DOCTORAL DISSERTATION

EXPERIMENTAL INVESTIGATIONS OF THE IMPACT OF SOCIAL INFLUENCE ON DOG-HUMAN INTERACTIONS

ZSÓFIA SÜMEGI

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EXPERIMENTAL INVESTIGATIONS OF THE IMPACT OF SOCIAL INFLUENCE ON DOG-HUMAN INTERACTIONS

Zsófia Sümegi
author

Dr. Anna Erdei
Head of Phd School of Biology
Dr. Ádám Miklósi
Head of Ethology Program

József Topál PhD, DSc
supervisor

Eötvös University Department of Ethology

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CONTENTS

1. GENERAL INTRODUCTION

There is an increasing scientific agreement that the origin of the domestic dog dates back several tens of thousands of years. In fact, the history of dog is a history of unique behaviour evolutionary process in which they have gradually become adapted to human environment and, as a result, became sensitive to human social signals (Hernádi et al 2012; Miklósi & Topál 2013). Human social environment provides a natural niche for dogs (Miklósi 2007) who seem to be predisposed to develop close contact with humans (Gácsi et al 2005). It has been reported (e.g. Palmer & Custance 2008; Gácsi et al 2013) that the relationship between a dog and its owner fulfils the behavioural criteria of attachment (c.f. Ainsworth 1969; Rajecki et al 1978) in many respects (e.g., contact seeking with the owner in emotionally distressing situation, using the owner as a secure base) which paved the way for the development of socially competent communicative interactions and synchronised collaborative activities between dogs and their human companion.

In line with this, several studies have provided empirical evidence for inter-specific social skills in dogs (e.g. Hare & Tomasello 2005). Dogs have been reported to be especially skilful in reading the expression of human communicative intent (i.e. name calling, eye-contact - Téglás et al 2012), and in utilizing directional gestures including gaze-alternation (Soproni et al 2001) and different types of pointing gestures (Soproni et al 2002). They are also able to differentiate human emotions (Turcsán et al 2014) and show emphatic-like response toward their owners (Custance & Mayer 2012).

Experiments presented in the current doctoral dissertation were designed on the basis of the idea that domestic dog is a particularly human-tuned social animal, whose behaviour has been largely shaped, both evolutionary and developmentally, by the human.

In the first study (Study 1) we investigated the details of how dogs' perseverative search error can be affected via human communicative signals in hide-and-search tasks. In Study 2 we experimentally tested the widely held notion that dogs' behavioural responses in task situations are under the influence of their owner's emotions. Next we focused on the special case of social influence, the placebo effect. Placebo effect in humans is mostly fuelled by social influence via suggestions (e.g. verbal information from a trustworthy, certified person - Kirsch 1999) but it can also stem from simple associative learning processes (conditioned placebo effect –McMillan 1999). Based on its interspecific social skills and its capacity to be socially influenced by humans, we hypothesized that dogs are susceptible to placebo effect.

In the subsequent studies, therefore, we investigated various aspects of this phenomenon in family dogs; in Study 3 we demonstrated the existence of conditioned placebo effects in dogs and then (in Study 4) we also tested how dogs can be influenced by their owners' expectations about the test situation.

Before providing the details of experimental investigations, in the next parts of the introduction (1.1., 1.2., 1.3.) we give a short overview of the evidence about dogs' sensitivity to human communication and their susceptibility to emotional contagion and we also provide a description of placebo effect and its relevance to nonhuman animals.

1.1. Receptivity to communicative signals

Increasing evidence suggests that the adaptation to the human environment during domestication has made dogs sensitive to human social signals (Hare and Tomasello, 2005, Miklósi & Topál 2013). They possess enhanced skills to read and respond to human communicative signals (e.g. Lakatos et al 2012) while intensively socialized wolves are less successful in utilizing human gestures (Hare et al 2002; Kubinyi et al 2007; Virányi et al 2008; but see Range & Virányi 2011). Dogs are able to recognize the communicative intent (Téglás et al. 2012) such as the eye-contact which is important also in human-dog communication (Kaminski et al 2012). It has also been reported that dogs are sensitive to the human's visual access in different task situations; e.g. when they beg for food (Gácsi et al, 2004) or steal forbidden piece of food (Kaminski et al 2013) or are asked to retrieve one of two objects (Kaminski et al 2009). They also readily exploit information about humans' visual perspectives (Kaminski et al 2009a, MacLean et al 2014).

Dogs are one of most skilled animals in reading pointing signals (Miklósi & Soproni 2006), they can find the hidden food based on several different and even unusual types of directional gestures (Soproni et al 2002). Based on the fact that dogs are able to generalize new type of gestures we can assume that they regard them as referential signals.

Dogs often rely on human communication even when it conveys an inefficient or mistaken solution. They follow the route of the human demonstrator around a fence even if there is a simpler and easier way to approach the goal and get the reward (Pongrácz et al 2003), and tend to rely on the human's pointing and ignore the smell of the reward when these two 'sources' provide conflicting information about the actual food location (Szetei et al 2003).

In object search tasks dogs are most successful if the target location is indicated communicatively (Bräuer et al 2006) and they seem to be more prepared to use human gestures when they are given cooperatively than competitively (Petterson et al 2011). Furthermore dogs prefer to choose an empty plastic pot signalled by the experimenter's communicative cues (eye contact, gaze alternation) even if they had been clearly (although indirectly) informed about the location of the reward (Erdőhegyi et al 2007). It seems that dogs are able to infer the location of the reward based on indirect information only if the human manipulation is counterbalanced among the potential hiding places. In a more recent study (Kupán et al 2011) subjects observed a communicative or a non-communicative demonstration in which a human retrieved a ball from under an opaque container while manipulating another transparent and empty one. After the demonstration dogs usually chose the baited container, but if the demonstration was accompanied by communicative signals and the demonstrator was present during the choice, dogs preferred to choose the empty one.
Based on these results, many assume that the dog propensity to follow human social signals often leads to poor performance in experiments investigating object representational skills. This idea gained empirical support from the study reported by Topál and his colleagues (2009) in which the authors showed that even adult pet dogs tend to commit the classic A-not-B error in object hiding and finding tasks.

1.1.1. What does A-not-B error tell us about socio-communicative receptivity?

Object representational skills in human infants as well as in several animal species develop through successive steps that Piaget (1954) defined as 6 distinctive stages of object permanence. A-not-B error occurs at Stage 4 during development. In the standard A-not-B task usually two (sometimes more e.g. Wellman et al. 1986) hiding locations, A and B, are used. The experimenter first hides a target object at the A location clearly visibly to the subject and, after 2-4 repetitions of such 'A trials', the same target object is hidden at the B location clearly visibly to the subject (B trials). The subject is allowed to search after each hiding event, and the A-not-B error emerges when the subject searches at location A even when the object is hidden at B.

This error was first described in infants between 8 and 12 months of age (Piaget 1954). Originally Piaget accounted for the A-not-B error by suggesting incomplete comprehension of object permanence, however since then many different proposals have been put forward, including insufficient attention (Harris 1989, Ruffman & Langman 2002), deficits of the short-term memory (Cummings & Bjork 1983), immature sensory motor integration system (Berthental 1996; Baillargeon et al 1985), inability to inhibit the previously rewarded motor response (Diamond 1985), covert imitation or automatic simulation of movements (Longo & Bertenthal 2006). A recent study (Topál et al 2008) proposed a quite different explanation based on infants' sensitivity to cues that signal a person's intent to communicate useful information ('pedagogical' receptivity - Csibra & Gergely 2009). The authors argue that A-not-B search error can be effectively induced in an ostensive-communicative context because young infants, who are especially susceptible to ostensive-referential gestures, tend to misinterpret the object-hidings at location A as potential teaching demonstrations. Thus the ostensively induced A-not-B search error can be seen as a conceptual illusion, the "illusion of being taught".

Animals including apes (Mathieu & Bergeron 1981; Poti 1989), monkeys (de Blois et al 1998, Neiworth et al 2003; Kis et al 2012a), birds (Pepperberg 1997; Pollok et al 2000, Zucca et al 2007) and dogs (Watson et al 2001; Topál et al 2009; but see Gagnon & Doré 1992; 1994) also commit similar errors in object search tasks. Furthermore it has been revealed that, similarly to 8-12 month old infants, adult dogs commit the A-not-B error in the communicative condition but do not show this response bias in a non-communicative context (Topál et al 2009). The authors concluded that dogs' performance in the A-not-B task might reflect their sensitivity to human communication and the increased perseverative error in the "communicative version" of the task is at least partly caused by dogs' willingness to obey experimenter's 'instructions' expressed through ostensive communication.

1.2. Receptivity to human emotions

Dogs are commonly believed to be sensitive not only to human communicative signals but also to the expressions human emotions. Evidence suggests that they show more intensive reaction to happy and angry face than neutral ones (Deputte & Doll 2011). Dogs can discriminate between different human emotional face expressions (Racca et al 2012) and prefer the picture illustrating happy face in contrast to neutral one (Nagasawa et al 2011).

People can express their emotions not only by their mimic but also by other nonverbal gestures and verbal cues, so we can assume that dogs can also pick up emotional signals other than facial emotions. A recent study has shown that they respond differently to the same command depending on the emotional tones of voice (Ruffman & Morris-Trainor 2011).
Dogs are not only sensitive to the emotional state of their owners (Morisaki et al. 2009), but their behaviour toward a scary object can even be influenced by the owner's emotional expression (Merola et al 2012). There are also experimental evidences that dogs can interpret human emotional expressions referentially. In two-way object choice tasks dogs were allowed to choose between two boxes containing different types of food reward after the human partner signalled them with a specific emotion (Buttleman & Tomasello 2013; Merola et al 2014). Dogs preferred the box signalled with positive emotion in the happy - disgust (Battleman & Tomasello 2013) and also in the happy – neutral conditions (Merola et al 2014). In a more recent study Turcsán and co-workers (2014) found that dogs are able to separate their own interest from the owner's preference. They often approach at first the object signalled by disgust but fetch to the owner – obeying the "Fetch!" command – the positively indicated object.
Dogs' interspecific social- and emotional responsiveness is further supported by recent investigations (Silva & Sousa 2011, Romero et al. 2013) that raised the possibility that dogs have the ability to feel humans' emotional experiences ('affective empathy'). It is worth mentioning, that unlike the cognitive empathy system which entails representing another's emotional experience (deWaal 2008), affective empathy, is often described as an 'automatic' process (Hatfield et al. 1993) stemming from an unconscious social contagion system. Emotional contagion, a concept coined by Hatfield et al (1992) can be described as an automatic response to perceiving another's emotional state through which a similar emotional response is triggered in the observer. It is widely accepted that the contagion of emotional responses does not require an ability to differentiate between own and other's emotions or any conscious control over emotional reactivity (Preston & de Waal 2002). Social contagion can be seen as the rudimentary mechanism that serves to synchronize partners at different levels (physiological, emotional and behavioural synchronization).
Emotional contagion has been extensively examined in rodents (for a review see Edgar et al 2012). For example social transmission of fear response has been reported in rats (Knapska et al 2010) and pain sensitivity in mice also seems to be influenced by a conspecific's pain response (Langford et al 2006; Jeon et al 2010).

Birds may also show evidence of emotional contagion, greylag geese (Wascher et al 2008) as well as chickens (Edgar et al 2011) show physiological responses while observing distressed conspecifics. Regarding the empathic abilities of nonhuman primates there is evidence for contagious yawning in both apes (chimpanzees - Anderson et al 2004) and monkeys (macaques - Paukner & Anderson 2006) and rapid facial reactions to the partner's emotional facial expression during play has been described in orangutans (facial mimicry - Ross et al 2008).

Empathic-like responding is usually more pronounced between familiar conspecifics than unfamiliar peers (e.g. Langford et al 2006; Bartal et al 2011; Ma et al 2011), importantly, however, contagious behaviour can occur also in heterospecific contexts. A recent study provides support for the notion of cross-species contagious yawning in human reared chimpanzees (Madsen et al 2013) and there is ample evidence suggesting emotionally connected heterospecific yawn contagion in dogs (Joly-Mascheroni et al 2008; Silva et al 2012; Romero et al 2013). Human-dog cross-species contagious yawning has a potential link with the specific social-cognitive capacities of the domestic dog (Yoon & Tennie 2010). In fact, many assume that dogs are socially tuned-in to humans because the result of their unique domestication process was the emergence of an evolutionary novel, inter-specific type of social competence which, among others, allowed for the establishment of a wide range of affiliative social relationships with humans (Miklósi & Topál 2013). The relationship between the dog and its owner is functionally similar to the mother-infant attachment (see Topál & Gácsi 2012 for a review) which is considered essential for the development of dogs' emotional responsiveness (Plutchik 1987). Moreover, a recent study has found a correlation between the owner's attachment profile and the quality of the dog-owner attachment bond (Siniscalchi et al 2013). In addition to providing further support for the notion that the dog-owner relationship resembles the connection between a mother and her child, these results also support the idea that dogs tend to assimilate the characteristics of their owners and this is manifested in their affective stance.

There is also some experimental evidence suggesting hormonal and physiological synchronisation between owners and their pet dogs. Affiliative interactions between dogs and humans can have stress relieving effects; lower cortisol level as well as increase oxytocin and dopamine levels in both species (Odendaal & Meintjes 2003; Miller et al 2009; Handlin et al 2012). Hormonal interactions between people and dogs may also occur under conditions of psychological stress (e.g. after losing a competition -Wirth et al 2006).

For example, Jones and Josephs (2006) investigated the hormonal changes in dog-human teams during agility competition and found that in losing teams, unlike in winning ones, the owners' pre-competition basal testosterone levels and their pre- to post-competition changes in testosterone are significant predictors of dogs' changes in cortisol level.

1.3. Placebo effect and its relevance to dog-human interactions

Investigation of the mechanisms as well as the behavioural and psychological dimensions of the placebo effect has become a burgeoning field of life sciences in the last few decades. According to the widely accepted definition, placebo is a substance or procedure that has no inherent power to produce an effect that is sought or expected (Stewart-Wiliams and Podd, 2004). The effect that placebos have can be highly variable involving both psychological and physiological changes (e.g. endogenous opiate release Petrovic et al., 2002, Wager et al., 2004).

Nevertheless, placebo effect is often conceptualized as a psychosocial context effect (Benedetti et al 2004) involving the formation of cognitive expectancies, a process driven by verbal information from a trustworthy, certified person (Benedetti et al 1999; 2003). This verbal information is different from an instruction or command; these are rather suggestions indicating that an individual will experience a particular response that occur non-volitionally (Kirsch 1999). For example "It will help you sleep" is a suggestion, because it suggests to the person that taking the pill will automatically induce sleep. The suggestive nature of words depends on more than the words themselves. In fact, suggestions need not be linguistic utterances at all. Suggestive information may be conveyed by the size, shape, and colour of a pill, for example, or by the behaviour of a model (Kirsch 1999).

Although placebo effects are usually regarded as specific to humans, we suppose that regarding the socio-cognitive skills of dogs (Kaminski 2008; Topál et al 2014) they also have the potential for certain type of placebo effect. We can assume that the owner could be able to mediate placebo effect to the dog via involuntary signals, because dogs are not only especially skilled in reading human communicative signals (e.g. Lakatos et al 2012) and emotions (Nagasawa et al. 2011; Ruffman & Morris-Trainor 2011), but they also could be easily influenced by different social signals (e.g. Prato-Previde et al 2008; Topál et al 2009; 2014). Dogs could also be influenced by involuntary cues. Lit and co-workers (2011), for example, investigated how human beliefs affect working dog outcomes in an applied environment.

Drug and explosive detection dog − handler teams participated in different search conditions when either the owner's knowledge (providing false information about the scent location) or the dog's interest (using decoy scent to mislead the dog) was manipulated. The authors found that handler beliefs about the scent location potentiated handler identification of detection dog alerts. Additionally, the owners' knowledge about the location had a greater affect on owner reported alerts than the dogs' interest.

Besides the placebo effect produced on mental level, this effect can also be produced on physiological level, without involving any higher cognitive skills (Price et al 2008; Benedetti et al 2003). Increasing evidence suggests that placebo responses can be formed by classical conditioning in both humans (Voudouris et al 1990) and different nonhuman species (McMillan 1999). This process is based on the association between an active substance (unconditioned stimulus) and some characteristic property of the substance (smell, taste, colour) and/or some environmental cues (places, persons, procedures, rituals) surrounding the treatment (conditioned stimuli). After repeated experience of the specific effects of the treatment, a procedure with the same features but without the active substance can produce the very same physiological and/or behavioural effects evoking a conditioned response. The induction of a placebo effect via conditioning is possible even when the effect of the treatment is unconscious and imperceptible to the subject (e.g. change in hormone level - Benedetti et al 2003 or immune response - Goebel et al 2002).

In addition to rats and other laboratory rodents that are often used to demonstrate the conditioned placebo effect (see Stewart-Williams & Podd 2004 for a review), some evidence suggests placebo-like effects in pet dogs that have undergone veterinary treatment. However, it is important to note that in all placebo studies on dogs, assessment of the magnitude of placebo responses has been based solely on the owners' subjective evaluation; therefore, the results could be strongly influenced by the owners' expectations (Muñana et al 2010; Jaeger et al 2005). Although the mechanism mediating the effects of placebo treatment in dogs is still unclear, Cracknell and Mills (2008) investigated the role placebo treatment plays in overcoming fear and anxiety. They found a significant anxiolytic effect in dogs that showed excessive fear response to fireworks. This result was also based on owners' reports, so further confirmation of conclusions about the role of placebo in alleviating fear or relieving pain would require the collection of behavioural data through direct observations.

1.4. Aims and questions

In line with the above literature review, four studies were designed to investigate the role social influence play in making dog-human interactions finely tuned in different situations.

As a first step in Study 1 we focused on the A-not-B error phenomenon. Experimental findings reviewed in section 1.1.1. raise the possibility that the experimenter's ostensive-communicative signals such as addressing, eye contact and gaze shifts during the hiding event can guide the dogs' attention more efficiently than other salient, but non-communicative attention getters (e.g. squeaky toy sound). However it has remained unclear, whether ostensive communicative cues next to location A act as a 'general instruction' or simply act as here-and-now attention getters for dogs. We hypothesized that if these signals next to location A act as general instruction, the A trials should play an important role in the emergence of search error. If however, communicative signals act as here-and-now attention getters, these signals close to location A in the B trials should be more influential in provoking search errors. In Study 1, among others, we aimed to answer this question.

Study 2 was based on the abovementioned findings on empathic-like responding in dogs (see section 1.2.). Few experimental studies have so far investigated emotional contagion in dogs, but these studies did not investigate the effects of such social influence on dogs' task performance. Here we hypothesized that the owner's emotional state could be contagious to dogs, and the aim of this study was to investigate whether the dogs can take over their owners' affective state while interacting with him/her, and whether or not this emotional impact affect the dogs' behaviour.

As a next step, in Study 3 and Study 4, we aimed to investigate different aspects of the placebo effect in dogs. Findings reviewed in section 1.3 are in line with the increasing evidence of dogs' human-tuned social cognitive skills (Kaminski 2008) and support the idea that the fear/anxiety-alleviating effect of placebo treatment in dogs is a phenomenon worth investigating within the context of the dog-human social bond. Although behavioural manifestations of separation anxiety in dogs are easy to observe (see Topál & Gácsi 2012) and behavioural symptoms of anxiety can be reduced by tranquilizers, placebo effect studies in this context are missing. Thus in Study 3 we investigated whether the placebo effect can be observed in dogs as a result of associative learning processes and then in Study 4 we investigated the occurrence of a specific type of placebo effect which can manifest itself through the owner's expectation.

2. EXPERIMENTS

2.1. STUDY 1: How human communicative signals influence the A-not-B search error?

The notion that dogs' receptivity to human communication can account for A-not-B errors is still a matter of debate and alternative explanations (insufficient attention, learning based on local enhancement) have also been proposed. Some suggest that dogs committed more error in the communicative condition of Topál et al. 2009 study because the object search task was attentionally more demanding in that context as compared to the non-social version of the task (Fiset 2010). Others (Marshall-Pescini et al. 2010) argue that perseverative search bias can emerge as a result of the local enhancing effect of the unbalanced cuing procedure. Namely, dogs were provided ostensive communicative signals adjacent to the A but not to the B location in the communicative condition while the experimenter used non-communicative attention getter (squeaky rubber toy) at both locations in the non-communicative condition. Although most of these concerns have been addressed (Topál et al 2010; Kis et al 2012b) providing further support for the communicative account, there are some open questions that require further investigations.

Firstly, although the aforementioned communicative account predicts different effects of communicative and non-communicative signals the question whether or not communicative and non-communicative attention getters have the same effects on dogs' performance has never been directly tested. A related point is that in Topál et al. (2009) study the experimenter "marked" the A location using the same salient signals (either communicative or non-communicative) in both phases of the task: in the A trials when the object was left there as well as in the B trials when the object was removed (sham baiting) and moved on to location B. Importantly, therefore, it was impossible to assess the relative significance of communicative signalling at location A in the A-trials versus in the B trials in eliciting the A-not-B errors.

Based on the above findings we may assume that addressing the dog and making eye contact next to location A as well as gaze shifts between the dog and the A location act as a 'general instruction' for dogs that suggest selecting that location (no matter where the toy object is located). If so, then ostensive communicative signals at location A in the A trials should play an important role in the emergence of search error during the B trials.

If, however, ostensive communicative signals simply act as here-and-now attention getters then these signals at location A in the B trials are expected to be more influential in provoking search errors.

Another important but often neglected factor of subjects' performance in studies assessing social cognitive skills is motivation (Toates 1995). For example, many argue that the willingness of food-deprived animals to work for food is higher (chicken - Bokkers et al 2004, sheep -Verbeek et al 2011, rabbit - Seaman et al 2008) and recently it has also been shown that highly motivated subjects (Indian Mynas - *Acridotheres tristis*) explore the feeder more and thus perform better in an innovation task (Sol et al 2012). Generally speaking, evaluating the motivation level is indispensable for deciding whether a subject is 'unable or unwilling' to perform well at a task (Kirkden & Pajor 2006). Motivation for food also strongly affects the dogs' willingness to participate in training and complete the task (training to give "paw" when commanded - Range et al 2012), to our knowledge however, the effect of motivation on dogs' performance in object search tasks has not yet been investigated.

In the A-not-B object search task motivation can be of great importance as this may effectively modulate subjects' attention towards the target object and/or the dogs' willingness to ignore the experimenter's communicative signals adjacent to the empty A location.

Thus we may hypothesize that highly motivated dogs will be more attentive towards the target object and even if A-not-B error stems from the dogs' "ready-to-obey" attitude they will be less eager to behave according the experimenter's ostensive communication and will search more often at location B in the B trials.

To address these points in the present study we investigated the associations between dogs' motivation to obtain the target object and their tendency to commit search error in different conditions in which we systematically manipulated the attention-getting signals in terms of their communicative character provided by the experimenter during object hiding.

2.1.1. Experiment 1

We investigated (i) whether or not the subjects' performance in the A-not-B object search task (Topál et al. 2009) is influenced by their motivation to obtain the target object, (ii) whether human communicative and non-communicative signals have different effects in directing dogs towards the empty A screen during the B trials (perseverative error) and (iii) whether dogs perseverative search bias is more heavily affected by the human ostensive communication at location A presented during the 'introductory' A trials or during the B trials.

2.1.1.1. Materials and Methods

Subjects

Eighty-two pet dogs were recruited on a voluntary basis. All were at least one year of age. The only criterion for selection was that the dog had never participated in an A-not-B object search task, and was motivated to play with a ball. Ten dogs had to be excluded because they were unwilling to participate in the test (they showed signs of distress and/or did not show any interest in retrieving the target object during the warm-up trials). The remaining 72 dogs (mean age±SD: 3.71±2.49 years, 36 males and 36 females, from 27 different breeds and 15 mongrels) were tested and included in the data analysis. (see Appendix 1)

Experimental arrangement

The experiments took place in a room (5 m x 2.5 m) at the Eötvös University, Budapest where two identical opaque plastic boxes (30 cm wide x 42 cm high x 23 cm deep) were placed 0.6 m apart to serve as hiding places. The owner held the collar of the dog that was facing the screens standing equidistant (2 m) from them. A squeaky rubber toy was placed on the floor 0.6 m from the A screen in line with the screens. (Figure 1)

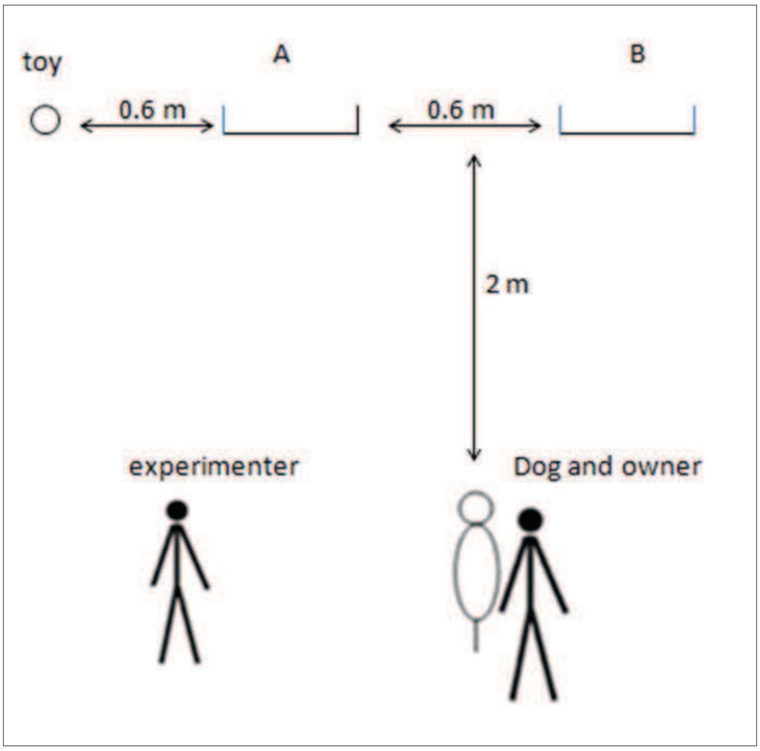


Figure 1. Experimental set up. Two identical opaque plastic boxes served as hiding places (A and B). The dog was facing the screens standing equidistant from them. A squeaky rubber toy was placed on the floor in line with the screens. The experimenter's starting point was next to the dog.

