


Cognitive bias test in dogs *(Canis familiaris)*

Is the bowl half full or half empty?

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Abstract

In the Netherlands, the number of dogs that enter shelters is about twenty thousand dogs a year of which 20-50% is rehomed. However, 15-20% of the adoptions is unsuccessful and the dogs are returned to the shelters. The primary reasons for relinquishment are dogs having problems in getting along with others, both with humans and other animals, and in general behavioural problems. The reason for owners and dogs not getting along will in part be due to how owners "parent" their dogs. In humans, combinations of variation in in dimensions of demandingness and responsiveness result in certain parenting styles that influence children's behaviour and development. This might also hold true for the relationship between owners and dogs and parenting styles may impact on the dog's quality of life, which was studied here. Most indicators of welfare in dogs seem indicative of arousal (intensity) rather than valence (pleasantness), but a useful measuring method may be the cognitive bias paradigm. Cognitive bias is about the influence of the affective state on how an animal processes information and the most used cognitive bias task is the judgement task which is the tendency of the animal to either view an ambiguous stimuli positively (optimistic) or negatively (pessimistic). The aim of the present study was to improve an existing judgement bias protocol by testing different cues and consequences, and investigate if measures of a dog's cognitive bias associate with its owner's parenting style. Three different groups of dogs were tested for optimism by means of a cognitive bias test (CBT), namely shelter dogs (n=12), assumingly representing a negative affective state, privately owned dogs (n=24) with an assumed positive affective state and trainee assistance dogs (n=14), which were assumed to have an intermediate affective state. Owners of the privately owned dogs filled out a questionnaire on parenting styles. Dogs were pseudo-randomly assigned to two different types of cognitive bias protocols out of six different protocols used. Cue discrimination was based on location of the bowl or size of it, and the consequences of (no) cue approach. Cognitive bias tests in which dogs discriminated between the positive cue and the negative were used for further analyses, which were 46 out of 100 tests. Cognitive bias tests based on location discrimination, rather than size discrimination, worked best and 32 out of 46 tests were understood as evident from cue discrimination (3-way interaction effect of cue, trial number and type of test Linear Mixed Model P=0.002). Latencies to contact the cues differed significantly between the three dog groups (P=0.022), but there was no significant group difference between cognitive bias (optimism) scores calculated with the behavioural test outcomes. Also, optimism scores did not correspond with owner reports (n=19. A relation was found between parenting style score and cognitive bias score, at least for the authoritarian style (n=19, ANOVA P=0.032) and the permissive style (P<0.1). Surprisingly, in both cases the higher parenting scores were associated with higher levels of optimism in the dogs, possibly indicating that an outspoken parenting style, regardless of which type, works better for dogs than ambiguity in the way of parenting. The main aim of this study was to test which combination of cues and consequences work best to determine cognitive bias in dogs. A major finding was that cue discrimination based on location was more effective in our dogs than discrimination based on size of the bowls. In the privately owned dogs, parenting styles of their owners were associated with cognitive biases, and assumed levels optimism, which illustrates one way of how owners influence the well-being of their dogs. The present findings suggest that you need to act in an outspoken way rather than an ambiguous way to promote optimism and well-being in dogs independent of which parenting style you have. Even though in humans each parenting style seems to have a more defined effect on the cognitive bias in children. In adolescents it is demonstrated that when an adolescent perceives their parent as being authoritative or permissive they are more optimistic than when they perceive their parent as being authoritarian or neglectful. Further research into parenting styles and the dog owner relationship might be of great importance in practice, for example to match prospective owners to shelter dogs so that the adoption procedure can be improved.

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Introduction

In the Netherlands, the number of dogs that enter shelters is about twenty thousand dogs a year of which 20-50% is rehomed (Rijksoverheid, 2015). However, 15-20% of the adoptions is unsuccessful and the dogs are returned to the shelters. The primary reasons for relinquishment based on two separate year-long surveys (n=698; n= 4500) are problems in getting along with others, both with humans and other animals, and behavioural problems (Diesel *et al.*, 2008; Neidhart and Boyd, 2002). The reason of not getting along with humans, might be because of a mismatch between owner and dog. In scientific literature on humans there is the concept of parenting styles, which emerged from the observation that childrearing practices are associated with competences in the child (e.g. Smetana, 1995). Parenting styles were studied by Baumrind (1967, 1971a, 1971b, 1989, 1991) and Maccoby and Martin (1983), for example, and Baumrind related child behaviour dimensions such as self-control, approach-avoidance tendency, subjective mood and peer affiliation to parent behaviour dimensions. These parenting dimensions were parental control, parental maturity demands, parent-child communication and parental nurturance. After making distinct dimensions Baumrind combined child dimensions and parent dimensions into patterns, which are known today as the three parenting styles of Baumrind. These parenting styles are labelled as authoritative, authoritarian, and permissive, and extended by a fourth by Maccoby and Martin. They investigated whether Baumrind's model could also be used for populations different from those that Baumrind used in her study. Maccoby and Martin created a model which, in theory, measured important facets of parenting, regardless of the population and make it generalizable (Darling, 1993). They proposed a distinction of the two dimensions parental demandingness and parental responsiveness. The parental demandingness refers to which extent the parents show control and supervision, where parental responsiveness refers to the extent in which parents show involvement and acceptance. Authoritative parents score relatively high for both parental demandingness as well as parental responsiveness. Parents like this are in control, but they do not put excessive restrictions on their child. Authoritarian parents have a weaker attachment relationship with their child than authoritative parents. There is generally a low level of trust and commitment with the child. Permissive parents are essentially very accepting and child-centred and are often characterized by a lack of parental control (Aunola *et al*., 2000). Extreme combinations of each parenting style dimension results in certain parenting styles that seem to have the biggest influence on children's behaviour and development (Baumrind, 1971). To identify parenting styles, a questionnaire was developed consisting of 133 questions (Robinson *et al.,* 1995). This questionnaire was used in practice (n=1251) and validated through multiple analyses, which resulted in a questionnaire with 62 questions. The human-dog relationship has similarities with the child-parent relationship, for example in terms of attachment behaviour in case of mother-infant interactions (Topál *et a*l., 1998; Palmer and Custance 2008; Prato-Previde *et al.,* 2003) and we assume that parenting styles are also present in the owner to dog relationship (this is currently under investigation by Koning, 2016). It is unknown how such parenting styles affect the behaviour and well-being of dogs and research into this requires tools that validly assess a dog's welfare status. Signs of poor welfare are expected to show in kennelled dogs, which experience relatively austere living conditions. At eight rescue centres staff recorded about hundred-fifty dogs daily to see if the dogs showed behavioural indicators of poor welfare such as repetitive pacing, wall bouncing and excessive vocalisation. Excessive barking was the most observed behaviour and after six weeks of observation dogs showed more repetitive pacing and wall bouncing (Stephen and Ledger, 2005). The relatively austere living conditions in shelters, with minimal living space, social contact, exercise and stimulation, are conducive to negative affective states in dogs. A comparison was made between short stay and long stay kennel dogs (n=56) which resulted in the suggestion that the welfare of these dogs is dependent on individual kennel experience rather than the time spend in the kennel (Titualer *et al.,* 2013). Compromised welfare may be due to poor health, but is especially associated with prolonged or frequent negative affective states (Mendl and Paul, 2004; Broom, 2007; Wurbel, 2009).

Animal welfare, including that of dogs, has become more important to society over the years. There are different views on what welfare is about mainly and Fraser (2009) discriminates three main domains, affective state, biological function and natural living. Affective states can be described as subjective emotional states (Boissy *et al.,* 2014) which animals experience and this implies that animals can suffer or experience pleasure, which was acknowledged by EU law in 1997 recognizing animals as sentient beings (European Union, 1997). Emotions are affective states that may be defined along dimensions of arousal (calm - aroused) and valence (pleasantness – unpleasantness, Lang and Davis, 2006), and the welfare of an animal is determined strongly by affective valence (Spruijt *et al*., 2001; Boissy *et al.,* 2007; Mendl *et al*., 2010a).

Unfortunately, most indicators of stress and welfare seem indicative of arousal rather than valence and it seems difficult to measure valence (pleasantness) instead of arousal (intensity). One of the measuring tools that may assess valence is the cognitive bias paradigm. Cognitive bias is the influence of affective states on how an animal processes information (Burman, 2014). The paradigm is based on results from human studies, as discussed later, showing that the affective state impacts on judgement, memory and attention. For instance, people in negative affective states pay more attention to threatening stimuli (attention bias), remember negative situations better (memory bias) and these people judge ambiguous stimuli more negatively (judgement bias) compared to people in a positive affective state. Subjects of these studies were diagnosed with an anxiety disorder or have an experimentally induced emotion (Paul *et al.,* 2005). These cognitive biases are often referred to as a pessimistic bias or an optimistic bias, though optimism and pessimism are perceived differently across studies. Some authors argue that these two are opposites of the same dimension (Beck *et al*., 1974; Scheier and Carver, 1985), but a study by Marshall *et al.* (1992) challenged this. Different measures were used to assess the dimensions of optimism and pessimism. Firstly, optimism and pessimism were assessed with the use of the Life Orientation Test (LOT) (Scheier and Carver, 1985) and the Hopelessness Scale (HS) (Beck *et al*., 1974). Secondly, the experimenters assessed neuroticism and extraversion with the help of a tool called the NEO Personality Inventory (Costa and McCrae, 1989a, 1989b), which was reduced into a version called the NEO Five-Factor Inventory. Lastly Marshall *et al.* (1992) assessed positive and negative affect with the Positive and Negative Affect Schedule (Watson *et al.*, 1988). Each of these “tests” had answers on a five-point scale, ranging from “I strongly disagree” to “I strongly agree”. The main result of this study was that factor analysis of both the LOT and HS showed that optimism and pessimism are different, but related structures. Optimism and pessimism were indirectly connected by fundamental dimensions of mood and personality. On the one hand pessimism was associated with neuroticism and negative affect and on the other hand optimism was associated with extraversion and positive affect. In accordance with the findings of Marshall *et al.* (1992), Wright and Bower (1992) found that happy people (positive valence and a slightly elevated arousal) are optimistic, which made these people report higher probabilities for positive events and lower probabilities for negative events. Sad people (negative valence and a slightly elevated arousal) are pessimistic, which makes them report a lower probability for positive events and a higher probability for negative events. In hundred-six persons, pessimism was found to be negatively correlated with happiness and optimism was positively correlated with happiness (Dember and Brooks, 1989). A more recent study by Kam and Meyer (2012) replicated the test of Marshall *et al.* (1992) with the addition of the other personalities of the five factor model: openness to experience, agreeableness, and conscientiousness. Findings showed that the results of Marshall *et al* (1992) were due to the fact that there was an unbalanced set of valenced items (the test sentences). Sentences stating optimism were usually favourable and for pessimism unfavourable (e.g. “I am always optimistic about my future” for optimism, or “If something can go wrong for me, it will” for pessimism) and the same was true for the personalities. Extraversion and neuroticism were measured by standard items, like “I am outgoing” for extraversion, which resulted in a strong positive valence for extraversion and ultimately resulted in a stronger correlation between optimism and extraversion since both share similar positive valence. This outcome was also seen in neuroticism and pessimism, which correlate strongly because both share the same negative valence. Hence, the previous studies results could have been due to the item valence effect. In the more recent study they annulled this effect by using a balanced set of oppositely-valenced items. Optimism correlated stronger with personality variables when they were linked with positive valence, while pessimism was correlated more with personality variables when these were negatively valenced. When extraversion and neuroticism were balanced with oppositely valenced items, optimism and pessimism did not show as many differential correlations with neuroticism and extraversion indicating that there was a reduced pattern of relationship between them. Altogether even though the recent study did not find the same pattern of relationship, they did still find a relationship demonstrating that it might be that optimism and pessimism are related structures.

In humans, affective states influence judgement about the future and the interpretation of ambiguous stimuli. Humans in a negative state are more likely to make pessimistic judgements and humans in positive states show more optimistic judgements (Eysenck *et al*., 1991; Wright and Bower, 1992; MacLeod and Byrne, 1996; Nygren *et al*., 1996; Mogg and Bradley, 1998; Paul *et al*., 2005). In research on this, test subjects were often classified in two overall groups namely those with an affective disorder (for example anxiety or depression) and a control group. Affective states of participants were assessed by having them fill in a survey or by clinically diagnoses (Eysenck *et al*., 1991; MacLeod and Byrne, 1996). Eysenck *et al.* (1991) had humans (n=48) rate an imaginary situation, which was described by the experimenter. Descriptions like "the doctor examined little Emma's growth" is more likely to be interpreted positively by individuals with low trait anxiety, and negatively by high trait-anxious individuals (Eysenck *et al*., 1991), in that the positive interpretation could be growth as in length and the negative interpretation could be growth of a tumour. Anxious subjects (n=75) also anticipated more negative future events which was measured by surveys determining an anxiety levels and a test which entailed that participants were asked to "imagine" as many possible positive and negative personal future events in a minute. As a control task they asked the participants to say as many words as they could as to have a baseline of verbal fluency (MacLeod and Byrne, 1996). A completely different approach as in the aforementioned studies was the induction of a negative or positive affective state. Inducing happy or sad moods resulted in happy subjects being optimistic, reporting higher probabilities for positive events and lower probabilities for negative events, while sad people were pessimistic, reporting higher probabilities for negative events and lower probabilities for positive events, like when participants (n=51) evaluated twenty-four future events (situations) and reported their probability (Wright and Bower, 1992). Furthermore, positive affective state subjects showed cautious optimism (Nygren *et al.,* 1996). They overestimated the prospects associated with phrases of winning compared to those of losing (optimism) and tended to bet less compared to controls (caution). In this study, participants (n=109) were asked to estimate the probability of losing or winning during a gambling bet (likely, unlikely, extreme unlikely et cetera). The positive affective state was induced by presenting one group of participants with a bag of candy (Nygren *et al.,* 1996). The aforementioned findings support that at least in humans affect causes cognitive biases and changes our perception of future events. Determining affective state and cognitive bias in animals is more difficult than in humans, but several studies with animals have produced promising results. Harding *et al.* (2004) used rats (n=9) from a predictable environment and an unpredictable environment (induced symptoms of depression). Once the rats were taught how to operate the lever, they learned to differentiate between the positive and negative cues (tone A or B). Consequently rats that were well trained would press the lever at the positive cue for the positive event and would refrain from pressing the lever at the negative cue, as to avoid the negative event. After training the rats were given ambiguous probe tones which were tones in between A and B. Rats with an assumed negative affective state, meaning they were kept in unpredictable environment, showed a higher latency to press the lever and pressed the lever less in response to the ambiguous tones in comparison with the rats from the predictable environment with a positive affective state. This demonstrates that rats with an induced negative affective state showed a more pessimistic-like response towards ambiguous cues. Most cognitive bias studies with animals involve judgement bias, which is the tendency of the animal to either view an ambiguous stimuli positively (optimistic) or negatively (pessimistic).The judgement bias test is carried out with a minimal of three stimuli, one signalling a positive event (reward) one signalling a negative or neutral event and one ambiguous cue. The animal then have to decide on the stimulus-response-outcome probabilities concerning the ambiguous stimuli, in the sense that it is similar to the positive cue and a response should be performed to experience the positive event or the negative cue and a response should be performed to prevent experiencing the negative event, but with the risk of being wrong and missing the positive event (Mendl *et al*., 2009). Dogs with separation- related behaviour exhibited relatively pessimistic judgement of ambiguous cues than the control group (Mendl *et al.,* 2010b). Dogs (n=25) were trained to differentiate between a positive and negative location, with a minimum of fifteen training trials. The 'positive' bowl contained a food reward while the 'negative' bowl had no reward. All bowl locations were at 4m distance from the dog and the dogs got a maximum of 30s to reach the bowl during each trial. The training trials stopped when, for the foregoing three positive trials and the foregoing three negative trials, the longest latency to approach the positive location was shorter than any of the latencies to reach the negative location. Three test trials were executed at each location separated by four training trials and dogs were leashed while performing the experiment. Further research looked at dogs with separation-related problems treated with Reconcile® (n=12), an antidepressant (Karagiannis *et al.,* 2015). Before treatment the dogs showed a more pessimistic bias compared to control dogs (n=12).

