Cognitive Bias as a Measurement of Emotional States in Dogs

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Titel
Title

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Författare
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Sammanfattning
Abstract

Cognitive bias can be used when determining emotional states in animals by assessing the animal's perception of an ambiguous stimulus. In the concept of animal welfare, both physical health as well as mental health of animals are involved. Therefore, cognitive bias can be a valuable tool in order to measure the mental health of an animal. The aim of this paper is to summarize and discuss how cognitive bias tests have been used to assess emotional states in dogs. Cognitive bias tests in dogs have been used to evaluate the emotional state of a dog with behavioural problems. It has also been shown to be useful when studying the effect of enrichment in the form of natural behaviour, such as being allowed to use its olfactory sense to a greater extent. Additionally, the connection between personality and cognitive bias is discussed. Hence, assessing the emotional state of dogs can be valuable in a welfare perspective.

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1 Abstract

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2 Introduction

2.1 Cognition and emotions

Cognition is described as mechanisms of animals to obtain information from the environment, process, store and act upon it. Included in these mechanisms are perception, learning, memory and decision-making (Shettleworth, 2009). Cognition can be affected by emotions, which can be defined as states that are evoked by so called rewards and punishers, as explained by Rolls (2005). A reward is in this context described as anything that an animal is willing to work for or something that encourages desired behaviour. On the contrary, a punisher is described as anything that an animal will want to escape or avoid, or that can possibly decrease the probability of performing undesired behaviour. For example, happiness is an emotion that can be evoked when one is given a reward (a hug, praise or a tasteful treat). In contrast, fear is an emotion evoked when one is faced with a punisher, such as an intimidating sound or an angry facial expression. Another example is frustration, anger or sadness that are emotions evoked when an expected reward is removed, whereas relief is an emotion evoked when a punisher is excluded or terminated. One function of emotions is to aid in the selection of a suitable action toward a reward or punisher, or the exclusion or termination of these. This is divided into two stages, whereas the evocation of an emotional state is the first stage and the selection of an action applicable to a given emotional state is the second. An additional function of emotional

states is their bias of cognitive function, thereby influencing how future events are interpreted (Rolls, 2005).

2.2 Human psychology and cognitive bias

The term cognitive bias can be defined as a selective or inaccurate way to process information that is emotion-relevant (Mineka & Tomarken, 1989 as cited by Mineka & Sutton, 1992). Cognitive bias has been used as a term to characterise how emotional states or personality traits affect cognitive processes (Mendl et al., 2009). Optimism and pessimism are defined as psychological dimensions, where optimism illustrates a more positive bias in perception or expectancy of positive life aspects. A classic example of this is to consider a glass half full. In contrast, a negative bias is illustrated by pessimism and in this case the example would be to consider the glass half empty (Dember et al., 1989). Depressed people usually exhibit a more negative or 'pessimistic' assessment toward ambiguous and future events, while the opposite response is exhibited by people in a more positive affective state (Paul et al. 2005).

2.3 Cognitive bias in animals

Similar to the human psychology, cognitive bias in animals also refers to how the animal is affected by its emotional state when processing information (Mendl et al., 2009). The terms 'affective state' and 'emotional state' are commonly used interchangeably. They often concern behavioural and physiological responses, as well as emotions (Paul et al. 2005). The most common method used to study cognitive bias in animals is to assess judgment biases. Judgment bias describes the tendency of an animal to respond with either positive or negative anticipation to ambiguous stimuli. Cognitive bias tests have been shown to be valuable tools when investigating animal welfare (Mendl et al., 2009). Animal welfare is an intricate concept where both physical health as well as mental health is included (Blokhuis et al., 2010). Cognitive bias is useful when measuring the latter.

2.4 The domestic dog

Thousands of years ago, humans domesticated dogs and since then, humans and dogs have lived in close association (Miklósi, 2015). The domestic dog is a common pet in many households and serves an important role not only as companions, but also in several professions in today's society. For example, dogs are frequently used by the police, in the military and as service dogs (e.g. guide dogs for blind people). Because of the dogs' integration in society, it may be of

interest for dog owners to be able to determine the mental health of their dogs in order to improve their welfare. Thus, a method to measure emotional states in dogs might be desirable, and so, this study will focus on how cognitive bias can be used to assess emotional states in dogs.

3 Materials and methods

To find information for this paper, Unisearch provided by the Linköping University library and Google Scholar were used to search for articles and books for this paper. The main focus was articles published from 2000 and forward, in order to obtain as modern and relevant information as possible. A few exceptions were made in order to find reliable information about definitions and historical studies. Studies on dogs were of most importance to this study, but a few articles about other animals were used to get a more general approach of the subject and to be able to discuss some main concepts. In order to find relevant articles to the study topic, the following keywords or combination of keywords were used: *cognitive bias, animals, judgment bias, dogs, emotional state, optimistic, pessimistic.*

