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„The influence of personality on cognitive bias in domestic dogs (*Canis familiaris*)“

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Julia Schößwender BSc

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ABSTRACT

Identifying an individual's cognitive bias and therefore being able to assess its affective state has recently attracted considerable attention when testing animals, as it can help to provide measures to improve animal welfare. Another currently hot topic is the understanding of personality in non-human animals. Quite some research has been done in both topics, but so far it has not been investigated whether an individual's personality could have an influence on its judgement of ambiguous stimuli. Personality has an influence on a variety of cognitive processes in animals, and human research indicates that there is a connection between personality and cognitive bias. The aim of this study was to determine whether personality influences cognitive bias in pet dogs (*Canis familiaris*). This study utilised a behavioural experiment and a questionnaire to assess the individual's personality. For the cognitive bias test a non-social, spatial discrimination task with a go/no-go procedure was used. After training to discriminate between a positive and a negative stimulus, dogs were tested on three new ambiguous stimuli. The results showed no correlations between personality traits and the judgement of ambiguous stimuli, however it is not totally clear if this result was due to the fact that there are no correlations or if the correlations just could not be found. A cause for not finding correlations could be due to a not perfectly fitting experimental setup for the used personality traits. Another reason could be that cognitive biases are not consistent over time, which so far has not been investigated, and thus could lead to the results found in this study. Therefore further investigations into this topic are necessary to establish if a link between personality and cognitive bias exists.

1 Introduction

Paradigms which have enabled the assessment of the cognitive bias of animals have recently attracted considerable attention. According to Warda and Bryant (1998) a 'cognitive bias' is the impact of emotional states on cognitive processes. The term 'cognition' refers here to mechanisms of information processing including attention, learning, memory and decision making. Indeed, evidence supports the idea that an individual's emotional state can influence a number of cognitive processes such as attention, memory and judgement and therefore leads to biases (see Paul et al. 2005 for a review). For example, in one study people with varying levels of self-reported depression were provided with a picture of an individual on a screen and asked to give either a yes or no response to the possibility of bad or good future events happening to them. In comparison the depressed people showed significantly more predictions of negative events occurring than the non-depressed people (Andersen et al. 1992). The terms emotions, emotional states and affective states are often used interchangeably and they will also be used this way in this thesis.

Hence, people in a negative affective state (e.g. being anxious or depressed) tend to make negative judgements about ambiguous stimuli or events in the future ('pessimism'), on the other hand people in a rather positive emotional state are more optimistic in their judgments (e.g. Eysenck et al. 1991). 'Pessimism' can be defined as an increased probability of classifying an ambiguous stimulus as predicting a negative outcome (Harding et al. 2004). So it appears that changes in these cognitive processes could be reliable indicators of emotional experiences in humans and even animals (Mendl et al. 2009). Currently, animal research is focusing on cognitive bias paradigms to evaluate affective state, due to its simplicity in testing. There has already been some research done concerning cognitive bias in non-human animals including rats (e.g. Harding et al. 2004; Burman et al. 2009; Brydges et al. 2011), starlings (e.g. Matheson et al. 2008,), dogs (e.g. Mendl et al. 2010; Burman et al. 2011; Müller et al. 2012), sheep (Doyle et al. 2010) and bees (Bateson et al. 2011). Being able to assess an animal’s cognitive bias can give an interesting insight into an animal’s emotional state and thus can be used as an improvement in animal welfare.

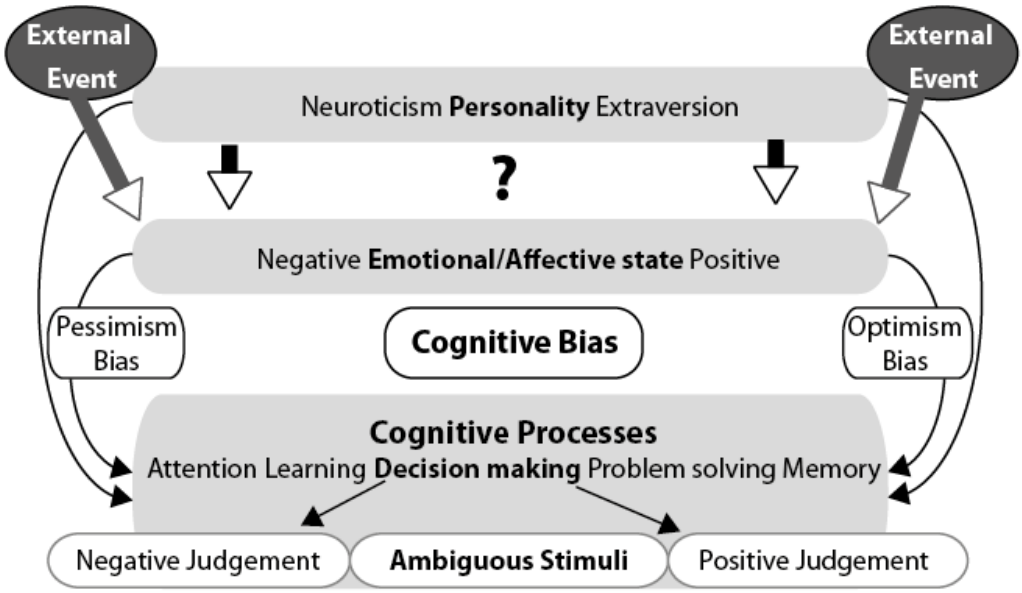
In addition, another topic which has attracted increasing interest over the past years is the understanding of personality in non-human animals. Animal personality describes the behavioural phenotype that is consistent over time and across situations and differs between individuals of the same species (Budaev 1998). Individuals of the same species exhibit pronounced individual variation in behavioural responses despite being subjected to similar conditions. Some individuals are bolder, more aggressive and more explorative than others. These differences seem to have a

biological meaning and have been referred to synonymously as behavioural syndromes, coping styles or personality (Overli et al. 2007; Sih et al. 2004). So far, the number of publications in this area is growing, meanwhile there have been studies on personality in apes (Weiss et al. 2006; Massen et al. 2013) dogs (Svartberg and Forkman 2002; Jones and Gosling 2005; Ley et al. 2008), rodents (Koohlhaas et al. 1999), birds (Groothuis and Carere 2005), fish (Moretz et al. 2007; Harris et al. 2010; Schürch and Heg 2010; Witsenburg et al. 2010; Martins et al. 2012) and also some invertebrates (Sinn et al. 2008).