After treatment the dogs showed responses alike the responses of the placebo treated control dogs. The learning phase and placement of bowls was consistent with that of Mendl *et al.* (2010b) (Karagiannis *et al.,* 2015).

A study with beagles (n=12) used visual cues based on a grey scale (Burman *et al.,* 2011). A habituation period of five days was used and dogs could explore the rooms and were familiarised with the researchers. Half of the beagles had a rewarding event, searching for food in a maze arena, and the other half did not. After the event (or not), the beagles were tested for cognitive bias. The training of a dogs was completed when it ran faster to the rewarded than to the unrewarded goal box (each goal box had its own grey shade) for six consecutive trials (half rewarded, half unrewarded), with a minimal of a second difference between the slowest run towards the rewarded box and fastest run towards the unrewarded box. All dogs were tested in the same room and the boxes were always at 6m distance from the subjects. It was predicted that dogs receiving the rewarding event would have a more optimistic bias, but actually they took longer to approach the ambiguous cue, suggesting a negative bias. The experimenters mentioned that this effect could be due to the motivation of the dogs and their satiety levels or with the ending of the rewarding event, leading unintentionally to a negative affective state (Burman *et al.,* 2011).

Owner absence or presence seems to have no effect on the bias of dogs, for example as found in a study with twenty-four pet dogs of mixed breeds (Müller *et al.,* 2012). The same test room was used for all dogs, with the bowls at a distance of 3m and a distance between bowls of 60 cm. The training consisted of ten trials in total, five positive and five negative. Training trials ended when the longest latency to approach the positive location was shorter than the shortest latency to approach the negative location for the last ten trials or when the maximum trials (120) were achieved. Training of dogs that did not achieve the criterion within 60 trials was continued on a separate day. The test itself was composed of two blocks of 26 trials (six probe trials, two per probe location, scattered within 20 standard trials). In between blocks there was a break of 15 minutes. Tests were done with the owners present for half of the read-out tests whilst not present for the other half. Dogs were thus held loosely by the collar by the owner or by the experimenter and the handler released the dog by letting go and giving the “go” command. The results revealed no effect of owner presence on cognitive bias, possibly because these dogs were used to be separated from their owners. Having been exposed to E-collars for training purposes did not have an effect on the dogs’ cognitive biases (University of Lincoln *et al.,* 2013). Dogs (n=34; n=57) with E-collar experience (n=34) or without E-collar experience (n=57) showed no differences in running speed towards the ambiguous probes, in a study in which tests were performed as in Mendl *et al. (*2010b), though the arena sizes differed across dogs as some tests were performed at home and some at the research facility. Staying time in a shelter also did not express in the dogs’ (n=56) cognitive bias (Titualer *et al.,* 2013), with the dogs being tested again following the test protocol of Mendl *et al.* (2010b). Treatment with oxytocin did make for a more positively biased dog (n= 64) (Kis *et al.,* 2015). Dogs were divided into four groups, i.e. combinations of treatment with oxytocin or placebo and (non)communicative context, and tested in accordance with the set-up described by Mendl *et al.* (2010b). Oxytocin is associated with positive affect and in dogs stroking, eating and exercising all resulted in higher concentrations of oxytocin in urine (Mitsui *et al.,* 2011).

The judgement bias test has been used in earlier studies with dogs, but questions remain concerning its validity and reliability. The reliability of the cognitive bias test can be increased by using the same observers and a consistent protocol. For example, one study found that the size of the testing arena had an effect on the bias of the animals (University of Lincoln *et al.,* 2013; University of Lincoln, 2013). Most of the dog studies were based on the method by Mendl *et al.* (2010b), but some details are obscure and Mendl *et al.* (2010b) do not mention the distance between the bowls. Furthermore there is no description if the test dogs ate prior to the test, whilst it was shown a higher satiety level might lead to a lesser motivation (Burman *et al.,* 2011). Some of the studies mentioned above used about ten dogs which raises the question if the results of these studies are reliable. In some studies, dogs were leashed while in others the dogs roamed free. For the safety of all parties involved in the tests the dogs should be kept on leash. It is critical that dogs can learn to discriminate between the cues used in a cognitive bias test. It seems that visual cues based on colour, such as the grey scale used by Burman *et al.* (2011), are more difficult to learn than spatial cues, but it is unclear what way of performing the cognitive bias test with dogs is optimal. The judgement bias test seems valid as in several studies the test measures a pessimistic bias when animals are in a negative affective state and an optimistic bias when the animals are in a positive affective state. Reliability of the test is debatable as experience with the testing conditions and procedure have an effect. Subjects learned that the ambiguous cues were unrewarded which lead to diminished responses to these cues (Doyle *et al.,* 2010b; Brilot *et al.,* 2010).

Also, the novelty of the test conditions may cause anxiety initially, which will influence the test results. Because of the questions that remain concerning the cognitive bias test with dogs, here we investigate different combinations of cognitive bias test cues and consequences to identify which combination is most effective. To validate the procedure we test the hypothesis that dogs in shelters are more pessimistic than privately owned dogs. If the cognitive bias test validly measures optimism in dogs we want to test the relation of the latter with parenting style scores of owners. Should parenting style scores associate with optimism in dogs, as a proxy for well-being, this might have implications for matching owners with dogs like in the adoption process of shelter dogs.

Material and methods

Subjects

Dogs (n=50; 3.95 ± 3.09 years old) were tested for optimism using the cognitive bias test. Shelter dogs (DOC-T; n=12) were tested and assumed to have a relatively negative affective state as opposed to privately owned dogs (pet dogs; n=24), with trainee assistance dogs (Hulphond Nederland, HN; n=14) being intermediate. The dogs were of different ages and breeds (Appendix – I). Before participating in the behavioural tests dog owners were asked to fill in a questionnaire concerning parenting styles, with two questionnaires being distributed, one with 62 items and one with 42 items. The first questionnaire comprised of questions about children and dogs, in accordance with the Parenting Practices Questionnaire (PPQ) of Robinson *et al* (1995), here adapted for dog owners. The second questionnaire was also based on the PPQ but shortened. Both questionnaires consisted of questions with a five point scale about parenting styles, and questions about information such as age, gender and breed. We asked the owners to fill in another survey (Appendix – II) upon arrival at the testing facility. This survey contained four questions about their view on the cognitive bias of their dog, for example: "Is your dog: worrisome or happy". If a person ticked all the first answers the dog was deemed as optimistic and if one of the answers was not the first one then the dog was scored as pessimistic.

Cognitive bias task

Dogs were tested for optimism by means of cognitive bias tests that were performed following 6 different protocols with each dog being tested twice on one day by means of two different protocols. We adopted the previously developed spatial task of Mendl *et al.* (2010b) with some adjustments (figure 1). Owners and handlers were instructed to not feed the participating dogs for at least 1h prior to testing. Prior to each training- and testing phase dogs were habituated to the room and researcher for five minutes. The handlers were asked to put a safety collar on the dog and put a leash on it. The researcher explained the course of action, asked the handlers to fill in the short survey concerning information about the dog (only the dog owners, not the caretakers from the shelter and HN, and told them that they could stop the test at any time if they wished for it. In case of DOC-T and HN we asked the handlers to perform both tests for one dog. After the handler and dog entered the experimental room, the dog could explore it and during this habituation time the handler was allowed to interact with the dog. After the habituation period the dogs were put on a leash (4m, attached to the wall) which was used in training and testing. The handler unleashed the dog from the short leash with which they came in. The testing area was minimal 3m x 5m so that the testing arena was the same for all dogs (figure 1). The test room contained a minimum of one camcorder, which was situated in a corner across from the dog. Both handler and researcher were present throughout the test.

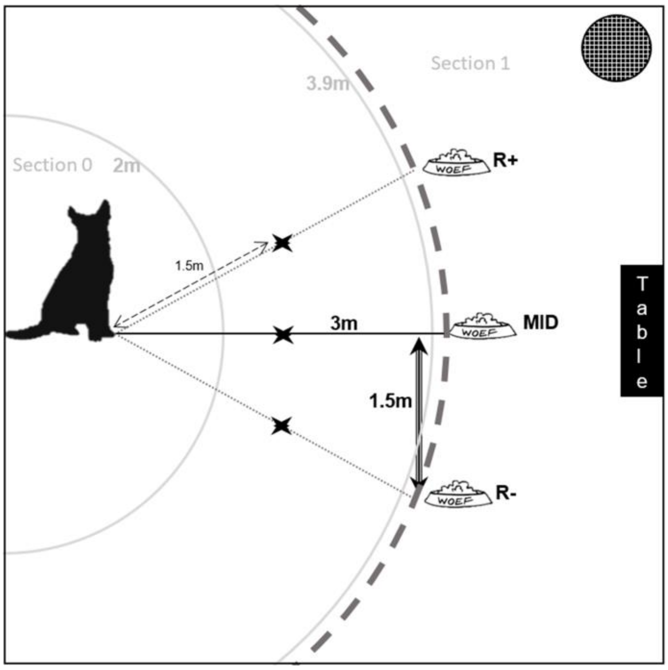

Fig. 1. Experimental set-up for the cognitive bias test. With R+ as the positive cue (positive event) and R- as the negative cue (aversive event) for the location tests. The bowl in the middle served as the ambiguous cue (MID) and was always empty. Note that this was done with the location cue. In case of the bowl size cue, the bowls were all placed in the MID position. The two section lines indicate the space in which the latency was measured. The bowls were all at 3m distance from the dog and the distance between bowls was 1.5m. The crosses at 1.5m from the dog indicate were the bowls were placed in the second pre-training trial. The circle in the top right corner represents the camcorder. The table is where the bowls were prepared. In between the table and the MID position was the spot where the researcher stood during the trials.

The training phase started right after the habituation period. Handlers were instructed to sit on a chair and position the dogs next to them, putting the dog in a sitting position, and position the short leash with which they came in under the chair. The handler positioned the dog so that they were oriented towards the bowls. The researcher stood at the other side of the room in front of the table and baited (or not, depending on trial sequence) a food bowl with either half a spoonful (wither height ≤ 20cm) of or a spoonful (wither height > 20cm) of dog food (Renske lamb®). The researcher always performed the same motions at the table to prevent dogs knowing or seeing that a bowl was baited or not. In this experiment dogs were trained to discriminate between two different cues, location and bowl size. Dogs were trained to differentiate between a positive cue (with a positive event, Pos) and a negative cue (with a negative event, Neg). Ultimately we used a 2 x 3 format (Appendix - III) comprised of two cues and three test variations. The first variation is the standard task in which dogs differentiate between a positive and negative cue, respectively baited with food or not (a). Secondly, the standard task was performed with the addition of an "aversive event" which meant that the lights were turned off for 5s when dogs approached the negative cue (b). Lastly, a standard task was performed where dogs were taught that the negative cue was unbaited plus that they would get a small reward when they stayed with the handler instead of checking the empty bowl (c). The researcher put the bowls (baited or unbaited) at 3m in front of the dog. Bowls were identical, had a false bottom and were of the same size in the location test (I), but different sizes in the other test (II): 24cm, 20 cm and 16cm. In case of the location cue, the 24cm bowl was placed in different locations (left, right and middle). Trials with the bowl size meant that the bowls were all placed in the middle location. The researchers told the handlers that they best not praise, reward or correct the dogs as this could affect the results. The handler sat on the chair and the dogs first got a pre-training trial to understand that there was food in the bowl. Before the pre-training trial, handlers were asked which command they used to release the dog (e.g. "free" or "go ahead"). The researcher asked the handler to use the same command by each trial. At each trial the handler was asked to grab the collar and hold on to it. When the experimenter stood back at the table, same position every trial, she signalled the handler by saying: "You may release the collar and say [command]". Further, the handlers were asked to place their hands on their legs to prevent them from pointing towards the bowls. The experimenter waited until the nose of the dog had been in the bowl, and the dog had eaten the food or not in case of the unbaited bowl, before signalling the handler to call the dog back. She did this by saying: "You may now call your dog back".

Pre-training trials

The pre-training trial (Appendix - III) for all tests started with showing the dog that there was food in the bowl. This was done with the positive cue, meaning that the positive "size or location" was used. The bowl was placed in front of the dog at different distances, i.e. at 1m, 1.5m and 3m, and the researcher dropped the food in it so that it was visible to the dog. The first step of 1m was excluded for shelter dogs as we wanted to prevent close contact between experimenter and test subjects. Two cognitive bias test protocols included additional pre-training trials, the third variation with the extra treat had extra pre-training trials. These extra trials were, Pos, Neg, Pos, Neg, $Neg_{pull\ back}$, Pos, $Neg_{pull\ back}$, $Neg_{pull\ back}$, Pos and Neg. The extra trials consisted of the positive and negative cue with an addition of restraining the dog at the first line (at section 0) in the case of $Neg_{pull\ back}$. This pre-training was done by instructing the handler to perform the basic handlings: taking hold of the collar and giving the releasing command, but to also hold on to the leash and let it run through their fingers until the dog's paws crossed the first line and then restraining the dog from going any further by holding the leash. When the dog was stopped the handlers were instructed to walk towards the dog, take the collar and lead the dog back to the start position. When they returned to the starting position the handler was instructed to give the dog a small treat. Again handlers were instructed to not interact with the dog minimally. This pre-training was done to teach the dogs that the negative cue meant a small treat from the owner and that there was nothing in the bowl. So after these pre-training trials dogs would have been able to differentiate between a positive cue which meant a big reward (Renske lamb®) and a negative cue which meant a small reward from the owner (standard training kibble).