General procedure

Warm up and assessing motivation

Before the test trials, subjects participated in an object retrieval task (2 trials). The purpose of this session was to familiarize the subject with the retrieval task as well as to categorize dogs in terms of their motivation to get the object. In these trials only 1 screen was placed on the floor (halfway between subsequent locations A and B) and the experimenter hid the ball behind it in full view of the dog that was then released to search for it. If the dog was unwilling to search it was encouraged by the owner. The dogs' level of motivation was assessed by scoring their behaviour (see in 'Data analysis' for more details).

Test trials

Test trials consisted of 4 A trials followed by 3 B trials.

During the A trials the experimenter stood next to the dog and attracted the dog's attention using communicative (addressing the dog and establishing eye-contact) or non-communicative (clapping her hand) signals.

Then she approached the ball and attracted the dog's attention again with the toy in her hand next to the A location (A_A) either in a communicative or non-communicative manner. If she used communicative signals at the beginning of a trial (while standing next to the dog), she also used the same communicative signals (addressing the dog and establishing eye-contact) when she picked up the ball from the floor. If the experimenter used non-communicative signals while standing next to the dog, she attracted the dogs' attention in a non-communicative manner (the toy in her hand made a squeaky sound) when she picked up the ball. Then she stepped behind screen A with the toy in her hand being constantly visible to the dog and placed the ball behind screen A. She passed behind screen B and went back to her starting point next to the dog. After showing her empty hands to the dog, the subject was allowed to approach the setup and inspect one of the locations.

The procedure in the B trials was similar to that of the A trials (either communicative or non-communicative attention-getting both at the starting point and at location A; B_A) except that the experimenter did not leave the ball behind screen A, but after a few seconds of 'sham baiting' the toy visibly re-emerged in her hand and she attracted the dog's attention by squeaking the toy next to the B screen (B_B). She moved on to screen B and placed the toy behind it, then she went back to her starting point showing her empty hands and finally the dog was allowed to make a choice.

During the whole experiment the owner was not allowed to give any commands to the dog. If the dog chose the baited screen it was allowed to play with the ball, but if the dog first visited the empty screen it was called back by the owner (while the experimenter also tried to prevent it from visiting the baited screen and retrieving the toy) and the next test trial began. Note, that the experimenter put the ball inside the baited box, thus for dogs it was necessary to look into a box to check if it is empty or not. In a few cases (21 out of the 216 B-trials) however, the dog first visited the empty A location, and yet, could retrieve the ball from behind the baited screen. In such cases the owner took the ball away from the dog as quickly as possible, and the dog was not allowed to play with the toy.

Experimental conditions

Subjects were assigned to one of four groups, representing all possible combinations of communicative / non-communicative cuing at the A screen during the first (A trials) and second (B trials) phases of the test. (Table 1). Subjects in the four experimental groups did not differ by age (ANOVA, $F_{(3,68)} = 0.761$, $p = 0.923$).

<table>
<tr><th></th><th colspan="3">Signals presented</th></tr>
<tr><th>experimental conditions
(N; males/females)</th><th>during A trial
next to the A screen
A_A</th><th>during B trial
next to the A screen
B_A</th><th>during B trial
next to the B screen
B_B</th></tr>
<tr><td>NonCom
(N=19; 10/9)</td><td>Non-communicative</td><td>Non-communicative</td><td rowspan="4">Non-communicative</td></tr>
<tr><td>ComA_A
(N=18; 9/9)</td><td>Communicative</td><td>Non-communicative</td></tr>
<tr><td>Com$A_A B_A$
(N=18; 7/11)</td><td>Communicative</td><td>Communicative</td></tr>
<tr><td>ComB_A
(N=17; 10/7)</td><td>Non-communicative</td><td>Communicative</td></tr>
</table>

Table 1. Signals presented next to the A- and B screen in the different experimental conditions. Note: During A trials the experimenter ignored the B screen (no cuing there).
Communicative signals: The experimenter turned with her face toward the dog during the hiding event, she addressed the dog (dog's name + Watch!), and established eye-contact with it. Non-communicative signals: The experimenter turned with her back toward the dog during the hiding event and she attracted the dog's attention making a conspicuous noise with the rubber squeak toy. Thus in this context there was no eye-contact, the experimenter did not look at, and did not talk to the dog.

Data analysis

The number of dogs' correct choices was coded in all conditions. The first inspected location was regarded as the subject's choice and a choice was scored as correct if the dog touched the baited screen with its nose or paw, or stood close to the box and looked behind it. Dogs received scores of 1 or 0 depending on whether they chose the baited or the empty location respectively.

The dogs' level of motivation was assessed by scoring their behaviour during the warm up trials according to the following criteria (for video protocols see: http://www.cmdbase.org/web/guest/play/-/videoplayer/156).

0 - Unmotivated: Total ignorance of the toy during warm-up trials (these dogs had to be excluded from further tests).

1 - Low motivated: The dog calmly waits while the experimenter places the ball behind the screen. Approaches the baited screen indirectly and after 3 sec. or more delay, leaves the toy behind the screen or drops it onto the floor and leaves there at least once.

2 - Moderately motivated: The dog calmly waits while the experimenter places the ball behind the screen. Approaches the baited screen immediately and directly when released. Retrieves the toy object, and readily gives it over to the owner.
3 - Highly motivated: The dog tries to release itself 1-3 times while the experimenter places the ball behind the screen. Approaches the baited screen immediately and directly when released. Subject retrieves the toy object, however, unwilling to give it over to the owner or to the experimenter, and/or tries to take the ball from the experimenter's hand at least twice.
4 - Over-motivated: The dog tries to release itself more than three times while the experimenter places the ball behind the screen. Approaches the baited screen immediately and directly when released. Picks up the toy, however, unwilling to retrieve and give it over to the owner or to the experimenter. When the toy is obtained by the experimenter the dog is trying to permanently retrieve it from her hand.

As the warm up phase was identical in all experimental conditions, it allowed us to carry out motivation scoring blind to the conditions and without knowing the later performance of subjects.

Furthermore, to check if dogs spent similar amounts of time gazing toward the human actor in the different conditions we measured the duration of time spent orienting toward the object-hiding events in the first A- and the first B trials of each condition.

Subjects' motivation and choice behaviour was assessed by the author of this thesis (ZS.S) and the reliability of the coding was measured using Cohen's Kappa value. A second person scored a randomly selected sample of 50% and Cohen's Kappa value was 1.0 for dogs' choice and 0.96 for motivation. Concerning the motivation scores there was only one disagreement between coders (moderate or high motivation) and in this case the first coder's score was accepted. The reliability for the duration of time spent orienting toward the object-hiding events was assessed by means of parallel coding of the 25% of the first A- and B trials total trials by two observers. Inter-observer reliability was also excellent (Pearson's correlation $r = 0.925$, $p < 0.001$).

We employed a Generalized Linear Model (binomial distribution) for the analysis of the effects of different signals (communicative vs. non-communicative) during hiding and the dogs' motivation to retrieve the toy on the dogs' tendency to commit A-not-B error. Number of successful B trials (0-3) was set as the dependent variable, type (communicative vs. non-communicative) of the cuing next to the A screen and timing of the sign (during A vs. B trials) as fixed factors and motivation score as covariate.

We used Kruskal-Wallis and Dunn's multiple comparison post tests to compare dogs' performance in the different motivation categories (1-4). The duration of time spent orienting toward the object-hiding events in the different conditions was also analysed by Kruskal-Wallis test, because data didn't follow normal distribution. In order to assess the effect of the different cues given during the hiding procedure the number of correct choices in the A and B trials was also compared to the 50% chance level using one-sample Wilcoxon signed rank tests. To compare the dogs performance in B trials of the different conditions Wilcoxon matched pairs tests and Kruskall-Wallis test were used. We also compared the percentage of dogs showing perseverative search bias towards the empty A location (A-not-B error) in the B-trial phase of the four different hiding-contexts using chi^2 test. A-not-B error was defined as selection of the empty (A) screen in the first B trial and at least one additional 'incorrect' choice during the 2nd and 3rd B trials.

Statistical tests were two-tailed, the α value was set at 0.05 and the statistical package SPSS version 18 was used.

2.1.1.2. Results

Analysis with a General Linear Model revealed that the type of attention getting signals (communicative or non-communicative) employed at the A screen during the B trials played a significant role in inducing the A-not-B error ($\chi^2_{(1)} = 7.205$ $p = 0.007$), but the type of cuing during A trials had only a marginally significant effect on dogs' performance ($\chi^2_{(1)} = 2.907$ $p = 0.088$). It is also worth mentioning that the context dependence of dogs' tendency to commit search error was probably not caused by dogs' selective attention because dogs paid as much attention to the object-hiding event in the non-communicative conditions as they did in the communicative ones (A-trial-phase: $\chi^2_{(3} = 6.337$ $p = 0.096$, B-trial-phase: $\chi^2_{(3)} = 3.304$ $p = 0.347$). More importantly, although subjects in the four experimental groups showed similar levels of motivation to obtain the target object in the warm up phase (Kruskal-Wallis test, $\chi^2_{(3)} = 3.049$, $p = 0.384$; Table 2), dogs' tendency to commit A-not-B error was heavily affected by their motivation scores ($\chi^2_{(1)} = 21.605$ $p < 0.001$). No interactions were found between the factors and covariate ($p > 0.1$ in all cases).

	Motivation			
Experimental condition	**Low**	**Moderately**	**Highly**	**Over**
NonCom (N=19)	1	14	2	2
ComA$_A$ (N=18)	5	9	2	2
ComA$_A$B$_A$ (N=18)	3	9	4	2
ComB$_A$ (N=17)	0	11	4	2

Table 2. Number of dogs in each motivation category in the four groups.

The effect of dogs' motivational characteristics on performance

The significant role of the level of motivation in the emergence of perseverative search errors is also clearly indicated by the comparison of the dogs assigned to the different motivation categories (Kruskal-Wallis test, $\chi^2_{(3)} = 13.167$, $p = 0.004$). Dogs categorized as over-motivated committed significantly less search errors than subjects belonging to other motivation categories (Dunn's multiple comparison post test, over-motivated vs. highly and low motivated $p < 0.05$, over-motivated vs. moderately motivated $p < 0.01$ Figure 2, Table 2). Our finding suggests that high level of motivation to take possession of the target object, together with other potential contributing factors such as lack of inhibition or training, effectively eliminates A-not-B error. This raises the possibility that extreme motivation can act as a confounding factor for the assessment of the effect of human ostensive communication on dogs' tendency to select the non-baited (A) location.

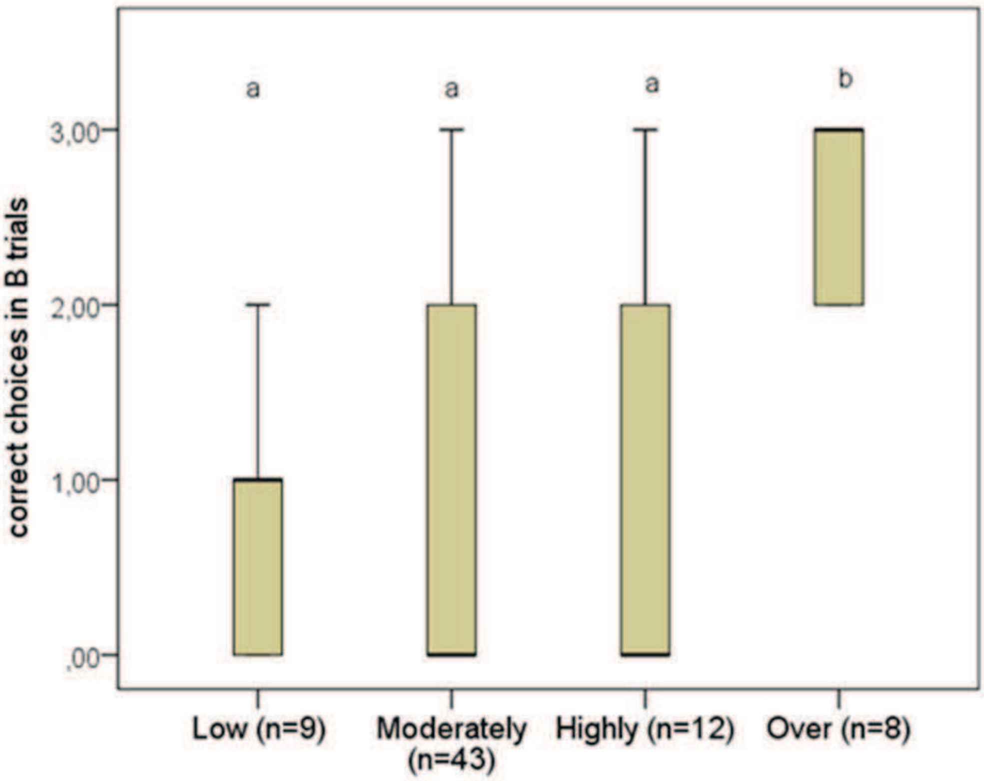


Figure 2. The effect of the level of motivation on dogs' choice behaviour in the B trials (median, quartiles, whiskers). Over-motivated dogs made significantly less search errors than subjects belonging to other motivation categories (Kruskal-Wallis test, Dunn's multiple comparison post test, different letters (a, b) indicate significant differences between groups * $p < 0.05$).

Thus we removed the eight over-motivated dogs (2-2 subjects from each group), and as there was still no difference between groups concerning their motivation scores (Kruskal-Wallis test, $\chi^2_{(3)} = 4.732$ $p = 0.192$) we re-run the Generalized Linear Model. This analysis revealed a significant effect of the type of attention getting signals (communicative or non-communicative) employed at the A screen during the B trials ($\chi^2_{(1)} = 9.436$, $p = 0.002$), while the type of cuing during A trials had no similar effect on dogs' performance ($\chi^2_{(1)} = 2.482$, $p = 0.115$) and motivation of the subjects did not play a role either ($\chi^2_{(1)} = 1.961$, $p = 0.161$). No interactions were found between the factors and covariate ($p > 0.1$ in all cases).

The effects of communicative vs. non-communicative signals on performance

The remaining 64 dogs showed a similar performance in all four conditions during the A trials (Kruskal-Wallis test, $\chi^2_{(3)} = 2.170$ $p = 0.538$). They fetched the toy reliably as they performed well above the success rate expected by random search (NonCom $T_+ = 153$ $p < 0.001$, ComA_A and ComA_AB_A $T_+ = 136$ $p < 0.001$; ComB_A $T_+ = 120$ $p < 0.001$, Wilcoxon signed rank tests). However subjects' made fewer correct choices in the B trials than in the A trials in all conditions (Wilcoxon matched pairs tests, NonCom $T_+ = 153$ $p < 0.001$; ComA_A $T_+ = 78$ $p = 0.0078$; ComA_AB_A $T_+ = 105$ $p = 0.001$; ComB_A $T_+ = 120$ $p = 0.001$). Comparisons to the 50% chance level (Wilcoxon signed rank tests) show that dogs displayed a significant search bias towards the empty (A) hiding place only in those conditions in which ostensive communicative signals were employed adjacent to the A screen (ComA_AB_A $T_+ = 26$ $p = 0.029$; ComB_A $T_+ = 1$ $p = 0.0001$) and subjects performed at chance level in the other two groups (NonCom $T_+ = 44.5$ $p = 0.124$; ComA_A $T_+ = 56$ $p = 0.56$, Figure 3).

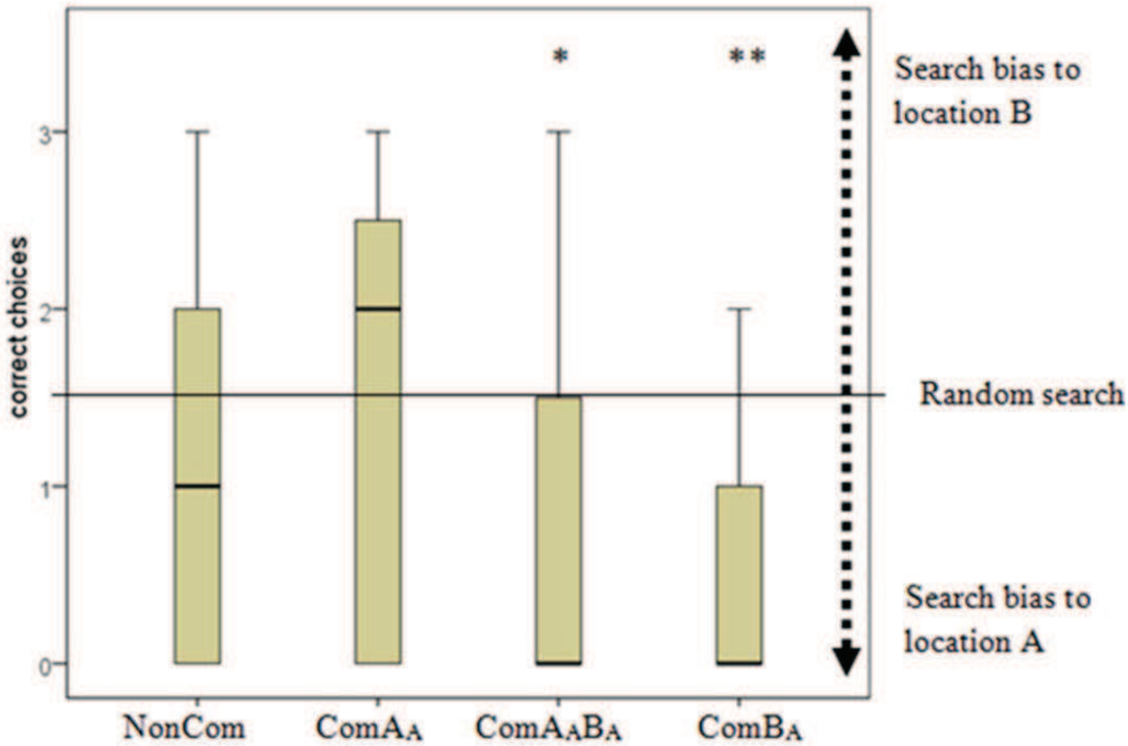


Figure 3. Number of correct choices in B trials in the four experimental groups (medians, quartiles, whiskers). Dogs in those conditions in which ostensive communicative signals were employed adjacent to the A screen (ComA_AB_A and ComB_A) show a search bias towards the empty (A) location, and subjects performed at chance level in the other two groups (NonCom and ComA_A). Comparisons to the 50% chance level (Wilcoxon signed rank tests) (* $p < 0.05$; ** $p < 0.01$).

The key role of ostensive communication adjacent to the empty A screen during the B trials in inducing the A-not-B error is further confirmed by the significant between-group differences (Chi-square test, $\chi^2_{(3)} = 11.656$ p = 0.009) in percentage of subjects showing perseverative search bias towards the empty A screen. Again, more dogs showed perseverative search error if the human experimenter employed communicative signals during the B trials next to the A screen (Com A_AB_A and $ComB_A$ vs. Com A_A and NonCom groups, Fischer exact test p = 0.002). (Table 3)

	Number of erroneous choices			
Experimental conditions	**Zero**	**One**	**Two**	**Three**
NonCom (N=17)	2	5	2	8
ComA$_A$ (N=16)	4	4	2	6
ComA$_A$B$_A$ (N=16)	2	2	4	8
ComB$_A$ (N=15)	0	1	4	10

Table 3. Number of dogs in the four different conditions performing different numbers of erroneous choices (searching at the empty screen) in the three B trials.

It seems like dogs rely on the experimenter's ostensive-communication as episodic instructions and/or "here-and-now" attention getters in the B trials because human communicative cuing at location A in the B-trials plays a more important role in the emergence of A-not-B search errors.

2.1.2. Experiment 2

Based on the above results in a subsequent experiment we expected to induce A-not-B error in dogs without performing any A-trials. Although previous research (Topál et al 2010; Kis et al 2012b) has argued that local enhancement or "sham-baiting" of the A hiding place does not alter dogs' perseverative response in the A-not-B context, here we hypothesized that in the 'only B trials' condition it becomes crucial whether or not the A hiding place is enhanced by the experimenter's ostensive communicative cues.

Thus we planned a hiding procedure in which in addition to omitting the A-trials we used three different types of B-trials: a *Social-Communicative* (Topál et al 2009) condition in which during the B-trials the dog's attention is directed to location A ('sham-baiting') after ostensively addressing the dog, the so called *Alleviated B trials* (Kis et al 2012b) condition in which this 'sham-baiting' is omitted and the experimenter goes directly to location B, and a *NonCommunicative* (Topál et al 2009) control condition.

2.1.2.1. Material and methods

Subjects

Sixty five task-naïve pet dogs participated in the study, all were at least one year of age (29 males, 34 females; mean age: 3.92 ± 2.52 years) (see Appendix 1). They were from 17 different breeds and 22 mongrels. Based on warm up trials (see below) all dogs' motivation scores were ranked from-low-to-high. Two dogs had to be excluded due to under-motivation and none of them was categorized as over-motivated (see Exp 1 for criteria). Subjects were assigned to three hiding contexts (see below) so that the distribution of age would not differ across conditions.

Procedure

The experiment was conducted in another room (3.9 m x 4.1 m) but the experimental arrangement was the same as described in Experiment 1 (Figure 1). Before the test trials, subjects participated in two warm up trials where only one screen was placed on the floor using the same procedure as in Study 1.

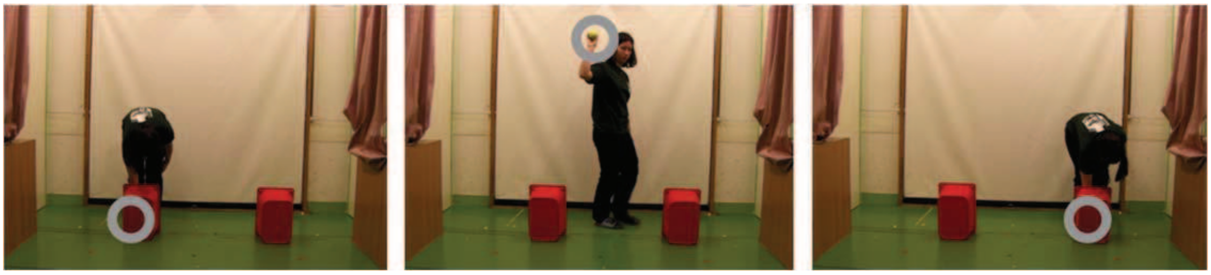
Test trials consisted of 3 B-trials without any previous A-trials. Depending on the experimental group subjects witnessed one of three different hiding procedures.

In the *'Communicative Hiding'* group *(Com-H*, N = 21, 14 males, 7 females) we aimed to test the role A trials play in inducing the A-not-B error, thus the hiding procedure was the same as reported in previous studies (Topál et al 2009; Kis et al 2012b) with the only difference that the A trials were omitted. During the three B trials the experimenter addressed the subject (dog's name + "Look!" in a high pitched voice), she approached the toy, picked it up and captured the dog's attention with the toy in her hand (by establishing eye-contact and addressing the dog).