The investigation into canine personality has used different methods ranging from behavioural tests (Svartberg and Forkmann 2002) to methods that exclusively use questionnaires (Hsu and Serpell 2003; Ley et al. 2008). In the study of Svartberg and Forkman (2002) five personality traits were described: playfulness, sociability, curiosity/fearlessness, chase-proneness and aggressiveness, and additionally a higher order shyness-boldness dimension was found, which is related to all the mentioned traits except aggressiveness. However, there are still some inconsistencies concerning the number of, and definitions of canine personality dimensions within the literature. Whereas Svartberg and Forkmann (2002) found just five personality traits, Jones and Gosling (2005) found seven traits including activity, submissiveness, sociability, fearfulness, reactivity, responsiveness to training and aggression. Ley et al. (2008) also mentioned the problem that there is so far no consensus in dog personality traits. The aim of their study was to identify canine personality traits using methods from human studies. Five traits were found including: extraversion, neuroticism, self-assuredness/motivation, training focus and amicability. Some of those traits also show some similarities to personality traits in other dog studies, although many traits were named differently, however some were also unique. Thus it has proved to be difficult to identify and define dog personality traits.

Fig. 1 should give a better overview of how everything connects. We already know that emotions have an influence on cognitive processes in animals and that it is possible to assess an individuals affective state through testing it's cognitive bias, which is a bias in cognitive processes. When using cognitive bias tests in animals to assess affective states, the easiest way is to use biases in decision making and judgement, so for example biases in how they judge situations or stimuli. External events can shift the emotional state into a positive or negative way which than would lead to a optimistic or pessimistic bias. Thus it would be interesting to to try to discover if there is a link between personality and cognitive bias.

Fig. 1 Overview of how emotions, cognitive processes and personality link together



When studying humans we might predict that shy/introvert people tend to judge ambiguous stimuli more negatively than extravert people. In some human literature a relationship between personality and emotions has been mentioned. Previous research has revealed that individuals high in neuroticism can show an appraisal-negative emotion relationship (Tong 2010). This does not mean that all negative appraisals are linked to negative emotion, but high neuroticism can lead to negative emotions in many ways (Tong 2010). For instance, those individuals high in neuroticism tend to have negative cognitive styles; e.g. they recall negative memories more often (Robinson and Gordon 2011; Marco and Suls 1993). The highly cited study by Marshall at al. (1992) found that there is a higher positive correlation between optimism and extraversion than between pessimism and extraversion, pessimism however correlated strongly with neuroticism. Another interesting paper by Sharpe et al. (2011) found a strong positive relationship between optimism and the personality traits emotional stability, extraversion, agreeableness and conscientiousness.

In non-human animals, a recent study on fish showed a link between coping styles and fearfulness. This study revealed that reactive or shy individuals with higher hypothalamo-pituitary-interrenal (HPI) responsiveness and more neophobic behaviour were the ones who showed more fearfulness and avoiding behaviour (Martins et al. 2011). So far there has not been much research carried out to find connections between personality and the effects of underlying emotional states on decision making in animals. However, the results from the human literature, and the fact that personality does have an influence on cognitive processes in animals (Carere and Locurto 2011; Boissy and Erhard 2013), could indicate a possible correlation.

The aim of this study was to find out whether there is a link between personality and cognitive bias, by examining how dogs judge ambiguous stimuli. When using the results from human literature we can predict that there could be a correlation between the traits extraversion, emotional stability, agreeableness and conscientiousness and a positive judgement of ambiguous stimuli, neuroticism on the other hand could lead to a negative judgement of stimuli in dogs. According to the study by Martins et al. (2011) shy individuals of the colonial fish *Neolamprologus caudopunctatus,* show more fearfulness, and as already mentioned, emotions like fearfulness and anxiety can lead to a negative cognitive bias. Therefore, personality traits that are related to the boldness dimension in dogs like sociability, curiosity/fearlessness and playfulness (Svartberg and Forkman 2002) are expected to show a more positive judgement. Bold individuals should be very sociable, curious and playful whereas shy individuals should be the opposite. According to these predictions, I decided to select just those personality traits that are most likely to show the expected correlations: extraversion, neuroticism and sociability. According to the previous literature in humans, we can hypothesize that there is a link between personality and cognitive bias in pet dogs. Correlations should be found between a positive cognitive bias and the traits sociability and extraversion, and between a negative cognitive bias and neuroticism. As yet connections between personality and cognitive bias in animals has not been investigated. Furthermore, results from this study could contribute to a better understanding of animal welfare (Boissy and Erhard 2013) and animal breeding. In the breeding area it could aid in finding the best individuals for breeding. In the welfare sector you try to reduce negative negative experiences. A difference in coping with fearful situations which can be due to different personalities could lead to differences in how the animals cope with this situations and therefore lead to different emotional states. Further it can be dangerous to handle animals with high levels of fear.

2 Material and Methods

2.1 Subjects

For this study 30 domestic dogs (*Canis familiaris*) were recruited, all of which lived as a family or companion dog. I used a balanced mixture of various dog breeds and mongrels (Tab. 1). Of these 30 dogs, 27 finished the whole experiment; three individuals had to be excluded. Two of them did not reach the criterion in the training phase of the cognitive bias test (due to anxiety, they were not willing to approach the bowl in a regular manner), and one dog did pass the training and

the training repetition but had to be excluded because in the testing phase it started to ran quicker to the negative bowl to manipulate it, than to the positive bowl. Of the final sample size of 27 dogs, 13 were females and 14 males (aged between one to ten years, Tab. 1).

Tab. 1 Subject list containing name, gender, age in years, breed, the side of the positive stimulus and the number of trials the dogs needed to reach criterion in the training and in the repetition phase

Name	Gender	Age	Breed	Positive Stimulus	Trainings trials until criterion	Repetition trials
Alaska	F	1	Norwegian Lundehund	R	30	20
Amy	F	2	Mix	L	30	10
Angelo	M	7	Mix	R	40	20
Archie	M	3	Parson Russell Terrier	R	40	10
Baghira	M	1	Australian Shepherd	R	30	20
Cally	F	2	Australian Shepherd	L	60	excluded
Charlie	M	4	Bearded Collie	R	40	10
Chili	F	2	Mix	R	20	10
Cookie	F	1	Border Collie	L	30	20
Cookie	M	1	Bearded Collie	R	40	20
Django	M	4	Mix	L	50	10
Enya	F	2	Wolfsspitz	R	40	10
Finya	F	4	Mix	L	excluded	
Ginger	F	7	Parson Russell Terrier	R	30	20
Ginger	F	9	Mix	L	40	20
Izzy	F	1	Border Collie	R	40	10
Laura	F	8	Mix	R	excluded	
Lenox	M	8	Mix	L	50	20
Lenny	M	6	Mix	R	40	20
Lilly	F	5	Mix	R	20	20
Meduna	F	1	Beauceron	R	40	20
Mellisa	F	10	German Shepherd	L	20	10
Mocca	F	2	Mix	L	40	10
Mogli	M	1	Mix	R	40	20
Mozart	M	9	Golden Retriever	R	60	20
Pascha	M	5	Hovawart	L	30	20
Rodger	M	10	Mix	L	60	10
Samy	M	5	Mix	L	30	10
Santos	M	5	Mix	L	40	10
Vespa	F	2	Mix	L	20	20

2.2 Personality test

To investigate the personality of the dogs a test designed by Borbala Turcsan (in progress, Department of Ethology, Eötvös Lorand University, Budapest, Hungary) was used, which is a test battery consisting of 15 short tests where the dogs were confronted with different situations. This test was conducted indoors in the Clever Dog Lab in a large testing room with the dimension 6 m x 7.25 m.