Training trials

The training trials (Appendix - III) were allocated in a fixed order with a maximum of three trials of the same type in consecutive order; Pos, Neg, Pos, Pos, Pos, Neg, Neg, Pos, Neg, Pos, Neg, Pos, Pos, Neg, Pos. The two protocols, test combinations, were assigned to each dog in pseudo-random order, because we wanted to have each test performed in all groups and we tried to balance the whole dataset this way. The readout parameter recorded during the trials was the latency to reach the cue (bowl), which was measured as the time between the dogs crossing the first line with its nose at section 0 and crossing the line of section 1 with its nose near the food bowl. The latencies were recorded live with the aid of stopwatch and reported on a form (Appendix – IV). Furthermore the test room was divided into two sections, one close to the starting position (0) and one near the food bowl (1). The researcher noted were the dog was after 10s. If dogs failed to reach the bowl within these 10s, the trial ended and a latency of 10s was recorded. When dogs reached the bowl before the 10s the handlers were asked to return the dog to starting position, this to prevent dogs playing with the bowl. We assumed that dogs learned the association between event and cue after fifteen trials. Each dog was tested twice, once with location and a test variation and the other time with bowl size and another test variation, each test took about 20 minutes. We tried to have at least 1h between the tests of the same dog in order to make sure dogs would be able to learn both protocols.

Test trials

Test trials were identical to the training trials except that the ambiguous cue was used (Appendix – III, indicated as middle), being either the middle position for the location cue (I) or the middle bowl size (20cm) for the size cue (II).

Data processing and statistics

Statistical analyses were done using Microsoft Excel and GenStat. Effects with P-values <0.1 are considered of interest and those up to P=0.15 are explained in further detail. Dogs (n=50) were tested for optimism using a cognitive bias procedure that was applied in six different combinations. Test subjects participated in two procedures, resulting in a total of 100 tests. Per cognitive bias test, the final 15 trials were analysed, including 6 runs to the empty bowl (negative cue) and 9 to the baited bowl (positive cue). The data set included multiple records per dog and Linear Mixed Models (Restricted Maximum Likelihood, REML) were used to account for this. In total 1500 records were analysed with the statistical model:

$$Y_{nopq} = \mu + TEST_n * CUE_o * TRIAL_p + DOG_q + e_{nopq}$$

With Y_{nopq} representing a latency score for dog (n=50) q to reach CUE (Pos, Neg) o during run (TRIAL 1 to 9) p in cognitive bias test protocol (6 TEST types) n. Interactions between fixed effects, including the 3-way interaction, were part of the statistical model and the random component dog accounted for the repeated measures on the same experimental unit. The overall mean and residuals are represented by μ and e, respectively. Effects were evaluated one-sidedly and for the interaction effect CUE*TRIAL the prediction was that the latency towards the negative cue should incline and the latency towards the positive cue should decline. Thus in the final trials there should be a larger latency difference between the positive and negative cue than during the first trials. In case of a significant main effect for CUE this difference should be clear from the start.

The tests in which dogs discriminated between the cues were identified and used for assessing optimism. For each test, 100 in total, the 15 trials were analysed with the following formula:

$$Y_{no} = \mu + CUE_n * TRIAL_o + e_{no}$$

With Y_{no} as the latency score to reach CUE (Pos, Neg) n during TRIAL (1 to 9) o per test. We picked the tests which showed a trend (one-sided P < 0.15) for the CUE.TRIAL 2-way interaction or the CUE main effect. Effects were evaluated the same as with the REML analysis mentioned before with the interaction effect of CUE*TRIAL and a main effect of CUE.

In total 46 tests were understood with 15 trials analysed per test, combining into 690 records in total which were analysed with the same REML as mentioned before with the formula:

$$Y_{nopq} = \mu + TEST_n * CUE_o * TRIAL_p + DOG_q + e_{nopq}$$

Effects were evaluated the same as with the other REML analysis.

In addition we analysed the differences in latency towards the positive and negative cue between groups. Per group 4 dogs understood this test, meaning that 180 records were analysed with a REML analysis with the following formula:

$$Y_{nop} = \mu + GROUP_n * POSITION_o * TRIAL_p + e_{nop}$$

With Y_{nop} representing a latency score for dog (n=12) q to reach CUE (Pos, Neg) o during TRIAL (1 to 9) p per GROUP (3 groups) n. Interactions between fixed effects, including the 3-way interaction, were part of the statistical model. The overall mean and residuals are represented by μ and e, respectively. Effects were evaluated two-sidedly.

Aside from afore mentioned analyses, we investigated if there was an effect of order in which the tests were performed. We analysed the 1500 records with a REML analysis with the formula:

$$Y_{nopq} = \mu + PHASE_n * CUE_o * TRIAL_p + DOG_q + e_{nopq}$$

With Y_{nopq} representing a latency score for dog (n=12) q to reach CUE (Pos, Neg) o during TRIAL (1 to 9) p per PHASE (test 1 or test 2) n. Interactions between fixed effects, including the 3-way interaction, were part of the statistical model and effects were evaluated two-sidedly.

Optimism scores were calculated based on the latencies to the last positive cue, last negative cue and the ambiguous cue. The scores were calculated as (Amb-Pos)/(Pos-Neg) with a range of -1 (pessimistic) to 0 (optimistic). Scores which exceeded the range were truncated into the same range of -1 to 0. The optimism scores were calculated on the basis of raw scores (last Pos and Last Neg) and on the basis of predicted means generated by ANOVA, taking the predictions for trial 9. A correlation was calculated between the cognitive bias score (CBS) calculated with the raw data and the predicted means from the ANOVAs for all dogs (n=38). When a dog understood both tests we calculated the mean CBS and took this score for further analysis. The relation between the calculated cognitive bias score and the owner reported optimism of the dog as calculated from the survey was tested with ANOVA, with the behaviour test score (0 to -1) and the survey scores (expressed with the same score) being the dependent and independent variable (co-variate), respectively. This analysis was done with only the pet dogs (n=19), since they had owners who filled in the survey. The effects were evaluated two-sidedly.

To test if the survey measured the same as the tests did we calculated the specificity and sensitivity. The owner reports were considered as the golden standard (true values) and CBT outcomes were compared to this. Using the following threshold of -0.6 dogs were labelled as optimists or pessimists and the specificity and sensitivity of the CBT was assessed against the owner reports as golden standards. In total 38 records on 19 dogs were used for the analysis.

Optimism scores (76 records on 38 dogs) were analysed for differences between the dog groups (pets, shelter dogs and trainee assistance dogs) using ANOVA, with the CBS (0 to -1) and the dog groups being the dependent and independent variable (co-variate), respectively. Outcomes were evaluated one-sidedly as it was assumed that dogs in shelters would be more pessimistic than privately owned dogs. The ratio of understood tests and misunderstood tests was analysed with Chi-square. Seventeen counts were expressed in a 2 x 3 cross table of understanding of the tests and dog group.

Lastly, we associated the cognitive bias scores with parenting style scores in a REML with the following formula:

$$Y_{nop} = \mu + PERM\_VAL_n * AUTV\_VAL_o * AUTN\_VAL_p + e_{nop}$$

With Y_{nop} representing the CBS per dog for the permissive parenting style n, the authoritative parenting style o and the authoritarian parenting style p. Interactions between fixed effects, including the 2-way interactions, were part of the statistical model. Ninety-five records on 19 dogs were analysed. Parenting style scores were calculated by summing answers, which were expressed on a 5-point scale, and expressing outcomes as percentage of the maximum The calculation was done by using the following formula: $\mathrm{PSS} = \left(\frac{\text{sum of questions scores}}{(\text{maximum score per question}*\text{answered questions})}\right) * 100\%$. The specific questions used were identified from a PCA analysis on the questions from the parenting style survey (appendix – V and VI). Using a threshold of loadings > $|0.4|$, the meaningful questions per component (parenting style dimension) were identified. Questions on which we based our calculation of the parenting style score (PSS) are presented in appendix – VII.

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Results

Dogs (n=50) were tested for optimism using a cognitive bias procedure that was applied in six different combinations. Test subjects participated in two procedures, resulting in a total of 100 tests. Per cognitive bias test, the final 15 trials were analysed, including 6 runs to the empty bowl (negative cue) and 9 to the baited bowl (positive cue). A total of 1500 records was analysed with a REML for the fixed effects: Test (A to F), Cue (positive, negative), Trial (1 to 9) and interactions between these three, with dog making up the random component of the statistical model. The predicted mean latency of all dogs was 2.4± 0.17s. Latencies to reach the cue were analysed for effects of Cue (negative or positive), Trial (1 to 9) and interactions between these. Significant (P<0.1) two-way interaction effects or a main Cue effect in the expected direction of the interaction- or main effect were assumed to indicate that dogs understood the principle and discriminated between the negative and the positive cue. The results of this analysis showed that there was a significant two-way interaction effect (P=0.006). The difference between the latency towards the positive cue (2.10s) and towards the negative cue (2.69s) were present which indicates that the dogs understood the difference between the cues. To check whether we could use a linear function we added a SPLINE function of Order and the interactions which plotted the data accordingly. Figure 2 shows the predicted mean latencies towards the positive and negative cue according to the linear function and the SPLINE function, the filled black symbols being the linear function and the open grey symbols are the spline function. As can be seen the SPLINE function also plots the data linear. Therefor we can use the linear function to analyse the data.

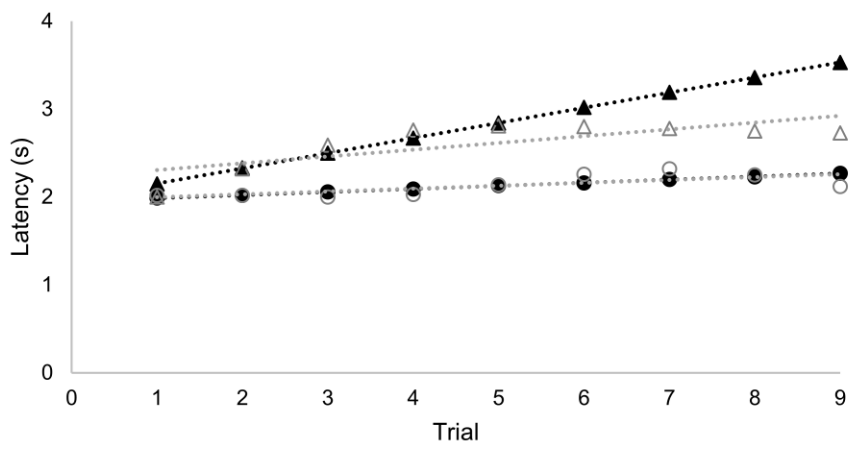


Fig. 2. Dogs (N=50) were tested for optimism in a cognitive bias test and latencies to reach cues are given for the training trials during training. Graphical display of differences in latency over all tests (n=100) between the linear (filled black) and SPLINE (open grey) function. The triangles represent the latency towards the negative cue and the dots represent the latency towards the positive cue. As can be seen the SPLINE function plots the data in a similar way as the linear function does.

Across dogs, the different CBT protocols caused different latencies as can be seen in figure 3 (P value for the 3-way interaction = 0.006). The CBT location tests (A, B & C) show a larger difference between the positive and negative cue than those with the size tests (D, E & F) (mean difference location cue=2.38s; mean difference size cue=0.15s).

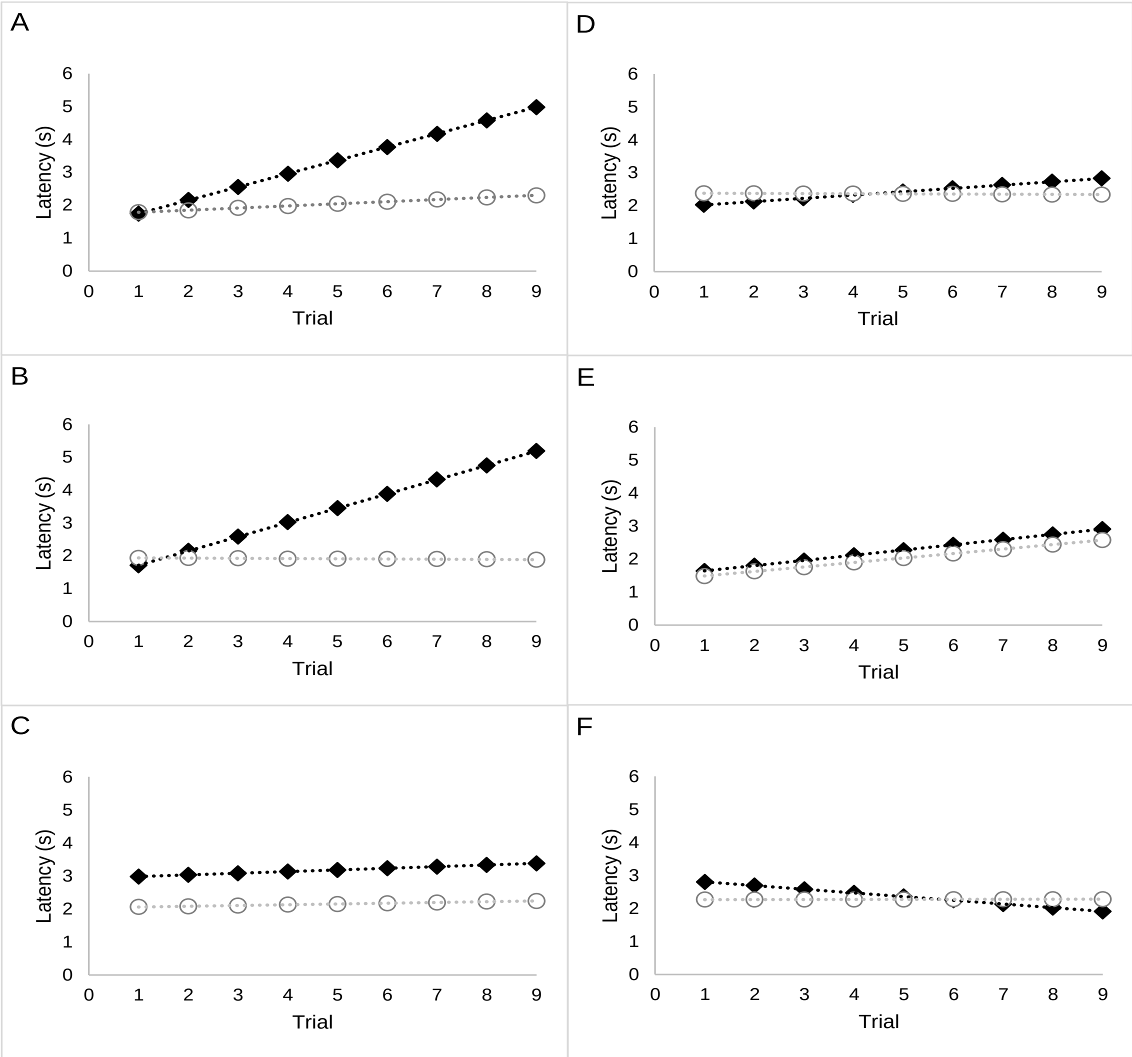


Fig. 3. Testing optimism of dogs with the CBT following different protocols (n=50). Graphical display of differences in latency over all tests (n=100) between the protocols (P=0.006). As can be seen the tests with location as cue (A=location*standard, B=location*light, C=location*treat) show the most pronounced difference in latency between the positive (grey and open) and negative cue (black and filled). The tests with size as cue (D=size*standard, E=size*light, F=size*treat) barely show a difference between the two cues.