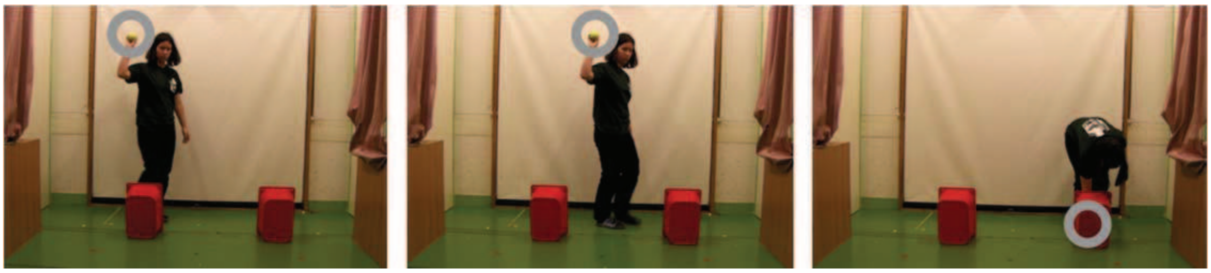
Afterwards she walked to the adjacent screen (A) and placed the toy behind it, than the toy visibly re-emerged in her hand and she showed the toy to the dog while looking at it. Finally she placed the toy behind screen B, returned to the dog showing her empty hands and the subject was allowed to make a choice. (Figure 4/a)

Testing a second group of dogs, the so called *'Alleviated B trials'* group (*Allev-B*, N = 21, 8 males, 13 females) we aimed to test the role 'sham baiting' of the A hiding place plays in inducing the A-not-B error. Thus in this condition, dogs witnessed the same hiding procedure as previously described in *Com-H* (subjects were addressed in a communicative way, by calling their name and making eye-contact), with the only exception that the experimenter did not 'sham bait' the toy behind screen A. She walked up to screen B following the same track as in the *Com-H*, while holding the toy visibly in her hand at the height of her eyes and looking continuously at the dog. (Figure 4/b)

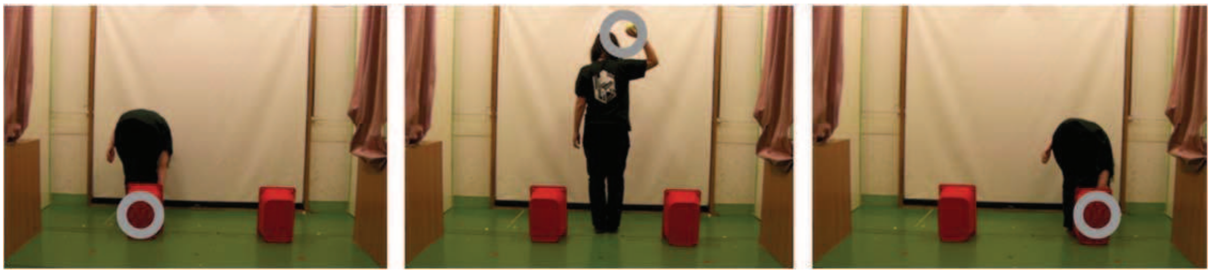
Finally as a control group we tested a group of dogs in the *'Non-Communicative Hiding'* condition *(NonCom-H,* N = 21, 7 males, 14 females) following the procedure described in Topál et al (2009) with the only difference that the A trials were omitted. The experimenter attracted the dog's attention by clapping her hands then she approached the toy and made a beeping sound with it without facing the dog. Afterwards she walked to the adjacent screen (A) with her back turned towards the dogs and placed the toy behind it, than the toy visibly re-emerged and made a beeping sound while the experimenter was still turned with her back. Finally she placed the toy behind screen B, returned to the dog showing her empty hands and the subject was allowed to make a choice. (Figure 4/c)



a)



b)



c)

Figure 4. Hiding procedure for the a) 'Com-H', b) 'Allev-B' and c) 'NonCom-H' conditions.

Data analysis

The dogs' motivation, attention and choices were measured in the same way as in Study 1. We used Kruskal-Wallis tests to check if dogs were similarly motivated to get the toy object and we employed also Kruskall-Wallis test for the analysis of the time spent orienting towards the object hiding events in the different conditions during the first trial. The number of correct choices in all three groups was compared to the 50% chance level using a one-sample Wilcoxon signed rank test. Furthermore, planned pair-wise comparisons between *'Com-H'* and *'Allev-B'* as well as *'Com-H'* and *'NonCom-H'* conditions were performed (Mann-Whitney tests).

2.1.2.2. Results

Subjects in the three experimental groups showed similar levels of motivation to obtain the target object in the warm up phase (Kruskal-Wallis test, $\chi^2_{(3)}$ =1.573, p = 0.455) and dogs in all three conditions watched the experimenter's activities for similar durations (*'Com-H'*: 96.8 %, *'Allev-B'*: 98.2 %, *'NonCom-H'*: 98.4 %; Kruskal-Wallis test, $\chi^2_{(2)}$ = 0.329, p = 0.848).

In the *'Com-H'* condition subjects displayed a search bias to the empty (A) location performing well below the success rate expected by random search (25% correct, T- = 190, p = 0.008) in the three B trials despite the fact that location A had never been baited. On the contrary when 'sham baiting' at A was omitted (*'Allev-B'* condition) subjects performed above chance (70% correct, T- = 49, p = 0.019), thus achieving a significantly higher number of correct choices than subjects in *'Com-H'* (U = 84, p < 0.001). Moreover in the *'NonCom-H'* group (neither 'sham baiting' nor communicative cuing at location A) dogs also performed above chance (68% correct, T- = 51, p = 0.023) and achieved a higher number of correct choices than subjects in the *'Com-H' condition* (U = 87; p < 0.001) (Figure 5).

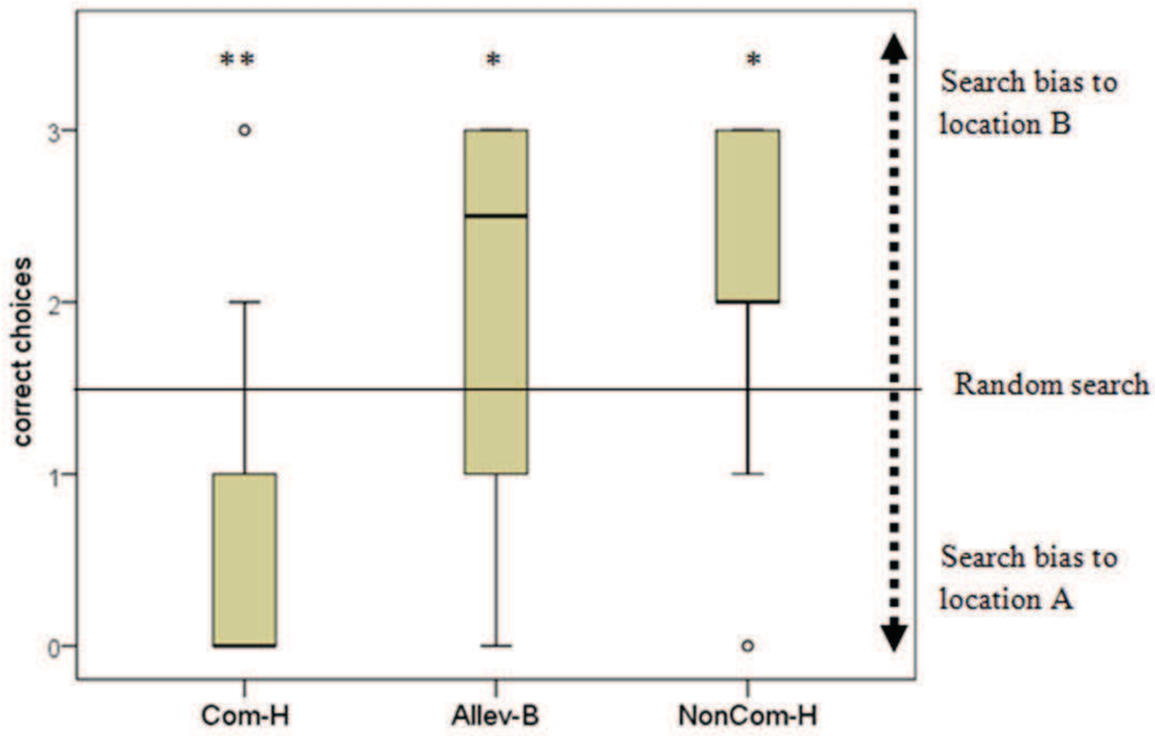


Figure 5. Number of correct choices in the different hiding conditions of experiment 2(median, quartiles, whiskers, outliers). Comparisons to the 50% chance level (Wilcoxon signed rank test) (* p < 0.05; ** p < 0.01).

The analysis based only on the first test trials in the different conditions shows quite similar results. Dogs in the *Com-H* group preferred to choose the empty A location (binomial test, test proportion: 0.5; p = 0.027; only 5 dogs of the 21 ones chose the baited location) while dogs in the *Allev-B* and *NonCom-H* groups showed a non-significant trend towards above chance performance (binomial test, test proportion: 0.5; p = 0.078; 15 dogs from the 21 ones selected the baited location in both conditions).

It seems that 'sham-baiting' at location A and the attraction of the dogs' attention by ostensive addressing signals next to the A location can both play a role in eliciting erroneous choices. A summary of the present results and findings from recent studies (Table 4) indicates that communicative (vs. non-communicative) cuing and other attention-directing acts (sham baiting) affect dogs' search bias in an interactive manner.

	Cuing next to A during A-trials	**Cuing next to A during B-trials**	**Sham baiting at A during B-trials**	**Search bias**	**Source**
Com-H	**-**	**Comm**	**Yes**	**Towards the empty (A)**	***Exp. 2***
Com-H	**Comm**	**Comm**	**Yes**	**Towards the empty (A)**	*Kis et al. 2012b Anim. Cogn.*
NonCom-H	**-**	**NonComm**	**Yes**	**Towards the baited (B)**	***Exp. 2***
NonCom-H	**NonComm**	**NonComm**	**Yes**	**No search bias**	*Topál et al. 2009 Science*
Allev-B	**-**	**Comm**	**No**	**Towards the baited (B)**	***Exp. 2***
Allev-B	**Comm**	**Comm**	**No**	**Towards the empty (A)**	*Kis et al. 2012b Anim. Cogn.*

Table 4. Experiment 2. Summary of results and comparison of findings from different studies. Comm: Eye contact & verbal addressing (dogs's name + Watch!); NonComm: squeaking the toy while back-turned.

This table clearly shows that sham baiting of the A screen without directing the dog's attention towards that location in an ostensive-communicative manner is insufficient to elicit the A-not-B error in dogs.

Moreover both the presence/absence and the timing of ostensive addressing signals are of great importance: Cues including eye contact and verbal addressing compared to non-communicative salient attention-getters (squeaking the toy) are more effective in inducing the dog to select the empty (A) location especially if the experimenter provides these signals next to the A location during B trials.

2.1.3. Discussion

In conclusion, dogs seem to react differently to communicative as opposed to non-communicative human signals in the A-not-B task. Subjects in the $ComA_AB_A$ group of Experiment 1 similarly to subjects in the social-communicative group of Topál et al's (2009) study displayed a search bias toward the empty A screen in the B trials, thus it seems that the non-communicative attention getters presented close to the B screen are insufficient to eliminate the error. Moreover these results confirm our hypothesis suggesting a specific effect of motivation on dogs' overall search performance. While the cues from the experimenter during hiding seem to affect the search behaviour of dogs with low-to-high motivation in similar ways, subjects who were characterized by extreme high level of motivation tended to ignore the experimenter's signals and focused their attention towards the toy object.

In line with the findings from earlier studies (Topál et al 2009, Topál et al 2010, Kis et al 2012b) the results of this experiment also support the differential effects of ostensive-communicative (vs. non-communicative) signals on dogs' tendency to commit the A-not-B error. However, the present results do not seem to support the notion that ostensive communication next to location A acts as a 'general instruction' for dogs, rather they act as episodic instructions and/or "here-and-now" attention getters in the B trials.

Results of Experiment 2 showed that A-trial-phase is not an indispensable part of the procedure inducing A-not-B error in adult dogs. Importantly, however, the communicative cuing next to the A location during B trials can increase the dogs' tendency to commit A-not-B error if, and only if it is either complemented with sham baiting of the A screen or the A location was previously repeatedly baited in an ostensive communicative context.

2.2. STUDY 2: Emotional contagion in dogs as measured by change in cognitive task performance.

As mentioned in the Introduction above, dogs are responsive not only to the human communicative but also to emotional cues (e.g. Custance & Mayer 2012; Merola et al 2012). Experimental evidences also suggest physiological synchronisation between owners and their pet dogs (Odendaal & Meintjes 2003; Miller et al 2009; Handlin et al 2012) for example hormonal interactions was found under conditions of psychological stress (Jones and Josephs 2006).

In this study we aimed to investigate if pet dogs can be influenced by the owners' emotions, namely whether the owners' affective state is contagious or not in the context of experimentally induced anxiety.

In addition to direct measurement of hormonal changes, the effects of stress on subjects' internal state can also be assessed indirectly; either by using questionnaires (e.g. Frankenhaeuser et al 1978) or by measuring changes in subjects' cognitive performance. Some studies suggest that stress hormones can have an inverted-U shape effect on learning and memory in both humans and nonhuman animals (McEwen & Sapolsky 1995; Belanoff et al 2001). While moderate stress has been shown to positively impact memory retention, high stress levels can lead to impaired cognitive performance.

Although findings suggest that dogs show high responsiveness to changes in their human caregiver's stress status, and there is also evidence that stress-related emotional changes can be tracked by memory tasks, investigation of the association between stress-induced changes in owners and their dogs as measured by changes in their memory performance is lacking in the literature.

We investigated whether pet dogs can take over the anxious inner state of their owners and whether changes in their owners' affective states have an effect on dogs' memory performance. We predicted that (I) our procedure should be sufficient to increase the owners' self-reported stress/anxiety in the 'stressed' condition; (II) these changes should have an effect on owners' memory performance and (III) the changes in owners' affective states should be contagious to dogs and the emotional contagion should be manifested in changes in the dogs' memory performance.

2.2.1. Materials and Methods

Subjects

52 dogs (mean age ±SD: 3.81±1.82years, 26 males and 26 females) participated in the study on a voluntary basis (see Appendix 2). Out of the 52 dogs, 37 were tested together with their owners (experimental conditions; owners' mean age ±SD: 30.5±8.4 years, 34 women and 3 men) Subjects were randomly assigned to one of the following three conditions: *Stressed owner* (N=19), *Non-stressed owner* (N=18), *Stressed dog* (N=15). In the subsequent sections, we refer to the first two conditions as "experimental" and to the third one as "control". The dogs were from 18 different breeds and 15 mongrels. Dogs' previous training experience was also assessed. Out of all the participants, 33 dogs had received some sort of obedience training, while 19 had never participated in any formal training. However, the distribution of "trained" and "untrained" dogs did not differ significantly across conditions, with 13, 12 and 8 trained dogs in the Stressed-owner, Non-stressed owner and Stressed dog conditions, respectively ($\chi^2(2) = 1.25$; $p = 0.53$).

Experimental arrangement

The experiment took place in a room (3.9 m x 4.1 m) at the Dept. of Ethology, Eötvös University, Budapest. Only a chair and some toys (a tennis ball and a rope) for the dog were placed in the room. These toys were present during the whole experiment, except for the dog memory tasks (see below) when only one ball as target object and 7 plastic flowerpots as hiding places were used. However in the ball-carrying task (Phase 2 – see below) and during the second dog memory task (Phase 3 – see below) additional balls (2-3) and containers (2) were also present.

Overview of the experimental procedure

The procedure consisted of three phases for both the experimental and the control conditions. In the experimental conditions the pre-manipulation phase (Phase 1) started by assessing the owners' baseline anxiety level (using a state anxiety questionnaire) and their memory performance (in a word list memory task) and we also measured the dogs' ability to retain the location of a ball in their working memory (in an object hiding and finding task). In the control condition, only the dog memory task was administered in phase 1.

This was followed by the manipulation (Phase 2) during which the owners in the experimental conditions had to answer questions about an article they had read before and they were also asked to complete collaborative tasks together with their dogs. The latter part was added to the procedure to enable the transfer of stress/anxiety between the human and his/her dog. Importantly, owners in the *Stressed owner* condition received mostly negative feedback, while owners in the *Non-stressed owner* condition were given only positive feedback. In the *Stressed dog* condition, the dog's anxiety level was manipulated by introducing a short period of separation from the owner. Finally, in the test phase (Phase 3), the owners' and their dogs' memory performances as well as the owners' state anxiety were re-tested using the same methods as used in Phase 1. In the control condition, only dogs' memory performance was assessed.

Procedure of the experimental conditions (Stressed owner and Non-stressed owner)

<u>Phase 1 – Baseline measures</u>

Right after their arrival, the owners filled out the Hungarian version of the State- and Trait Anxiety Inventory (STAI; Sipos & Sipos 1983 see Appendix 3) which is widely used by psychologists to measure anxiety both at a particular point in time (state) and in general (trait).

After this the owner and his/her dog were led into the experimental room by the Experimenter (E) and were allowed to explore the room for a few minutes. Then the owner made the dog sit at a predetermined starting point and the E placed seven identical brown plastic flowerpots (11cm high, 14 cm in diameter) on the floor in a semicircle (Figure 6). The dog was sitting equidistant from the bowls (3 meters away) while being held by the owner. The E then took the target object (a tennis ball), showed it to the dog, walked straight towards one hiding location, and placed the ball into the pot clearly visibly to the dog. After the hiding event the dog was led out of the room by the owner, the E also left the room and they waited outside for 30 seconds before re-entering the room. On re-entering the room, the dog was led to the starting point by the owner and then it was released and allowed to search for the object until finding it. During this the owner was allowed to encourage his/her dog, but was instructed not to give any specific instructions and not to direct the dog toward any of the containers. All dogs received 5 trials in a predetermined order.

Two different hiding orders (L3, R2, M, R3, L2 and R3, L2, M, L3, R2 respectively) were used and the order of the 5-trial blocks was counterbalanced across subjects in each group. The 2 terminal pots (R1 and L1 – see Figure 6) were never baited. Dogs had as much time as they needed to find the object.

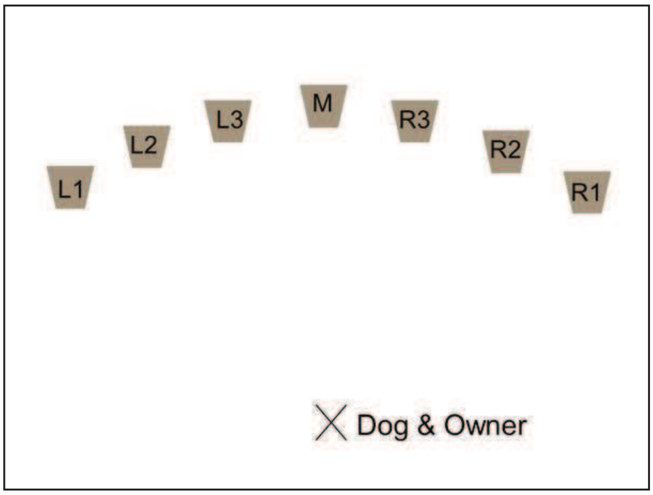


Figure 6: Experimental arrangement of the dog Spatial Working Memory task. The owner made the dog sit equidistant from the 7 plastic containers serving as hiding places. The positions of the containers are labelled as L (left) 1-3, R (right) 1-3 and M (middle).

After this the owners' memory performance was measured by Kirschbaum et al's declarative memory task (Kirschbaum et al 1996). In the learning phase of the task the owners were given a list of 24 words for 5 minutes to read and memorize. This was followed by a 5 minute long distraction phase, during which they had to read a scientific paper about dog behaviour. Finally, owners were asked to recall those words (N=10) from the 24-words-list that begin with „mo" or „ko" (depending on the list) within 2 minutes. We used two different lists of words (word set A and B) and these were counterbalanced across conditions. Subjects in the *Non-stressed owner* condition were provided with a reading matter in the distraction phase which was easy to read and understand while subjects assigned to the *Stressed owner* condition were given a more challenging text. Dogs were together with their owners in the experimental room throughout the declarative memory task while the E was absent during the learning and distraction phases. Dogs were allowed to explore the environment, play and interact with their owners freely.

Phase 2 - manipulation

After this the E asked the owners several questions about the scientific article they had read during the distraction phase of the declarative memory task. This phase lasted for approximately 5 minutes. In the *Stressed owner* condition E gave mostly negative feedback and sometimes pointed out that the other participants were able to tell the right answer. However, in the *Non-stressed owner* condition the E gave only positive feedback and sometimes praised their performance by adding that the other participants were *not* able to tell the right answer.

This was followed by interactive situations, when owners were asked to complete different kinds of collaborative tasks together with their dogs. First a ball-carrying task, during which the dog had to carry balls under the direction of its owner from a container into another one for 5 minutes. The containers were placed in two corners of the room and only one of the containers was baited with the balls. In the next 2 minutes they had to perform basic obedience tasks (sitting, laying and staying) and they also had the opportunity to show other tricks. The ball-carrying and obedience tasks were also accompanied by the experimenter's negative or positive feedback. In the *Non-stressed owner* condition the E praised the dyads for performing the task well and did not comment the wrong performance. In the Stressed owner condition the E expressed her disapproval of the dyad's bad performance (in neutral speaking style) and did not comment on the instances where the dyad was successful.. In the last 3-4 minutes of the manipulation the experimenter gave the text back to the owner for an additional 2 and a half minutes and in the next minute she asked further questions. Owners' responses received either positive (*Non-stressed* condition) or negative (*Stressed* condition) reinforcement.

Importantly, both praise and disapproval were given by the E in a neutral tone of voice and she behaved in a neutral manner throughout Phase 2.

Phase 3 - measuring subjects' performance after the manipulation

Owners were asked to fill out the same questionnaire (State- and Trait Anxiety Inventory) as in Phase 1.

Then we repeated the object hiding and finding tasks in order to measure the dogs' ability to retain the location of a ball in their working memory.

We used the exact same procedure as in Phase 1: first, dogs participated in the same memory task, however, they were provided with the other 5-trial block than in Phase 1 (as described above in the section about Phase 1). Then owners completed the same memory task as in Phase 1 with the only exception that they were provided with the other set of words (A or B) and the reading material in the distraction task was also different.

Procedure in the Control condition (Stressed dog)

<u>Phase 1 – baseline measure</u>

First, dogs participated in the same memory task as was described above in Phase 1 for the other two conditions. This was followed by a 15 minute break, thus the time elapsed between the first and the second memory task was the same as in the other two conditions. During the break the owners and the dogs were sitting in the waiting room of the department.

<u>Phase 2 - manipulation</u>

After the break elapsed, the E introduced the dog and the owner to the experimental room, then the owner left the scene and the dog was allowed to explore the room freely in the presence of the E for 2.5 minutes. If the dog showed distress behaviours (see below) less than 20 seconds long during this period the separation was continued for additional 2.5 minutes. If the dog showed signs of distress for at least 20 seconds, it was reunited with the owner and phase 3 was administered. The E played with the dog or petted it depending on its willingness.

<u>Phase 3: measuring dogs' performance after the manipulation</u>

Using the same procedure as in Phase 1, we repeated the object hiding and finding tasks, however, dogs were provided with a different order of object hiding trials.

Data collection

Owners anxiety levels were measured by STAI scores consisting of two separate 20-item (rated from 1 to 4) self-report scales; one scale measures state anxiety (s-STAI) and the other measures trait anxiety (t-STAI, Sipos & Sipos 1983) (see Appendix 3). Higher scores indicate increased level of anxiety.

Based on the STAI scores measured repeatedly in Phase 1 (pre-manipulation) and Phase 3 (post-manipulation) we also calculated the change which indicates the effect of the manipulation on owners' anxiety levels in the different conditions.

Owner's memory performance was measured by the number of words they could recall correctly. The change in their performance was also calculated as the difference between pre- and post-manipulation task performance.

Dog's working memory performance was calculated on the basis of the number of erroneous choices (looking into an empty pot). The number of empty containers visited by the dog during trials 1-5 was added up and this was used as an indicator of task performance (higher scores indicates poorer memory abilities). The change in dogs' working memory performance was also calculated as the difference between pre- and post-manipulation measures.

It was also measured how intensely the dogs were encouraged by their owners during the memory task. We coded the number of any kind of verbal encouragements (e.g.: Search! You can go! Where is the ball? Fetch the ball!) given by the owner during the trials.

The owner's behaviour while interacting with his/her dog (in Phase 2 of the two experimental conditions) was also analysed using the following variables: relative duration of time spent with playing (i.e. any vigorous, toy-related behaviour between the dog and the owner); relative duration of time spent with physical contact (i.e. any form of bodily contact); number of positive (encouragement, praise etc.) and negative (prohibiting, scolding) verbal feedback provided by the owner.

In Phase 2, the number of positive (praise, telling it is a right answer) and negative (scolding, telling it is a wrong answer) verbal feedback provided by the Experimenter in response to the owners' answers were also recorded.

In Phase 2 of the *Stressed dog* condition (control), while separated from their owners, dogs' behaviour was recorded and the following five mutually exclusive behaviour categories were coded:

Passive behaviours: standing, sitting or lying down.

Exploration: activity directed toward non-movable aspects of the environment, including sniffing, distal visual inspection (staring or scanning), close visual inspection, or oral examination.

Physical contact: any form of bodily contact with the experimenter

Play: any vigorous, toy- or social partner-related behaviour, including running, jumping, or any physical contact with toys (chewing, biting)

Distress behaviours: active behaviours resulting in physical contact with the door (scratching, jumping at etc.) and/or vocalising (i.e. barking, growling, howling, whining).

In order to exclude the possibility that dogs' affective states were directly influenced by the experimenter during the manipulation phase in the two experimental conditions, a coder blind to both the condition and the purpose of the study coded the perceived stress level of the situation on a one-to-ten scale. Crucially, the coder did not speak the language that was used throughout the experiment; therefore he could not understand the content of the communication. He had to base his judgments on non-verbal gestures, tone of the voice and other non-linguistic cues, which resemble the information dogs may pick up on during the interaction between the experimenter and the owner.