For this study seven tests were chosen from the personality test for further analysis (given that those tests were expected to be linked to the personality traits of interest): the exploration test, picture test, greeting test, cage test, t-shirt test, teaching test and the novel object test.

Exploration Test

This test was the first of the whole test battery, and was designed to measure exploration levels in the dogs and how they behave in a new environment. In the exploration test the owner entered the room with the dog on the leash, walked to the centre of the room, which was marked with a big red x, and released the dog from the leash. The dog was then allowed to explore the room for one minute in which it was totally ignored by the owner. Meanwhile the owner stood in the centre of the room ignoring the dog. After one minute a beep noise indicated that the owner should go to the table, pick up a clipboard and start the picture test.

Picture Test

The picture test was also designed to measure the dogs' level of exploration and also shows dependency of the dog. In the picture test the owner walked slowly along the walls of the testing room to study pictures of dog faces with different emotions. The owners have been asked by the experimenter to identify the emotions and to note them in the clipboard. This part was not important for the later analysis but should occupy the owner for one minute. Again the dog was allowed to move freely around the room. After one minute the beep noise was sounded again to signal the owner to go back to the centre of the room, call the dog and reattach the leash.

Greeting Test

Immediately after the picture test followed the greeting test. This test was designed to examine the dog's level of sociability. After the dog was put back on the leash the experimenter entered the room and walked up to the dog until she was within reach of the leash. The experimenter then greeted the dog and whilst constantly talking to it, tried to pet it. If the dog did not react the experimenter crouched down and tried again to greet. After this she stepped away two steps and talked in a friendly way to the dog again and tried to pet it.

Cage Test

The cage test was a problem solving task and the eighth test in the test battery. A metal crate was used which was placed about two meters away from the owner who was sitting on a chair with the dog between his/her legs. In the first phase of the test a piece of sausage was put in front of the cage which the dog was allowed to eat.

In the second phase, a piece of sausage on a string was placed inside the cage, and the end of the string was allowed to lie just outside the front of the cage so that the dog could use its paw or mouth to pull the string and the sausage out of the cage. The dog had five minutes to complete the task. The owner verbally encouraged the dog for the first 30 seconds. This part of the test stopped if the dog was either successful, the five minutes were over or if the dog gave up and stopped interacting with the cage for more than one minute.

If the dog was successful in phase two a third phase followed where the string with the sausage was attached to the cage, which made it impossible for the dog to pull the string out. This part of the test was designed to measure a dogs level of persistency. Again this test stopped either after five minutes or if the dog gave up and stopped interacting with the cage for more than one minute. The owner was again allowed to encourage the dog for the first 30 seconds. The two phases were used to create a case in which it was not possible for the dog to reach the sausage.

T-shirt Test

The t-shirt test immediately followed the cage test, and was designed to put the dog in a mildly stressful restrictive/confining situation. Here the owner was asked to put a t-shirt on their dog by gently placing the shirt over the dog's head, and placing each front paw through the arm holes, and finally tying the additional material of the t-shirt in a knot around the dog's abdomen, all without talking or giving commands to the dog. The time limit for this task was one minute. If it took the owner longer than one minute the test was terminated. After putting on the t-shirt the owner slowly

walked around the room for 30 seconds ignoring the dog. This test should show how the dogs react in such a slightly stressful and restrictive/confining situation, are they following their owner, are they not moving at all or are they freely exploring the room.

Teaching Test

In this test, which was the twelfth test in this test battery, the dogs individual problem solving skills were measured. It was measured if they where looking for help from the owner or doing the task on their own and as well if the kept going until they succeeded or gave up. The owner showed the dog a piece of sausage and repeatedly hid the food in a small plastic bin. The dog's attention was drawn to the owner by calling the dog and taking off the lid of the bin, and placing the food in the bin. The owner was asked to take the lid off the bin by holding the rim of the lid, put the piece of sausage inside and close the bin again. To keep the attention of the dog on the bin and the owner, the owner talked to the dog constantly. The owner repeated this movement four times then closed the lid and stepped three steps away from the bin. The dog was then released to try to get the food out of the bin. The test ended either when the dog was successful or when one minute was over. The owner was allowed to encourage the dog for the whole testing time. Straight after this test, the novel object test was carried out.

Novel Object Test

Here a novel object was presented to the dog and the dog's response recorded. This test was designed to measure dog's behaviour when confronted with a potential scary object. The owner held the dog by the collar both facing in the direction of the back wall of the room, so that they both could not see the experimenter placing the toy in the middle of the room. The experimenter then placed a mechanical moving, laughing soft toy in the middle of the room out of sight of the dog. The owner was told to release the dog as soon as he/she heard the toy making sounds; the dog was free to approach or retreat from the toy as it chose. The owner was allowed to turn around and watch the dog. This test terminated after one minute, during this time the owner was asked to ignore their dog. After one minute the toy was switched off and the owner could go to the toy take it into their hands and motivate the dog to come near and examine it.

In addition to the personality test, the owners filled out a questionnaire about the personality of their dogs, developed and validated by Jones (2008) and translated into German by Stefanie Riemer (a PhD student in the Clever Dog Lab at the time of this study).

2.3 Cognitive bias test

For the cognitive bias test the dogs were trained in a non-social spatial discrimination task (go/no-go procedure), similar to the one used by Mendl et al. (2010) and Müller et al. (2012), which consisted of the discrimination of the two outermost positions in the training phase and three additional intermediate positions during testing. The experiment took place indoors, in a room with the dimensions (6 m x 7.25 m) This room was used for practical reason, as it was mostly available. The room was a different one than was used in the personality test but had the same dimensions. The positions were aligned in a semicircle, so that every location had the same distance (4 m) to the dog (Fig. 2). The training and the testing took place on two different days with at least one day in between (mean number of days in between 5.9, maximum days in between 35).