Next, the 15 trials (6 runs to the negative cue and 9 to the positive) per dog CBT combination were analysed with ANOVA. Latencies to reach the cue were analysed for effects of Cue (negative or positive), Trial (1 to 9) and interactions between these. Significant (P<0.1) two-way interaction effects or a main Cue effect in the expected direction were assumed to indicate that dogs understood the principle and discriminated between the negative and the positive cue. Figure 4 shows a dog that understood the test, while figure 5 shows one that didn't. The linear lines represent the predicted means, while the symbols represent the raw data.

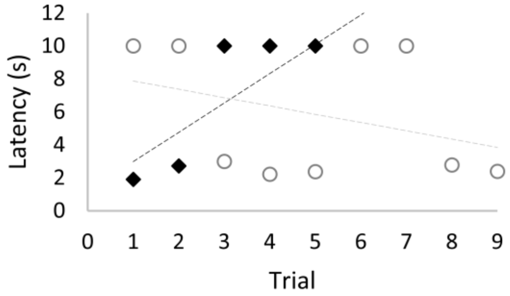


Fig. 4. Understood test where latencies to reach cues are given for the training trials during training. The linear lines were created with the predicted means of an ANOVA analysis which showed that this test was understood (P=0.017). Symbols indicating raw data and lines indicating predicted data. The filled black symbols and lines represent the latency towards the negative cue and the open grey lines and symbols represent the latency towards the positive cue. There is a distinct difference in latency between the positive cue, which is going down, and the negative cue, which is going up which indicates that a dog has understood the difference between the cues.

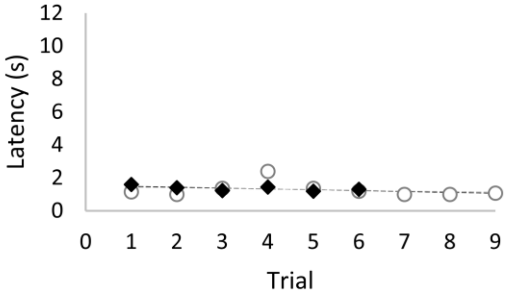


Fig. 5. Misunderstood test where latencies to reach cues are given for the training trials during training. The linear lines were created with the predicted means of an ANOVA analysis which showed that this test was misunderstood (P=0.444). Symbols indicating raw data and lines indicating predicted data. The filled black symbols and lines represent the latency towards the negative cue and the open grey lines and symbols represent the latency towards the positive cue. There was almost no difference in latency towards the positive and negative cue which indicates that a dog has not understood the difference between the cues.

The total number of cognitive bias tests in which dogs discriminated between the negative cue and the positive was 46 out of 100 (tables 1 and 2). Thirty-two of the understood tests were with the location cue and only 14 with the size cue and dogs seemed better at discrimination based on location of the cues than based on its size.

Table 1. Understood tests with the location cue.

Test	Values	% (Total)	% (Location)
LOC*standard	12	26	38
LOC*light	9	20	28
LOC*extra treat	11	24	34
Location total	***32***	***70***	***100***

Table 2. Understood tests with the size cue.

Test	Values	% (Total)	% (Size)
SIZE*standard	4	9	29
SIZE*light	8	17	57
SIZE*extra treat	2	4	14
Size total	***14***	***30***	***100***

The statistical (REML) analysis as described was repeated with data on cognitive bias tests (n=46) in which dogs discriminated between the two cues, as shown by a significant (P<0.1) main Cue effect or interaction effect between Test, Cue and Trial (figure 6). This analysis showed again a significant three-way interaction effect (P=0.002). The largest differences in predicted mean latency towards the positive and negative cue at the last trial (trial 9) were found in the following protocols: location*standard (Pos=1.69s; Neg=5.25s), location*light (Pos=1.8s; Neg=6.91s), location*extra treat (Pos=2.29s; Neg=4.08s) and size*standard (Pos=2.24s; Neg=5.72s). The tests with the least difference were size*light (Pos=1.91s; Neg=2.27s), and size*extra treat (Pos=1.52s; Neg=1.29s).

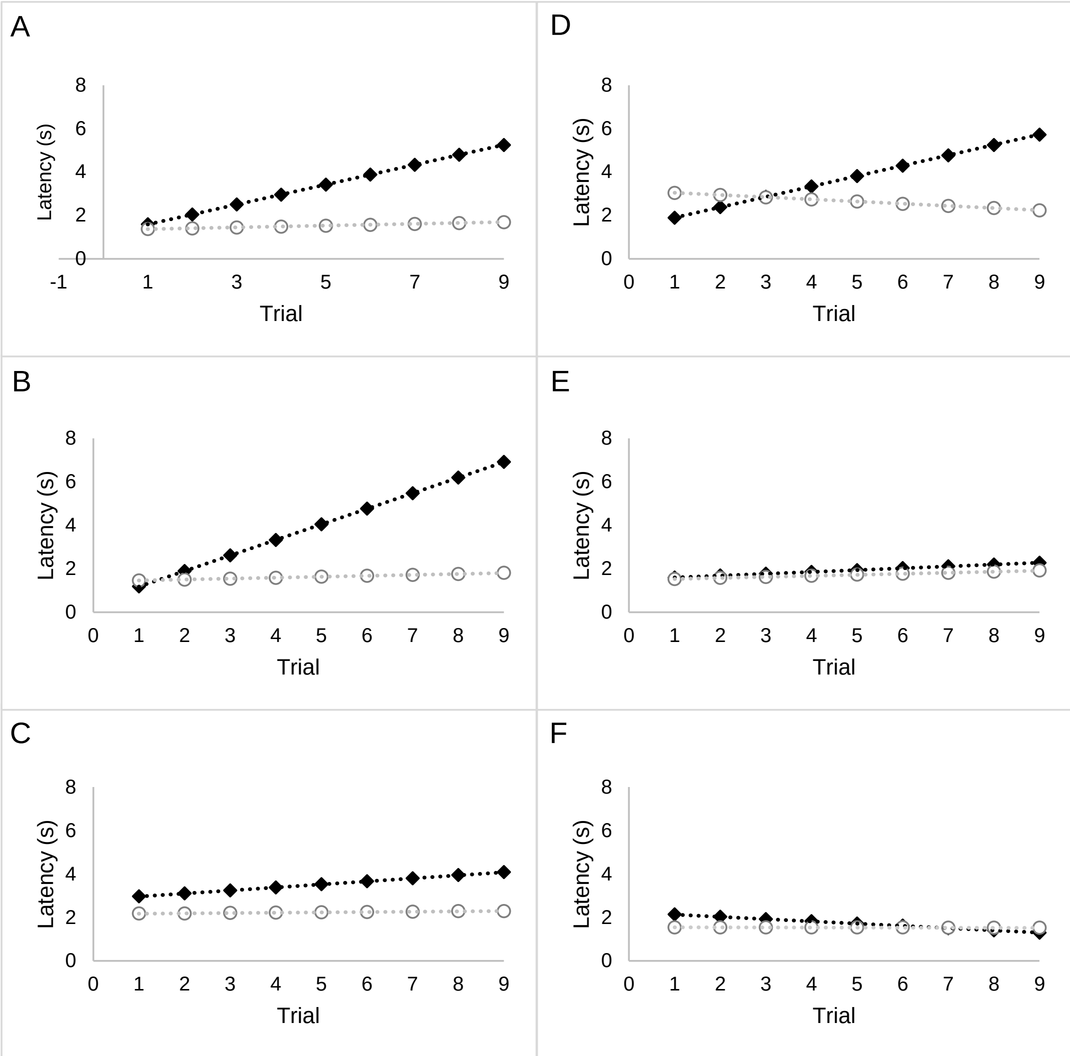
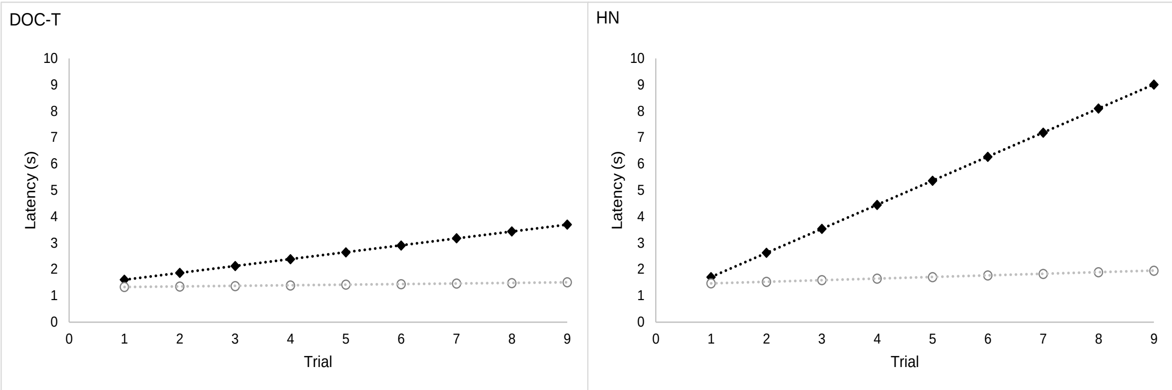


Fig. 6. Testing optimism of dogs with the CBT following different protocols. Graphical display of differences in predicted mean latency over understood tests (n=46) between the protocols (P=0.002). As can be seen the following tests show the most profound difference in latency between the positive (open grey) and negative cue (filled black): A=location*standard, B=location*light, C=location*treat and D=size*standard. The other tests with size as cue (E=size*light, F=size*treat) barely show a difference between the positive and negative cue.

The latencies to reach the cues were tested for differences between the dog groups (pets, shelter dogs and trainee assistance dogs) using REML analysis. A total of 180 records on the understood location*standard tests were analysed for the fixed effects: Group (HN, DOC-T, Private), Cue (positive, negative), Trial (1 to 9) and interactions between these three, with dog making up the random component of the statistical model. The significant three-way interaction (P=0.022) is illustrated in figure 7. Trainee assistance dogs had the most pronounced distinction in predicted mean latency between the positive and negative cue at the last trial (Pos=1.95s; Neg=9.01s), i.e. as compared to the private dogs (Pos=1.93; Neg=3.37) and shelter dogs (Pos=1.51s; Neg=3.7s).



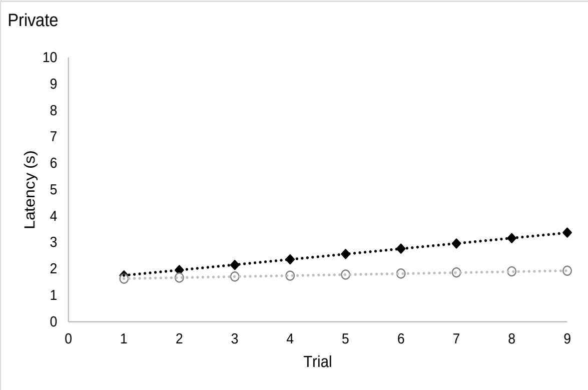


Fig. 7. Testing optimism of dogs with the CBT following the location*standard test. Graphical display of differences in predicted mean latency during the location*standard tests (n=12, 4 dogs per group) between the groups (P=0.022). As can be seen trainee assistance dogs (HN) show the most clear distinction in latency towards the negative cue (filled black) and positive cue (open grey).

Aside from the aforementioned analyses, we tested for the possible effect of order of the tests. A total of 1500 records was analysed with REML for the fixed effects: Phase (first test, second test), Cue (positive, negative), Trial (1 to 9) and interactions between these three, with dog making up the random component of the statistical model. There was no significant interaction effect (P=0.347) nor a significant main effect of Phase (P=0.695).

Optimism scores, with a total of 228 records for 38 dogs, were calculated as $\frac{(A-P)}{(P-N)}$, with the letters indicating the cues (ambiguous, positive, negative) and representing latencies (s) to contact the cue. The latencies to Pos and Neg were calculated in two different ways. Firstly calculating the score with the raw data (-0.30±0.56; [-1,0]) and the latencies from the last trials (trial 9 for the positive cue, trial 6 for the negative cue). The second way was a calculation based on the predicted means from the ANOVA analyses (-0.08±0.50) with the latencies from the last predicted trials (trial 9 for both cues). It was demonstrated that these two scores (Appendix – VIII) had a significant slight positive correlation (Spearman's rank correlation, r_s=0.46, P<0.1). This can also be seen in figure 8. Since there is only a weak correlation between the raw data and predicted data, even though this correlation is significant, we used both scores in the following analyses.

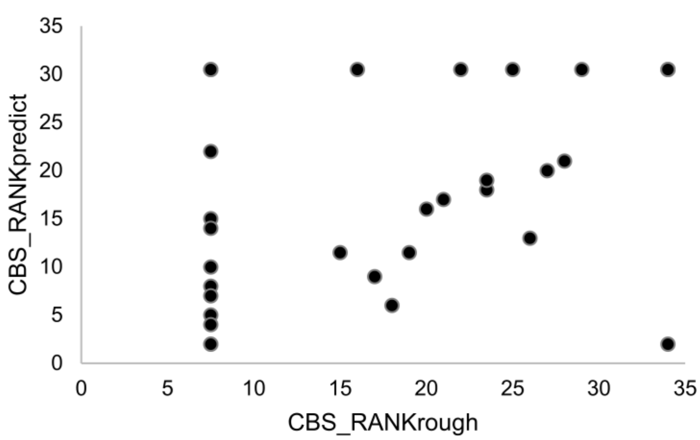


Fig. 8. Spearman's rank correlation between raw- and predicted data (n=38). The correlation between CBS_rough (CBS based on the raw data) and CBS_predict (CBS based on the predicted data from the ANOVA). Each dot represents a ranked subject. Since some subjects ranked the same less than 38 dots can be seen in the figure. A slightly positive correlation is seen (r_s=0.46, P<0.1).

Optimism of the dogs, ranging from 0 to -1 as derived from the behaviour tests was related to owner reported optimism, as calculated from the surveys the owners filled in (-0.63 ± 0.63) using ANOVA (Appendix – IX). The calculation entailed that if a person ticked all the first answers of the survey the dog was deemed as optimistic (score 0) and if one of the answers was not the first one then the dog was scored as pessimistic (-1). This analysis was done using only the understood tests of the private dogs. When a dog understood two tests the mean of the CBS was taken for further analysis (n=19). Both analyses showed that there was no significant difference between survey scores 0 and -1, as the independent variable, and cognitive bias scores as dependent variables, neither for the raw data (P=0.643) nor with the predicted data (P=0.601).

The behaviour tests outcomes were translated into dogs being optimistic or pessimistic and evaluated for sensitivity and specificity against the owner reported assessment as golden standard (n=19; 38 records). We took the survey answers as given by the owners as golden standard, so this served as the true data and compared the survey score with the CBS (rough and predicted data) from all tests (table 3). As can be seen in the table when the boundary was set at -0.6 (optimistic<-0.6; pessimistic>-0.6) with the raw data it meant that 24% of the dogs were identified as being either optimistic or pessimistic in the tests, with a correct identification (in comparison with the survey scores) of 29%.

Table 3. Sensitivity and specificity between the survey CBS and the CBS outcome from the behavioural tests.

