Van der Borg, J.A.M., Beerda, B., Ooms, M., de Souza, A.S., van Hagen, M., Kemp, B. 2010. Evaluation of behaviour testing for human directed aggression in dogs. *Applied Animal Behaviour Science* 128: 78 - 90.

Van der Ploeg, H.M. 1982. De Zelf-Beoordelings Vraagenlijst (STAI-DY): De ontwikkeling en validatie van een Nederlandstalige vragenlijst voor het meten van angst. *Tijdschrift voor psychiatrie* 24: 576 - 588.

Van Reenen, C.G., Engel, B., Ruis-Heutinck, L.F.M., van der Werf, J.T.N., Buist, W.G., Jones, R.B., Blokhuis, H.J. 2004. Behavioural reactivity of heifer calves in potentially alarming test situations: A multivariate and correlational analysis. *Applied Animal Behaviour Science* 85:11–30.

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

Vial, G.C., Stabenfeldt, G.H., Franti, C.E., Ling, G.V. 1979. Influence of environment on adrenal cortical response to ACTH stimulation in clinically normal dogs. *American Journal of Veterinary Research* 40 (7): 919 - 921.

Wang, J., Rao, H., Wetmore, G.S., Furlan, P.M., Korczykowski, M., Dinges, D.F., Detre, J.A. 2005. Perfusion functional MRI reveals cerebral blood flow pattern under psychological stress. *Proceedings of the National Acadamy of Sciences of the United States of America* 102 (49): 17804 - 17809.

Wells, D.L. 2004. The facilitation of social interactions by domestic dogs. *Anthrozoös* 17 (4): 340 - 352.

Appendix 1

STAI questionnaire translated to Dutch. The complete questionnaire was given to the owners at arrival, only the first page was given after each behavioural test.

Een aantal uitspraken die mensen hebben gebruikt om zichzelf te beschrijven is hieronder gegeven. Lees elke uitspraak en zet per uitspraak een streepje op de lijn om aan te geven hoe je je ***nu*** voelt, ***op dit moment***. Er zijn geen goede of foute antwoorden. Besteed niet teveel tijd aan een beschrijving maar zet een streepje dat het best beschrijft hoe je je op dit moment voelt.

	Helemaal niet	Helemaal wel
1. Ik voel me kalm	I----------	----------I
2. Ik voel me zeker	I----------	----------I
3. Ik ben gespannen	I----------	----------I
4. Ik voel me opgejaagd	I----------	----------I
5. Ik voel me op mijn gemak	I----------	----------I
6. Ik voel me van streek	I----------	----------I
7. Ik maak me momenteel zorgen over mogelijke tegenslagen	I----------	----------I
8. Ik voel me voldaan	I----------	----------I
9. Ik voel me angstig	I----------	----------I
10. Ik voel me comfortabel	I----------	----------I
11. Ik voel me vol zelfvertrouwen	I----------	----------I
12. Ik voel me nerveus	I----------	----------I
13. Ik ben zenuwachtig	I----------	----------I
14. Ik voel me besluiteloos	I----------	----------I
15. Ik ben ontspannen	I----------	----------I
16. Ik voel me tevreden	I----------	----------I
17. Ik maak me zorgen	I----------	----------I
18. Ik voel me verward	I----------	----------I
19. Ik voel me stabiel	I----------	----------I
20. Ik voel me prettig	I----------	----------I

Een aantal uitspraken die mensen hebben gebruikt om zichzelf te beschrijven is hieronder gegeven. Lees elke uitspraak en zet per uitspraak een streepje op de lijn om aan te geven hoe je je ***over het algemeen*** voelt. Er zijn geen goede of foute antwoorden. Besteed niet teveel tijd aan een uitspraak maar zet een streepje dat het best beschrijft hoe je je over het algemeen voelt.

	(bijna) Nooit	(bijna) Altijd
21. Ik voel me prettig	I----------	----------I
22. Ik voel me nerveus en rusteloos	I----------	----------I
23. Ik voel me tevreden met mezelf	I----------	----------I
24. Ik zou graag zo gelukkig willen zijn als anderen lijken	I----------	----------I
25. Ik voel me een mislukking	I----------	----------I
26. Ik voel me uitgerust	I----------	----------I
27. Ik ben kalm en evenwichtig	I----------	----------I
28. Ik heb het gevoel dat moeilijkheden zich zo opstapelen dat ik ze niet kan overwinnen	I----------	----------I
29. Ik maak me teveel zorgen over dingen die er niet echt toe doen	I----------	----------I
30. Ik ben gelukkig	I----------	----------I
31. Ik heb verontrustende gedachten	I----------	----------I
32. Ik heb een gebrek aan zelfvertrouwen	I----------	----------I
33. Ik voel me zeker	I----------	----------I
34. Ik maak beslissingen makkelijk	I----------	----------I
35. Ik voel me niet goed genoeg	I----------	----------I
36. Ik ben tevreden	I----------	----------I
37. Een onbelangrijke gedachte speelt in mijn hoofd en stoort me	I----------	----------I
38. Ik neem teleurstellingen zo serieus dat ik ze niet uit mijn hoofd kan zetten	I----------	----------I
39. Ik ben een stabiel persoon	I----------	----------I
40. Ik raak gespannen en wordt onrustig als ik nadenk over mijn recente zaken en belangen	I----------	----------I

Appendix 2

First page of the questionnaire 'interpreting dog signals' (in Dutch). After each movie fragment, these questions were asked.

Let goed op het gedrag van de hond in het volgende filmpje.
Beantwoord na het bekijken van het filmpje de onderstaande vragen.

* In hoeverre is deze hond...