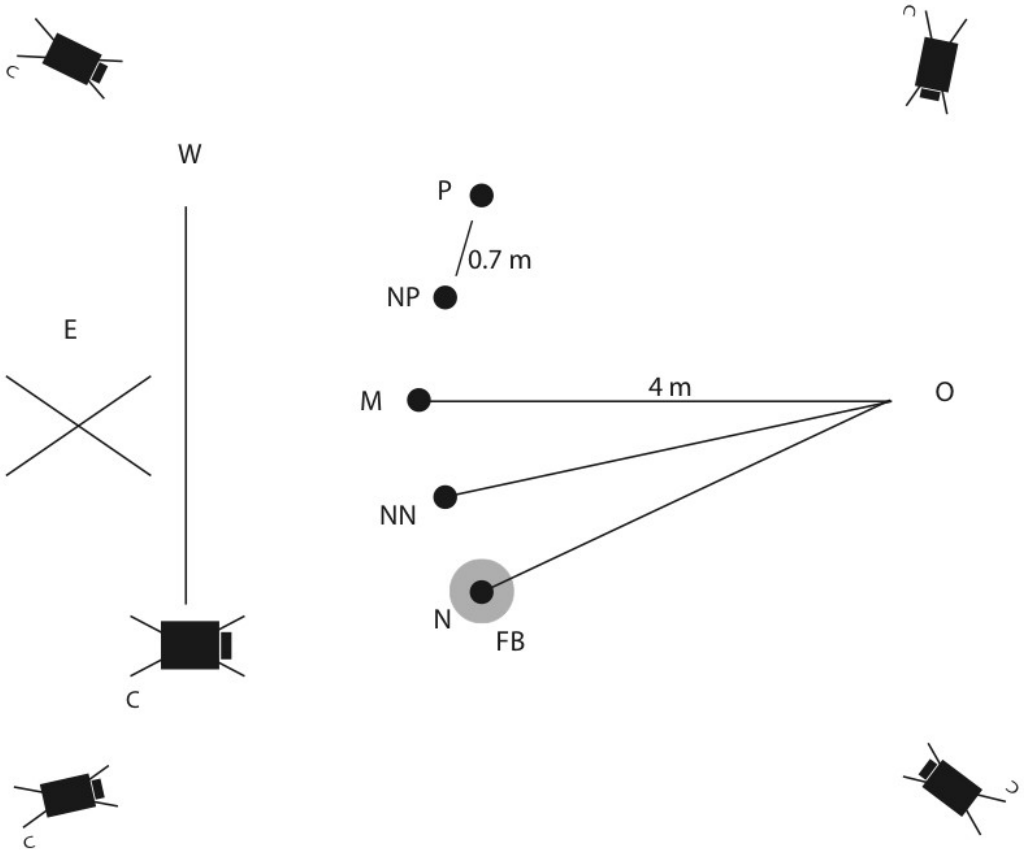


Fig. 2 The experimental setup for the cognitive bias test
C: camera E: experimenter, FB: food bowl at the negative position (N) M: middle, N: negative, NN: near negative, NP: near positive, P: positive, O: owner with dog, W: dividing wall,

Training

The dogs were given the possibility to habituate to the room prior to testing, (they were allowed to explore the room for about a minute off-leash). Three dogs needed special attention to get habituated to the room, as they were very anxious. For these three dogs the habituation to the room and the training took place on two different days.

The dogs were trained to discriminate the two outermost positions either P (positive) or N (negative). The positive location was always reinforced with a piece of food in the food bowl, and at the negative position the bowl was never rewarded. The bowls were presented one at a time, and the positive bowl was always positioned at the same location P, and the negative at N. The sequence of presentation was alternated in a pseudo-random manner. The side for the positive or negative position was counterbalanced throughout the subjects, so half of dogs had P on the left side and the others on the right side (Tab. 1).

The owner sat on a chair and had the dog sitting between their legs four meters away from the positions. The dog was attached to a 4.5m long leash so that they were not able to come and look for the experimenter behind the wall, and to make it easier for the owners to recall them after each trial. The owner was blindfolded to prevent him/her from seeing which location the food bowl was placed and therefore giving unintentional cues to their dogs. The bowls used for this task were two visually identical sets of two plastic flower pots, stuck in each other and taped together. Two sets of bowls were used to have one for the rewarded position and one for the unrewarded position to avoid that the dogs could reward themselves by licking the leftovers from the empty pot. Licking the leftovers could have a rewarding value and therefore reduce the learning effect for the dog. In between both sets of the two pots a little piece of sausage was placed to exclude that the dogs just followed odour cues to either the positive or negative locations. Dogs were therefore not able to use olfactory cues to discriminate the location of the food, and instead must use a visual (positional) discrimination.

To keep the training non-social, the owner covered the eyes of the dog, so that the dog was not able to watch the experimenter place the bowl, as this could influence the dogs' bias. After placing the bowl in its position the experimenter went back behind the wall, from where she could watch the dog on a small camera next to the wall, but could not be seen by the dog. The experimenter then clapped her hand on her thigh to inform the owner to uncover the eyes of the dog. When the dog had looked at the bowl the experimenter clapped again indicating the owner

should release the dog. To release the dog the owner was asked to give a verbal command that did not force the dog to go but allowed him to, something like “free” or “ok” at the same time as releasing the dog. If the dog did not go immediately the owner was instructed before the testing to give the command a second time, if the dog still did not move the experimenter stopped the trial after 30 seconds. A trial was completed if the dog reached the placed bowl or after 30 seconds passed without the dog reaching the bowl.

The dogs were given a maximum of 60 trials per day including 30 P trials and 30 N trials, mixed in a random order with a short break of about 5 minutes every 20 trials. The dogs reached the criterion when they were faster in all the P trials than in the N trials in the last 10 consecutive trials, and with a mean difference between those two positions of at least one second (Mann-Whitney *U* test: $p < 0.01$).

Testing

The procedure for testing was nearly the same as for the training. Before the testing could start there was a short training repetition with a maximum of 20 trials to see if the dogs were still able to distinguish the two stimuli (N and P) and then followed a short break of about 5 minutes. If they did not reach criterion after 20 trials the training was repeated and the testing was conducted on another day, otherwise the dog proceeded to testing. The criterion for the training repetition was similar to the one in the training; the only difference was that the mean difference between N and P had to be at least two seconds, additionally to being faster to reach the P than the N location in 10 consecutive trials. For the cognitive bias test the individuals were provided additionally with probe trials of three ambiguous positions (NN (near negative), M (middle), NP (near positive)), which were all unrewarded. It consisted of two sessions of 26 trials each, including in pseudo-random order 10 N trials, 10 P trials and 6 trials with ambiguous stimuli (2 NN, 2 M and 2 NP, Fig 3). The order and position of the probe trials within the test was randomised and different for each individual over the two sessions. After the first session, all dogs were given a break of about 10 minutes where the owner was asked to leave the room with the dog.

Fig. 3 Sequences for the two test sessions, X stands for one of the 3 ambiguous stimuli (NN, M, NP)

P P N N **X** N P N **X** N N P **X** P P N P **X** N P N **X** P N P **X**

N N P P **X** P N P **X** P P N **X** N N P N **X** P N P **X** N P N **X**

When reviewing the already existing literature on cognitive bias in animals it appears that three or more ambiguous stimuli were commonly used (e.g. Burman et al. 2009; Doyle et al. 2009; Mendl et al. 2010; Burman et al. 2011; Müller et al. 2012). In this study I decided to use three ambiguous stimuli for two reasons. First, the anxiety-depression model (Salmeto et al. 2011) predicts that individuals in a weakly negative emotional state (anxiety) will judge in particular near-negative stimuli more negatively compared to the baseline, whereas individuals in a strongly negative emotional state (depression) will judge also near-positive stimuli more negatively compared to the baseline. The literature about cognitive bias shows that bias effects can be found at all three probe locations (Mendl at al. 2009). Therefore, one might predict that, if cognitive bias is linked to personality traits, a correlation will primarily be found for responses to the near-negative stimulus. Second, the use of multiple ambiguous stimuli can reduce learning effects during test sessions.