Data	Raw		Predicted	
CBS Threshold	CBT -0.5	CBT -0.6	CBT -0.5	CBT -0.6
True positive	4	4	4	4
True negative	2	6	3	2
False positive	15	15	15	15
False negative	17	13	16	17
Sensitivity	0.19	0.24	0.20	0.19
Specificity	0.12	0.29	0.17	0.12

As one can see sensitivity is the highest with the boundary of -0.6 of the CBS (optimistic<-0.6; pessimistic>-0.6) with the raw data meaning that there is a 24% chance of indicating a dog as being pessimistic or optimistic. The specificity is also highest in that column, which implies that 29% of the cases are identified correctly.

The CBS (rough- and predicted data) were analysed for possible differences between the three dog groups (n=46) using ANOVA. There was no significant difference neither with the mean predictions of CBS with the raw data of DOC-T (-0.70), Private (-0.54) and HN (-0.49) (P=0.302) nor with the mean predictions of CBS with the predicted data of DOC-T (-0.30), Private (-0.28) and HN (-0.27) (P=0.489). The ratio of understood tests and misunderstood tests was analysed with Chi-square (table 4), showing that the probability of understanding the test and discriminating between the positive cue and the negative one did not differ between the groups (χ^2, P=0.62). It is noticeable that shelter dogs understood the least number of tests (37.5%), while Private dogs (47.9%) and Trainee assistance dogs (50%) almost understood half of the tests.

Table 4. Contingency table for Chi-square test.

Test	Group			
	Private	HN	DOC-T	Total
Understood	23 *(22.08)*	14 *(12.88)*	9 *(11.04)*	46
Misunderstood	25 *(25.92)*	14 *(15.12)*	15 *(12.96)*	54
Total	48	28	24	100

(Italic) = expected values

Lastly we compared the cognitive bias scores (rough- and predicted data) with the parenting style scores (Appendix – IX) of the owners using ANOVA (n=19). The parenting style scores were calculated with the questions from the questionnaires that were comparable and had a PCA-loading of 0.4 or higher. The mean percentages of each parenting style are as follows: authoritarian 42.46±13.33, authoritative 75.21±7.67 and permissive 46.87±16.42 with a range of 0 to 100%.
The analysis showed that there was no significant interaction effect between the parenting styles on the optimism scores (P>0.1; both with the CBS calculated with raw and predicted scores). There were significant main effects of both the authoritarian parenting style (P=0.058) and the permissive parenting style (P=0.022), at least when CBS were based on raw data. The analysis with CBS predicted data only showed a main effect of the permissive parenting style (P=0.026). Since there were no interaction effects we took these out of the analysis and ran the ANOVA again to see if the main effects would become clearer. This was not the case as the significance stayed the same in the raw data (authoritarian, P=0.058; permissive, P=0.0222) and in the predicted data (permissive, P=0.026). When omitting the main effect which was not significant (authoritative) the main effects of authoritarian and permissive were at the p-levels of P=0.032 and P=0.014, respectively (raw data). For the predicted data the p-value for permissiveness became P=0.033. The figure below depicts the data analysis without the insignificant effects. It shows that with increasing scores for parenting styles the cognitive bias score increases, more or less regardless of the type of parenting style.

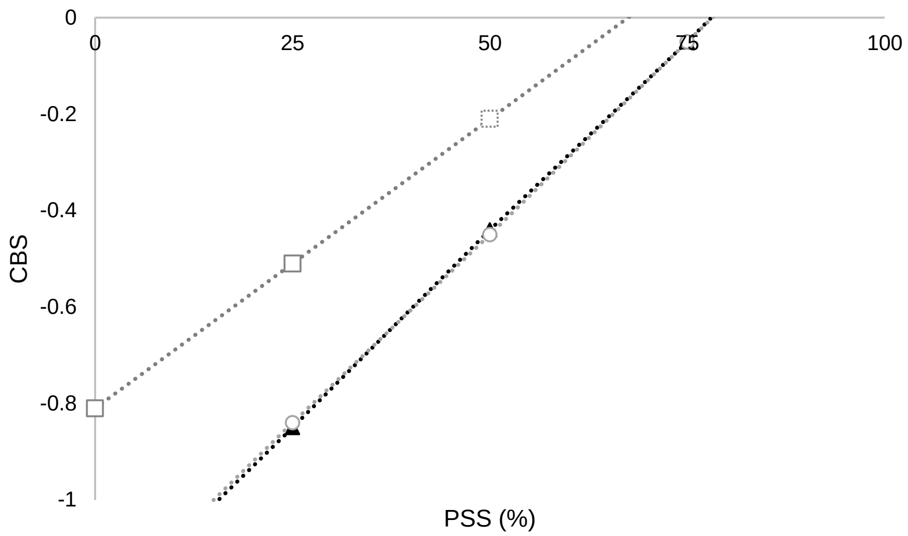


Fig. 9. Relation between the CBS (cognitive bias score) and the PSS (parenting style score). As is visible in the graph it seems that with an increasing score for a specific parenting style the CBS also increases. This was demonstrated for the raw data with parenting styles authoritarian (filled black triangles) and permissive (open light grey dots) as well as for the predicted data with the permissive parenting style (open grey squares).

Discussion

Cognitive bias tests with dogs often make use of location as the discriminative cue, with the positive event that is signalled by the cue being food and the negative event being unrewarded. We wondered if this was the best combination of cue and consequences, for example as in earlier studies on cognitive bias in animals, as discussed next, the negative event was more aversive. In general, the reliability and validity of the cognitive bias model for measuring enduing traits, i.e. optimism, may be questioned as transient states are of influence. In a study with twenty-four rats, subjects were taught to make a distinction between two cues that signalled locations with either a reward (palatable food) or a punishment (unpalatable food). The rats were then split up into groups which were trained and tested under different light conditions and rats that were switched from high light during training (aversive) to low levels of light during testing (rewarding) responded in an optimistic fashion (Burman *et al.,* 2009). A wide range of signals have been used in cognitive bias tests with animals, like olfactory cues to teach mice (n=100) to discriminate between vanilla (palatable reward) and apple (unpalatable reward, Boleij *et al.,* 2012). The ambiguous cue in this paradigm was a mixture of the odours. The level of optimism of the mice fluctuated with light conditions, white being more aversive than red, and mouse strains differing in anxiety (Boleij *et al.,* 2012). Odours have been used also with bees, which were conditioned to differentiate between two odours (Bateson *et al.,* 2011). During conditioning three combinations of reward (CS+) and punishment (CS-) were used: (1) 1.0 M sucrose (CS+) versus 0.3 M sucrose (CS-), (2) 1.0 M sucrose (CS+) versus 0.01 M quinine (CS2), and (3) 2.0 M sucrose (CS+) versus 0.01 M quinine (CS-). Often food is used as a reward in cognitive bias tests but various alternatives exist and a model with mice used a positive location that predicted access to the home cage versus a negative location that resulted in an air puff (Kloke *et al.,* 2014). In a study with mice, subjects were taught to differentiate between eight arms in a maze, where two arms were positive, two negative and four served as the ambiguous locations. Reaching the end of a positive arm caused that the lights went off and activated a pellet dispenser which dispensed a chocolate flavoured pellet (Novak *et al.,* 2015). When mice reached the end of a negative arm the lights would stay on and there would be a burst of white noise. Cognitive bias test paradigms based on spatial discrimination and food as rewards, with the punisher being no food or unpalatble food, have been done with in goats (n=18, Briefer and McElligott*,* 2013), horses (n=12, Freymond *et al.*, 2014) and pigs (n=48, Carreras *et al.,* 2016). The use of more pronounced punishers should facilitate that tests subjects make more deliberate choices in cognitive bias test paradigms, but for ethical reasons these should be of minimal intensity when working with dogs. Studies with starlings used a time-out as a negative event. Eight birds were taught to differentiate between a red and green light. One colour was designed as the correct response (producing food), resulting in the chosen light to stop flashing and remained illuminated for 2 seconds. The other colour was designed to signal the negative event, meaning both lights would stop and a timeout of 30 seconds occurred (Matheson *et al.,* 2008). Starlings have also been trained to differentiate the background shades of a food bowl (Brilot *et al.* 2010; Bateson & Matheson*,* 2007*)*. They had to learn that a dark background meant a big reward while a light background meant a small reward, but since the shades of grey were not, on itself, enough for the birds to discriminate between the positive and negative cues the experimenters made cardboard lids containing either a red triangle or green cross. Half of the starlings were trained to associate the red triangle with the large reward and the green cross with the small reward, the other half trained the association in reverse (Brilot *et al.* 2010; Bateson & Matheson*,* 2007*)*. Cues used in sheep are typically based on location and a number of studies with varying sample sizes have been done (Doyle *et al*., 2010a (n=20); Doyle *et al.*, 2010b (n=20); Sanger *et al.*, 2011; Doyle *et al.*, 2011a (n=36); Doyle *et al.,* 2011b (n=26); Verbeek *et al.*, 2014a (n=41); Verbeek *et al.,* 2014b (n=41); Guldimann *et al.,* 2015 (n=24)). Food was typically used as the positive event and the revealing of a dog as a negative event. Others working with sheep used a fan blower as a negative event and conspecifics as a positive reward. Verbeek *et al.* (2014a, 2014b) used location with extra visual cues in their judgement bias test with sheep. The locations were marked visually, with the positive location being the lightest green (palatable food) and the negative location being the darkest green (unpalatble food, Verbeek *et al.,* 2014b). In a study with twenty-four sheep, visiting differently coloured boxes was reinforced with concentrated feed and salt or punished with straw(Guldimann *et al.,* 2015). Visual cue discrimination has been used also in chickens (n=38), which were learned two different light signals in combination with the location of a food bowl. The light signals (white and blue light) were placed beside each other along the wall next to the tube (which would provide food) and they signalled either the arrival of the reward (corn) or that the chickens would not get a reward (Wichman *et al.,* 2012).

Other than visual cues, sounds have been used and, for example, ten pigs were trained to differentiate between such auditory cues (Douglas *et al.,* 2012). Pigs were trained to either go to a location with food or a location were a plastic bag was waved in front of the pig's face (Douglas *et al.,* 2012).
Together these studies provide an overview of the variety of cues and consequences used to measure cognitive bias in animals, without clear indications what works and doesn't. For this reason we tested dogs following different protocols based on the type of cue (location or bowl size) and consequences (food versus no-food or no-food with lights out or no-food in combination with a small food reward when not responding to the negative cue). In our study with 50 dogs, of which each was tested twice, cognitive bias tests with location show the most pronounced difference in latency between the negative and positive cue (total of 100 tests). These tests are also most often "understood" by the dogs (32 tests), as evident from significant longer latencies to reach the negative cue as the positive cue. Bowl size as a cue made that fewer tests (14 tests) which were understood by the dogs, in terms of discriminating between the positive cue and the negative. Dogs are able to discriminate between circles that differ 10% in size which was investigated by presenting dogs (n=8) with a pair of circles on a computer monitor (Wuister, 2016). In this MSc thesis research, dogs got sessions of ten trials (60 trials in total) in which they were rewarded with food if they made the correct choice, meaning picking the larger circle, or unrewarded if they made the wrong choice (Wuister, 2016). In our study we used bowls with a diameter of 24cm, 20cm and 16cm so there is a 10% difference between the sizes. However, the perception of the dogs was not an aerial view, so it might be that this difference was not as clear by looking at the side-view of the bowls. Another aspect of the bowl size is that maybe the dogs are used to a certain bowl size and that they tend to view this size as promising. The type of cue used is likely to influence how readily dogs learn an association and it seems that visual cues such as the grey scale used by Burman *et al.* (2011) are more difficult to learn than spatial cues. Burman et al. (2011) reported a mean 93 trials needed to reach learning criterion in the former and 29 in the latter. The number of trials needed for the dogs to actually differentiate between the positive and negative cue is an important factor to take into consideration. In our study, 46 out of 100 tests were understood and training consisted of 15 trials per dog in which the dog could learn the difference between two cues in signalling a food reward or not. In most cognitive bias studies dogs had multiple training sessions which lasted several days and which were repeated extensively (Mendl *et al*., 2010b; Karagiannis *et al.,* 2015; Burman *et al.,* 2011; Müller *et al.,* 2012; Titualer *et al.,* 2013; Kis *et al.,* 2015). Most of the studies used a learning criterion before going into the test phase, like that for the foregoing three positive trials and the foregoing three negative trials the longest latency to approach the positive location was shorter than any of the latencies to reach the negative location (Mendl *et al.,* 2010b). Other criteria used were that the dog had to run faster to the rewarded than to the unrewarded position, with a minimal of one second difference between the slowest run towards the rewarded position and fastest run towards the position (Burman *et al.,* 2011). Training has been ended when the longest latency to approach the positive location was shorter than the shortest latency to approach the negative location for the last ten trials or when the maximum trials (120) were achieved (Müller *et al.,* 2012). Dogs' learning require that tasks are repeated over time, preferably with time spaced between learning trials. Eighteen dogs were trained to touch a mouse pad with their front paw. The dogs were divided into two training groups, one group which trained five times a week and another group which trained once a week. It was concluded that dogs that trained once a week learned better given the same amount of training time (Meyer and Ladewig, 2008; Demant, 2011).

Analysing the cognitive bias tests in which our dogs discriminated between the positive cue and the negative cue (46 tests that were understood), it appeared that the tests with location were understood the best expressing as the biggest difference in latencies to the positive cue and negative cue. The best protocols in our study seemed to be the standard test, with a baited and unbaited bowl, and the light test, with the baited bowl and the unbaited bowl accompanied with the 5s lights off. Earlier studies showed how cognitive bias in dogs can be measured with location as cue for discriminating between the positive event and the negative event, being rewarded with food or being unrewarded (Mendl *et al*., 2010b; Karagiannis *et al.,* 2015; Müller *et al.,* 2012, Titualer *et al.,* 2013). What remains uncertain is whether or not our procedure of 5s light-off acted as a punisher. Rodents are sensitive to light, with intense light being aversive (Burman *et al.,* 2009), in line with rats being crepuscular animals. For dogs, this would then be the other way around, since dogs are diurnal. Even though, it is debatable in the present study if dogs perceived the short lasting darkening as aversive it will have functioned of a marker for their choice, however the addition of this "aversive" consequence to the cognitive bias protocol did not improve learning in our dogs. Another protocol which was developed in this study was is the extra treat variation. In this variation dogs would suffer a consequence by going to the negative cue, meaning that they missed out on the extra treat given by the owner when staying put.

By making the approach of the negative cue more costly, we hoped to make dogs more carefully consider its decision to run or not. In other studies, as mentioned before, a wrong choice has a bigger consequence than only having an unbaited bowl. The addition did not lead to improved learning in comparison to the application of the conventional spatial discrimination with food or no-food.