Data analysis

First we employed a Generalized Estimating Equation for the analysis of the effect of the trial (performance before vs. after the manipulation) as within-subject factor and the effect of the type of the manipulation (*Stressed owner* vs. *Non-stressed owner*) as a between-subjects factor on the STAI scores and the memory performance of the owners. We performed the same analysis on the memory performance of the dogs with the modification that we included the *Stressed dog* condition in the type of manipulation variable and the previous training experience as covariate. For within-group comparisons Wilcoxon Matched-Pairs Ranks tests were used for discrete variables and paired t-tests for continuous variables (play and physical contact). For between-groups comparisons Mann-Whitney tests were used for discrete variables and unpaired t-tests for continuous variables. In the case of STAI scores and memory performances the changes due to the manipulation were calculated by subtracting the 'before-manipulation' values from the 'after- manipulation' values. The relationships between the variables were examined by Spearman correlation.

SPSS version 20 software was used for statistical analyses, all tests were two-tailed and the α value was set at 0.05.

2.2.2. Results

Changes in the owners' trait and state anxiety levels (pre- vs. post manipulation periods)

The owners' trait-anxiety seemed to be stable throughout the experiment; it was not influenced either by the trial (GEE, χ^2 = 1.166 p = 0.280) or by the type of manipulation (χ^2=1.239 p = 0.266) and the interaction was also not significant (χ^2 = 0.517 p = 0.472). In contrast, there was a significant interaction of the two main factors for the owners' state anxiety (GEE, χ^2 = 27.747 p < 0.001) without any significant main effects (trial: χ^2=0.009 p=0.923 type of manipulation: χ^2 = 1.508 p = 0.219).

Owners in the *Stressed* condition received significantly more negative (p < 0.001) and less positive (p < 0.001) feedback than owners in the *Non-stressed* condition (Mann-Whitney tests, $U_{(35)}$ = 0.00 for both) and these different types of manipulations affected their affective status differently. Namely, owners after having received negative feedback from the experimenter(S*tressed owner* condition) reported significantly greater increase in their state anxiety in comparison with those who received only positive feedbacks (N*on-stressed owner* condition) during the manipulation phase (Mann-Whitney test, $U_{(35)}$ = 12.5 p < 0.001) (Figure 7).

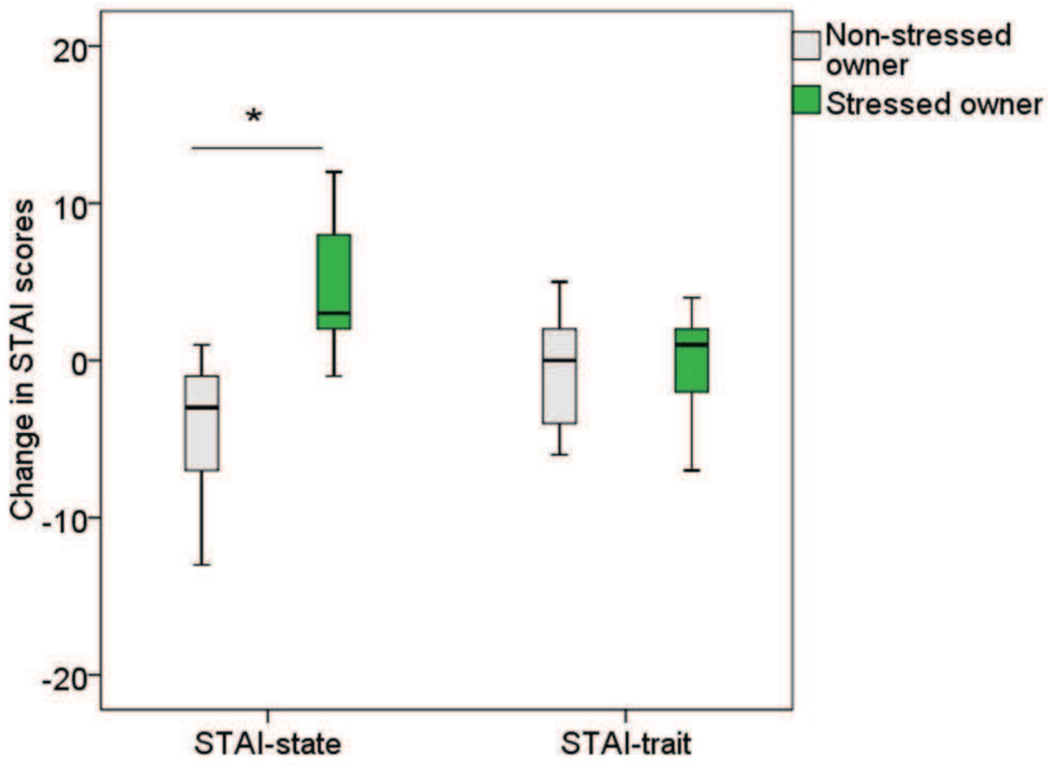


Figure 7: Comparison of the owners' state-anxiety scores obtained from pre- and post-manipulation phases (median, quartiles and whiskers) in the Non-stressed- and Stressed owner conditions. (* $p < 0.001$)

Owners' memory performance (pre- vs. post manipulation periods - comparison between the two experimental conditions)

There was a significant trial X type of manipulation interaction on the owners' memory performance (GEE, $\chi^2 = 8.248$ $p = 0.004$) without any main effects (trial: $\chi^2 = 0.268$ $p= 0.605$ type of manipulation: $\chi^2 = 0.008$ $p = 0.931$). Although the initial performance did not differ between the two experimental conditions (Mann-Whitney test, $U_{(35)} = 125$ $p = 0.169$; Figure 8), the change in the number of recalled words was higher in the *Stressed owner* condition compared to the *Non-stressed owner* condition (Mann-Whitney test, $U_{(35)} = 91$ $p = 0.014$; Figure 9). This suggests that moderately increased anxiety improved the participants' memory performance. Moreover the owners' memory performance changed according to the change in their state anxiety (s-STAI) scores as was indicated by a positive correlation between them (Spearman's rank correlation test, $r_{(35)} = 0.39$ $p = 0.017$).

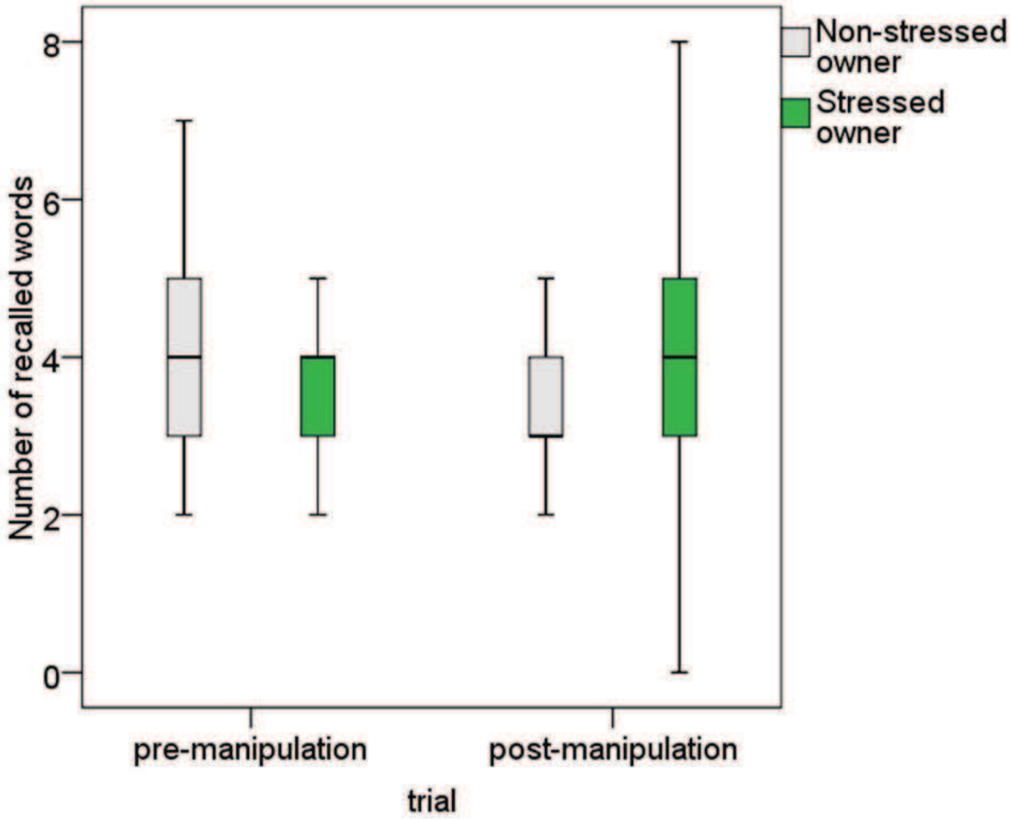


Figure 8: Number of words (median, quartiles and whiskers) recalled by the owners in the declarative memory task before and after the manipulation.

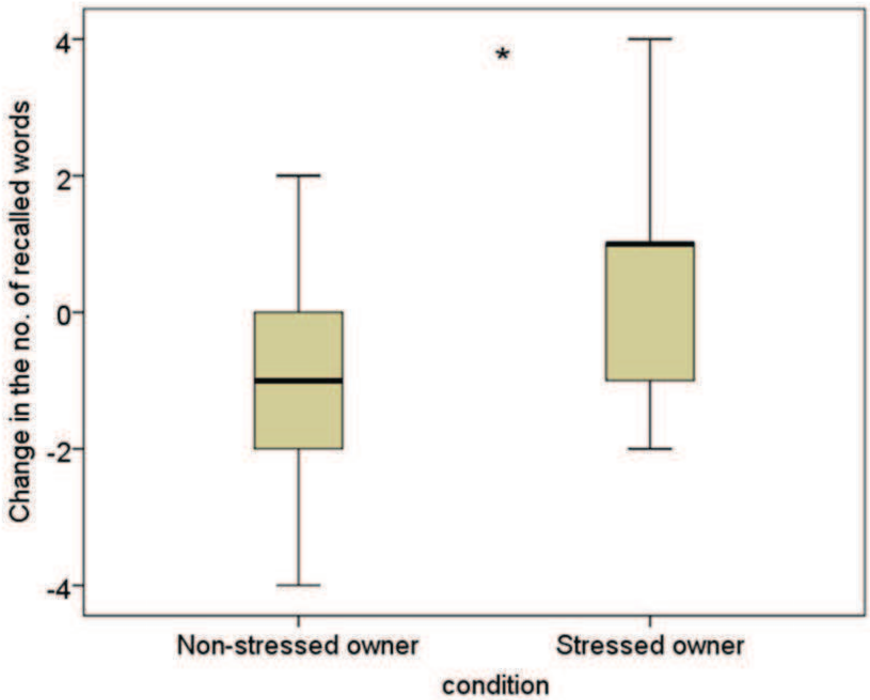


Figure 9: Changes in the number of words (pre- vs. post-manipulation phases; median, quartiles and whiskers) recalled by the owners in the declarative memory task. (* p = 0.014)

Factors potentially influencing emotional contagion between dogs and their owners

In order to determine whether negative feedback given by the experimenter during the *Stressed* condition have the potential to become a direct stressor for the dogs, we have analysed the non-Hungarian coder's ratings of perceived level of stressfulness in the manipulation phase (Phase 2). Our analysis showed that based on the experimenter's non-verbal gestures, tone of the voice and other non-linguistic cues a human coder cannot discriminate between the *Stressed owner* and the *Non-stressed owner* conditions (Mann-Whitney test, $U_{(35)} = 130.5$; $p = 0.175$). This finding provides indirect evidence that stressing the owner by the E was not directly perceptible by the dogs.

We next investigated the possibility whether dogs' stress level could be influenced through their owners' different behaviour in the manipulation phase of the Stressed vs. Non-stressed condition. In fact, dogs got the opportunity to freely interact with their owners in Phase 2 and thus we may assume that during this period the perception of expressive behaviours of the owner can transfer emotional states from the owner to his/her dog. In line with this assumption we coded and analysed the owners' behaviour while interacting with their dogs. Although there was no difference between the groups regarding the time spent with physical contact (two sample t-test, $t_{(35)} = 0.011$ $p = 0.768$), dog-owner pairs in the *Stressed owner* condition played less than in the *Non-stressed owner* condition ($t_{(35)} = 2.069$ $p = 0.01$). Playing seems to be a good behavioural indicator of the owners' distress, because it correlates with the change in s-STAI (Spearman's rank correlation test, $r_{(35)} = -0.453$ $p = 0.005$) and with the change in the owners' memory performance as well ($r_{(35)} = -0.37$ $p = 0.024$). Further analyses showed that owners in both conditions gave more positive than negative reinforcements (Wilcoxon Matched-Pairs Ranks tests, *Stressed owner* condition: $Z_{(18)} = -2.201$ $p = 0.028$ *Non-stressed owner* condition: $Z_{(17-} = 3.726$ $p < 0.001$) and the number of negative reinforcements were not significantly different between conditions (Mann-Whitney test, $U_{(35)} = 165$ $p = 0.854$). At the same time dogs in the *Non-stressed owner* condition were reinforced positively significantly more frequently than in the *Stressed owner* condition ($U_{(35)} = 86$ $p = 0.01$). These characteristic changes of the owners' behaviour in the Stressed condition could potentially contribute to the contagion of stress in dog-human relationships.

Dogs' behaviour during the separation phase (Stressed Dog condition, Phase 2)

All but two dogs showed active sign of distress for less than 20 sec (0-6.6 sec.) during the 2.5 minutes separation thus for these subjects (N=13) the duration of this episode was prolonged (+2.5 min.).The analysis of the relative percentage of the time spent with the different behaviours shows that dogs interacted with the experimenter 29.7%(range 1.2-89.9%) of the time on average. This was either physical contact (9.6±14.1%) or playing (20.1±26.7%) with the experimenter. They also explored the room (22.3±7.9%, range 11.1-34.5%) and behaved passively (30.2±19.2, range: 4.8-60.4%). Dogs spent 17.7±15.6% of time in close proximity (<1m) of the door but showed distress behaviours on average only 5.46±13.1% (range: 0-50%) of the total duration.

Dogs' memory performance (pre- vs. post manipulation periods - comparison between all three conditions)

Analysing the dogs' memory performance we found a significant main effect of trial (pre- vs. post manipulation periods: GEE, χ^2 = 7.89; p = 0.005), without a main effect of type of manipulation (χ^2=1.227; p=0.541) or previous training experience (χ^2 = 0.887; p = 0.346). More importantly there was an interaction between manipulation type and trial (χ^2 = 12.464 p = 0.002) (Figure 10).In comparison with their 'baseline' performance (Phase 1) dogs in both the *Stressed owne*r and the *Stressed dog* conditions showed a significant improvement in the post-manipulation (Phase 3) working memory test (Wilcoxon Matched-Pairs Ranks tests, *Stressed owner* condition: $Z_{(18)}$ = 2.682 p = 0.007, *Stressed dog* condition: $Z_{(13)}$ = 2.253 p = 0.024). In the *Non-stressed owner* condition, however, there was no change ($Z_{(17)}$ = 1.261 p =0.207).

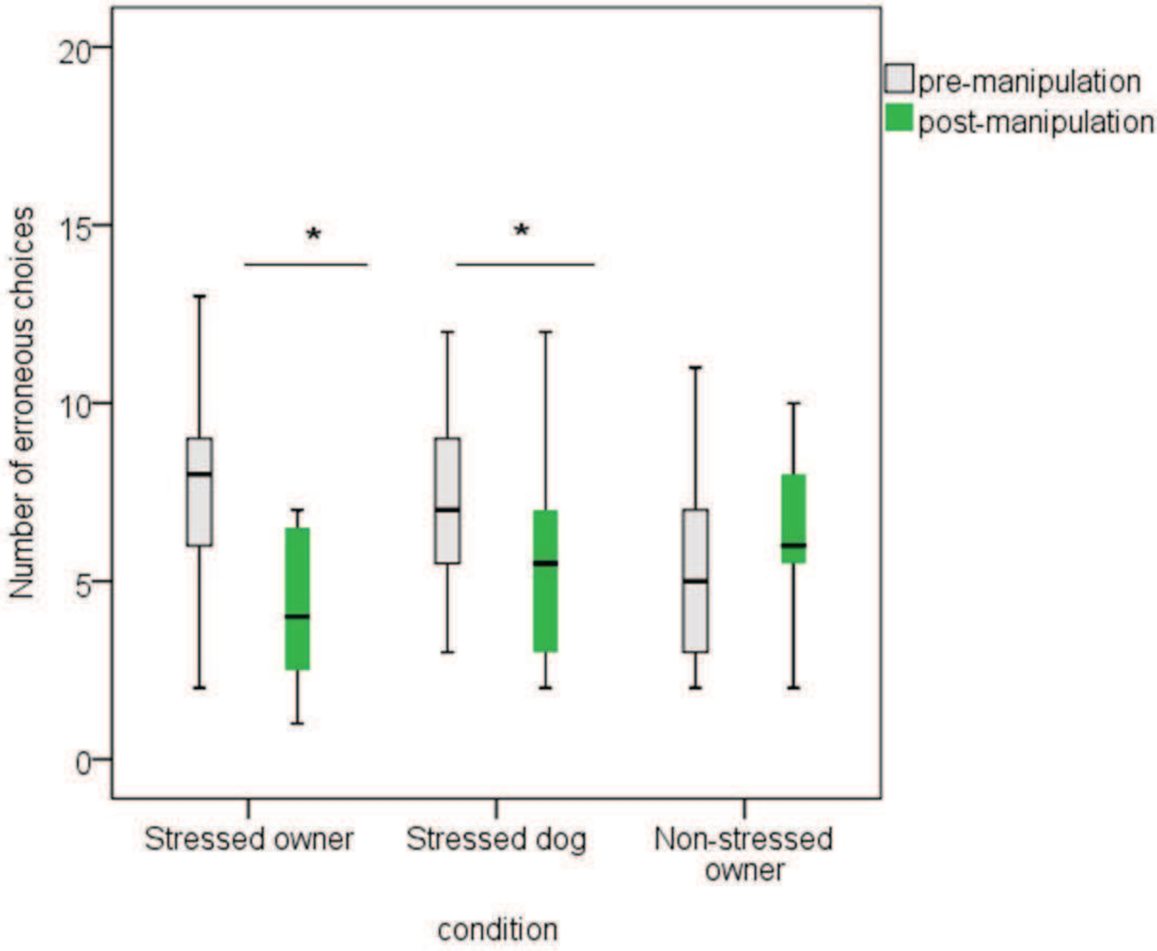


Figure 10: Number of erroneous choices (pre- vs. post-manipulation phases; median, quartiles and whiskers) by the dogs in the memory task. (* $p < 0.05$)

The finding that dogs' working memory performance varied as a function of the manipulation in Phase 2 was further supported by the analysis of the difference between pre- and post-manipulation measures. That is, the number of errors changed differently in the three conditions (Kruskal Wallis test $\chi^2_{(2)} = 10.641$ p = 0.0049; pairwise comparisons with Bonferroni correction: *Stressed owner* vs. *Non-stressed owner: p<0.05; Stressed dog* vs. *Non-stressed owner: p < 0.05*). Dogs in the *Stressed* conditions showed an improved memory performance (Figure 11).

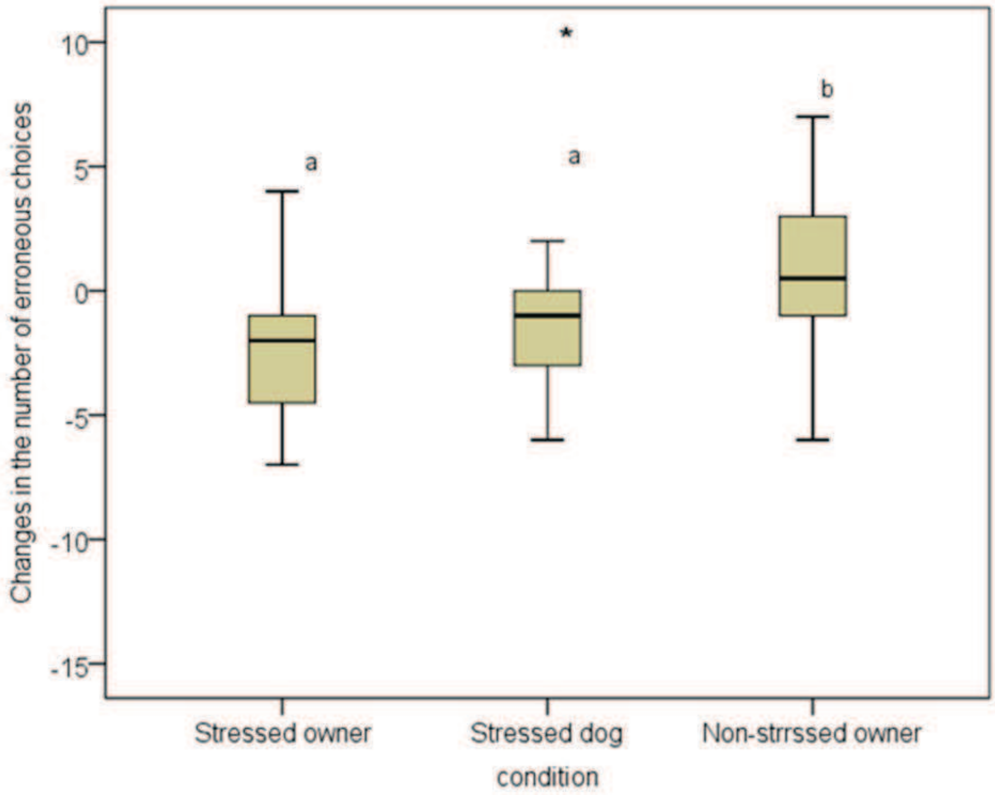


Figure 11: Changes in the number of dogs' erroneous choices in the Spatial Working Memory task (pre- vs. post-manipulation phases; median quartiles and whiskers). (* p = 0.0049)

There is a negative correlation between the change in number of errors and the change in the owners' stress level (Spearman's rank correlation test, $r_{(35)} = -0.483$ $p = 0.002$) which suggest that dogs' performance was affected by their owners' affective states. It is also worth mentioning that dogs' change in memory performance also correlated with the relative time spent with playing ($r_{(35)} = 0.439$ $p = 0.007$), dogs whose owners tended to play more with them during the manipulation phase committed more errors when re-tested in the memory task (Phase 3).

Dogs' better performance in the two *Stressed* conditions cannot be explained by the owners' more explicit encouragement, because the number of (verbal) encouragements did not differ between the pre- and post-manipulation phases (Phase 1 vs. Phase 3, Wilcoxon Matched-Pairs Ranks tests, *Stressed dog* condition: $Z_{(14)} = 29$ $p = 0.21$;*Stressed owner* condition: $Z_{(18)} = -1.122$ $p = 0.262$; *Non-stressed owner* condition: $Z_{(17)} = -0.855$ $p = 0.393$). Moreover there is no significant differences between the three groups (Kruskall Wallis test, before the manipulation: $\chi^2_{(2)} = 1.56$ $p = 0.46$ after the manipulation: $\chi^2_{(2)} = 3.08$ $p = 0.21$).

In addition, we analyzed whether previous training experience influenced dogs' memory performance. We compared the performance of dogs that had received some sort of official training (33) with those that had not (19), and found no difference either before (Mann-Whitney test $U_{(51)} = 259.5$ $p = 0.302$) or after ($U_{(51)} = 285.5$ $p = 0.592$) the manipulation. The change in performance was not affected by previous training either ($U_{(51)} = 268.5$ $p = 0.389$).

2.2.3. Discussion

These results allow us to conclude that the owners' state anxiety was effectively manipulated by the experimenter (i.e. after having received negative feedbacks, owners achieved higher state anxiety scores). The owners' performance in the declarative memory task also seems to be affected by their anxiety level, leading to a better performance in the *Stressed owner* condition and findings from the *Stressed dog* condition indicate a similar effect of anxiety on dogs' spatial working memory.

A key finding of the present study is that the anxiety experienced by the owner influences their dog's behaviour and that these effects are manifested in the cognitive domain. We propose that this phenomenon can be best explained by emotion contagion as the dogs' performance was not directly reliant on the owner's affective state or behaviour. Dogs had to solve the task on their own, therefore any change in performance had to be the result of previous interactions. Since very similar effects were observed in the memory performance of the owners, it is plausible to assume that the change of affective state was also similar.

The improvement of spatial working memory performance of dogs in the *Stressed owner* condition was similar to that of the *Stressed dog* condition. Moreover, dogs' working memory performance significantly correlated with the change in the owners' self-reported anxiety level and changed in the same direction as the owners' memory performance. Since there were significant differences in the owners' play behaviour and the use of positive reinforcements while interacting with their dogs, we may assume that the owners' affective state was transmitted at least partly through these behaviour signals. Of course dogs could be influenced by other sources of information, for example the owners' body language (Merola et al 2012), facial expression (Nagasawa et al 2011; Racca et al 2012), emotional valence of the commands (Ruffman & Morris-Trainor 2011), or other unobservable behavioural signals or odour cues (Prehn-Kristensen et al 2009).

This study gives further support for the idea that the real emotions of the owner can influence the dog; and our results suggest that the underlying mechanism may be emotion contagion. This points to the conclusion that it is possible to influence the dog's stress level via the owner even in an 'artificial', experimentally controlled situation.

2.3. STUDY 3: Studying the conditioned placebo effect in dogs.

Separation related behaviours, the fear or dislike of isolation from the owner even in familiar environments, are frequently reported problems in pet dogs (Wright & Nesselrote 1987). Separation anxiety can manifest not only in physiological change but also in behavioural symptoms, efforts to re-establish the proximity with the owner such as scratching the door, orientation to the door, vocalisation.