2.4 Analysis

Both experiments (cognitive bias test and personality test) as well as the training for the cognitive bias test were videotaped. The videos of the personality and cognitive bias test were later analysed by using Solomon coder (© András Péter). For the statistical analysis SPSS v. 21 was used.

2.4.1 Personality

When analysing the personality test, several durations were measured and some nominal values were assigned. All the variables used from the personality test with their coding definition and the type of variable can be found in the table below (Tab. 2).

Tab. 2 Name, type and explanation of variables coded for the personality test (E: experimenter)

Test	Variables	Definition	Type
Exploration Test	EXPLmove	Time spent moving	duration
	EXPLexpl	Time spent exploring, having the nose within 10 cm of a surface or the floor actively sniffing	duration
	EXPLown1m	Time spent within 1 meter of the owner	duration
Picture Test	PICmove	Time spent moving	duration
	PICexpl	Time spent exploring, having the nose within 10 cm of a surface or the floor actively sniffing	duration
	PICown1m	Time spent within 1 meter of the owner	duration
Greeting Test	GREETappE	0: does not approach 1: approaches the E hesitatingly or after a while when called 2: approaches immediately when called 3: immediate approach or run (without calling)	nominal
	GREETgreet	0: is not interested/does not approach/ approaches initially but then avoids so no real interaction with E 1: slowly sniffing or passively standing after approach maybe avoid (little interest towards the experimenter) with or without tail wagging 2: friendly greeting, tail wagging, may cuddle up, jump or lick 3: very excited/ enthusiastic greeting with intensive searching for contact and tail wagging	nominal
	GREETtail	0: no or very little wagging 1: wagging intermittently 2: wagging most of the time	nominal
	GREETjump	Dog jumps up yes/no (1/0)	nominal
	GREETcuddle	Dog cuddles up to E; seeks body contact, positions itself to be petted (1/0)	nominal
	GREETfollow	The E walks a few steps to the side after greeting the dog, to see if the dog follows. 0: does not follow 1: follows when talked to/ encouraged 2: follows without invitation	nominal
Cage Test	CAGEatO	Time spent within 1m of the owner	duration
	CAGEori	Time spent actively engaging with the cage	duration
T-Shirt Test	TSHIRTfolow n	Time spent following the owner while the t-shirt was on	duration
Teaching Test	BINoribin	Time spent actively engaging with the bin or with the nose within 10cm of the bin	duration
	BINoriO	Time spent looking at the owner	duration
Novel Object Test	TOYdurO	Time spent within 1m of the owner	duration
	TOYoriO	Time spent looking and orienting towards the owner	duration
	TOYdurtoy	Time spent within 1 m of the toy	duration
	TOYoritoy	Time spent looking and orienting towards the toy	duration

From the different tests from the personality experiment certain variables were selected to identify the chosen personality traits (Tab. 3).

Tab. 3 The variables from the personality test that should explain the selected personality traits

Extraversion	Neuroticism/Dependency	Sociability
EXPLmove	EXPLown1m	GREETgreet
EXPLexpl	PICown1m	GREETcuddle
PICmove	CAGEatO	GREETappE
PICexpl	TSHIRTfolown	GREETtail
CAGEori	BINoriO	GREETfollow
BINoribin	TOYdurO	GREETjump
TOYdurtoy	TOYoriO	
TOYoritoy		

The behavioural variables selected for the extraversion trait were chosen because they explained traits like being lively, active, enthusiastic and eager, which are for example part of the extraversion trait in the study of Ley at al. (2008). They also used characteristics like being cautious and fearful for a neuroticism trait. I decided to use variables that described dependency and seeking help from the owner (by being close to, and watching the owner), as it was not easy to find traits that explained fearfulness, nervousness and cautiousness. The variables used for the sociability trait were selected as those or similar characteristics were also used in other dog personality studies (Svartberg and Forkman 2002; Jones and Gosling 2005; Ley et al. 2008).

Additionally the questionnaire by Jones (2008) was utilised to look for fitting personality traits and to strengthen the traits found in the experiment. The questionnaire explained an extraversion trait, a fearfulness trait and a neuroticism trait, by using certain facets that were already validated or by using specific combinations of existing individual questions. As no clear facets were included for the trait sociability, I did not calculate a sociability trait using the questionnaire. The already existing facets excitability, playfulness and active engagement were used for an extraversion component. Due to the fact that there was no distinct neuroticism trait calculated in this questionnaire, the already existing facets non-social fear, fear of dogs and fear of people were used for a fearfulness trait, which was used in other studies as part of neuroticism (Ley et al. 2008). Additionally, a putative neuroticism trait was calculated by using a choice of five questions from the questionnaire. The questions used were: “Is your dog shy”, “Is your dog afraid of unknown people”,

“Is your dog aloof”, “Is your dog nervous/afraid” and “Is your dog lethargic”. The owners were instructed to rate the questions with numbers from one to five (1: disagree strongly, 2: disagree, 3: neither agree nor disagree, 4: agree, 5: agree strongly). Facet scores were calculated by summing up the nominals from the questions, so the score for each facet ranged from 5 - 15. Each facet contained three questions. For the putative neuroticism trait a score was calculated from the selected questions by using a PCA.

Principal Component Analysis (PCA) with direct oblimin rotation was used to identify the selected personality traits. For each personality trait, for the questionnaire and the experiment (Tab. 3), an individual PCA was calculated.

2.4.2 Cognitive Bias

For the cognitive bias tests, the approach latencies to all stimuli were determined. The measurement started from the point where the owner released the dog until the dog’s nose was within 2 cm of the bowl. Since running speed may vary with the dog’s body size and/or motivation, I calculated the adjusted latency score following Mendl et al. (2010).

$$\text{Latency score} = \frac{(\text{mean latency to probe stimulus} - \text{mean latency to positive stimulus})}{(\text{mean latency to negative stimulus} - \text{mean latency to positive stimulus})}$$

Thus, a latency score of 0 corresponds to the average response latency to the positive stimulus and a latency score of 1 corresponds to the average response latency to the negative stimulus. For the means only the N and P trials from the testing phase were used, those from the training repetition were not included.

For the statistical analysis a repeated measures ANOVA with Fisher's Least Significant Difference test (LSD) was used to examine whether there was a significant difference between the approach times to the probe stimuli. To obtain homogeneity of variance the data was log transformed, normality was already given.