Using a standard cognitive bias test based on location discrimination, dogs with different backgrounds showed different latencies to reach the test cues. Trainee assistance dogs from Hulphond Nederland (HN) showed the most distinguished difference in latency between the positive and negative cue. Groups of dogs were tested at different locations and one could argue that this explained differences between groups. Arena size in cognitive bias tests does matter when it comes to latency differences (University of Lincoln *et al.,* 2013; University of Lincoln, 2013). Such effects are not expected to have played a major role in the present study as arena sizes were standardized across the different locations. There were differences between test locations though. Trainee assistance dogs were trained to not approach a food bowl unless a specific command ("smullen") was given. In our test we wanted the dogs to have a choice so we used a different command ("release"). Later it was disclosed that the "release" command was only used in the setting of dogs going off the leash in the forest, but never in combination with food. This implies that the command "release" in the context of the cognitive bias test may have been confusing to the trainee assistance dogs. We agreed with the handlers that they would interpret whether the dog had understood the command, and repeat it for a maximum of three times if the dog did not show signs of understanding. Trainee assistance dogs often carried the empty (negative cue) back with them and the playing around may have functioned as positive feedback, making the negative cues less negative and test outcome biased towards pessimism. Some dogs were handled by different handlers during the two tests and, for example, the room at HN was not as dark as the room used for private dogs and shelter dogs. Times between two cognitive tests fluctuated from hours, up to one day for some trainee assistance dogs and shelter dogs only. The dogs' body position at start differed between sitting and standing, with shelter dogs typically doing the latter. Variation in the aforementioned factors will have caused variation in the data, decreasing the likelihood that effects could be identified as significant. Satiety levels of the dogs were controlled to a limited degree by instructing owners and handlers not to feed the dogs one hour prior to testing. In earlier cognitive bias studies with dogs, the latter were first rewarded with food as to produce positive affect but next acted pessimistically assumingly because they had a full stomach and were not as motivated anymore to run towards the bowls (Burman *et al.,* 2011). Controlling satiety levels when testing dogs for cognitive bias in a model based on food rewards seems important.
Cognitive bias test outcomes for optimism were compared to owner reports using ANOVA, which did not reveal any correspondence. Apparently, the behaviour tests measures something different in the dogs than what owners perceive as optimism in daily life. An alternative way of analysing results was done in that behaviour test outcomes were expressed nominally as being optimistic or pessimistic and evaluated for sensitivity and specificity against the owner reported assessment as golden standard. It showed that it meant that 24% of the dogs were identified as being either optimistic or pessimistic in the tests, with a correct identification (in comparison with the survey scores) of 29%. This shows that there is still some progress to be made in either the behavioural tests on optimism or the survey use for assessing this on the basis of owner reports. The survey contained four questions about the dog being pessimistic or optimistic, and a dog was deemed pessimistic if one of the answers was not maximal. It is questionable if this is the most accurate way and some answer were confusing to the owners, meaning that another survey may need to be developed and validated.
We hypothesised that dogs from the shelter would be more pessimistic than pet dogs, because shelter dogs often show indications of chronic stress and prolonged negative affect (Stephen and Ledger, 2005; Titualer *et al.,* 2013; Mendl and Paul, 2004; Broom, 2007; Wurbel, 2009). Present findings did not confirm this, for which several explanations exist. First of all, the shelter dogs may have experienced the tests as a positive event, since they were getting attention and were out of their kennels. This might have influenced their affective state towards the positive. The opposite might hold true for private dogs, as they were taken to the test facility, which was an unknown place and room, possibly causing anxiety. As indicated, trainee assistance dogs often played around with the empty bowl (negative cue) making it less negative and bending scores towards optimism. The issue here may be that short-lasting states (emotions) may intervene with the measurement of longer lasting affective states (moods) that more closely link to living conditions. An induced emotion influences the outcome of the cognitive bias test as was seen in earlier studies (Burman *et al.,* 2009). For example, human participants were asked to estimate the probability of losing or winning during a gambling bet (likely, unlikely, extreme unlikely et cetera) and positive emotions were induced by presenting one group of participants with a bag of candy.

This made them overestimate the prospects associated with phrases of winning compared to those of losing (optimism) and tended to bet less compared to controls (caution) (Nygren *et al.,* 1996).

It was tested if the understanding of cognitive bias tests, in terms of discriminating between positive cues and negative ones, was dependent on the three groups, but this was not the case (χ^2, P=0.62). Shelter dogs understood the least number of tests (37.5%), while Private dogs (47.9%) and trainee assistance dogs (50%) almost understood half of the tests. Possibly, shelter dogs were a bit more excited during tests and / or the least trained. Training increases learning ability of a dog where high excitability (arousal) is associated with impairment of learning (Gold, 1995; Morley *et al.*, 2001). Male Wistar rats (n=64) were administered with different doses of drugs (producing hyperactivity and hyperthermia) to see the effect of these drugs on several memory tasks and high doses of the drugs impaired memory and thereby learning. Age of the dogs may have played a role in the discriminative learning as the mean age of shelter dogs was higher (6.17 ± 2.55) than that of the privately owned dogs (4.48 ± 3.08) and of the trainee assistance dogs (1.14 ± 0.36). Old age is associated with reduced learning and memory (González-Martínez *et al.,* 2013). Dogs (n=87) were categorised into four categories (young, middle-aged, cognitively unimpaired aged or cognitively impaired aged) and had to perform a food searching task and a problem solving task. It showed that young dogs were faster and more capable in finding food, and had a better performance in the problem solving task (González-Martínez *et al.,* 2013).

Parenting styles of an owner could have an effect on the welfare of an animal. In studies with children it is shown that each parenting style has its own influence on the competence of the child. The impact of the authoritative parenting style was found to be associated with good adjustment of the child to school and the child's engagement to school and customarily a high performance. The children from these parents typically showed better problem solving and critical thinking. Authoritarian parents discourage independence of the child and the excess control these parents often exhibit has been affiliated with children's passivity and an absence of interest in learning. If a child's environment is not controlled, which is typical for permissive parents, the child has an increased risk of becoming impulsive. Moreover, these children have the tendency to not be as successful as children that were raised with a different parenting style (Aunola and Nurmi, 2005). Since the bond between owner-dog and parent-child is similar in terms of attachment behaviour it is possible that an owner's parenting style also influences the competence of its dog. Six-hundred-seventy-nine participants filled in a survey which assessed the effect of human-dog attachment on the dislike dogs had for training (Volsche, 2015). Two surveys were used, one for professional dog trainers and one for dog owners. The survey for owners had four parts: demographic data, PALS survey (PALS survey: The Pet Attachment and Life-Impact questionnaire is a psychometric designed to assess owner to pet attachment levels), dog training philosophies and open questions. It was suggested by Volsche that parenting styles and dog training techniques have a lot of similarities (see also Appendix – X). We wondered if we could also see an association between parenting style and optimism scores. In humans it was demonstrated that adolescents who viewed their parents as authoritative or permissive were more optimistic than adolescents who perceived their parents as authoritarian or neglectful (Cenk and Demir, 2015). The 1353 adolescents filled in the Life Orientation Test (LOT) to measure optimism. To assess their view on the parenting style of their parent the Parental Attitude Scale (PAS) was used. This tool was developed to measure three patterns: acceptance/involvement, strictness/supervision and psychological autonomy (Lamborn *et al.,* 1991). Only the two dimensions acceptance/involvement and strictness/supervision were used since they indicated the parenting styles (Cenk and Demir, 2015). In our study we did not find such an association between parenting style and optimism scores. It seems that when a person expresses a certain parenting style clearly, which in our study was indicated with a high percentage for a given style, a dog will be relatively more optimistic. In our study only the authoritarian and permissive parenting styles had this significant effect. That the authoritative parenting style did not have similar effects might have something to do with the type of questions asked in the questionnaire, as most of the questions were rather harsh (e.g. "I use a corrective flick when my dog misbehaves") so some people might not fill in the correct answer because they are afraid of how this might represent them. Alternatively, it may have resulted from the distribution of the questions which were used to calculate the score (13 for authoritative, 9 for authoritarian and 6 for permissive), though these questions were validated and should therefore be indicative of parenting styles. It should be taken into consideration that participants of the behavioural tests did not give a complete representation of the whole population since not all types of owners would participate in these tests, for examples those being extremely authoritarian, permissive.

The underlying dimensions of parenting are demandingness and responsiveness, which are both high with an authoritative parenting style and this means that this style has several aspects in common with both the authoritarian and permissive parenting styles. It may be more difficult to ascertain effects of this parenting style relative to the two others.

Conclusion

The main aim of this study was to identify which combination of cues and consequences are best to determine optimism by cognitive bias in dogs. Cognitive bias tests based on local discrimination worked better than those based on size discrimination, in that in these tests the most pronounced difference in latencies to reach negative cues and positive cue were found. The tests based on locations also resulted in a higher number of tests that were understood by the dogs. We hypothesised that shelter dogs would be more pessimistic than privately owned and trainee assistance dogs, but this was not confirmed. Ultimately we wanted to see if there was a relation between parenting style scores of dog owners and cognitive bias scores in the dogs. Such a relation could be used for a better adoption process and better matching of prospective owners with shelter dogs. There was a relation between parenting style score and cognitive bias score for two parenting styles: authoritarian and permissive. Surprisingly, in both cases the higher parenting scores were associated with higher levels of optimism in the dogs, possibly indicating that an outspoken parenting style, regardless of which type, works better for dogs than ambiguity in the way of parenting. Additional research is needed to better understand this relation better and it is interesting to know if some parenting styles have a favourable effect on the well-being of dogs, as well as if dogs with a certain cognitive bias thrive better under certain parenting styles. Such research might have great practical relevance for the adoption procedure of shelter dogs.

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Appendices

Appendix I – Subjects

Group	Name	Gender	Neutered	Age (years)	Breed
Private	Nous	female	no	9	Golden Retriever
Private	Mailo	male	no	7	Dutch Smoushond
Private	Sem	male	yes	11	Labrador Retriever
Private	Bo	male	yes	1	Mixed
Private	Aviendha	female	no	4	Groenendael
Private	Woody	male	yes	2	Teckel
Private	Nija	female	yes	4	Mixed Mastiff and American bulldog
Private	Djessie	female	no	3	Chihuahua
Private	Amy	female	yes	4	Mixed
Private	Saar	female	yes	6	Labrador Retriever
Private	Nik	male	yes	5	Mixed Retriever
Private	Turi	male	no	1	Swedisch vallhund (Västgötaspets)
Private	Watson	male	no	0.5	Teckel
Private	Garon	male	yes	9	Golden Retriever
Private	Zoë	female	no	4	Stabyhoun (Stabij)
Private	Morris	male	no	1	Mixed Old German Shepherd
Private	Mans	male	no	3	German Pinscher
Private	Abi	female	yes	3	Mixed
Private	Imke	female	no	1	Stabyhoun (Stabij)
Private	Lobke	female	no	4	Staffordshire Bull Terrier
Private	Boasz	male	no	3	Schnauzer (Riessenschnauzer)
Private	Zorro	male	yes	5	Mixed Beagle and Labrador Retriever
Private	Tommy	male	no	6	Chihuahua
Private	Noa	female	yes	11	Labrador Retriever

HN	Denthe	female	yes	1	Mixed
HN	Ivy	female	yes	2	Labrador Retriever
HN	Zep	female	yes	2	Labrador Retriever
HN	Doebus	female	yes	1	Mixed
HN	Evan	male	yes	1	Labrador Retriever
HN	Gydo	male	yes	1	Labrador Retriever
HN	Funkie	male	yes	1	Labrador Retriever
HN	Dango	male	yes	1	Labrador Retriever
HN	Gwendy	female	yes	1	Labrador Retriever
HN	Moos	female	yes	1	Labrador Retriever
HN	Mawo	male	yes	1	Labrador Retriever
HN	Galvin	male	yes	1	Golden Doodle
HN	Flac	male	yes	1	Labrador Retriever
HN	Djazz	female	yes	1	Mixed

DOC-T	Lola	female	no	3	American Staffordshire Terrier
DOC-T	Shasta	male	no	6	German Shorthaired Pointer
DOC-T	Benji	male	yes	1	Mixed Shepherd
DOC-T	Kelly	female	no	8	Malinois
DOC-T	Aiko	male	yes	7	Mixed Husky
DOC-T	Kyra	female	no	10	American Staffordshire Terrier
DOC-T	Dexter	male	no	7	American Staffordshire Terrier
DOC-T	Trudie	female	no	5	Mixed Staffordshire Bull Terrier
DOC-T	Tipie	female	no	5	Mixed Jack Russell Terrier
DOC-T	Tyson	male	no	9	American Staffordshire Terrier
DOC-T	Iris	female	no	8	Mixed Staffordshire Bull Terrier
DOC-T	Corry	female	no	5	Malinois

Appendix II – Survey CBT

Cognitive bias vragenlijst

Naam van de hond: ______________________

Postcode: ______________________

Als je het gezegde 'het glas is voor iemand half vol of half leeg' in gedachte neemt, is het glas (de voerbak) voor jouw hond dan:

O Half vol, je hond kijkt overwegend positief naar wat er om hem heen gebeurt
O Half leeg, je hond kijkt overwegend negatief naar wat er om hem heen gebeurt

Mijn hond is overwegend:

O Gelukkig en blij ('happy')
O Bezorgd en bedrukt ('worrisome')

Als er iets gebeurt in de omgeving van je hond, reageert hij dan overwegend:

O Enthousiast
O Bezorgd

Wat zou je hond doen als hij/zij een onbekend object ziet?

O Gaat er snel op af om het object te verkennen
O Blijft op een afstand en gromt naar het object
O Gaat er kalm op af
O Blijft op een afstand

Appendix III – Test protocol and trial sequence

Table 1. Test protocols of the cognitive bias test.