	Helemaal niet	Nauwelijks	Gemiddeld	Behoorlijk	Helemaal wel	Weet niet
Onzeker	O	O	O	O	O	O
Gespannen	O	O	O	O	O	O
Gestresst	O	O	O	O	O	O
Bang	O	O	O	O	O	O
Opgewonden	O	O	O	O	O	O
Speels	O	O	O	O	O	O
Dominant	O	O	O	O	O	O
Agressief	O	O	O	O	O	O

* Als mijn hond zich zo zou gedragen, zou ik...

	Zeker niet	Waarschijnlijk niet	Misschien	Waarschijnlijk wel	Zeker wel	Weet niet
Mijn hond op dezelfde manier behandelen als anders	O	O	O	O	O	O
Mijn hond kalmeren met geruststellende woorden	O	O	O	O	O	O
Mijn hond aaien	O	O	O	O	O	O
Dit gedrag corrigeren	O	O	O	O	O	O
Dit gedrag aanmoedigen	O	O	O	O	O	O
Mijn hond afleiden van waar hij mee bezig is	O	O	O	O	O	O
Mijn hond negeren	O	O	O	O	O	O
Mijn hond van de situatie weghalen	O	O	O	O	O	O
De aanleiding van het gedrag weghalen	O	O	O	O	O	O

anders, namelijk....
[_____]
[_____]

Appendix 3

List of movie fragments used in the questionnaire investigating owner's interpretation of, and response to, dog behaviour. A small description is given for each movie to indicate which behaviour is shown by the dog, and which dog was rated by the owners when more than 1 dog were visible in the movie fragment.

1.	https://www.youtube.com/watch?v=VuOOKh72wfI	Excitement
2.	https://www.youtube.com/watch?v=CJ3oz4cU6Ks	Fearful stafford
3.	https://www.youtube.com/watch?v=8WiJ3uGcn4w	Stress release
4.	https://www.youtube.com/watch?v=Wt7yPiZ1e0k	Labrador; calming signals
5.	https://www.youtube.com/watch?v=9N9JaexYX5Q	Barking
6.	https://www.youtube.com/watch?v=gmjgUWiNmnM	Tail chase
7.	https://www.youtube.com/watch?v=G5P9A9tr4QA	Dachshund; submissive behaviour
8.	https://www.youtube.com/watch?v=z7OCAaM3q9g	Stereotyped pacing
9.	https://www.youtube.com/watch?v=ivfsh-JW_g8	Calm approach
10.	https://www.youtube.com/watch?v=5SXoxmlojmk	Aggression
11.	https://www.youtube.com/watch?v=GM2vnNEue3o	Black dog; play bow
12.	https://www.youtube.com/watch?v=7QQin6m7w-4	Aggression
13.	https://www.youtube.com/watch?v=IDutPr7Sz54	Beagle; alert, insecure
14.	https://www.youtube.com/watch?v=dUUN0lvRArY	Shadow chase
15.	https://www.youtube.com/watch?v=U3dkVDId-Rc	Golden retriever; calming signals
16.	https://www.youtube.com/watch?v=iUUGq5RZlUs	White-brown dog; alert
17.	https://www.youtube.com/watch?v=J3jtlPqfRHo	Aggression
18.	https://www.youtube.com/watch?v=D0EAf4I6PcY	Terrier; mounting behaviour

Appendix 4

Ethogram used during the behaviour tests. Behaviour was observed using this ethogram during all test phases except the two choice test, where relevant observations were recorded manually. All observed behaviours are divided in several categories and for each behaviour it is indicated during which test phases it was measured. Events are behaviours that are only recorded as frequencies, states are behaviours from which the frequency as well as the duration is recorded.

Behaviour	Test phases	Description	Type
Stress signals			
Paw lift	All	Lift one paw up in the air	Event
Panting	All	Increased breathing frequency, mouth open	Event
Urogenital check	All	Check urogenital area with nose	Event
Whine	All	High pitched vocalization	Event
Bark	All	Bark	Event
Jump	All	Front paws in the air, standing on hind paws	Event
Tongue flick	All	Lick mouth or nose	Event
Yawn	All	Yawn	Event
Stretch	All	Stretch body and limbs	Event
Scratch	All	Scratch body with paw	Event
Shake	All	Shake body	Event
Freeze	All	Stand frozen, eyes focused on an object	Event
Attention			
To owner	Yawning	Look at owner	State
Look away	Yawning	Look away from owner	State
Activity			
Stand	Yawning, manipulations	Standing on four legs	State
Sit	Yawning, manipulations	Sit with hind part touching the ground	State
Lie	Yawning, manipulations	Lie with body touching the ground	State
Walk	Yawning, manipulations	Move around	State
Other			
Treat eaten	Obedience	Take treat from box and eat it	Event
Left	Interactions, social referencing	Cross the fence on the left side	Event
Right	Interactions, social referencing	Cross the fence on the right side	Event
Line 2	Social referencing	Cross line 2 with 1 paw	Event
Behaviours owner			
Good yawn	Yawning	Long, convincing yawn with mouth wide open	Event
Bad yawn	Yawning	Short, weak yawn with mouth little open or mouth covered with hand	Event
Mouth movement	Yawning	Mouth opening	Event
Command come	Interactions, social referencing	Owner asks dog to come	Event
Command lie	Interactions	Owner tells dog to lie down	Event
Command sit	Interactions	Owner tells dog to sit	Event
Command no	Obedience	Owner tells dog not to eat treat	Event
Positive verbal	Interactions, obedience	Owner speaks to dog with positive tone	Event
Negative verbal	Interactions, obedience	Owner speaks to dog with correcting tone	Event
Positive physical	Interactions, obedience	Owner pets dog in a positive way	Event
Negative physical	Interactions, obedience	Owner touches dog in correcting way	Event
Leave room	Obedience	Owner moves towards door to leave room	Event