2.4.3 Correlation between Personality and Cognitive Bias

I checked for correlations between the personality traits (using the trait scores gained through calculating a PCA), and the judgement of the ambiguous stimuli (the adjusted scores for NN, M and NP). For this correlation a Pearson correlation coefficient was calculated, given that the residuals of

the data were normally distributed.

2.5 Ethical Note

The procedures of this study were approved by the Ethical- and Animal Welfare commission of the Veterinary University of Vienna in accordance with GSP guidelines and national legislation. The dog owners participated voluntarily and gave informed consent in writing prior to testing.

3 Results

3.1 Personality

The PCA over the eight variables of the personality test which I assumed to be related to extraversion produced three components. The percentage of the variance explained was 39 % for component 1, 21% for component 2 and 13% for component 3 (Tab. 4). The PCA produced three components instead of the expected one component for the trait extraversion; therefore it was not possible to tell which of the components explained the trait the best. Hence these components were not used for a correlation with the cognitive bias data.

Tab. 4 The results of the PCA using the variables from the personality experiment for the personality trait extraversion showing the factor loadings for each component.

	Components		
Variables	**1**	**2**	**3**
PICmove	**0.932**	-0.008	0.229
PICexpl	**0.848**	-0.040	-0.217
EXPLexpl	**0.720**	0.083	-0.233
BINoribin	0.024	**-0.871**	0.186
EXPLmove	0.053	**0.658**	0.211
TOYoritoy	-0.067	-0.011	**-0.905**
TOYdurtoy	0.109	-0.299	**-0.775**
CAGEori	0.127	0.198	**-0.737**

KMO criterion: 0.615
Bartlett test for sphericity: $p<0.001$

The same applies for using the experiment variables for a neuroticism score. When using the variables where the dogs were near the owner or looking at them to find a dependency trait, which could be part of the neuroticism trait, the PCA found three components (Tab. 5). Component 1 explained 33.3% of the variance, component 2 19.7% and component 3 18.1%. So these results also were not used for any further correlations.

Tab. 5 The results of the PCA using the variables from the personality experiment for the personality trait neuroticism showing the factor loadings for each component.

	Components		
Variables	**1**	**2**	**3**
TOYoriO	**0.909**	-0.193	0.047
TOYdurO	**0.609**	0.287	0.434
CAGEatO	**0.592**	0.514	-0.301
TSHIRTfolown	0.033	**0.823**	-0.080
PICown1m	-0.123	**0.736**	0.256
BINoriO	-0.170	0.213	**0.806**
EXPLown1m	0.322	-0.180	**0.712**

KMO criterion: 0.556
Bartlett test for sphericity: p=0.034

Additionally the variables from the questionnaire were used to identify an extraversion and neuroticism trait. For the extraversion trait the facets active engagement, playfulness and excitability were used. The PCA produced one component explaining 74% of the variance and high factor loadings of 0.913 for excitability, 0.885 for playfulness and 0.776 for active engagement.
For the fearfulness trait the PCA produced one factor explaining 65.6% of the variance with loadings of 0.833 for fear of people, 0.916 for non-social fear and 0.658 for fear of dogs.
The PCA for the putative neuroticism trait revealed one component explaining 63.8% of the variance, with high factor loadings between 0.636 and 0.922.

A sociability component explaining 64.8% of the variance was found with the highest loading of 0.922 and the lowest loading of 0.544 using nominal variables from the experiment (Tab. 6).

Tab. 6 Factor loadings for the personality trait sociability.

Variables	Factor loading
GREETgreet	0.922
GREETcuddle	0.881
GREETappE	0.880
GREETtail	0.850
GREETfollow	0.686
GREETjump	0.540

KMO criterion: 0.835
Bartlett test for sphericity: $p<0.001$

3.2 Cognitive Bias

For the training of the cognitive bias test the individuals needed a mean number of 37.5 trials to distinguish between the positive and the negative sides (Tab. 1). In the training repetition all individuals reached the criterion within 20 trials with a mean of 15.6 trials.

The results show that there was a significant difference between the three ambiguous stimuli NN, M and NP (repeated measures ANOVA, $F_{(2, 25)}=61.183$, $p<0.001$), with highest adjusted scores for the stimulus NN and lowest scores for the stimulus NP (Fig. 4).

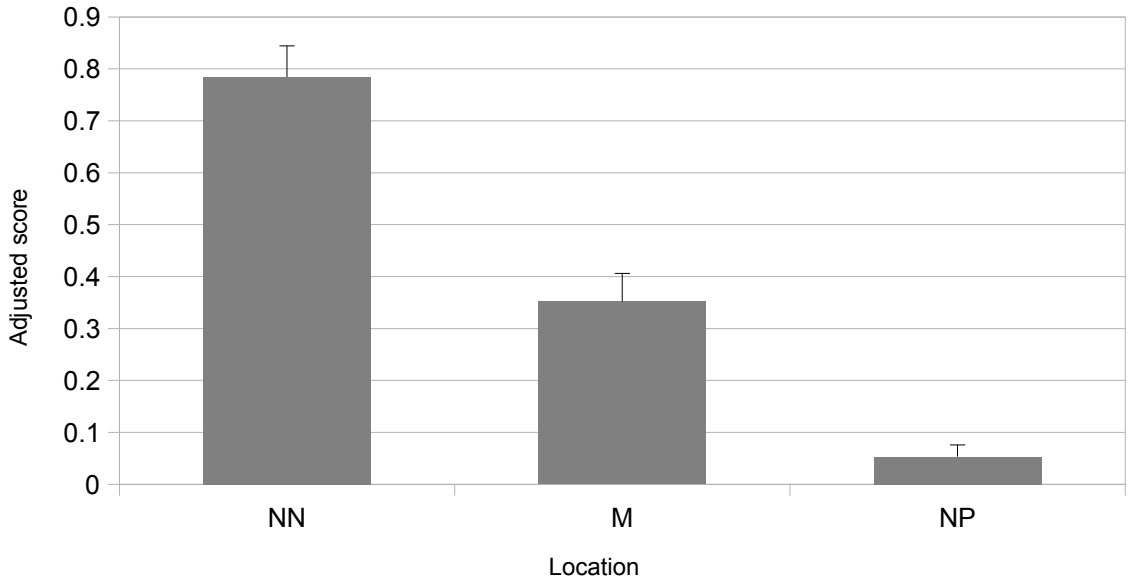


Fig. 4 Adjusted scores for the three ambiguous stimuli Near Negative (NN) Middle (M) and Near Positive

(NP) shown as mean with standard error.