Cues	Test variation	Reward	Aversive event
Location (I)	Standard test (a)	Food	No food
	Light (b)	Food	No food & Lights off
	Extra treat (c)	Food	No food
Size (II)	Standard test (a)	Food	No food
	Light (b)	Food	No food & Lights off
	Extra treat (c)	Food	No food

Table 2. Pre-training trials

Position	Trials
Positive, ***1m***	1
Positive, ***1.5m***	2
Positive, **3m**	3
Positive	4
Negative	5
Positive	6
Negative	7
Negative, pull back	8
Positive	9
Negative, pull back	10
Negative, pull back	11
Positive	12
Negative	13

Table 3. Training (test) trials

Position	Trials
Positive	1
Negative	2
Positive	3
Positive	4
Positive	5
Negative	6
Negative	7
Positive	8
Negative	9
Positive	10
Negative	11
Positive	12
Positive	13
Negative	14
Positive	15
Middle	16

Appendix IV – Form used during tests

Hond: ______________________________

VoterID: ______________________________

Test: I II

Test variation: a b c

Position	Trials	Latency	Section
Positive	1		
Negative	2		
Positive	3		
Positive	4		
Positive	5		
Negative	6		
Negative	7		
Positive	8		
Negative	9		
Positive	10		
Negative	11		
Positive	12		
Positive	13		
Negative	14		
Positive	15		
Middle	16		

I= location II= bowlsize	a= standard b= standard+ light c= standard + extra treat

Positive = ______________________

Negative = ______________________

MR MAS-student

Position	Trials	
Positive, ***near dog***	1	
Positive, ***halfway***	2	
Positive	3	
Positive	4	
Negative	5	
Positive	6	
Negative	7	
Negative, pull back	8	
Positive	9	
Negative, pull back	10	
Negative, pull back	11	
Positive	12	
Negative	13	

Appendix V – PCA large (62 items) parenting style questionnaire

Table 1. PCA loadings

Questions	load[1]	load[2]	load[3]	load[4]
Q133	0.3559	-0.4466	0.0289	0.0886
Q138	0.3557	-0.4894	0.0539	0.1316
Q143	-0.0444	0.0495	0.3832	0.0841
Q148	-0.4554	-0.3244	-0.0755	0.3248
Q153	0.1114	-0.4011	-0.0912	0.1418
Q158	-0.4733	-0.2760	0.0221	0.0966
Q163	-0.4516	-0.1214	0.1283	-0.2065
Q168	0.3033	-0.3087	0.2680	0.0266
Q173	-0.5884	-0.2456	0.0901	0.2019
Q178	-0.0753	0.5632	0.2937	0.0815
Q183	-0.0076	-0.5481	-0.0983	0.0655
Q188	0.3062	-0.3834	0.2820	0.0868
Q193	-0.5230	-0.1315	0.2572	0.1081
Q198	0.2712	-0.6235	-0.2710	-0.0216
Q203	0.1438	-0.0843	0.3383	-0.3052
Q208	-0.5742	-0.2805	-0.1857	-0.2104
Q213	0.2761	-0.5549	-0.0441	-0.1816
Q218	-0.5266	-0.2979	-0.1646	-0.1907
Q223	0.3657	-0.3709	0.3270	-0.0100
Q228	-0.3773	-0.1497	0.1809	-0.2841
Q501	-0.4005	0.0615	0.3529	-0.0434
Q506	0.4480	-0.2504	0.2248	-0.0586
Q511	-0.3847	-0.1073	0.1196	0.2465
Q516	-0.0876	0.1142	0.4095	-0.3022
Q521	-0.4786	-0.3320	-0.0447	0.0124
Q526	0.4146	-0.5008	0.1102	0.1254
Q531	-0.5202	-0.3157	-0.0980	0.2497
Q536	-0.0761	0.5227	-0.0153	0.2145
Q541	-0.3783	-0.0184	0.4540	0.2669
Q546	0.0855	-0.0104	0.2702	-0.2884
Q551	-0.2167	0.0364	0.4361	0.4003
Q556	-0.3214	0.0829	0.4789	0.2797
Q561	0.3867	-0.3484	0.3179	0.0425
Q566	-0.4667	-0.1912	-0.1749	0.3735
Q571	0.0834	-0.0152	0.2248	0.4096
Q576	-0.5467	-0.3071	-0.1789	-0.3609
Q581	0.3888	-0.4154	0.1517	0.1974
Q586	-0.5712	-0.1445	-0.1377	0.2227
Q591	0.3771	-0.4468	0.1332	0.1794
Q596	0.2293	-0.2117	0.4344	0.1097
Q601	-0.6404	-0.1120	0.2604	0.1278
Q606	-0.3426	0.1780	0.4941	0.0600
Q611	0.2532	-0.0593	0.2587	-0.2724
Q616	0.3951	0.2518	0.2716	-0.2427
Q621	-0.5214	-0.2926	-0.0651	-0.2036
Q626	0.2768	-0.1831	0.0886	-0.2598
Q631	-0.4332	-0.1577	0.1335	0.0016
Q636	0.0616	-0.1766	0.2463	-0.2770
Q641	-0.4428	0.0426	0.3292	-0.3347
Q646	-0.0305	0.1032	0.4435	-0.2676
Q651	-0.5346	0.0458	0.3438	-0.0484
Q656	0.4275	-0.2803	0.3066	0.0334
Q661	-0.2311	-0.1563	0.0750	-0.1335
Q666	0.2622	-0.1299	0.4481	0.0001
Q671	-0.3513	-0.1786	0.1175	0.1122
Q676	-0.0451	0.0890	0.2195	-0.0930
Q681	0.3817	-0.5219	0.0696	0.0901
Q686	0.2215	0.4479	0.0760	0.2579
Q691	-0.2321	-0.1782	0.3382	-0.2107
Q696	-0.4591	-0.4250	-0.2153	-0.1699

Q701	-0.0969	0.1921	0.5547	0.0716
Q706	-0.5662	-0.2552	0.0750	-0.2530

Percentage of variation of principal components analysis: Load [1] 13.87%, Load [2] 8.93%, Load [3] 6.85% and Load [4] 4.19%.
Dark grey = loading>0.4
Light grey= loading<0.4, but the highest loading of that question

Table 2. Questions corresponding with the PCA loadings.

	Question	Official PS	Correlation
Authoritative parenting style			
Q148	Ik heb het leuk met mijn hond.	AUTV	-0.4554
Q158	Ik moedig mijn hond aan ‘hond’ te zijn, ook als het leidt tot een vieze of natte hond.	AUTV	-0.4733
Q163	Ik lok gewenst gedrag uit bij mijn hond met voer of spel, ook als hij zich op dat moment misdraagt.	PERM	-0.4516
Q173	Ik toon respect voor de behoeften van mijn hond door hem aan te moedigen ‘hond’ te zijn.	AUTV	-0.5884
Q193	Ik houd voorkeuren van mijn hond in gedachten als ik plannen maak.	AUTV	-0.5230
Q208	Ik oefen gedrag stap voor stap met mijn hond, zodat ik zeker weet dat hij begrijpt wat ik van hem vraag.	AUTV	-0.5742
Q218	Ik buig ongewenst gedrag van mijn hond om naar meer gewenst gedrag.	AUTV	-0.5266
Q228*	Ik zet een beloning in (voer/speeltje) als mijn hond echt iets moet doen.	AUTV	-0.3773
Q501	Ik moedig mijn hond aan zijn gemoedstoestand te tonen, zo mag hij grommen bij ongemak.	AUTV	-0.4005
Q506	Ik stuur mijn hond meer op basis van straf dan door gebruik te maken van zijn natuurlijke behoeften.	AUTN	0.4480
Q511*	Ik ken de namen van hondse speelkameraadjes van mijn hond.	AUTV	-0.3847
Q521	Ik prijs mijn hond als hij iets goed doet.	AUTV	-0.4786
Q526	Ik gebruik een corrigerende tik als mijn hond zich misdraagt.	AUTN	0.4146
Q531	Ik speel en heb plezier met mijn hond.	AUTV	-0.5202
Q561*	Ik roep of schreeuw als mijn hond zich misdraagt.	AUTN	0.3867
Q566	Ik ben makkelijk en ontspannen in de omgang met mijn hond.	AUTV	-0.4667
Q576	Ik oefen bepaald gedrag met mijn hond, voordat ik dat gedrag vraag in een voor de hond moeilijke situatie.	AUTV	-0.5467
Q586	Ik toon geduld met mijn hond.	AUTV	-0.5712
Q601	Ik houd rekening met de gevoelens en behoeften van mijn hond.	AUTV	-0.6404
Q616*	Ik ben zelfverzekerd wat betreft de opvoeding van mijn hond.	***PERM***	0.3951
Q621	Ik denk na over regels die ik mijn hond opleg.	AUTV	-0.5214
Q626*	Ik ben meer bezorgd over mijn eigen gevoelens dan die van mijn hond.	AUTN	0.2768
Q631	Ik vertel mijn hond dat hij braaf is als hij probeert mijn sturing op te volgen, zelfs als hij daarin niet slaagt.	AUTV	-0.4332
Q641	Ik help mijn hond inzien wat het gevolg is van zijn gedrag, door hem keuzes te geven in situaties.	AUTV	-0.4428
Q651	Ik houd de wensen van mijn hond in gedachten voordat ik hem vraag iets te doen.	AUTV	-0.5346
Q656	Ik kan in woede uitbarsten richting mijn hond als hij iets doet waarvan hij weet dat ik dat niet wil.	AUTN	0.4275
Q661*	Ik ben op de hoogte van zorgen over mijn hond die mijn buren (mogelijk) hebben.	AUTV	-0.2311
Q671*	Ik toon affectie aan mijn hond door te aaien, bijvoorbeeld onder zijn kin.	AUTV	-0.3513
Q696	Ik geef aan mijn hond aan, wat ik van hem verwacht.	AUTN	-0.4591
Q706	Ik denk na over waarom mijn hond iets doet als hij zich misdraagt.	AUTV	-0.5662
Authoritarian parenting style			
Q133	Ik prik met mijn vinger, of geef een kort schopje als mijn hond zich misdraagt. Zo haal ik hem uit het gedrag.	AUTN	-0.4466
Q138	Ik gebruik korte rukjes aan de lijn, of trek terug, als mijn hond aan de lijn trekt.	AUTN	-0.4894
Q153	Als twee honden vechten, corrigeer ik eerst, om daarna na te denken over waarom het gebeurde.	AUTN	-0.4011
Q168*	Ik scheld en heb kritiek als het gedrag van mijn hond niet voldoet aan mijn verwachtingen.	AUTN	-0.3087
Q178	Ik bepaal duidelijke, strenge regels voor mijn hond.	***PERM***	0.5632
Q183	Ik laat mijn hond weten hoe ik denk over goed en slecht gedrag van	AUTV	-0.5481

	hem.		
Q188*	Ik zet dreigen in als straf, zonder noodzaak te voelen tot rechtvaardiging richting mijn hond.	AUTN	-0.3834
Q198	Als ik mijn hond iets vraag, moet hij dat doen, omdat ik het zeg en ik de baas ben.	AUTN	-0.6235
Q213	Ik eis dat mijn hond dingen doet.	AUTN	-0.5549
Q223*	Ik duw of trek aan mijn hond als hij ongehoorzaam is.	AUTN	-0.3709
Q536	Ik geef consequenties (gevolgen) aan het gedrag van mijn hond als deze iets tegen mijn zin doet.	***PERM***	0.5227
Q581	Ik verhef mijn stem als mijn hond zijn gedrag moet verbeteren.	AUTN	-0.4154
Q591	Ik pak mijn hond beet als hij ongehoorzaam is.	AUTN	-0.4468
Q681	Ik gebruik fysieke (lichamelijke) correcties (bijvoorbeeld een tik of een slipketting) als een manier om het gedrag van mijn hond te verbeteren.	AUTN	-0.5219
Q686	Ik zorg voor consequenties (een leermoment) als mijn hond ongewenst gedrag toont.	***PERM***	0.4479
Q696**	Ik geef aan mijn hond aan, wat ik van hem verwacht.	AUTN	-0.4250
Permissive parenting style			
Q143*	Ik sta mijn hond toe op te springen tegen mensen, als het maar vriendelijk is.	PERM	0.3832
Q203*	Ik ben onzeker over het oplossen van ongewenst gedrag bij mijn hond.	PERM	0.3383
Q516	Ik vind het moeilijk om mijn hond te corrigeren.	PERM	0.4095
Q541	Ik toon medeleven als mijn hond pijn heeft of gefrustreerd is.	AUTV	0.4540
Q551	Ik verwen mijn hond.	PERM	0.4361
Q556	Ik troost mijn hond als hij overstuur is.	AUTV	0.4789
Q596	Ik dreig met straf richting mijn hond, maar voer het niet daadwerkelijk uit.	PERM	0.4344
Q606	Ik sta toe dat mijn hond mijn besluiten beïnvloedt, bijvoorbeeld wat betreft de route tijdens de wandeling.	AUTV	0.4941
Q646	Ik ben bang dat het corrigeren van mijn hond bij ongewenst gedrag ertoe leidt dat hij me minder leuk vindt.	PERM	0.4435
Q666	Ik dreig vaker naar mijn hond dan dat ik echt een correctie geef.	PERM	0.4481
Q676*	Ik negeer ongewenst gedrag van mijn hond zoals najagen van wild, blaffen naar vreemden of plassen tegen winkels in een winkelgebied.	PERM	0.2195
Q691*	Ik voel me slecht naar mijn hond als ik een fout maak bij zijn begeleiding.	AUTV	0.3382
Q701	Ik ben toegeeflijk richting mijn hond als hij scène maakt (blaft, uitvalt), of iets niet doet wat ik wil.	PERM	0.5547

Italic and bold = reversed scale score
*= correlation lower than 0.4
**=correlation higher than 0.4, but also (a higher) correlation in loading 1

Appendix VI –PCA small (42 items) parenting style questionnaire.

Table 1. PCA Loadings

Questions	load[1]	load[2]	load[3]	load[4]
Q94	-0.0285	0.5371	0.0988	0.1712
Q99	-0.2974	0.0095	-0.3561	-0.1026
Q104	0.3358	0.2595	-0.3868	-0.4257
Q109	0.2593	-0.2881	-0.2859	0.2934
Q114	0.1521	-0.2828	-0.4794	-0.0823
Q119	-0.0470	-0.2153	-0.5059	0.0236
Q124	-0.4567	0.4724	0.0791	0.0346
Q129	0.3408	0.3008	-0.1640	0.0497
Q134	-0.0812	0.1396	-0.4387	0.2699
Q139	-0.5521	0.2058	0.0143	-0.1447
Q144	0.4355	0.3291	-0.3636	-0.2838
Q149	-0.5271	0.3917	0.0770	0.1750
Q154	0.2864	0.4792	-0.2258	0.1751
Q159	0.3832	0.3382	-0.1473	0.2878
Q164	-0.3356	-0.0810	-0.3870	0.3655
Q169	0.0926	-0.5486	-0.0594	-0.2841
Q174	0.2321	0.1931	-0.4020	-0.3080
Q179	-0.5155	0.4523	0.0422	0.1678
Q184	0.2816	0.5577	-0.2099	0.2367
Q189	-0.4395	0.1365	-0.1444	-0.0228
Q194	0.0049	-0.3221	-0.5627	0.1106
Q199	0.4097	0.4507	-0.0227	0.0560
Q204	-0.3787	0.0671	-0.1925	-0.2153
Q209	0.1536	0.4892	-0.2825	-0.1229
Q214	-0.4381	0.5620	0.1083	-0.0596
Q219	-0.2369	-0.3084	-0.4984	0.1992
Q224	-0.3760	0.0380	-0.4613	-0.1273
Q229	0.2128	0.3536	-0.1732	0.0899
Q234	-0.0390	-0.1959	-0.3318	0.0842
Q239	-0.5012	0.0888	-0.3981	-0.1410
Q244	-0.6534	0.2179	0.0659	-0.0165
Q249	0.2675	0.4037	-0.0165	-0.1629
Q254	0.2603	0.4950	0.0226	0.0614
Q259	-0.1944	-0.0283	-0.2356	0.0373
Q264	-0.2307	-0.5593	-0.2871	0.0524
Q269	0.2433	-0.0114	-0.2675	0.4000
Q274	0.3961	0.3407	-0.3123	-0.0938
Q279	-0.5658	0.1899	-0.1582	-0.1098
Q284	-0.5964	0.1797	-0.2133	-0.1834
Q289	0.2560	-0.0052	-0.4617	-0.1379
Q294	-0.2798	0.2388	-0.1694	-0.0832
Q299	-0.3576	-0.0726	-0.1566	0.2837

Percentage of variation of principal components analysis: Load [1] 12.34%, Load [2] 10.89%, Load [3] 8.40% and Load [4] 3.71%.

Dark grey = loading>0.4

Light grey= loading<0.4, but the highest loading of that question

Table 2. Questions corresponding with the PCA loadings.