It has been suggested that dogs possess a specific behaviour organising mechanism (called interspecific attachment), which evokes specific responses in stress situations related to separation from the attachment figure (see Topál & Gácsi 2012 for a review). The most widely used experimental paradigm to study dog-human attachment and separation anxiety is the Strange Situation Test (SST), which capitalizes on the tendency of dogs to show specific behaviours when separated from the owner in an unfamiliar room (Topál et al 1998). In this context, efforts to re-establish the proximity (scratching the door etc.) are typical characteristics of dogs' behaviour (e.g. Prato-Previde et al 2003; Palmer & Custance 2008).

These behaviour symptoms associated with physiological changes (Palestrini et al 2010) can be reduced by medication or behaviour therapy (Butler et al 2011; Appleby & Plujimakers 2004). Concerning the medication to treat anxiety disorders in dogs, Sedalin is one of the widely used psychoactive drugs. Its active substance is acetylpromazine, which has a tranquilizing effect (Booth, 1991) as it causes a general depression of the nervous system characterised by both neuronal and behavioural changes (Tontodonati et al., 2007).

Although behavioural manifestations of separation anxiety in dogs are easy to observe and behavioural symptoms of anxiety can be reduced by tranquilizers, placebo conditioning studies are missing. Thus, in the first experiment of Study 3 we aimed to investigate the role of placebo in reducing dogs' separation related distress behaviours and to determine whether it is possible to produce a conditioned placebo-effect after repeated experiences of the anxiolytic effects of psychoactive drug (Sedalin) treatment in the experimental situation.

Moreover, since responsiveness to expectancy based placebo treatment in humans is positively affected by subjects' dispositional optimism (Geers et al 2005; 2007; 2010; Morton et al 2009), in a follow up study (Experiment 2) we aimed to test whether individual differences in dogs' susceptibility to the placebo effect are linked to the subjects' tendency to form positive expectations about upcoming events.

Discrimination learning tasks are standardly used to assess positive expectation bias in non-human animals (Harding et al 2004) including rats (Burman et al 2009), sheep (Doyle et al 2010), starlings (Bateson & Matheson 2007), and honeybees (Bateson et al 2011). After the subjects have learned that one stimulus (sound, colour, location, etc.) is negative (non-reinforced), while another one is positive (reinforced) they typically respond with higher latency to the negative stimulus. When subjects are presented with an ambivalent stimulus (transition between negative and positive stimuli), "optimistic" subjects respond as if they were presented with the positive stimulus (Mendl et al 2009). This method was successfully applied for dogs with location cues (Mendl et al 2010; Müller et al 2012) and in colour discrimination contexts (Burman et al 2011).

We hypothesised that there would be a significant positive correlation between dogs' susceptibility to placebo conditioning (measured by the relative change in behaviour signs of distress), and their positive expectation bias scores (measured by Mendl et al.'s 2010 discrimination learning task).

2.3.1. Experiment 1: The role of Conditioned placebo effect in dogs' separation anxiety

2.3.1.1. Materials & Methods

Subjects

Adult pet dogs and their owners were recruited on a voluntary basis. Owners completed a brief questionnaire about their dog's behaviour during different separation situations, and those dogs that were affected in at least 3 out of the 7 contexts, and were reported to show behavioural problems (e.g. excessive barking, salivating, destructive behaviour) when left alone in an unfamiliar place were selected. An additional criterion for selection was that the dog was not taking any medication and had no known health problem. All owners were provided with adequate information about the effects of Sedalin and they signed the informed consent form to participate. However, owners were not informed of the specific aims and design of the study, and they did not know if their dogs had been given Sedalin or vitamin before the trials. The procedure was approved by the Ethical Committee for Animal Experimentation of Eötvös University (No. XIV-I-001/521-4/2012), and conducted in accordance with the national laws regulating animal research.

Thirty-one adult (> 1 year) pet dogs were included in the experiment, but 3 owners and their dogs did not come back to all trials. The remaining 28 dogs (mean age±SD: 1.8±3.09 years, 15 males and 13 females from 13 different breeds and 13 mongrels) were tested and included in the data analysis (see Appendix 4). Subjects were randomly assigned to either the *Conditioned* or the *Control* group (N = 14-14). The two groups did not differ in their mean age ($t_{(26)}$ = 0.905, p = 0.374), sex ratio ($\chi2_{(1)}$ = 0.144, p=0.705), breed distribution ($\chi2_{(7)}$ = 3.0, p = 0.885), body weight ($t_{(26)}$ = 0.786, p=0.439), separation anxiety questionnaire score ($U_{(26)}$ = 84, p = 0.541) and in terms of duration from baseline to test trial ($t_{(26)}$ = 1.047, p=0.305), and duration from the last conditioning event to test trial ($t_{(26)}$= 0.0, p > 0.999).

Experimental arrangement

The experiment took place in a room (3.9 m x 4.1 m) at the Family Dog Project lab, at Eötvös University, Budapest. Only a chair and some toys for the dog were placed in the room. Two different doors were used by the two human participants, the owner and the stranger (Figure 12). The stranger was always a woman who was unfamiliar to the dogs.

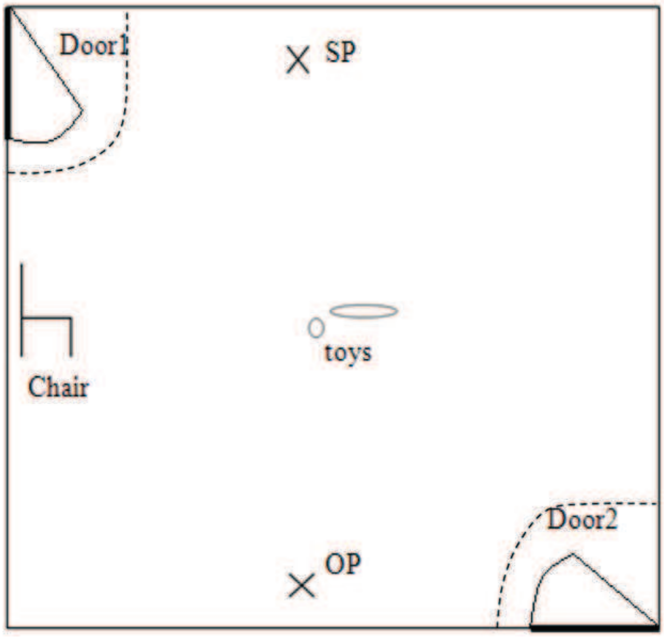


Figure 12. Schematic layout of the experimental arrangement (Study 3, Exp. 1).
A chair and some toys were present in the experimental room. Door 1 was used by the stranger to enter; Door 2 was used by the owner to enter. The areas near the door are indicated with broken lines. SP & OP were places marked with adhesive tape on the floor where the stranger (SP) and the owner (OP) stood (see Procedure).

Procedure

Dogs participated in five trials, taking 1-4 day breaks (at least 24 hours) between them.

Baseline trial

The procedure was identical for both groups. Subjects participated in a modified and shortened version of Strange Situation Test (Topál et al 1998). It consisted of 3 episodes, each lasting for 2 minutes. Human participants (owner and stranger) followed detailed instructions that determined their behaviour during the test. The three episodes were preceded by a short introductory phase during which the experimenter introduced the dog and the owner to the experimental room through Door 2, and the dog was allowed to explore the room for 30 s. Then, the experimenter left the room with the owner through Door 2.

The episodes followed each other in a fixed order: the dog was 1) alone, 2) with a stranger, 3) with the owner in the experimental room.

Episode 1: Dog alone

The dog was left alone, and observed by the owner and experimenter on the monitor in the adjacent room (without speaking, thus the dog could not hear people in the adjacent room).

Episode 2: Dog & Stranger

The stranger entered the room (through Door 1), stepped up to a predetermined point (SP) and stood there for 1 minute. She adjusted her behaviour to that of the dog (petted its head and back if the dog initiated contact) and tried to keep the dog away from the doorway by playing or petting (depending on the preference of the dog). After 1 minute, she sat on the chair and stopped playing. During the second minute she was allowed to pet the dog if it initiated contact.

Episode 3: Dog & Owner

The owner entered the room through Door 2 and stepped up to a predetermined point. Meanwhile, the stranger left through Door 1. The owner then greeted and comforted the dog (petting and playing – depending on the dog's reaction). The owner stood at the predetermined point (OP) until the end of the episode, playing with and/or petting the dog if it initiated.

Conditioning trials (2-4)

In case of the three conditioning trials, 25 minutes before each trial, dogs received either a sedative drug (Sedalin Gel Oraldoser A.U.V. manufactured by Vetoquinol Biowet Sp.z.o.o., dose: 1 ml/35 kg body weight) in a piece of liverwurst (approx. 10 g, manufactured by Szegedi Paprika Zrt.) or a non-sedating vitamin formulation (dose: 1 ml/35 kg body weight, Canigest Paste manufactured by TRM Pet Products) in a piece of liverwurst. Sedalin is widely applied by veterinarians as tranquilizer and anesthetic premedicant; it shows effects in 20 minutes and lasts 6-12 hours. The vitamin did not have any effect during the experiments. Dogs received the treatment in the kitchen of the department and spent the 25 minutes there resting next to the owner.

In order to increase the saliency of 'treatment' and to facilitate the formation of associations between the physiological effects of pre-trial treatment and the unfamiliar test environment, we introduced an additional salient treatment right before the conditioning trials in both groups. The experimenter sprayed the dogs' muzzle and paws with clear water (using a hand pump spray bottle) and during the spraying she gave one more piece of liverwurst to the dog.

Conditioning trials included three episodes similar to the Baseline, however, the owner was present with the dog in all three episodes in order to avoid any possibility of separation from the owner being directly associated with the anxiolytic effects of Sedalin. Episodes 1 and 3 were identical to episode 3 in the Baseline trial. In episode 2, in contrast to the Baseline trial, the owner did not leave but was standing at the predetermined point and was allowed to interact with the dog while the stranger was in the room.

Test trial

In the test trial, all dogs were treated similarly. Both groups received placebo (vitamin treatment) in a piece of liverwurst 25 minutes before the trial. Their muzzles/paws were sprayed with water and they received one more piece of liverwurst right before the trial (Table 5). The procedure of this trial was identical to that described in the Baseline.

After the conditioning trials and test trial the owners' opinion about the type of treatment (Sedalin or placebo) their dogs received was asked.

<table>
<tr><th></th><th>Baseline trial</th><th>Conditioning (trials 2-4)</th><th>Test trial</th></tr>
<tr><td>Conditioned group (N=14)</td><td rowspan="2">Separation
No pre-treatment</td><td>No separation
Sedative pre-treatment (Sedalin)
Water spray</td><td rowspan="2">Separation
Non-sedating pre-treatment (vitamin)
Water spray</td></tr>
<tr><td>Control group (N=14)</td><td>No separation
Non-sedating pre-treatment (vitamin)
Water spray</td></tr>
</table>

Table 5. Experimental design of Experiment 1.
All types of pre-treatments contained the additional water spraying and a piece of liverwurst right before the trials.

Behaviour coding

As behaviours related to separation anxiety are typically displayed close to the exit/entry door (see e.g. Prato-Previde et al 2003; Palmer & Custance 2008; Palestrini et al 2005), we recorded the durations of anxiety-related behaviours while staying close (< 1 m) to the doors. The two doors were not differentiated because both could be considered as a potential exit by the dogs. On the other hand to examine the sedative effect of the drug the time spent passively was also measured. Relative durations were recorded for both variables.
Definitions of the behaviour categories:

Passive behaviours: standing, sitting or lying down anywhere but at the door while alone (PASS-A), in the presence of the stranger (PASS-S), or in the presence of the owner (PASS-O).

Door-distress: displaying behavioural signs of distress while staying close to the door; active behaviours resulting in physical contact with the door (scratching, jumping at etc.) and/or vocalising (i.e. barking, growling, howling, whining) in the close proximity (< 1 m) of the door while alone (D/DISTR-A), in the presence of the stranger (D/DISTR-S), or in the presence of the owner (D/DISTR-O).

Door-passive: staying (standing, sitting, or lying down) in the close proximity of the door (< 1 m) without physical contact with it, and/or vocalisation while alone (D/PASS-A), in the presence of the stranger (D/PASS-S), or in the presence of the owner (D/PASS-O).

Inter-observer agreement was assessed by parallel evaluation of the behaviour of 20% of the total sample by two independent coders who were blind to the conditions. The analysis of inter-observer agreement yielded a very good inter-observer reliability (Cohen's kappa values; PASS: 0.92, D/DISTR: 0.87, D/PASS: 0.91).

Data analysis

The relative percentage of the time spent in the above behaviours was calculated for the statistical analyses. Variables did not have Gaussian distribution (Kolmogorov Smirnoff test). At first we analysed the data with Generalized Estimating Equation (GEE) which is an extension of the GLM algorithm to accommodate the modelling of repeated measurement following non-normal distribution (Hardin & Hilbe 2003). We employed a GEE analysis to examine the effect of the trial (1^{st}, 2^{nd}, 3^{rd} conditioning and test trials) as within-subject factor and the effect of the group (conditioned vs. control) as between subject-factor on the owners' opinion about the treatment. GEE analysis was also employed to examine the effect of the repetition (1^{st}, 2^{nd} and 3^{rd} conditioning trials) as within-subject factor and the effect of the pre-treatment (administering Sedalin vs. vitamin) as between subject-factor on passive behaviour of dogs during the Conditioning trials. To analyse the effect of the conditioning we used GEE analysis to examine the effect of the trial (baseline vs. test) as within-subject factor and the effect of the pre-treatment (administering Sedalin vs. vitamin) during the Conditioning trials as between subject-factor on the dogs' behaviour. When GEE analysis revealed significant trial x treatment interaction, we calculated the change in the dogs' behaviours from Baseline to Test trials. We assumed that the difference in the relative durations of separation distress related behaviours expressed by the Sedalin conditioned dogs would be an indicator of subjects' susceptibility to the placebo effect. We subtracted the relative duration (time%) of a given behaviour in Baseline from the relative duration of that behaviour in Test trial. The 'difference values' of the *Conditioned* and *Control* groups were compared with Mann-Whitney U tests.

SPSS version 18 software was used for statistical analyses.

2.3.1.2. Results

Dogs' behaviour during the Conditioning trials

As the owners were present in the experimental room throughout these trials, it is not surprising that only few dogs (4 in the 'Conditioned' and 3 in the 'Control' groups) displayed any behavioural signs of distress. Dogs spent hardly any time with distress behaviours; on average 0.5% (Sedalin group) and 0.65% (Control group) of the total duration, and, this remained extremely low even after repeated trials (0.2-1% of time during the 1st, 2nd and 3rd conditioning trials in both groups). However, dogs spent much more time with passive behaviours (on average 31 and 28% in the Conditioned and the Control groups respectively) and there was no effect of repetition (treatment: $\chi^2_{(1)} = 0.2$, $p = 0.655$; repetition: $\chi^2_{(2)} = 4.796$, $p = 0.091$).

Owners' evaluation of treatment effects

Although we did not find significant effects of Sedalin treatment on the recorded behaviour variables, the owners in the conditioned group thought more often compared to the control group that their dog received Sedalin gel in the conditioning trials (GEE analysis, group effect: $\chi^2 = 4.023$, $p=0.045$; trial effect: $\chi^2 = 5.973$, $p = 0.113$; interaction: $\chi^2 = 2.816$, $p = 0.421$), but not in the test trial (Mann-Whitney test, $U_{(26)} = 84$, $p = 0.541$).

Dogs' behaviour in the Test vs. Baseline trials: the effects of conditioning

Separation episode (Episode 1)

During the separation episode dogs' passive behaviour was influenced by interaction between the trial and treatment (GEE, $\chi^2 = 6.537$, $p = 0.011$) with no significant main effects of the factors (trial: $\chi^2 = 0.356$, $p=0.551$; treatment: $\chi^2 = 0.016$, $p = 0.901$). The change from Baseline to Test trials in the *Conditioned* group was positive and significantly different from the slight negative change in the *Control* group (Mann-Whitney test, $U_{(26)} = 50$, $p = 0.027$) (Figure 13).

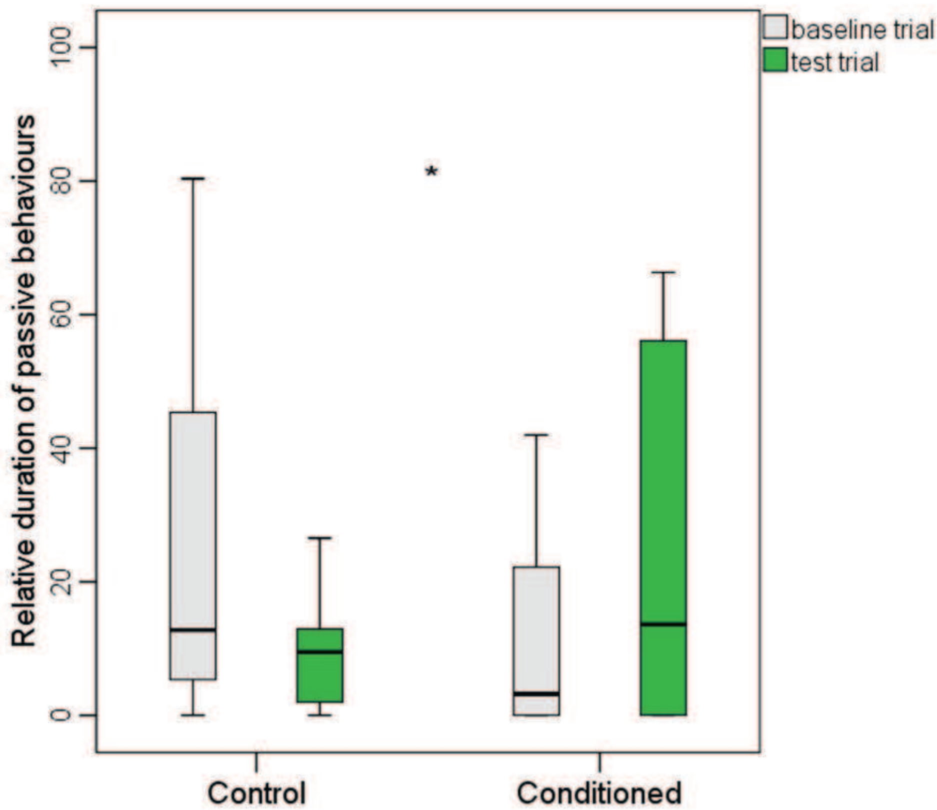


Figure 13. Relative duration of passive behaviours in Episode 1 (median, quartiles and whiskers). Dogs in the two groups showed different changes in passive behaviour after the conditioning. * indicates significant ($p < 0.05$) trial (Baseline vs. Test) x treatment (administering Sedalin vs. vitamin) interaction.

Concerning passive behaviours close to the door, however, GEE analysis did not show significant main effects or interaction (trial: $\chi^2 = 0.239$, $p = 0.625$; treatment: $\chi^2 = 0.017$, $p = 0.896$; interaction: $\chi^2 = 1$, $p = 0.317$). The analysis of behavioural signs of distress close to the door showed a significant interaction between the trial and treatment (GEE, $\chi^2 = 4.66$, $p = 0.031$) with no main effects of trial (Baseline vs. Test: $\chi^2 = 0.001$, $p = 0.985$) or treatment (Sedaline vs. Vitamin: $\chi^2 = 0.481$, $p = 0.488$) (Figure 14). We found significant difference between changes in the *Conditioned* and the *Control* group (Mann-Whitney test, $U_{(26)} = 48$, $p = 0.021$; Figure 15). Results of the separation episode are summarized in Table 6.

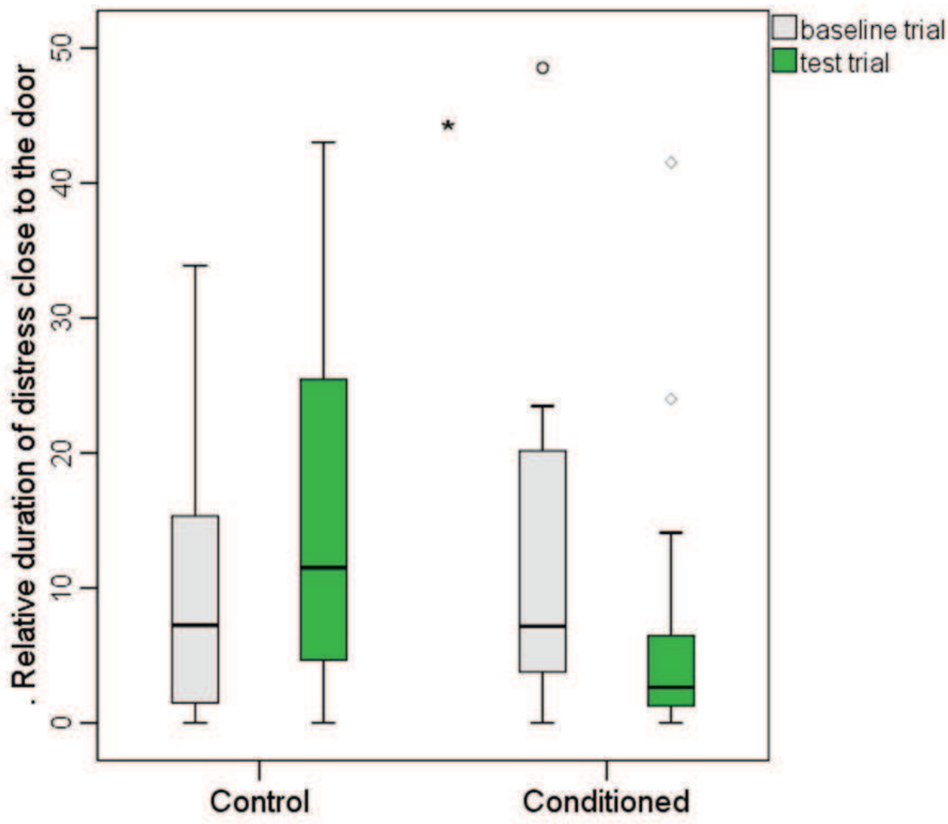


Figure 14. Relative duration of distress close to the door in Episode 1(median, quartiles and whiskers). Dogs in the two groups showed different changes in distress signs close to the door after the conditioning. * indicates significant ($p < 0.05$) trial (Baseline vs. Test) x treatment (administering Sedalin vs. vitamin) interaction.

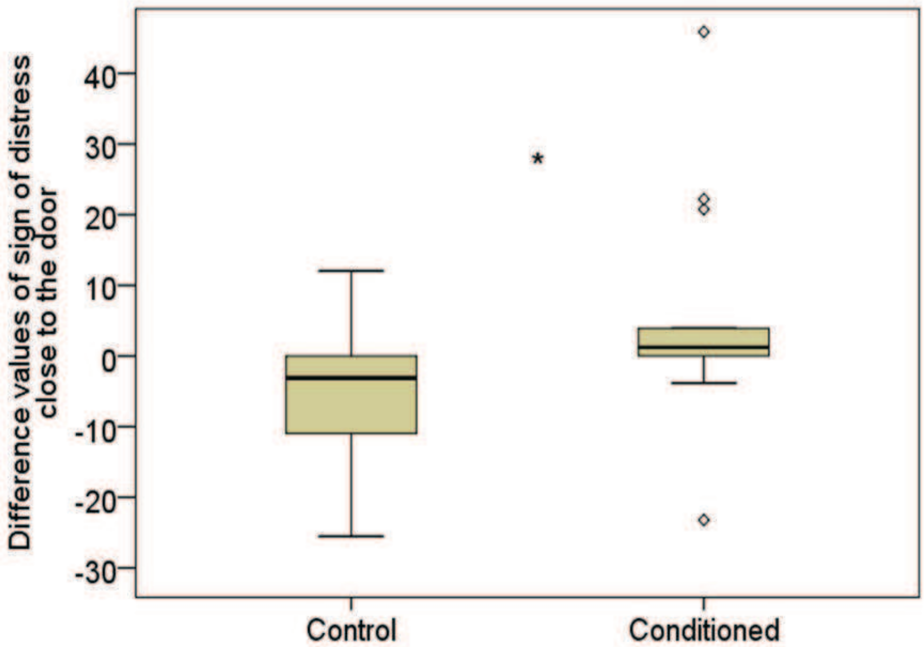


Figure 15. Difference values of sign of distress close to the door (median+quartiles+outlier data). Dogs in the Conditioned group have higher difference scores (compared to the Control group), which represent higher placebo response (higher change in distress). * indicates significant ($p < 0.05$) between group difference .

	GEE analysis (based on raw data)			Mann-Whiney test (change from baseline to test trial)
	trial (baseline vs. test)	treatment group (conditioned vs. control)	trial x treatment interaction	conditioned vs. control group
D/distr-A	$\chi^2_{(1)}=0.001$, $p=0.985$	$\chi^2_{(1)}=0.481$, $p=0.488$	$\chi^2_{(1)}=4.66$, $p=0.031$	$U_{(26)}=48$, $p=0.021$
PASS-A	$\chi^2_{(1)}=0.356$, $p=0.551$	$\chi^2_{(1)}=0.016$, $p=0.901$	$\chi^2_{(1)}=6.537$, $p=0.011$	$U_{(26)}=50$, $p=0.027$
D/PASS-A	$\chi^2_{(1)}=0.239$, $p=0.625$	$\chi^2_{(1)}=0.017$, $p=0.896$	$\chi^2_{(1)}=1$, $p=0.317$	$U_{(26)}=79$, $p=0.401$

Table 6. Summary of the statistical analyses (separation episode, Study 3, Exp. 1).