When looking at the individual adjusted scores, the results of the cognitive bias test show that there was a high individual variance for the probe stimuli NN, M and NP. For example, Django judged the NN stimulus even more negatively than the N stimulus but judged M and NP to be very positive. In contrast Lennox and Mogli judged all three stimuli as very positive. Chili judged the M stimulus as the most negative. Between-individual variance differed for the three probe stimuli (Bartlett's test: chi-square=21.82, df=2, $p<0.001$). The lowest variance was found for NP (0.014), the variances for the other stimuli were high with 0.078 for M and 0.098 for N, however no significant differences for the variances between M and NN were found (chi-square=0.33, df=1, p=0.57) (Fig. 3, Fig. 5).

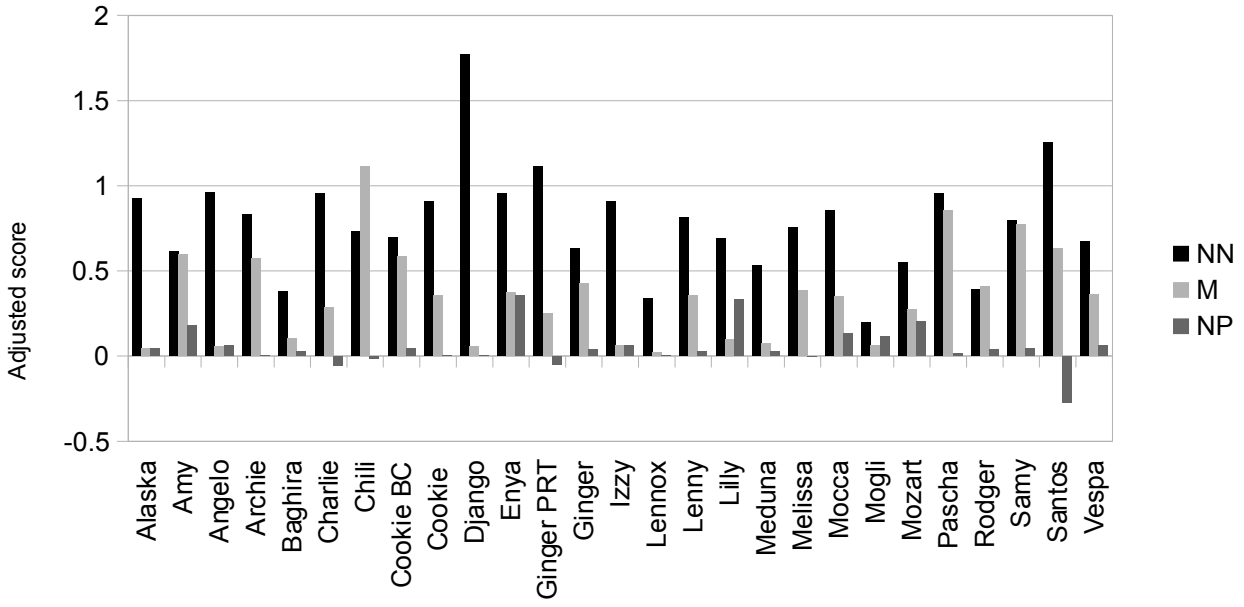


Fig. 5 Individual adjusted scores from the cognitive bias test for the NN, M and NP stimuli

3.3 Correlation between Personality and Cognitive Bias

The correlations between the personality traits and the adjusted scores did not give any significant results. All the coefficients of correlation according to Pearson were very low. The coefficient between sociability and adjusted scores for NP was the highest with a coefficient of

-0.283 (p=0.153) but nevertheless not significant (Tab. 7).

Tab. 7 Correlation (Pearson) between the personality traits and the adjusted scores for the three probe stimuli

Personality traits	**Probe Stimuli**					
	NN		**M**		**NP**	
	r	**p**	**r**	**p**	**r**	**p**
Extraversion	0.135	(p=0.501)	-0.161	(p=0.424)	0.203	(p=0.310)
Neuroticism	-0.036	(p=0.860)	-0.195	(p=0.331)	-0.228	(p=0.253)
Fearfulness	-0.051	(p=0.799)	-0.135	(p=0.502)	-0.159	(p=0.429)
Sociability	0.113	(p=0.576)	-0.106	(p=0.599)	-0.283	(p=0.153)

Variables from the experiment were used only for the trait sociability, for all the other traits the data from the questionnaire was used.

4 Discussion

This study found no correlations between personality traits and cognitive bias, so it seems that the personality of a dog does not indicate how they judge ambiguous stimuli. In this case the question now is, are there truly no connections between personality and cognitive bias, or are the results from the current study due to a weakness in the experimental setup?

The behavioural personality test used in this study and its coding may not be totally perfected yet. Additionally the personality test was not specifically designed to find the specific personality traits that were used in this study. Using the experimental data for the personality trait extraversion did not lead to a clear component. The results of the PCA for the extraversion trait, revealed an unexpected three components instead of one. When looking at the variables that loaded on the components, it was not possible to clearly label these components and hence tell which of the components explained the trait the most accurately. The same applied for the neuroticism trait. In general it seems quite difficult to find a fitting experimental setup to identify a trait like neuroticism as it is not easy to test behaviours like shyness, insecurity, nervousness, anxiety or quick stress reaction in a behavioural test. Still I tried to find variables that could show uncertainty, shyness, anxiety and variables that indicate dependence like staying near to the owner. However, although most of the data from the personality test could not be used, it was possible to use the data from the questionnaire by Jones (2008). I identified an extraversion trait by using the existing facets excitability, playfulness and active engagement. The Questionnaire did not give a neuroticism trait

but as fearfulness is part of neuroticism the existing facets non-social fear, fear of dogs and fear of humans were used for a fearfulness component. Additionally, I tried to find a putative neuroticism trait by choosing questions that should explain this trait the best. One clear component was found using those questions. The personality traits used were chosen given that in the human literature links with optimism and pessimism were found for these traits (Marshall et al. 1992; Sharpe et al. 2011), nevertheless no correlation with cognitive bias could be detected.

The best results for personality traits might be achieved by combining a behavioural experiment and an additional questionnaire, and through drawing correlations for the traits found in the experiment and the questionnaire. This could provide evidence for the reliability of personality traits and thus strengthen the results. It was not possible to combine the results from the behavioural test and the questionnaire to strengthen the results for the personality traits, as either the experimental data did not lead to clear traits, (as I discovered for the neuroticism and the extraversion trait), or the questionnaire did not give a clear trait (as for the sociability trait).

The cognitive bias results gave very nice individual variances with the individuals judging the provided probe stimuli, especially for the NN and M stimuli, very differently; only the variance for NP was low. The low variance for NP would explain why no correlation was found for this position but does not explain the lack of significant correlation for the other stimuli. However, it could be that the tested biases in the cognitive bias test were not due to personality but could instead reflect short term induced affective states. Some individuals were not totally comfortable in the room and it was possible that some could have had negative experiences prior to the testing which could lead to a more negative bias in the testing procedure. So personality could have an influence on how intense the individuals are effected by negative experiences and therefore on the resulting affective state (Boissy and Erhard 2013).