	Question	Official PS	Correlation
Authoritarian parenting style			
Q124**	Ik corrigeer mijn hond wanneer zijn/haar gedrag niet aan mijn verwachtingen voldoet	AUTN	-0.4567
Q129*	Ik houd rekening met mijn hond wanneer ik plannen maak	AUTV	0.3408
Q139	Ik gebruik een corrigerende tik wanneer mijn hond niet doet wat ik wil	AUTN	-0.5521
Q144	Wanneer ik zie dat mijn hond zich slecht voelt, maak ik dat hij/zij zich beter voelt	AUTV	0.4355
Q149	Wanneer mijn hond iets moet doen, is dat omdat ik dat zeg en de baas ben	AUTN	-0.5271
Q159*	Ik probeer ongewenst gedrag van mijn hond om te zetten in gewenst gedrag	AUTV	0.3832
Q179	Ik eis dat mijn hond naar mij luistert	AUTN	-0.5155
Q189	Ik corrigeer mijn hond vaak zonder erbij na te denken	AUTN	-0.4395
Q199**	Ik ben geduldig met mijn hond	AUTV	0.4097
Q204*	Ik barst in woede uit naar mijn hond	AUTN	-0.3787
Q214**	Ik corrigeer mijn hond om te zorgen dat zijn/haar gedrag betert	AUTN	-0.4381
Q239	Ik dreig als manier om te corrigeren	AUTN	-0.5012
Q244	Ik gebruik een fysieke correctie wanneer mijn hond niet doet wat ik wil	AUTN	-0.6534
Q274*	Ik sta open voor de gevoelens en behoeften van mijn hond	AUTV	0.3961
Q279	Ik pak mijn hond beet wanneer hij/zij niet naar mij luistert	AUTN	-0.5658
Q284	Ik trek / duw mijn hond als hij/zij niet naar mij luistert	AUTN	-0.5964
Q294*	Ik roep wanneer ik het gedrag van mijn hond afkeur	AUTN	-0.2798
Q299*	Ik houd me meer bezig met mijn eigen gevoelens dan met de gevoelens van mijn hond	AUTN	-0.3576
Authoritative parenting style			
Q94	Ik laat mijn hond merken wat gewenst en ongewenst gedrag is	AUTV	0.5371
Q124	Ik corrigeer mijn hond wanneer zijn/haar gedrag niet aan mijn verwachtingen voldoet	AUTN	0.4724
Q154	Ik speel samen met mijn hond	AUTV	0.4792
Q169	Ik heb bepaalde regels waaraan mijn hond zich moet houden	***PERM***	-0.5486
Q179**	Ik eis dat mijn hond naar mij luistert	AUTN	0.4523
Q184	Ik probeer leuke momenten met mijn hond te hebben	AUTV	0.5577
Q199	Ik ben geduldig met mijn hond	AUTV	0.4507
Q209	Ik gebruik lichamelijk contact zoals knuffelen en aaien om de liefde voor mijn hond te uiten	AUTV	0.4892
Q214	Ik corrigeer mijn hond om te zorgen dat zijn/haar gedrag betert	AUTN	0.5620
Q229*	Ik prijs mijn hond wanneer hij/zij braaf is	AUTV	0.3536
Q249	Ik weet met welke honden mijn hond graag speelt en met welke niet	AUTV	0.4037
Q254	Ik ga ontspannen om met mijn hond	AUTV	0.4950
Q264	Ik kom zelfverzekerd over in de opvoeding van mijn hond	***PERM***	-0.5593
Permissive parenting style			
Q99*	Ik corrigeer mijn hond door hem/haar tijdelijk alleen te zetten	AUTN	-0.3561
Q114	Wanneer mijn hond iets niet wil doen wat ik vraag, dan laat ik het daarbij	PERM	-0.4794
Q119	Ik ben bang dat mijn hond mij niet meer aardig zal vinden als ik hem/haar corrigeer	PERM	-0.5059
Q134	Ik probeer mijn hond met beloningen "om te kopen", zodat hij/zij doet wat ik wil	PERM	-0.4387
Q164*	Ik heb vaak "strijd" met mijn hond	AUTN	-0.3870
Q174	Ik verwen mijn hond	PERM	-0.4020
Q194	Ik vind het moeilijk om mijn hond te corrigeren	PERM	-0.5627
Q219	Ik vind het moeilijk om het gedrag van mijn hond te veranderen	PERM	-0.4984
Q224	Ik dreig vaker met straf dan daadwerkelijk te straffen	PERM	-0.4613
Q234*	Ik laat toe dat mijn hond andere mensen lastig valt	PERM	-0.3318
Q259*	Ik corrigeer mijn hond door het wegnemen van zijn/haar speeltjes	AUTN	-0.2356
Q289	Ik houd rekening met mijn hond (zoals het liever niet nat willen worden) voordat ik hem/haar iets laat doen	AUTV	-0.4617

Italic and bold= reversed scale score
*= correlation lower than 0.4
**=correlation higher than 0.4, but also (a higher) correlation in loading 1

Appendix VII – Questions (from both questionnaires) used for parenting style score

PS	Q 62-item	Question in 62-item questionnaire	Q 42-item	Question in 42-item questionnaire
AUTHORITATIVE	**506**	**Ik stuur mijn hond meer op basis van straf dan door gebruik te maken van zijn natuurlijke behoeften.**	**189**	**Ik corrigeer mijn hond vaak zonder erbij na te denken**
	521	Ik prijs mijn hond als hij iets goed doet.	229	Ik prijs mijn hond wanneer hij/zij braaf is
	526	Ik gebruik een corrigerende tik als mijn hond zich misdraagt.	139	Ik gebruik een corrigerende tik wanneer mijn hond niet doet wat ik wil
	531	Ik speel en heb plezier met mijn hond.	154	Ik speel samen met mijn hond
	566	Ik ben makkelijk en ontspannen in de omgang met mijn hond.	254	Ik ga ontspannen om met mijn hond
	586	Ik toon geduld met mijn hond.	199	Ik ben geduldig met mijn hond
	601	Ik houd rekening met de gevoelens en behoeften van mijn hond.	274	Ik sta open voor de gevoelens en behoeften van mijn hond
	651	Ik houd de wensen van mijn hond in gedachten voordat ik hem vraag iets te doen.	289	Ik houd rekening met mijn hond (zoals het liever niet nat willen worden) voordat ik hem/haar iets laat doen
	656	**Ik kan in woede uitbarsten richting mijn hond als hij iets doet waarvan hij weet dat ik dat niet wil.**	**204**	**Ik barst in woede uit naar mijn hond**
	148	Ik heb het leuk met mijn hond.	184	Ik probeer leuke momenten met mijn hond te hebben
	163	*Ik lok gewenst gedrag uit bij mijn hond met voer of spel, ook als hij zich op dat moment misdraagt.*	*134*	*Ik probeer mijn hond met beloningen "om te kopen", zodat hij/zij doet wat ik wil*
	193	Ik houd voorkeuren van mijn hond in gedachten als ik plannen maak.	129	Ik houd rekening met mijn hond wanneer ik plannen maak
	218	Ik buig ongewenst gedrag van mijn hond om naar meer gewenst gedrag.	159	Ik probeer ongewenst gedrag van mijn hond om te zetten in gewenst gedrag
AUTHORITHARIAN	536	Ik geef consequenties (gevolgen) aan het gedrag van mijn hond als deze iets tegen mijn zin doet.	**114**	**Wanneer mijn hond iets niet wil doen wat ik vraag, dan laat ik het daarbij**
	581	Ik verhef mijn stem als mijn hond zijn gedrag moet verbeteren.	214	Ik corrigeer mijn hond om te zorgen dat zijn/haar gedrag betert
	591	Ik pak mijn hond beet als hij ongehoorzaam is.	279	Ik pak mijn hond beet wanneer hij/zij niet naar mij luistert
	681	Ik gebruik fysieke (lichamelijke) correcties (bijvoorbeeld een tik of een slipketting) als een manier om het gedrag van mijn hond te verbeteren.	244	Ik gebruik een fysieke correctie wanneer mijn hond niet doet wat ik wil
	686	Ik zorg voor consequenties (een leermoment) als mijn hond ongewenst gedrag toont.	**109**	**Ik corrigeer mijn hond niet wanneer hij/zij ongewenst gedrag vertoont**
	178	Ik bepaal duidelijke, strenge regels voor mijn hond.	169	Ik heb bepaalde regels waaraan mijn hond zich moet houden
	183	Ik laat mijn hond weten hoe ik denk over goed en slecht gedrag van hem.	94	Ik laat mijn hond merken wat gewenst en ongewenst gedrag is
	198	Als ik mijn hond iets vraag, moet hij dat doen, omdat ik het zeg en ik de baas ben.	149	Wanneer mijn hond iets moet doen, is dat omdat ik dat zeg en de baas ben
	213	Ik eis dat mijn hond dingen doet.	179	Ik eis dat mijn hond naar mij luistert
PERMISSIVE	516	Ik vind het moeilijk om mijn hond te corrigeren.	194	Ik vind het moeilijk om mijn hond te corrigeren
	541	Ik toon medeleven als mijn hond pijn heeft of gefrustreerd is.	144	Wanneer ik zie dat mijn hond zich slecht voelt, maak ik dat hij/zij zich beter voelt
	551	Ik verwen mijn hond.	174	Ik verwen mijn hond
	556	Ik troost mijn hond als hij overstuur is.	104	Ik troost mijn hond en toon begrip wanneer hij/zij een slechte dag heeft
	646	Ik ben bang dat het corrigeren van mijn hond bij ongewenst gedrag ertoe leidt dat hij me minder leuk vindt.	119	Ik ben bang dat mijn hond mij niet meer aardig zal vinden als ik hem/haar corrigeer
	666	Ik dreig vaker naar mijn hond dan dat ik echt een correctie geef.	224	Ik dreig vaker met straf dan daadwerkelijk te straffen

Bold = reversed scale
Italic = not used, not the same translation in the two questionnaires, one correlates with permissive, other with authoritative parenting style

Appendix VIII - CBS of all dogs

Subject	Group	Name	CBS_rough*	CBS_predict*
1	DOC-T	Aiko**	-0.43	0.00
2	DOC-T	Benji	-0.65	-0.53
3	DOC-T	Dexter**	-1.00	-0.65
4	DOC-T	Iris	-1.00	-0.35
5	DOC-T	Lola	-0.80	-0.56
6	DOC-T	Trudie	-1.00	-0.02
7	DOC-T	Tyson	0.00	0.00
8	Private	Amy	-0.35	0.00
9	Private	Aviendha**	-1.00	0.00
10	Private	Djessie	-0.15	-0.08
11	Private	Garon	-1.00	-1.00
12	Private	Imke**	-0.86	0.00
13	Private	Lobke	-1.00	-0.58
14	Private	Mailo	0.00	0.00
15	Private	Mans	-1.00	-0.62
16	Private	Morris	-1.00	-0.46
17	Private	Nija	-0.11	-0.04
18	Private	Noa	0.00	-1.00
19	Private	Nous	-1.00	0.00
20	Private	Saar	-0.37	-0.14
21	Private	Sem**	0.00	0.00
22	Private	Tommy	-0.37	-0.13
23	Private	Turi	-1.00	-0.76
24	Private	Watson**	0.00	0.00
25	Private	Woody	-0.44	-0.17
26	Private	Zoë	-0.55	-0.32
27	HN	Dango	-1.00	0.00
28	HN	Denthe	0.00	0.00
29	HN	Djazz	0.00	0.00
30	HN	Evan	-0.02	0.00
31	HN	Flac**	-0.29	-0.51
32	HN	Funkie	-1.00	-0.54
33	HN	Galvin	0.00	0.00
34	HN	Gydo**	-0.68	-0.63
35	HN	Ivy	-1.00	-1.00
36	HN	Mawo	0.00	0.00
37	HN	Moos	-1.00	0.00
38	HN	Zep	-0.94	-0.53

* CBS scores calculated with the raw data (CBS_rough) and the predicted data from the ANOVA analyses (CBS_predict).
** These dogs understood two tests and thus had two different CBS. We chose to take the mean of the two CBT scores to further analyse the scores.

Appendix IX - Cognitive bias scores, Parenting style scores and Survey scores for private dogs

Group	Name	CBS_rough*	CBS_predict*	CBS_Survey**	AUTN_Validated[#]	AUTV_Validated[#]	PERM_Validated[#]
Private	Amy	-0.35	0.00	-1.00	25.00	68.75	70.83
Private	Aviendha[§]	-1.00	0.00	0.00	25.00	76.92	66.67
Private	Djessie	-0.15	-0.08	0.00	63.89	71.15	37.50
Private	Garon	-1.00	-1.00	-1.00	55.56	73.08	37.50
Private	Imke[§]	-0.86	0.00	-1.00	30.56	81.25	37.50
Private	Lobke	-1.00	-0.58	-1.00	44.44	77.08	41.67
Private	Mailo	0.00	0.00	-1.00	41.67	67.31	55.00
Private	Mans	-1.00	-0.62	0.00	38.89	83.33	12.50
Private	Morris	-1.00	-0.46	-1.00	27.78	81.25	41.67
Private	Nija	-0.11	-0.04	0.00	38.89	80.77	58.33
Private	Noa	0.00	-1.00	0.00	63.89	63.46	37.50
Private	Nous	-1.00	0.00	-1.00	61.11	73.08	33.33
Private	Saar	-0.37	-0.14	-1.00	58.33	82.69	33.33
Private	Sem[§]	0.00	0.00	-1.00	44.44	67.31	45.83
Private	Tommy	-0.37	-0.13	-1.00	55.56	63.46	54.17
Private	Turi	-1.00	-0.76	-1.00	38.89	73.08	29.17
Private	Watson[§]	0.00	0.00	-1.00	47.22	89.58	66.67
Private	Woody	-0.44	-0.17	-1.00	44.44	80.77	54.17
Private	Zoë	-0.55	-0.32	0.00	36.11	87.50	29.17

* CBS scores calculated with the raw data (CBS_rough) and the predicted data from the ANOVA analyses (CBS_predict).
** The survey scores were calculated by looking at the answers of the survey, scoring a dog optimistic (0) or pessimistic (-1).
\# AUTN_Validated, AUTV_Validated, and PERM_Validated are the parenting style scores in percentages calculated with the validated questions.
§ These dogs understood two tests and thus had two different CBS. We chose to take the mean of the two CBT scores to further analyse the scores.

Appendix X – Comparison of parenting style and training methods

Human Parenting Style*	Dog Training Method	Hallmarks of Methods
Authoritarian Parenting	Dominance Theory Traditional Training	Focus on control; physical correction and punishment; expectations that learner should "know better."
Authoritative Parenting	Humane Hierarchy Lure Reward Clicker Training	Focus on guidance; management of environment to mitigate behavior; reward of "good choices;" expectations that parent/owner should teach and guide towards proper choices.
Permissive Parenting	Anthropomorphism	Focus on lack of control; rationalizing beyond learner's age/capacity; expectations that love will result in proper choices.
Uninvolved/Indifferent Parenting	Anthropomorphism	Focus on autonomy; neither guidance nor control; expectations of "pre-programming"

(Volsche, 2015)