Episodes 2 and 3

There were no significant main effects or interactions for any of the behaviour variables in those episodes when the owner or the experimenter was present (GEE analyses, PASS-S: trial: $\chi^2 = 0.232$, p = 0.627; treatment: $\chi^2 = 0.052$, p = 0.819; interaction: $\chi^2 = 0.609$, p = 0.435; D/PASS-S: trial: $\chi^2 = 0.061$, p = 0.804; treatment: $\chi^2 = 0.551$, p = 0.458; interaction: $\chi^2 = 0.055$, p = 0.815; D/DISTR-S: trial: $\chi^2 = 0.069$, p = 0.793; treatment: $\chi^2 = 2.667$, p = 0.102; interaction: $\chi^2 = 1.736$, p = 0.188; PASS-O: trial: $\chi^2 = 2.291$, p = 0.130; treatment: $\chi^2 = 0.657$, p = 0.418; interaction: $\chi^2 = 1.863$, p = 0.172; D/PASS-O: trial: $\chi^2 = 0.716$, p = 0.398; treatment: $\chi^2 = 0.344$, p = 0.558; interaction: $\chi^2 = 2.270$, p = 0.132); D/DISTR-O: trial: $\chi^2 = 0.905$ p = 0.342; treatment: $\chi^2 = 0.816$, p = 0.366; interaction: $\chi^2 = 1.249$, p = 0.264).

These results show that the two types of treatment during the conditioning phase of the experiment affected dogs' later behaviour differently. After having received treatment with placebo (non-sedating vitamin) before the Test trial, the behaviour of dogs in the 'dog alone' episode depended on whether they had been treated with sedative substances during the conditioning phase.

Results are not likely to be explained by carry over effect of Sedalin, because we did not find any correlation between the time elapsed between the last conditioning trial and the test trial (ranged between 1-8 days) and the placebo effect (i.e. behaviour change from Baseline to Test trials) (Pearson r = 0.33, p = 0.265).

2.3.2. Experiment 2: Expectancy bias in dogs

2.3.2.1. Materials & Methods

Subjects

Twenty-one dogs (mean age±SD: 3.3±2.02 years, 11 males and 10 females, from 9 different breeds and 8 mongrels) from the 28 subjects that participated in Experiment 1 were called back for Experiment 2, 1-26 months after the first experiment. (One dog from the Conditioned group and six dogs from the Control group of Experiment 1 were not available any more.)

Procedure

The procedure was based on the study of Mendl et al (2010). The Cognitive Bias Test was conducted in the same room as Experiment 1, the owner and an experimenter were present with the dog throughout the test. At the start of each trial, the owner led the dog to the starting position while the experimenter, standing behind the dog and the owner, baited (or did not bait, depending on trial type) a plastic pot (11cm high, 14 cm in diameter) with a piece of sausage (see Figure 16).

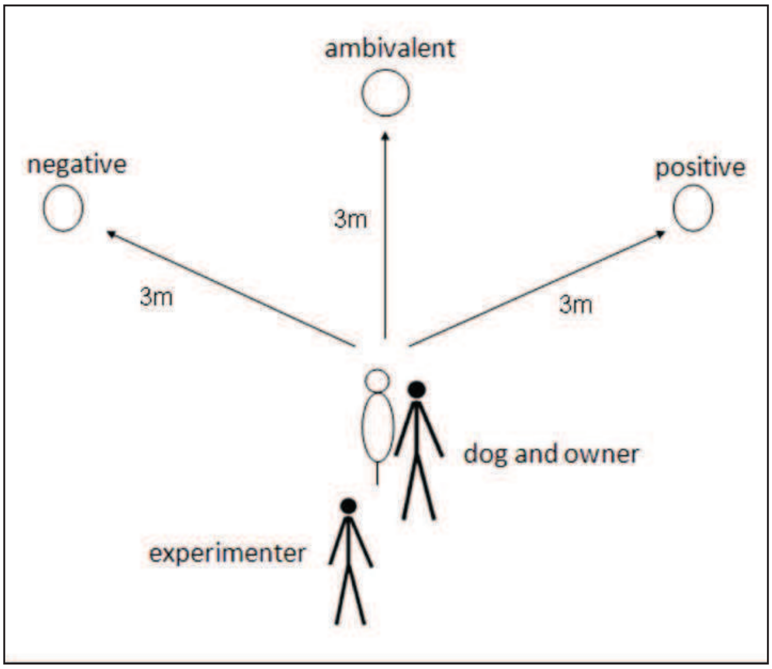


Figure 16. Experiment 2: Arrangement of the cognitive bias test.
The experimenter standing behind the dog and the owner baited (or did not bait, depending on trial type) a plastic pot with a piece of sausage. Then she placed the food bowl at one of three pre-determined locations (negative, ambivalent, positive), then she went behind the owner, and the dog was released to approach the bowl.

Training trials

Dogs were first trained that, when the pot was placed at one ('positive'- P) location, it contained food, and when it was placed at another ('negative'- N) location, it was empty. The locations were equidistant from the dog. For 11 dogs, P location was on the right hand side, and for 10 dogs it was on the left. The training always started with four warm up trials; two P trials (baited pot placed at the P location), when dogs could see the baiting, and two N trials (non-baited pot placed at the N location), in which the experimenter showed the empty container to the dog.

Subsequently, P and N training trials were presented in a pseudorandom order, with no more than two trials of the same type being presented consecutively. Importantly however, in these trials, dogs were prevented from witnessing whether the container was baited or not, since the experimenter baited (or not) the pot behind the dog while the owner gently prevented the dog from looking back. When the experimenter had placed the pot and returned to her position behind the owner, the dog was released and allowed to choose. Owners were allowed to encourage their dog (saying “You can go!”). Training trials continued until the latency for each of the last five N trials was longer than any of the latencies for the last five P trials. After the dog had reached this learning criterion, the test trials began.

Test trials

Testing began once the learning threshold was achieved. Test trials were identical to training trials except that in three cases the empty pot was placed at the ‘ambivalent’ location (A) equally spaced between the P and N locations (see Figure 10). The ambiguous trials were followed by one P and one N trial (9 trials in total; e.g.: APN, ANP, APN) in random order.

The purpose of the test trials was to investigate how dogs responded to the ambivalent location and whether they tended to approach them with a speed more similar to that at P location (indicating anticipation of a food reward – an ‘optimistically’ biased judgement of the ambivalent cue) or N location, that is, more slowly (indicating lower anticipation of food – a ‘pessimistically’ biased judgement).

Data analysis

Considering the wide range of time that elapsed between Experiment 1 and 2, we checked the data for any association with this duration (Pearson correlation test) to determine if the conditioning of the subjects might have had an effect on the expectancy scores.

The latency to reach the pot was defined as the time that elapsed between being released by the owner and the moment the dog put its head into the pot, or touched it with its nose. Latency was recorded for each trial. If the dog did not approach the container within 30 s, the trial was terminated, a latency of 30 s was allocated, and the next trial was initiated. Mean latencies followed normal distribution (Kolmogorov-Smirnov test).

Based on the study by Mendl et al (2010), a *positive expectancy score* was calculated for each dog. That is, we adjusted each dog's mean ambivalent trial latencies ($M_{lat}A$) by taking into account its mean 'baseline' latencies to get to the positive ($M_{lat}P$) and negative ($M_{lat}N$) locations during the test phase as follows:

$$\text{positive expectancy score} = \frac{(MlatN - MlatA)}{(MlatN - MlatP)} \times 100$$

Higher scores indicate stronger positive expectancies. Positive expectancy scores followed normal distribution (Kolmogorov-Smirnov test).

Based on the results of Experiment 1, the individual placebo response could be best indicated by the relative change in the door-distress variable in Episode 1 (D/DISTR-A in the Baseline vs. Test trial). Higher relative changes are supposed to represent stronger placebo responses so the relative change of this value was calculated for each dog.

As the relationship between the placebo response values and positive expectancy scores was not linear, a logarithmic transformation was made on the placebo response values, thus the relationship could be analysed with Pearson-correlation.

2.3.2.2. Results

Subjects reached the training criterion on average after 30 trials (range 12-57 trials), and P and N locations were strongly differentiated also in the test trials; dogs approached the plastic pot sooner in P than in N type test trials (paired sample t-test, $t_{(20)}=4.036$ $p<0.001$). The positive expectancy scores ranged from -12.36 to 1179.5 (mean ± SD: 124.67 ± 243.79). Treatment groups did not differ in terms of positive expectancy scores ($t_{(19)} = 1.322$ $p = 0.202$) and there was no association between the time elapsed since the conditioning of the dogs in Experiment 1 and the expectancy scores (Pearson correlation test, $r_{(20)} = 0.335$ $p=0.149$). We revealed a significant positive relationship between the positive expectancy scores and placebo response values in case of the conditioned group (Pearson correlation test, $r_{(12)} = 0.697$ $p = 0.008$, Figure 17) but not in the control group ($r_{(7)} = 0.268$ $p = 0.521$).

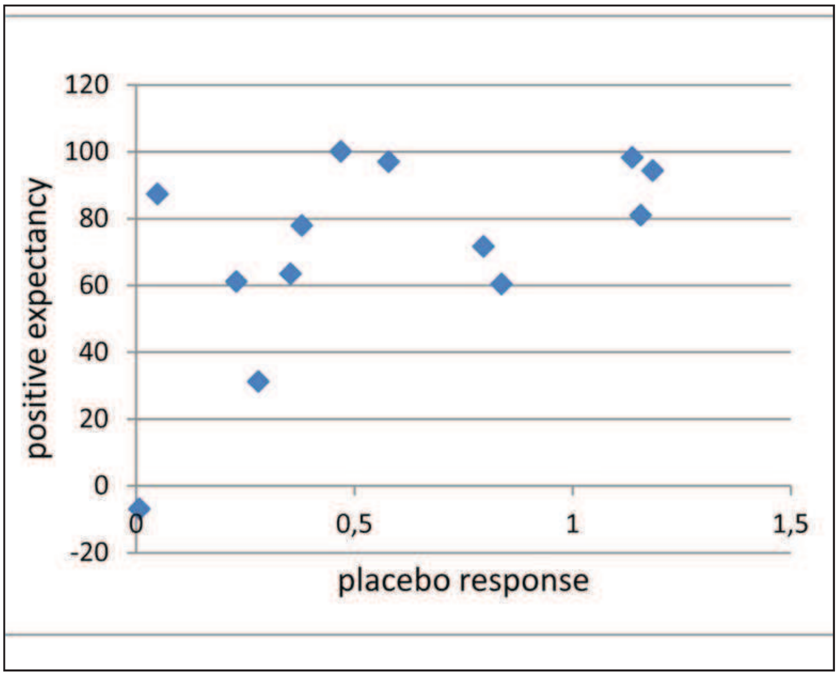


Figure 17. Relationship between the individual placebo response and positive expectancy

There is a logarithmic relationship between the positive expectancy scores and the placebo response values (r = 0.697 p = 0.008) in the conditioned group.

These results indicate an association between 'cognitive bias' and 'susceptibility to placebo conditioning' measures in dogs, suggesting that dogs that have stronger positive expectancies (are more "optimistic") tend to be more responsive to the stress relieving effects of placebo treatment after conditioning with an active substance.

2.3.3. Discussion

Our results provide the first behavioural evidence in dogs for the development of a conditioned placebo effect, an effect that is well-known in humans (Bendetti et al 2003; Goebel et al 2002) and in laboratory animals (Isaac & Isaac 1976). In the two experimental groups (repeated treatment with sedative drug vs. non-sedating vitamin) we observed opposite trends of changes in separation anxiety related behaviours. The effects of sedative drug conditioning manifested itself via increased passivity and decreased duration of behavioural signs of distress displayed close to the door. In contrast, dogs in the control group showed an opposite tendency in these responses.

Considering that using a double dose of Acepromazine (compared to our design), Tontodonati et al (2007) could not find any physiological or behavioural effects 16 hours after the treatment, long-term effects of acetylpromazin (Sedalin) are unlikely to explain the behaviour changes of the *Conditioned* group. Moreover if carry-over effect took place we would expect that the magnitude of the placebo effect correlates with the time elapsed between the last conditioning trial and the test trial, however we did not find such correlation.

The results of Experiment 2 expand our knowledge on placebo conditioning in dogs and highlight the potential importance of expectancy bias on the formation of placebo responses. The finding that dogs that were more responsive to the placebo treatment tended to show stronger positive expectancy in an ambivalent situation seems to be consistent with the conclusions of human studies (Geers et al 2005; 2007; 2010; Morton et al 2009). Importantly however, these human studies investigated the expectancy based and not the conditioned placebo effect. Although it remains unclear whether conscious learning (Stewart-Williams & Podd 2004; Kirsch 1985) or some ‘cognitively blind’ physiological response plays a more prominent role in the observed placebo effect, the association between dogs’ positive expectancy scores and the magnitude of placebo-induced responses suggests that the observed placebo effect could not be entirely explained by unconscious factors.

2.4. STUDY 4: Can the owner's expectancy mediate placebo effect to dog?

After the low-level placebo effect has been shown in dogs, in an additional study we examined whether it is possible to produce placebo effect without any systematic associative conditioning (previous drug treatment). Earlier studies had suggested placebo-like effect in dogs without pretreatment with active substance. Muñana and her colleagues (2010) found in a meta-analysis of three earlier studies that 26-46% of the dogs suffering from epilepsy showed significant improvement after the administration of a placebo. It was also reported that treatment with placebo is sufficient to relieve pain in dogs with dysplasia (Jaeger et al 2005). More recently in a double-blinded, placebo-controlled clinical trial Cracknell and Mills (2008) found significant placebo anxiolytic effect in dogs that showed excessive fear response to fireworks.

Importantly, however, the evaluation of placebo response has been based solely on the owners' subjective scoring and therefore, the results could also be strongly influenced by the owners' beliefs and expectations. These studies raise some further questions worthy of investigation. First of all, we cannot be sure if there was any improvement in dogs' health status and/or behaviour. The fact that authors' conclusions are based on the owners' subjective evaluation raises the possibility that the phenomenon stems from the owner's expectations regarding the treatment outcome. Second, even if we suppose that the placebo treatment was effective, there is no evidence to support the mechanism mediating the effect between placebo treatment and health/behaviour consequences.

In the current study, therefore, we directly manipulated the owner's expectations regarding the treatment of the dog and at the same time we also measured changes in the dogs' behaviour. Dogs participated in a separation test (similar to Exp.1/Study 3) two times repeatedly. After the first separation episode dogs were treated with placebo without any active substance and then re-tested with the very same separation test procedure. Importantly, however, we systematically manipulated the owners' expectations about their dogs' behaviour: half of the owners were given the false information that their dog received tranquilizer while the other half of the owners were told that their dog did not receive any active substance. We aimed to study whether the owners' expectation regarding the treatment influenced the owner's evaluation of the treatment effect. That is, whether the owners are able to adjudge their dogs' behaviour objectively during an experiment.

In our analysis of changes in dogs' behaviour (test1 vs. test2) we compared the owners' subjective behaviour scoring with the results obtained by objective coding.
The second and main question of this study was whether the owners' strong (and false) expectations about treatment effect have the potential to mediate placebo effect to their dogs. We hypothesized that if dogs are susceptible to their owners' expectation, dogs of 'misinformed' owners will behave more calmly after the placebo treatment.

2.4.1. Materials and Methods

Subjects

Twenty-seven adult (> 1 year) pet dogs (mean age ± SD: 4.04 ± 2.74 years, 17 males and 10 females from 13 different breeds and 9 mongrels) and their owners participated in the experiment on a voluntary basis (see Appendix 5). Subjects were randomly assigned to either the *Manipulated* (N=14) or the *Control* group (N= 13).

Experimental arrangement

The experimental arrangement was exactly the same as in Exp.1/Study 3 (see Figure 12).

Procedure

Subjects participated in a modified and shortened version of Strange Situation Test (SST) (Topál et al 1998) two times with a 15 minutes break between them. After the first SST, dogs were treated with placebo but the owners' expectations were manipulated by giving different information regarding the treatment. Owners in the manipulated group were told that the dog received a tranquilizer Calming Aid (dose: 4 ml/10 kb body weight) in a piece of liverwurst. They were provided with information about the effects of Calming Aid and they signed an informed consent form to participate. Owners in the Control group were told that they are participating in the control group of the study so the dog received placebo which is a piece of liverwurst without tranquilizer.

SST pre-treatment phase:

The procedure of the SST was the same as in the sedative drug conditioning study (Study 3), it consisted of 3 episodes, each lasting for 2 minutes.

Human participants (owner and stranger) followed detailed instructions that determined their behaviour during the test. The three episodes were preceded by a short introductory phase during which the experimenter introduced the dog and the owner to the experimental room through Door 2, and the dog was allowed to explore the room for 30 s. Then, the experimenter left the room with the owner through Door 2.

The episodes followed each other in a fixed order: the dog was 1) alone, 2) with a stranger, 3) with the owner in the experimental room.

Episode 1: Dog alone

The dog was left alone, and observed by the owner and experimenter on the monitor in the adjacent room (without speaking, thus the dog could not hear people in the adjacent room).

Episode 2: Dog & Stranger

The stranger entered the room (through Door 1), stepped up to a predetermined point (SP). She adjusted her behaviour to that of the dog (petted its head and back if the dog initiated contact) and tried to keep the dog away from the doorway by playing or petting (depending on the preference of the dog). The stranger stood at the predetermined point (OP) until the owner entered the room.

Episode 3: Dog & Owner

The owner entered the room through Door 2 and stepped up to a predetermined point. Meanwhile, the stranger left through Door 1. The owner then greeted and comforted the dog (petting and playing – depending on the dog's reaction). The owner stood at the predetermined point (OP) until the end of the episode, playing with and/or petting the dog if it initiated.

Treatment & Interaction phase:

After the SST dogs with their owners were led to the adjacent room. All dogs were given a piece of liverwurst. After the treatment the dog and owner were waiting 15 minutes there without any specific instruction. Only a chair and some toys for the dog were in the room.

SST post-treatment phase:

After the 15 minutes elapsed dogs and owners re-entered the testing room and participated a second SST. The procedure was identical to that of pre-treatment phase.

After the second SST the owners were asked about the effect of the treatment. They scored the change in the dogs' anxiety on a 5 point scale (strongly reduced= -2, slightly reduced= -1, unchanged= 0, slightly increased= +1, strongly increased= +2). Owners' opinion about the type of treatment (tranquilizer or placebo) was also asked at the end of the experiment.

Behaviour coding

Dogs' behaviour was coded during the Strange Situation Tests using the very same behaviour categories (passive behaviours door-distress, door-passive) and definitions as in Study 3.

The owner's behaviour while interacting with his/her dog during the Treatment & Interaction phase was also analysed using the following variables:

Playing with the dog: the owner initiates playing (any vigorous, toy-related behaviour) irrespective of the dog's willingness.

Physical contact: any form of bodily contact between the dog and the owner.

Relative durations were recorded for both variables.

Inter-observer agreement was assessed by parallel evaluation of the behaviour of 20% of the total sample by two independent coders who were blind to the conditions. The analysis of inter-observer agreement yielded a very good inter-observer reliability (Cohen's kappa values; PASS: 0.91, D/DISTR: 0.88, D/PASS: 0.89, playing: 0.83, physical contact: 0.96).

Data analysis

First we employed a General Linear Model for the analysis of the effect of the trial (pre-treatment vs. post-treatment) as within-subject factor and the effect of the manipulation (M*anipulated vs Control group*) as a between-subjects factor on the dogs' behaviour during the SSTs. Dogs' behaviour from the first to the second SST were compared with paired t-tests. Owners' behaviour was compared between the two groups using unpaired t-test. The owners' opinion about the treatment were analysed with Mann-Whitney U test and with Wilcoxon signed rank test.

SPSS version 20 software was used for statistical analyses, all tests were two-tailed and the α value was set at 0.05.

2.4.2. Results

Owners' opinion about the treatment

Owner's expectations were successfully manipulated since the owners in the manipulated group reported more often that their dog received tranquilizer than owners in the control group ($U_{(26)} = 32.5$, $p = 0.003$) at the end of the experiment.

Although the owners' opinion about the change in the dogs anxiety was not different between the two groups ($U_{(26)} = 79$, $p = 0.583$), only the owners in the manipulated group reported a significant decrease in their dogs' anxiety ($T_{(13)} = 36$, $p = 0.008$) (Figure 18).

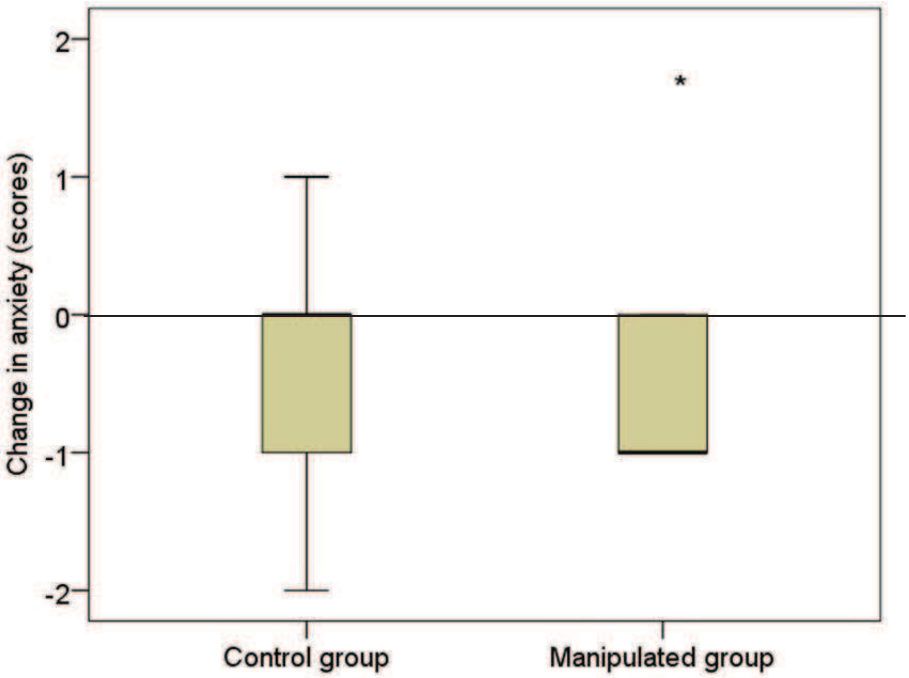


Figure 18. Owners' opinion about the change in dogs' anxiety (median, quartiles and whiskers). Owners in the manipulated group reported a significant decrease in dogs' anxiety. *: Scores are different from 0. (-2 = strongly reduced, -1 = slightly reduced, 0 = unchanged, +1 = slightly increased, +2 = strongly increased)

Owners' behaviour during the break

The owner's belief about the treatment his/her dog received significantly affected their play behaviour during the Treatment & Interaction phase. Those owners who believed that their dog received tranquilizer played less than those who were correctly informed as to the ineffectiveness of the placebo treatment ($t_{(25)} = 2.11$, $p = 0.045$).

Regarding the physical contact with the dog there was not any difference between the owners ($t_{(25)} = 0.966$, $p = 0.257$).

Dogs' behaviour during the pre-treatment and post-treatment SST phases

Episode 1 (Separation episode)

Concerning the behavioural signs of distress close to the door there was a significant interaction between the trial and manipulation (GLM, $F = 5.819$, $p = 0.024$) with no significant main effects of trial (pre-treatment vs. post-treatment: $F = 0.004$, $p = 0.952$) or manipulation (Manipulated vs. Control group: $F = 0.163$, $p = 0.690$) (Figure 19). In the manipulated group dogs showed less signs of distress in the post-treatment phase compared to the pre-treatment phase ($t_{(13)} = 2.376$ $p = 0.034$) while dogs' behaviour in the control group remained the same ($t_{(12)} = 1.345$ $p = 0.204$).