So far many cognitive bias experiments were carried out by changing housing conditions or environmental enrichment, which are all long-term changes, to induce a bias in judgement of ambiguous stimuli (e.g. Harding et al. 2004; Matheson et al. 2007; Burman et al. 2009; Brydges et al. 2010; Douglas et al. 2012), to assess their emotional state. To see if the results from the cognitive bias tests are consistent over time or very sensitive to short-term induced affective states, I would suggest further studies in which the same individuals should be tested with different cognitive bias tests. If this leads to the result that there are differences in judgements depending on the method or on the date when they were conducted, finding correlations with personality traits will be extremely difficult. If there is no consistency in cognitive bias results without a particular induced affective state it could mean that the individuals are constantly influenced by environmental factors. Consequently, the different environmental factors for each individual would need to be reduced, by

using animals that are all kept the same way and have the same environmental influences, (by using laboratory or shelter dogs for example) in order to check for correlations with personality. Still even if the cognitive bias does reveal short-term induced affective states, it does not necessary mean that no correlations between cognitive bias and personality can be found but does make finding them very difficult. There was one study where they tried to induce a short-term affective state in dogs through the absence of the owner, but the cognitive bias test did not show a negative judgement bias (Müller et al. 2012). So it may not be so easy to induce short-term affective states. It could also be that existing correlations between personality and cognitive bias are not apparent but that the means from the cognitive bias test are masking each other in comparison to the personality baseline. Revealing such small effects would need a much bigger sample size.

So one reason for the lack of correlations could be due to the small sample size, in fact the number of individuals (N=27) would be high enough to identify obvious correlations but not necessarily weak correlations ($r<0.3$). In the study of Sharpe et al. (2011) they had more than 4000 participants, the results showed some high correlations but also some weak but significant correlations, whereas, the results of this study do not even show a tendency.

In conclusion, this study did not reveal any correlations between personality and cognitive bias in pet dogs; however I would not conclude that there is no connection. Looking through the literature, especially in the human area, connections have been found (Sharpe et al. 2011) and so far most of the research in animal cognition was primarily adapted from human studies and has led to similar results. For instance Ley et al. (2008) was able to apply human personality testing methods to pet dogs and received partly the same personality traits. Also cognitive bias tests were adapted from human research and improved through behavioural testing (given that animals are not able to speak), to make it possible to be used also in animals.

One benefit to finding positive results could be to help select the right breeding animals, or even help in identifying the most fitting individuals to be trained as guide dogs or for rescue or police work. Further research into this topic is necessary using revised methods. One possibility would be to use shelter or laboratory individuals that have been kept in the same environment, with the same keeping practices to minimize the possibility of changed judgement bias due to short term induced affective states. In addition, as already mentioned, it would be interesting to compare different cognitive bias tests on the same individuals to check for consistency in cognitive bias scores. And finally, the sample size should be significantly increased. But in a master thesis this is not possible in the given (proper) time frame.

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7 Zusammenfassung

Durch die Möglichkeit den kognitiven Bias eines Tieres herauszufinden ergibt sich die Chance auch dessen emotionalen Zustand festzustellen. Dieses Thema zog in der Wissenschaft in letzter Zeit immer mehr Aufmerksamkeit auf sich, da dies auch einen Beitrag zur Verbesserung des Tierschutzes und der artgerechten Tierhaltung leisten kann. Ein weiteres interessantes Thema ist das Verständnis von Persönlichkeit bei Tieren. In beiden Bereichen wurde bereits einiges an Forschung betrieben, jedoch wurde bisher noch nicht weiter erforscht ob die Persönlichkeit eines Individuum's einen Einfluss darauf haben könnte, wie jenes Individuum einen uneindeutigen Stimulus einschätzt. Nachgewiesener Weise hat Persönlichkeit Auswirkungen auf verschiedenste kognitive Prozesse bei Tieren und auch die Literatur in der humanen Forschung deutet darauf hin, dass zwischen Persönlichkeit und kognitivem Bias ein Zusammenhang besteht. Das Ziel dieser Studie ist es herauszufinden ob die Persönlichkeit eines Haushundes (*Canis familiaris*) einen Einfluss darauf hat wie dieser einen uneindeutigen Stimulus einschätzt. In dieser Studie wurde ein Verhaltensexperiment durchgeführt und ein Fragebogen verwendet um die Persönlichkeit der einzelnen Hunde festzustellen. Für den kognitiven Bias Test wurde eine nicht soziale Methode mit einer räumlichen Diskriminierungsaufgabe verwendet, mit einem Ablauf bei der die Hunde entweder zur Position hingingen oder eben nicht hingingen. Die Resultate ergaben keine Korrelationen zwischen Persönlichkeitsfaktoren und der Einschätzung der einzelnen uneindeutigen Stimuli. Bei diesen Resultaten kann man jedoch nicht eindeutig sagen, ob einfach nur kein Zusammenhang zwischen Persönlichkeit und kognitivem Bias besteht oder ob diese Ergebnisse durch mögliche Schwächen in der experimentellen Durchführung entstanden sind. Folglich könnten die Ergebnisse nun bedeuten, dass entweder tatsächlich kein Zusammenhang zwischen Persönlichkeit und dem kognitiven Bias besteht oder sie könnten auf Grund dessen entstanden sein, dass der kognitive Bias eines Individuums nicht über die Zeit konstant ist was folglich dazu führt, dass kein Zusammenhang gefunden werden kann. Somit würde ich raten weiterhin in diesem Bereich zu recherchieren um herauszufinden ob tatsächlich kein Zusammenhang besteht.

8 Curriculum vitae

Kriehubergasse 9/5
1050 Wien
Tel.: 0650 8741451
E-Mail: julia.sch@sol.at

Julia Schößwender BSc

DOB: 11. 11. 1986

Place of Birth: Oberndorf bei Salzburg

Family status: unmarried

School Education:

Year	School
1993 - 1997	Volksschule Oberndorf
1997 - 2001	Hauptschule Oberndorf
2001 - 2006	HBLA Annahof Salzburg Focus: Medieninformatik

University

Year	Focus
2006 – 2010	Zoology Bachelor of Science Bachelor Thesis: "Habitat bezogene Schwimmfähigkeit der Gattung *Nebria* und *Oreonebria* aus dem Gletschervorfeld des Hornkees in den Zillertaler Alpen, Österreich"
2010 - present	Behaviour, Neurobiology and Cognition Master of Science

Publications

Martins, C.I.M., Schaedelin, F.C., Mann, M., Blum, C., Mandl, I., Urban, D., Grill, J., Schößwender, J., Wagner, R.H., 2012. Exploring novelty: a component trait of behavioural syndromes in a colonial fish, *Behaviour*, 149, 215-231

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Computer Literacy

Windows and Mac OSX operation systems,
Programs: Microsoft Office (Word, Excel, Power Point, Access, Outlook)
HTML
Photoshop
Illustrator
SPSS

Language skills

English: fluent in spoken and written
French: basic knowledge