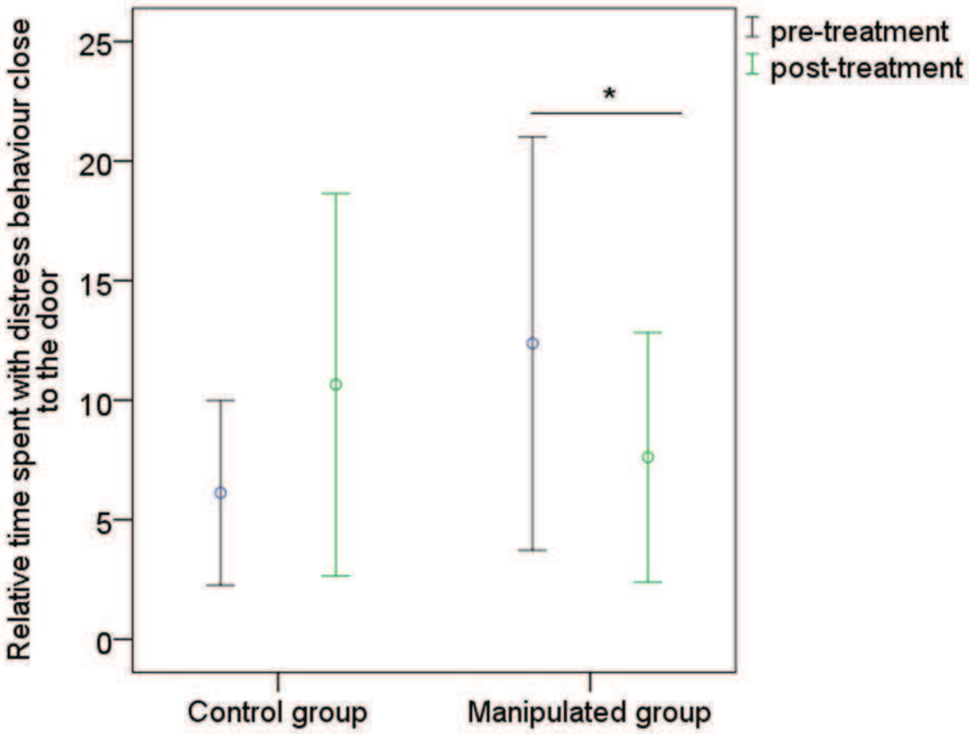


Figure 19. Relative duration of distress close to the door (mean + SD) in Episode 1.
Dogs in the manipulated group showed less distress behaviour in the post-treatment phase in spite of dogs in the control group. * indicates significant difference at p = 0.05 level

Concerning passive behaviours close to the door, however, GLM analysis did not show significant main effects or interaction (trial: $F = 0.738$, $p = 0.398$; manipulation: $F = 1.014$, $p = 0.324$; interaction: $F = 0.326$, $p = 0.573$).

The analysis of dogs' passive behaviour far from the door showed a significant trial x manipulation interaction (GLM, $F = 4.941$, $p = 0.035$) with no main effects of the factors (trial: $F = 0.176$, $p = 0.678$; manipulation: $F = 0.692$, $p = 0.413$) (Figure 20). Dogs in the manipulated group behaved more passively in the post-treatment phase as compared to the pre-treatment phase ($t_{(13\ )} = 2.389$, $p = 0.033$) while dogs' behaviour in the control group remained unchanged ($t_{(12)} = 1.060$, $p = 0.310$).

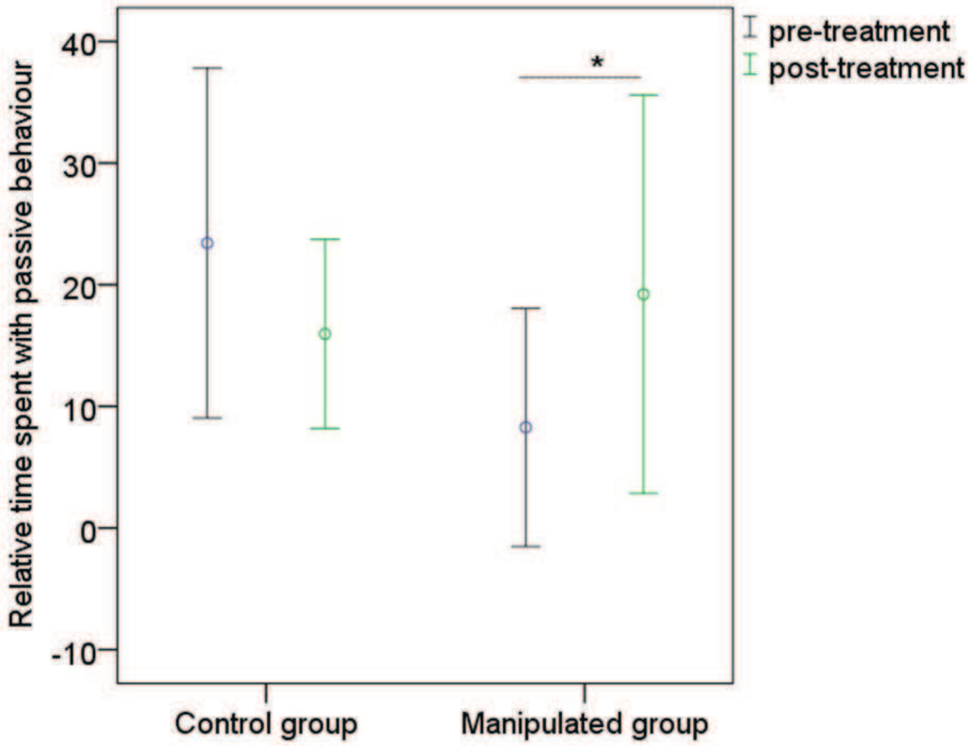


Figure 20. Relative duration of passive behaviours (mean + SD) in Episode1.
Dogs in the manipulated group showed more passive behaviour in the post-treatment phase in spite of dogs in the control group. * indicates significant difference at p = 0.05 level

Episodes 2 and 3

There were no significant main effects or interactions for any of the behaviour variables in those episodes when the owner or the experimenter was present (GLM analyses, D/DISTR-S: trial: $F = 0.395$, $p = 0.535$; manipulation: $F = 0.129$, $p = 0.722$; interaction: $F = 1.592$, $p = 0.219$; D/PASS-S: trial: $F = 0.534$, $p = 0.472$; manipulation: $F = 0.284$, $p = 0.599$; interaction: $F = 0.577$, $p = 0.454$; PASS-S: trial: $F = 0.024$, $p = 0.878$; manipulation: $F = 1.787$, $p = 0.193$; interaction: $F = 0.601$, $p = 0.445$; D/DISTR-O: trial: $F = 0.010$, $p = 0.920$; manipulation: $F = 1.717$, $p = 0.202$; interaction: $F = 0.063$, $p = 0.804$;

D/PASS-O: trial: F = 0.078, p = 0.782; manipulation: F = 1.832, p = 0.188; interaction: F = 0.010, p = 0.920; PASS-O: trial: F = 0.001, p = 0.980; manipulation: F = 0.00, p = 0.988; interaction: F = 0.808, p = 0.377).

2.4.3. Discussion

Results of study 4 suggest that the owner's belief about the treatment and its effect could have an influence on the dog's behaviour. Dogs whose owner believed that the dog was treated with tranquilizer (Manipulated group) behaved less stressful after the placebo treatment, namely they showed less signs of active distress close to the door, and behaved more passively compared to the pre-treatment trial. However dogs whose owner knew that the dog did not receive any tranquilizer (Control group) behaved similarly after the placebo treatment as before. It is important to emphasise that test situations were video-recorded and analysed later and these findings are based on the detailed analyses of dogs' behaviour. It is also worth mentioning that owners assessed the behaviour of their dog quite well; in line with the detailed behaviour analysis they scored their dogs in the Manipulated group as less anxious after the treatment than before, while owners in the control group did not see any change in their dogs' behaviour.

In sum these results seem to support the idea that the owner can mediate an expectancy-based placebo effect to his/her dog. We may assume that the effect was mediated by the owner's belief about upcoming experience. That is, due to misleading information which the experimenter introduced earlier in the procedure, the owner formed the expectations about the behaviour of his/her dog. Later, during the 'Treatment & Interaction' phase the owner interacted with his/her dog in line with this expectation (i.e. played less with the "sedated" dog). Evidently, we cannot be sure how the expectancy-based effect was mediated to the dog, but it seems the at least partly through behaviour signals (less intensive initiation of playful interactions). In addition to play behaviour owners could have given several involuntary signals (including changed body posture. speech prosody, olfactory cues etc.) while interacting with the dog during the 15 min. waiting period.

However, more research is necessary to not only confirm the phenomenon of such 'indirect' expectancy-based placebo effect in dogs, but also to determine the relative contribution of the owner's behavioural, olfactory and speech prosody cues to the formation of placebo effect in dogs.

3. GENERAL DISCUSSION

Results of the above experiments provide further support for the notion that dogs have highly developed inter-specific social skills and therefore they can be influenced by human social signals. We confirmed that dogs are sensitive to human ostensive-communicative signals and emotional state, and their behaviour could even be affected by both voluntary and involuntary signals as well.

The first study has revealed three main characteristics of the A-not-B error committed by adult dogs. We found that i) subjects' performance in this object search task is influenced to a certain extent by their motivation, ii) the human communicative and non-communicative signals have different effects in directing dogs' attention to the A hiding place and iii) no A trials are needed to induce A-not-B error. Human communicative cuing at location A in the B-trials plays a more important role in the emergence of A-not-B search errors which supports the conclusion that dogs rely on the experimenter's ostensive-communication as episodic instructions and/or "here-and-now" attention getters in the B trials.

Although the influence of the dogs' motivational characteristics in food-related test situations (inequity aversion: Range et al 2012; working memory task: Miller & Bender 2012) has been recently reported, the role of motivation has not yet been investigated in tasks designed to study dogs' search for objects. Study 1 provides the first evidence that motivation to obtain the toy object may be one of the key factors for dogs' tendency to commit the A-not-B error. We found that over-motivated individuals' search behaviour was basically goal directed and thus, they showed no tendency to commit search errors even in situations where location A was sham baited and/or the empty location was highlighted by the experimenter's ostensive addressing signals. This suggests that high motivation towards the reward object might overwrite or mask the effect of other cues and therefore it should be taken into account in virtually all cognitive tests.

Our results further support the notion that the communicative and non-communicative signs have different effects on dogs' behaviour in object hide-and-search situations (see also Topál et al 2009, Kis et al 2012b). Thus we cannot exclude the possibility that dogs' erroneous choices in the B trials stem from their disposition to act in line with a human demonstration. This account suggests that the experimenter's ostensive addressing signals during object-hiding events acted as not only making the subject recognize the location of the toy but manifesting a specific behaviour.

Obviously, however, several types of cognitive bias can occur due to an attentional bias (Eysenck et al 2007). Thus the dogs' increased tendency to commit A-not-B errors in the communicative conditions could also be explained by a low level, attentional account. In fact, it has been found (Clearfield et al 2009) that the salience of cues associated with hiding the object at location B significantly affect human infants' perseverative search bias. In line with this we may assume that the experimenter's 'communicative' activities and sham baiting have simply attracted dogs' attention more than the other conditions, facilitating their learning of the rule 'this goes here'. We should note, however, that the analysis of the dogs' amount of attention toward the object-hiding events in the different conditions does not seem to fully support this attentional account. By using a colourful toy object that emits salient sound cues while being hidden, our study was carefully designed to ensure that dogs pay as much attention to the object-hiding event in the non-communicative conditions as they did in the communicative ones. As an alternative explanation, we can also presume a merely distracting effect of social cues: more errors could be attributed to the higher attentional demands required to follow the trajectory of the toy in the B trials (c.f. Fiset 2010).

Anyway, our results are in agreement with recent studies which proposed that dogs in object search tasks (Bräuer et al 2006; Erdőhegyi et al 2007; Kupán et al 2011) and in food search (Prato-Previde et al 2008) tasks often rely on human communicative gestures. We suggest that dogs can sensitively and somewhat selectively pick up those cues that humans usually use to address a potential recipient (eye contact, verbal addressing – see also Teglás et al 2012), and these cues can strongly influence the dogs' behaviour. An interesting aspect of our findings is that the selection of the empty (A) location can also be elicited without any previous A trials and the ostensive addressing signals presented next to the A location during B trials plays a key role in committing search errors. This seemingly contradicts with the results of Osthaus et al (2010) showing that the number of A trials plays a crucial role in inducing the A-not-B error. But this can be explained by the fact that they used a different method (dogs had to make a detour through a gap at one end of a straight barrier in order to reach a target) with a non-communicative hiding procedure.

The influential effect of the human communication on the dogs' behaviour and several other functional similarities between infants and dogs (like committing the A-not-B error in communicative condition) are widely assumed to be affected by the domestication process (Hare & Tomasello 2005).

This hypothesis, among others, is supported by the fact that intensively socialised wolves do not commit the A-not-B error, not even when the experimenter presents ostensive-communicative signals during the hiding event (Topál et al 2009). We should also note, that in this comparative study both wolves and dogs were tested with food reward, and the motivation for food may be different between the two species and this can also account for the species differences in search response. Based on the fact that the over-motivated dogs perform better than the others (see Exp 1), and that wolves tend to show reward oriented behaviour instead of looking at humans (Miklósi et al 2003) we may assume that wolves in the A-not-B error task were simply much more motivated to get the reward and that is why they committed less errors.

In Study 1 we confirmed that dogs can be socially influenced by voluntary ostensive-communicative signals while in Study 2 we showed evidence, that dogs' behaviour can also be affected by involuntary emotional signals. In Study 2 we aimed to investigate the emotional contagion between dogs and owners and examined whether dogs show some sign of taking over their owners' affective state in a case where only the owner's affective state was manipulated. We also investigated whether the effects of this kind of contagion of an emotional state (increased level of stress) transfer to a different domain by affecting spatial working memory performance as well. It has been shown that stress and stress hormones influence cognitive performance following an inverse U shape dose-response relationship in both humans (Belanoff et al 2001) and nonhuman animals (Roozendaal 2000; Salehi et al 2010), so low to moderate levels of distress have an improving effect on cognitive functions (Shors et al 1989). Psychological stress can also cause physiological changes (Chida & Hamer 2008) and it mainly affects the hippocampus, the area of the declarative memory (Diamond et al 1994). Our results are in line with these notions. The owners' memory performance increased with their increasing anxiety and dogs' spatial working memory improved also after a stressful separation event.

Although we did not measure any physiological sign of anxiety such as heart rate, we believe that the questionnaire we used is also appropriate for these purposes because it is a widely-used and standardized tool to measure anxiety. In case of dogs evidence indicates that individual stress response is difficult to measure based on heart rate, because it is significantly influenced by activity level and body position (see Maros et al 2008). Our results and previous findings suggest that the memory performance could be a good indicator of the change in individual affective state.

The fact that both stressed owners and their dogs showed improvement in memory task performance indicates that the owners' state anxiety, at least in some circumstances, can be contagious to dogs. Moreover, this raises the possibility that the phenomenon of emotional contagion can be tracked by measuring changes in dogs' memory performance.

Although dogs heard the experimenter's positive or negative feedback during the interaction phase, it is highly unlikely that dog's affective state was directly influenced by the experimenter. First the foreign coder who could basically rely on the same cues as a dog (voice pitch, facial expression and other non-verbal gestures) did not find any difference between the two conditions. Second, the feedback was not given to the owner in the form of command words, but in full and complex sentences. Therefore, it would be very hard for dogs to infer the meaning of these utterances especially considering the scarcity of evidence about dogs' ability to understand human verbal communication (see Bloom 2004). Third, it has been shown that dogs are more likely to pay attention to communication that is directed to them as opposed to a third party – in this case the owner (e.g. Virányi et al 2004). Thus we propose that our results can be best explained by emotion contagion between the owners and dogs.

Regarding the owners' memory performance it is important to note that owners' improved performance in a stressful situation could not only be generated by the moderately increased stress levels; but could also be facilitated by the procedure, by the method of the manipulation. Namely, negative verbal feedback in a skill performance situation can be regarded as a kind of failure, and this can inspire people to perform better in the next task independent of the increased level of stress that negative feedback supposedly elicits. However, the literature also provides evidence suggesting that feelings of failure, when losing a competition, can cause stress hormone release (Bhatnagar & Vining 2003), therefore it may not be possible to disentangle these two seemingly different effects. Moreover, perceiving a situation more or less stressful depends on personality as well (Wirth et al 2006).

One possible alternative explanation of our results could be based on the discrepancy in the difficulty of the initial task. That is, owners performed more poorly in the baseline phase of the *Stressed owner* condition because they had a more difficult text to read and therefore they had more room for improvement by the end of the experiment. However, this is not likely since there was no main effect of condition on the memory performance of owners and pairwise analyses also confirm the notion that initial performance did not differ between the two experimental conditions.

The declining memory performance in the *Non-stressed owner condition* can be best explained by fatigue, because participants had to read and learn a lot and solve several tasks during the long time of the experiment. On the other hand they probably did not feel any motivation to perform better at the end of the experiment.

Another factor that could have influenced the success of the manipulation is the dogs' level of training. It could be argued that since we expected the transmission of affective state to happen – at least partly – during an obedience task, dogs that had gone through obedience training might respond differently and may not experience that much stress (or alternatively may be more attuned to the owner and therefore be more sensitive to their signals). However, we have shown that the change in memory performance did not depend on the level of training, therefore this explanation can also be ruled out.

A key finding of Study 2 is that the stress experienced by the owner is contagious to their dogs and that these effects are also transferred to the cognitive domain. Owners probably gave some involuntary signals toward their dogs that could mediate their affective state. We found differences in the owners' play behaviour and the use of positive reinforcements while interacting with their dogs, so the owners' affective state was transmitted at least partly through these behaviour signals besides of others that cannot be objectively coded and analysed from video records.

One of the most important questions in the literature on emotional contagion concerns the problem of how these behavioural cues contribute to the transmission of emotions. Taking an interspecies approach to the question can shed some further light on the matter. Non-conscious mimicry of expressions has been suggested to play a key role in intraspecies cases (e.g. Hatfield et al 1993) during which the emotional expression of one individual is imitated by the observer, generating a similar feeling in him/her too. However, non-conscious mimicry is unlikely to work properly between individuals of a different species. Therefore it seems a plausible explanation that a more sophisticated perception of the social context contributes to the phenomenon and that it cannot be accounted for by such direct physiological changes. The importance of a higher level of social sensitivity is also in line with findings that show that less social species, such as the red-footed tortoise, are not susceptible to a related phenomenon, contagious yawning (Wilkinson et al. 2011). Moreover the relationship between the dog and its owner is functionally similar to the mother-infant attachment (see Topál & Gácsi 2012 for a review) which is considered essential for the development of emotional responsiveness (Plutchik 1987).

The dog's special sensitivity to human behavioural cues however, can lead to the appearance of emotional contagion between different species and may also serve similar functions as in a human-to-human interaction.

Our findings are in line with recent experimental data suggesting that dogs' behaviour can be influenced by the pretended emotion of a human. For example they show an empathic-like response toward a crying human (Custance & Mayer 2012), react to an unfamiliar object according to the owner's attitude (Merola et al 2012) and fetch the object indicated with positive emotions (Turcsán et al 2014). Study 2 extends our understanding of these results since the change in the memory performance observed in dogs is unlikely to be attributed to any conditioned response to the behavioural cues of the human.

In addition to responsiveness to human social-communicative signals, studies 3 & 4 highlight another aspect of dogs' human-tunedness. In fact, results of Study 3 provide the first behavioural evidence in dogs for the formation of a conditioned placebo effect, which has already been shown both in humans (Bendetti et al 2003; Goebel et al 2002) and laboratory animals (Isaac & Isaac 1976). During the separation, dogs repeatedly treated with sedative drug behaved more quietly after the placebo treatment in the test trial compared to dogs that did not receive sedative drug. This observation fits neatly into the placebo conditioning framework (McMillan 1999); therefore we assume that the repeated experience with the effects of Sedalin, as an unconditioned stimulus, could have resulted in the formation of a relaxed inner state, which was associated with some characteristic property of the pre-treatment procedure and/or with some environmental cues of the experimental set up as conditioned stimuli. As a result of this associative process, treatment procedure with the same features but without administration of Sedalin could reduce some behavioural signs of separation distress.

Importantly, we found no relevant differences between the *Conditioned* and *Control* groups in those episodes of Test trial in which the owner or the experimenter were present (Episodes 2 and 3). This suggests that the placebo effect, as a conditioned response, was specifically associated with the separation from the owner, despite the fact that separation anxiety was not triggered during conditioning trials where dogs were not separated. Moreover, the procedure was designed to eliminate the possibility that dogs develop reduced behaviour signs of distress as a conditioned response. That is, owners were present throughout the conditioning trials in order to avoid any possibility of creating *direct association* between the separation from the owner and the anxiolytic effects of Sedalin.

During the conditioning trials dogs had the opportunity to learn about the 'relaxed nature' of the environment but they had no opportunity to learn how to cope with separation distress under the influence of Sedalin. In the test trial only one aspect of the conditioning environment was changed: the presence/absence of the owner. In this new context the associative memory traces regarding the anxiolytic effects of Sedalin could have been mediated by the procedural aspects of the placebo administration and/or by the cues of the testing environment.

One may also assume that repeated treatment of Sedalin would affect dog's behaviour independent from the placebo effects, that is the changes we have observed was merely due to the drug remedial effects. In fact, both benzodiazepines and serotonin uptake inhibitors (e.g. clomipramine, fluoxetine), in practice, are often used repeatedly until they resolve anxiety related behaviour problems and thus drug remedial effects of these anxiolytic medicines are often presumed. A minimum of several days may be required for serotonin reuptake inhibitors to achieve full efficacy in reducing anxiety. It is also worth mentioning that benzodiazepines, unlike acetylpromazine (Sedalin), are addictive substances, therefore, when discontinuing benzodiazepines, gradual withdrawal is essential. However, Sedalin is one of the few psychoactive drugs which have an immediate sedative effect without any known long-term effects (through blocking of dopaminergic-receptors rapidly and temporarily). The lack of long-term effect of Sedalin has been supported by the Tontodonati et al (2007) paper, and our results also do not support any carry-over (remedial) effect in the test trial.

Although the significant conditioning effect in the Sedalin group was evident, it should also be noted that our placebo conditioning method had some practical limitations. The liverwurst might not be an ideal specific signal for the sedative drug, and the late sedative effect might also impair the formation of an association. We hoped to overcome these potential problems using the water spray procedure. In fact, spraying the dogs' muzzle and paws with water can be perceived as a salient and unusual stimulus event that could potentially be a key component of R-S learning during the conditioning phase, and thus a good mediator of the placebo effect. Of course, water spraying might have been strange and mildly aversive for dogs, but the aversiveness of medical treatments does not weaken or eliminate the (conditioned) placebo effects in humans (e.g. de Craen et al. 2000). Using more stimuli, we cannot assess to what extent the different components of the treatment triggered the placebo effect, because any combination of them could be associated with the sedative state. The effect of the Sedalin gel could also vary among and even within subjects.

There is a genetic variability in sensitivity to acepromazine (e.g., due to mutation of the P-glycoprotein Multi Drug Resistant 1 gene), but only two individuals participated from the breeds that are more sensitive. Additionally, a relatively long time passed between the baseline and the test trials and there were relatively few, only three, conditioning trials (we should note that the number of trials affects the placebo-response in case of humans, see e.g. Colloca et al 2010).

Despite the above-mentioned potential confounding factors, our results provide strong support for the existence of a conditioned placebo effect in dogs because the assessment of the behavioural change was based on behaviour observations and not on the owners' report (c.f. Munana et al 2010; Jaeger et al 2005; Cracknell & Mills 2008). It seems that a wide range of placebo phenomena, even in humans, is often nothing more than "contextual healing" (Miller & Kaptchuk 2008; Di Blasi & Kleijnen 2003) because, in addition to the medicine or treatment, the situational context of the healing (environmental cues and the ritual of the treatment) can also play a crucial role in the process (Kaptchuk 2002).

It is also worth mentioning that our findings concerning the conditioned placebo effect in alleviating separation anxiety have some veterinary implications and can be used to improve owners' and their dogs' daily life. Severe cases of separation anxiety often require the use of medications in addition to a behaviour modification program. Once the desired effect is achieved, the dose of the medicine may be gradually reduced and finally merely the procedure can maintain the effect. However, so far the administration method of the medicine has not been considered as important. Our results suggest that applying a specific regimen, that is, administrating the medicine always with the same environmental cues, for example with the same specific food type and with a set ritual, the real medicine can later be effectively replaced by placebo. As the anxiety relieving effect of placebo conditioning in dogs is of great applied importance, more research is needed to get a better perspective on the most efficient aspects of the treatment and the situational context that contributes to the manifestation of the placebo effect.

The results of the follow-up experiment in Study 3 (i.e. dogs that were more responsive to the placebo treatment tended to show stronger positive expectancies) indicate that the observed placebo effect could not be entirely explained by unconscious physiological factors. Results seem to suggest not only the physiological level placebo effect produced by classical conditioning but also a mental level placebo effect mediated by the owners' expectations.

This idea is also supported by earlier studies suggesting a special relationship between dogs and humans (e.g. Topál & Gácsi 2012) and the owner's influential effect on dog's behaviour (Merola et al 2012; Siniscalchi et al 2013).

As a next step, in Study 4, we examined whether the placebo effect can be mediated by the owner's expectations. We manipulated the owners' expectations about the dogs' treatment (tranquilizer or placebo) and found that changes in dogs' behaviour fitted to their owners' expectations. It is important to note that the owners in Study 3 were informed ambiguously before the trials (i.e. the dog will receive either tranquilizer or ineffective placebo) and they could not (and did not) form solid expectations about the treatment their dogs received (as was shown by the post-experimental inquiry). Thus the observed placebo effect in Study 3 was produced by the previously repeated administration of Sedalin and the owners' expectations played only a minor (if any) role. However, when owners' were given unambiguous (false or true) information about the treatment (in Study 4), we found that the owners' expectations have the potential to mediate an effect similar to that of the placebo conditioning. Importantly, owners were able to assess the behaviour of their dog quite well in this experiment which indicates that owners' perception of their dogs' behaviour was not affected by their pre-formed expectations.

Similarly to Study 2 it seems that at least partly the effect was mediated through the owners' behaviour. If the owners believed that their dog received tranquilizer they behaved less actively namely played less with the dog. However, before drawing a firm conclusion about the "mediating effect" of the owner's play behaviour in connection with the observed changes in dogs' placebo response (i.e. changes in stress-related behaviours), it would be needed to see how the systematic (experimental) manipulation of the owners' play behaviour affect dogs' performance. Moreover, the expectancy-based placebo effect in dogs may be based on other (uncontrolled) signals that come from the owner and mediate the effects of the owner's expectations on dogs' performance (such as odour cues, unconscious subtle behaviours etc.).

In conclusion, Study 3 and Study 4 provide the first behavioural evidence of both conditioning- and expectancy-based placebo effects in dogs and give new insights into the potential mechanisms supporting dogs' susceptibility to placebo effects. These results open the door for studying the mechanism of placebo responses in the dog on its own right and provide further support for the validity of the application of the dog as a model species towards a better understanding of some aspects of the placebo phenomena in humans.

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SUMMARY

There is an increasing scientific agreement that the history of dog is a history of unique behaviour evolutionary process in which they have gradually become adapted to human environment and, as a result, became sensitive to human social signals (Miklósi & Topál 2013). Experiments presented in the current doctoral dissertation were designed on the basis of the idea that domestic dog is a particularly human-tuned social animal, whose behaviour has been largely shaped, both evolutionary and developmentally, by the human.

In the first study we investigated the details of how dogs' perseverative search error can be affected via human communicative signals in hide-and-search tasks. Our results give further support for the notion that dogs commit the search error because they follow the human ostensive communicative signals indicating the empty location. However, results do not seem to support the notion that ostensive communication acts as a 'general instruction' for dogs, rather they act as episodic instructions and/or "here-and-now" attention getters.

Dogs are also sensitive to the owner's emotions (Turcsán et al 2014), and earlier findings indicate continuous yawning (Romero et al 2013) too. Thus in Study 2 we experimentally tested the widely held notion that dogs' behavioural responses in task situations are under the influence of their owner's emotions.. Results show that the anxiety experienced by the owner influences their dog's behaviour and that these effects are manifested in the cognitive domain. The stressful treatment of the owner increased the memory performance both of the owners and their dogs, which can be best explained by emotion contagion as the dogs' performance was not directly reliant on the owner's affective state or behaviour. The affective state of the owner was transmitted at least partly through behavioural signals which also suggest that the owner can influence their dog involuntarily.

Based on its interspecific social skills and its capacity to be socially influenced by humans, we hypothesized that dogs are susceptible to placebo effect. In study 3 we demonstrated the existence of conditioned placebo effects in dogs. After repeated treatment with sedative drug, the placebo treatment in the same context resulted in less active signs of distress and more passive behaviour. We found very similar effect of the placebo without previous medical treatment, when the owners were informed that the dog received tranquilizer. Probably they transmitted this effect through involuntarily behavioural signals during they waited for the medicine's effect.

An additional result of these studies that dogs' receptivity to placebo effect is in relationship with their positive expectancies such as was found in case of humans (Geers et al. 2007).
Our results open the door for studying the mechanism of placebo responses in the dog in its own right and provide support for the validity of the application of the dog as a model species for studying even those types of placebo effect which are usually regarded as human specific.

ÖSSZEFOGLALÓ

Egyre több tanulmány bizonyítja, hogy a kutya a domesztikációnak köszönhetően fogékonnyá vált az ember különböző szociális jelzéseire (Miklósi és Topál 2013), ezért úgy gondoljuk, viselkedése szociális jelekkel, különös hatékonysággal befolyásolható. Ez az elképzelés adja a disszertáció kiindulás hipotézisét. Vizsgálatsorozatunk első lépéseként arra a kérdésre fókuszáltunk, hogy az osztenzív kommunikatív jelzések milyen hatással vannak az A-nem-B hiba elkövetésére kutyáknál. Eredményeink alátámasztják azt az elképzelést, miszerint a kutyák a kommunikációs (szándékkifejező és referenciális) jelzésekkel megjelölt edényt választják, akkor is, ha a bemutatóból egyértelműen kiderül, hogy az üres. Azonban ezeket a jelzéseket nem általános, hanem 'itt és most' típusú utasításként értelmezik az A-nem-B feladat során.

Második vizsgálatunk kiindulópontja az a megfigyelés, hogy a kutyák érzékenyek a gazda érzelemkifejésére is (Turcsán és mtsai 2014). Korábbi tanulmányok azt is kimutatták, hogy az emberi ásítás is ragadós a kutyára (Romero és mtsai 2013), ezért kíváncsiak voltunk arra, hogy vajon a gazda érzelmi-hanguli (affektív) állapota átragad-e a kutyára. Kísérletünkben a gazdák és kutyák szorongásának mértékét memóriateszttel mértük, hiszen az enyhe stressz pozitív hatással van a kognitív teljesítményre (Belanoff és mtsai 2001). A gazdában kiváltott szorongás javította a memóriateljesítményt nemcsak a gazdák, hanem kutyáik esetében is, éppúgy, ahogy a gazdától rövid időre elválasztott, és ily módon enyhén stresszelt kutyák teljesítménye is javult. Úgy gondoljuk eredményeink leginkább azzal magyarázhatók, hogy a gazda szorongása átragadt a kutyára, ami feltehetőleg a gazda viselkedésén keresztül adódott át.

Mivel a kutyák viselkedése akaratlanul is befolyásolható, kíváncsiak voltunk lehetséges-e bennük placebo hatást kialakítani, amelynek egyik típusa szintén a szociális befolyásolás eseteként értelmezhető. Először a fiziológiai szinten is működő, klasszikus kondicionáláson alapuló placebo hatás jelenségét vizsgáltuk.

A vizsgálat során miután a kutyákat több alkalommal nyugtatóval kezeltük, úgy találtuk, hogy az ezt követően alkalmazott ugyanolyan tulajdonságú és ugyanolyan módon beadott placebo is nyugtató hatású volt. A kondicionálást követően placebóval kezelt kutyák ugyanis kevesebb jelét mutatták a szeparációs szorongásnak és passzívabban viselkedtek, mint kontroll kezelést kapott társaik. Egy további kísérletben ugyanilyen hatást tapasztaltuk akkor is, ha a gazda elvárását manipuláltuk a kezeléssel kapcsolatban, vagyis ha a gazda azt hitte, hogy a kutyája nyugtatót kapott, akkor a kutyák kevesebb jelét mutatták a stressznek. A vizsgálatok további érdekes eredménye, hogy a placebo hatásra való fogékonyság az emberekhez hasonlóan a kutyáknál is összefüggésben állhat a pozitív elvárások kialakítására való hajlammal ('optimizmus'). Mindezek alapján a kutya megfelelő alanynak bizonyul a placebo hatás vizsgálatához, hiszen az eddig humán specifikusnak tekintett mechanizmusok megértéhez is jó modellállat lehet.

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APPENDIX

Appendix 1. Breed, age and sex data of subjects in Study 1

EXPERIMENT 1			
NonComm			
Name	**breed**	**age (year)**	**sex**
Rea	german shepherd	3.5	female
Mona	hungarian vizla	1.5	female
Feri	labrador retriever	10	male
Igor	labrador retriever	6.5	male
Daisy	english cocker spaniel	4	female
Alma	groendale	4	female
Dió	border collie	5.5	male
Mogyoró	border collie	0.6	female
Molly	íe szetter	1.5	female
Pablo	groendale	1.5	male
Maimai	husky	2	female
Nash	rotweiler	7	male
Rozi	border collie	4.5	female
Móric	border collie	6	male
Admirális	golden retriver	1	male
Ofra	golden retriever	4.5	female
Greg	hungarian vizla	2	male
Olivér	fench bulldog	2	male
Káldi	labrador retriever	XXNDA	male
CommAB			
Name	**breed**	**age(year)**	**sex**
Bull	mongrel	1	male
Trisztán	schipperke	2.5	male
Lili	parson russel terrier	4	female
Aszír	golden retriever	1	male
Kifli	duchsel	0.8	female
Sally	groendale	6	female
Rozi	english cocker spaniel	1	female
Betyár	german shepherd	5	male
Bodza	pointer	7	female
Boci	mongrel	5	female
Csinszka	mongrel	6	female
Azúr	border collie	7.5	male
Sziporka	mongrel	8	female
Rico	canary islands dog	1	female
Dominik	havanese	1	male

Nox	mongrel	4	female
Berián	malinois	3.5	male
Masni	jack russel terrier	2	female
CommB			
Name	**breed**	**age (year)**	**sex**
Csili	border collie	1	male
Csoki	mongrel	3	female
Ropi	mongrel	4	female
Cerber	malinois	1	female
Picur	mongrel	NDA	female
Kópé	mongrel	NDA	male
Dömper	mongrel	9	male
Grog	border collie	3	male
Gréti	rotweiler	4	male
Gazsi	hungarian vizla	5	male
Boldizsár	english cocker spaniel	1.5	male
Miska	pointer	4	male
Mango	retriever	3	female
Meggi	labrador retriever	2.5	female
Piszi	germanpincher	2.5	female
Metosz	mongrel	6	male
Csoki SK	mongrel	1	male
CommA			
Name	**breed**	**age (year)**	**sex**
Peti	poodle	10	male
Cakkos	hungarian vizla	4	male
Panka	hungarian vizla	3	female
Ike	rigdeback	3	male
Tora	akita inu	1	female
Jona	bolognese	6	male
Frutti	lurcher	0.75	female
Odie	mongrel	1.5	male
Bodza	golden retriever	1	female
Ananász	labrador retriever	5	female
Lucky	mongrel	5	male
Villám	hungariasn greyhound	2	female
Szellő	hungariasn greyhound	8	female
Benji	tibetan terrier	0.8	male
Porcogó	duchsel	3.5	male
Haga	labrador retriever	8	male
Engi	golden retriever	7	female
Dana	boxer	2	female

EXPERIMENT2			
Com-H			
Name	**breed**	**age (year)**	**sex**
Chili	border collie	2	male
Zorka	mongrel	3	female
Áfonya	golden retriever	11	male
Apacs	border collie	6	male
Boldizsár	golden retriever	8	male
Bubu	tibetian terrier	3	male
Artúr	foxterrier	4	male
Lexi	mongrel	2	female
Betyár	german shepherd	6	male
Rege	mongrel	5	male
Bundás	labrador	2	male
Suzie	mongrel	3	female
Bandita	golden retriever	1	male
Pita	NDA	NDA	female
Cinkos	NDA	NDA	male
Sunny	West Highland White Terrier	9	female
Dino	NDA	NDA	male
Quent	NDA	NDA	male
Amy	NDA	NDA	female
_Quintin	NDA	NDA	male
Blubell	NDA	NDA	female
Allev-B			
Name	**breed**	**age (year)**	**sex**
Lulu	West Highland White Terrier	4	female
Tia	golden retriever	3	female
Mázli	hungarian vizla	2	male
Mabu	foxterrier	5	female
Boni	foxterrier	2	female
Brúnó	NDA	NDA	male
Daniel	labrador	2	male
Alma	mongrel	4	female
Kyra	rottweiler	7	female
Szeder	mongrel	3	female
Émy	golden retriever	1	female
Brúnó2	mongrel	9	male
Jag	beagle	3	male
Myke	staffordshire terrier	4	male
Jeny	staffordshire terrier	3	female
Opál	NDA	NDA	female
Mixi	foxterrier	5	female
Manó	mongrel	2	female

Tappancs	Irish setter	3	male
Dió	mongrel	2	male
Jessy	german shepherd	11	female
Ncom			
Name	**breed**	**age (year)**	**sex**
Chili	border collie	3	male
Dominik	Havanese	3	male
Cherry	schapendoes	2	female
Hörby	boston terrier	1	male
Becses	hungarian vizla	8	male
Cetli	hungarian vizla	2	male
Arwen	collie	3	female
Álom	hungarian grayhund	1	female
Amper	border collie	2	male
Bob	border collie	6	male
Yana	mongrel	7	male
Peny	mongrel	1	male
Momo	golden retriever	4	female
Dása	mongrel	3	female
Lunes	border collie	6	female
Piero	border collie		male
Marci	hungarian vizla	3	male
Meggi	NDA	NDA	female
Mese	border collie	2	female
Monty	border collie	4	male
Glenn	border collie	3	female

Appendix 2. Breed, age, sex and training data of subjects in Study 2

Non stressed owner				
Name	**breed**	**age (year)**	**sex**	**training**
Valter	golden retriever	1.5	male	not trained
Fanta	labrador retriever	4	female	not trained
Brúnó	hungarian vizla	4.5	male	not trained
Ebony	schipperke	3.5	female	not trained
Lucifer	mongrel	2.5	male	not trained
Tappancs	border collie	4	male	trained
Aida	mongrel	1.5	female	trained
Soma	labrador retriever	2	male	trained
Raiki	german shepherd	2	male	trained
Liza	collie	2	female	trained
Joy	golden retriever	2	male	trained
Zoé	foxterrier	2	female	trained
Bodza	foxterrier	2	male	trained
Lovag	hungarian vizla	1	male	trained
Picúr	mongrel	9	female	trained
Brúnó	golden retriever	7	male	trained
Early	mongrel	6	male	trained
Cleo	dalmatian	3.5	female	trained
Stressed owner				
Name	**breed**	**age (year)**	**sex**	**training**
Artúr	foxterrier	5.5	male	not trained
Macska	golden retriever	5	male	not trained
Matyi	mongrel	5	male	not trained
Beigli	mongrel	5.5	male	not trained
Maya	golden retriever	2	female	not trained
Panka	poodle	6	female	not trained
Mese	border colli	2	female	not trained
Firka	west highland white terrier	1.5	female	trained
Cira	chihuahua	5	female	trained
Lea	boxer	4	female	trained
Totti	yorkshire terrier	4,5	male	trained
Angie	border collie	5	female	trained
Negró	havanese	1,5	male	trained
Smafu	mongrel	4.5	female	trained
Prézli	hungarian vizla	4	female	trained
Marcipán	jack russel terrier	4.5	male	trained
Fibi	mongrel	6	female	trained
Maci	mongrel	7	male	trained
Chaster	golden retriever	2	male	trained

Stressed dog				
Name	**breed**	**age (year)**	**sex**	**training**
Luca	mongrel	2.5	female	not trained
Arven	collie	4	female	not trained
Peti	labrador retriever	1.5	male	not trained
Maja	west highland white terrier	2	female	not trained
Dot	border collie	2.5	male	not trained
Sziszi	mongrel	5	female	not trained
Fanta	labrador retriver	4.5	female	not trained
Nisa	NDA	NDA	female	trained
Gréti	rotweiler	6.5	female	trained
Eni	shiba inu	3	female	trained
Dízel	mongrel	5	male	trained
Body	NDA	NDA	male	trained
Maya	golden retriever	3.5	female	trained
Sanders	golden retriever	5	male	trained
Piton	mongrel	5	male	trained

Appendix 3. State- Trait Anxiety Inventory

STAI form Y-1 (state anxiety –in Hungarian)

ÁLLAPOTSZORONGÁS

Az alábbiakban néhány olyan megállapítást olvashat, amelyekkel az emberek önmagukat szokták jellemezni. Kérjük, figyelmesen olvassa el valamennyit, és húzza alá vagy karikázza be a jobboldali számok közül a megfelelőt, attól függően, hogy **ÉPPEN MOST** (ebben a pillanatban) **HOGYAN ÉRZI MAGÁT**. Nincsenek helyes vagy helytelen válaszok. Ne gondolkozzon túl sokat, hanem jelölje meg a jelenlegi érzéseit legjobban kifejező választ.

	egyáltalán nem	**kissé**	**eléggé**	**teljesen**
1. Nyugodtnak érzem magam.	1	2	3	4
2. Biztonságban érzem magam.	1	2	3	4
3. Feszültnek érzem magam.	1	2	3	4
4. Valami bánt.	1	2	3	4
5. Gondtalannak érzem magam.	1	2	3	4
6. Zaklatott vagyok.	1	2	3	4
7. Aggódom, hogy bajba keveredem.	1	2	3	4
8. Kipihentnek érzem magam.	1	2	3	4
9. Szorongok.	1	2	3	4
10. Kellemesen érzem magam.	1	2	3	4
11. Elég önbizalmat érzek magamban.	1	2	3	4
12. Ideges vagyok.	1	2	3	4
13. Nyugtalannak érzem magam.	1	2	3	4
14. Fel vagyok húzva.	1	2	3	4
15. Minden feszültségtől mentes vagyok.	1	2	3	4
16. Elégedett vagyok.	1	2	3	4
17. Aggódom.	1	2	3	4
18. Túlzottan izgatott és feldúlt vagyok.	1	2	3	4
19. Vidám vagyok.	1	2	3	4
20. Jól érzem magam.	1	2	3	4

STAI form Y -2 (trait anxiety –in Hungarian)

VONÁSSZORONGÁS

Az alábbiakban néhány olyan megállapítást olvashat, amelyekkel az emberek önmagukat szokták jellemezni. Kérjük, figyelmesen olvassa el valamennyit, és húzza alá vagy karikázza be a jobboldali számok közül a megfelelőt, attól függően, hogy **ÁLTALÁBAN HOGYAN ÉRZI MAGÁT.**

	soha	**néha**	**gyakran**	**mindig**
21. Jól érzem magam.	1	2	3	4
22. Gyorsan elfáradok.	1	2	3	4
23. A sírás ellen küszködnöm kell	1	2	3	4
24. A szerencse engem elkerül.	1	2	3	4
25. Sokszor hátrányos helyzetbe kerülök, mert nem tudom elég gyorsan elhatározni magam.	1	2	3	4
26. Kipihentnek érzem magam.	1	2	3	4
27. nyugodt, megfontolt és tettre kész vagyok.	1	2	3	4
28. Úgy érzem, hogy annyi megoldatlan problémám van, hogy nem tudok úrrá lenni rajtuk.	1	2	3	4
29. A semmiségeket is túlzottan a szívemre veszem.	1	2	3	4
30. Boldog vagyok.	1	2	3	4
31. Hajlamos vagyok túlságosan komolyan venni a dolgokat.	1	2	3	4
32. Kevés az önbizalmam.	1	2	3	4
33. Biztonságban érzem magam.	1	2	3	4
34. A kritikus helyzeteket szívesen elkerülöm.	1	2	3	4
35. Csüggedtnek érzem magam.	1	2	3	4
36. Elégedett vagyok.	1	2	3	4
37. Lényegtelen dolgok is sokáig foglalkoztatnak és nem hagynak nyugodni.	1	2	3	4
38. A csalódások annyira megviselnek, hogy nem tudom kiverni őket a fejemből.	1	2	3	4
39. Kiegyensúlyozott vagyok.	1	2	3	4
40. Feszült lelkiállapotba jutok és izgatott leszek, ha az utóbbi időszak gondjaira-bajaira gondolok.	1	2	3	4

Appendix 4. Breed, age, sex and body weight data of subjects in Study 3

Conditioned group					
Name	**breed**	**age (year)**	**sex**	**weight (kg)**	
Angus	german dog	1	male	60	
Hami	foxterrier	2.5	male	11	
Olivér	french bulldog	1	male	13	
Nico	boxer	2.5	male	32	
Zsakett	beagle	1.5	male	10	
Töki	mongrel	6	female	14	
Zokni	foxterrier	6	female	8,5	
Joker	border collie	2	male	23	missing from Exp. 2
Gimli	mongrel	3	male	14	
Kárin	mongrel	6	female	6	
Merlin	labrador retriever	NDA	male	26	
Muzsika	mongrel	5	female	11,7	
Panka	golden retriever	2	female	28	
Lujzi	mongrel	6	female	9	
Control group					
Name	**breed**	**age (year)**	**sex**	**weight (kg)**	
Héra	juck russel terrier	1	female	5,5	
Akira	mongrel	1.5	female	22	missing from Exp. 2
Metosz	mongrel	7	male	22	
Szergej	west highland wight terrier	2.5	male	8	missing from Exp. 2
Csillag	husky	2	female	17	missing from Exp. 2
Skippi	mongrel	2	female	29	
Rambó	poodle	3	male	3	
Pedró	hungarian vizla	3	male	27	missing from Exp. 2
Chandler	mongrel	2	male	19	
Negró	mongrel	3.5	female	11	
Manó	mongrel	4	female	13	missing from Exp. 2
Berry	french bulldog	1	male	14	
Foltos	beagle	4	female	13	
Neelix	mongrel	2.5	male	15	missing from Exp. 2

Appendix 5. Breed, age and sex data of subjects in Study 4

Manipulated group			
Name	**breed**	**age (year)**	**sex**
Panka	golden retriever	2	female
Börbi	mongrel	NDA	female
Bueno Mio	boxer	3.5	male
Aldó	german shepherd	1	male
Vackor	bichon havanese	7	male
Olivér	french bulldog	3	male
Hermi	mongrel	3.5	female
Ardi	sheltie	0.8	male
Dorisz	groendale	6	female
Indi	border collie	4	male
Ebony	shipperke	4	female
Trisztán	shipperke	6.5	male
Dorka	mongrel	5	female
Control group			
Name	**breed**	**age (year)**	**sex**
Milo	jack russel terrier	2	male
Apollo	husky	3	male
Maszat	mongrel	3	male
Barka	mongrel	9	male
Káldor	labrador retriever	6	male
Merlin	labrador retriever	6	male
Manó	mongrel	8	female
Mirabelle	havanese	2	female
Lizi	mongrel	9	female
Rénó	german shepherd	3	male
Guszti	boston terrier	0.8	male
Mazsi	mongrel	2	female
Pajti	mongrel	4	male
Nico	german shepherd	1	male

[38]ADATLAP
a doktori értekezés nyilvánosságra hozatalához

I. A doktori értekezés adatai

A szerző neve: Sümegi Zsófia
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A doktori értekezés címe és alcíme:
Experimental investigations of the impact of social influence on dog-human interactions

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A doktori iskola neve: Biológia Doktori Iskola
A doktori iskolán belüli doktori program neve: Etológia Program
A témavezető neve és tudományos fokozata:.Dr. Topál József, DSc
A témavezető munkahelye: MTA TTK Kognitív Idegtudományi és Pszichológiai Intézet

II. Nyilatkozatok

A doktori értekezés szerzőjeként[40]
a) hozzájárulok, hogy a doktori fokozat megszerzését követően a doktori értekezésem és a tézisek nyilvánosságra kerüljenek az ELTE Digitális Intézményi Tudástárban. Felhatalmazom a Természettudományi Kar Tudományszervezési és Egyetemközi Kapcsolatok Osztályának ügyintézőjét Bíró Évát, hogy az értekezést és a téziseket feltöltse az ELTE Digitális Intézményi Tudástárba, és ennek során kitöltse a feltöltéshez szükséges nyilatkozatokat.
b) kérem, hogy a mellékelt kérelemben részletezett szabadalmi, illetőleg oltalmi bejelentés közzétételéig a doktori értekezést ne bocsássák nyilvánosságra az Egyetemi Könyvtárban és az ELTE Digitális Intézményi Tudástárban;[41]
c) kérem, hogy a nemzetbiztonsági okból minősített adatot tartalmazó doktori értekezést a minősítés *(dátum)*-ig tartó időtartama alatt ne bocsássák nyilvánosságra az Egyetemi Könyvtárban és az ELTE Digitális Intézményi Tudástárban;[42]
d) kérem, hogy a mű kiadására vonatkozó mellékelt kiadó szerződésre tekintettel a doktori értekezést a könyv megjelenéséig ne bocsássák nyilvánosságra az Egyetemi Könyvtárban, és az ELTE Digitális Intézményi Tudástárban csak a könyv bibliográfiai adatait tegyék közzé. Ha a könyv a fokozatszerzést követőn egy évig nem jelenik meg, hozzájárulok, hogy a doktori értekezésem és a tézisek nyilvánosságra kerüljenek az Egyetemi Könyvtárban és az ELTE Digitális Intézményi Tudástárban.[43]

2. A doktori értekezés szerzőjeként kijelentem, hogy
a) az ELTE Digitális Intézményi Tudástárba feltöltendő doktori értekezés és a tézisek saját eredeti , önálló szellemi munkám és legjobb tudomásom szerint nem sértem vele senki szerzői jogait;
b) a doktori értekezés és a tézisek nyomtatott változatai és az elektronikus adathordozón benyújtott tartalmak (szöveg és ábrák) mindenben megegyeznek.

3. A doktori értekezés szerzőjeként hozzájárulok a doktori értekezés és a tézisek szövegének plágiumkereső adatbázisba helyezéséhez és plágiumellenőrző vizsgálatok lefuttatásához.

Kelt: Budapest 2014. 10. 29.

Sümegi Zsófia
a doktori értekezés szerzőjének aláírása

[38] Beiktatta az Egyetemi Doktori Szabályzat módosításáról szóló CXXXIX/2014. (VI. 30.) Szen. sz. határozat. Hatályos: 2014. VII.1. napjától.
[39] A kari hivatal ügyintézője tölti ki.
[40] A megfelelő szöveg aláhúzandó.
[41] A doktori értekezés benyújtásával egyidejűleg be kell adni a tudományági doktori tanácshoz a szabadalmi, illetőleg oltalmi bejelentést tanúsító okiratot és a nyilvánosságra hozatal elhalasztása iránti kérelmet.
[42] A doktori értekezés benyújtásával egyidejűleg be kell nyújtani a minősített adatra vonatkozó közokiratot.
[43] A doktori értekezés benyújtásával egyidejűleg be kell nyújtani a mű kiadásáról szóló kiadói szerződést.