4 Results

4.1 History of cognitive bias tests on animals

The first judgment bias test on animals was carried out by Harding et al. (2004). In this test, rats were trained to press a lever when they heard a certain tone that was associated with something positive. In this case, the reward was receiving food. They were also trained to avoid pressing the lever when they heard another sound that was associated with something negative. This negative event was white noise played for 30 seconds in 70 db. The rats were considered to have learned the difference between the sounds when they were able to respond correctly to each tone in more than 50% of the trials. After the training, the rats were divided into two groups. One group was put in a so called 'unpredictable' housing and the other group was put in a so called 'predictable' housing. In 'unpredictable' housing, at any one day up to two negative interventions were made at least two hours before or after each test session. These interventions would be the cage being tilted or unfamiliar, introduction of a stranger of the same species, the light/dark cycle being reversed temporarily or the bedding in the cage being left damp. The interventions were random and never set to happen at the same time. In 'predictable' housing, the conditions were maintained the same as they were during training. After nine days

of training, ambiguous tones of intermediate frequencies between the positive and the negative sounds were presented to the rats. In order to investigate how the positive and negative events affected the anticipation of the rats, ten daily test sessions were held in which it was observed whether the rats would press the lever as a response to the ambiguous tones. Results showed that rats kept in the 'unpredictable' housing responded slower and did not exhibit as many responses to ambiguous tones close to the tone associated with something positive and to that tone itself. This means that rats in 'unpredictable' housing seem to have reduced anticipation of a positive event. Overall, these findings suggest that cognitive bias can be used as a way to measure affective states in animals.

According to Paul et al. (2005), most research about animal emotions is focused on negative affective states, and positive emotions are often thought to be both behaviourally and physiologically difficult to determine. In order to assess positive affective states, Bateson and Matheson (2007) developed a different method for cognitive bias tests that could be easily adapted to other species than rats. This method involved taste associations. In their study, they used European Starlings (*Sturnus vulgaris*) which they kept in two different cage types; one being the standard cage the birds were kept in during training sessions and the other being enriched cages with various items for the birds to explore. Bateson and Matheson (2007) aimed to investigate whether there was an association between an enriched environment and a more positive affective state. If this was the case, it would result in the birds being more optimistic to ambiguous cues when they were kept in enriched cages. Starlings were trained to flip the lid off a Petri dish containing a mealworm. White lids were associated with appetizing mealworms, while dark grey lids were associated with unappetizing mealworms. Intermediate pale grey lids were used as ambiguous cues. The results showed that starlings that had recently been moved from an enriched cage to a standard cage approached and flipped the intermediate pale grey lids to a smaller extent than starlings that had been moved from the cages in opposite order. According to Bateson and Matheson (2004), this suggests that birds that have experienced a negative change in quality of their environment showed a more pessimistic affective state. This study is the first one to show that earlier experiences of animals have an impact on their affective responses to a certain degree of environmental enrichment. Overall, it is possible to use taste association as a method to assess cognitive bias and therefore, affective states in animals.

Inspired by the cognitive bias test developed by Bateson and Matheson (2007), Burman et al. (2008) decided to use a spatial cognitive bias task on rats housed in enriched or unenriched

cages. The spatial cognitive bias task involved placing a pot at different locations in a test arena. These locations consisted of one rewarded location in which the pot contained food, one unrewarded location in which the pot was empty, as well as three ambiguous locations between the rewarded and unrewarded locations. The rats were trained to discriminate between the rewarded location and the unrewarded location. Once they had learned to discriminate between the two locations, the actual test was performed. The test was carried out over a period of three days. Each day, the rats were presented with 13 trials each, consisting of five rewarded locations, five unrewarded locations as well as three ambiguous locations that were unrewarded. The latency of the rats to approach the different locations was measured. Results showed no difference in latency to approach the rewarded location and the unrewarded location comparing rats kept in enriched cages with rats kept in unenriched cages. However, rats kept in enriched cages were quicker to approach the ambiguous location closest to the unrewarded location than were the rats kept in unenriched cages. According to Burman et al. (2008), this suggests that rats kept in enriched cages were more likely to show an optimistic approach than rats kept in unenriched cages did to the ambiguous location closest to the unrewarded location. In conclusion, a spatial cognitive bias task might be an effective way to indicate profound changes in the emotional state of animals and it may be easily adapted to other species (Burman et al., 2008).

4.2 Cognitive bias in dogs

Cognitive bias has also been studied in dogs. It is commonly used to assess the emotional state of a dog with behavioural problems or to investigate how enrichments may enhance emotional states in dogs. For example, Mendl et al. (2010) studied the performance of dogs with separation anxiety in a cognitive bias test. This was done to determine whether they had a more negative emotional state than other dogs. Similar to the method used by Burman et al. (2008), the dogs were trained to associate a positive location with a bowl of food and a negative location with an empty bowl. In the cognitive bias test, three ambiguous locations were used, and an empty bowl was placed at one of these locations for each trial (Figure 1). For each of the locations, three trials were presented in the test. In between each test trial, four training trials with either positive or negative locations were presented. It was measured how fast the dogs approached the ambiguous locations, where a quick speed indicated an optimistic judgment and a slow speed indicated a pessimistic judgment. The results showed a more pessimistic judgment of the

ambiguous locations in dogs that expressed separation-related behaviour to a greater extent (Mendl et al., 2010).
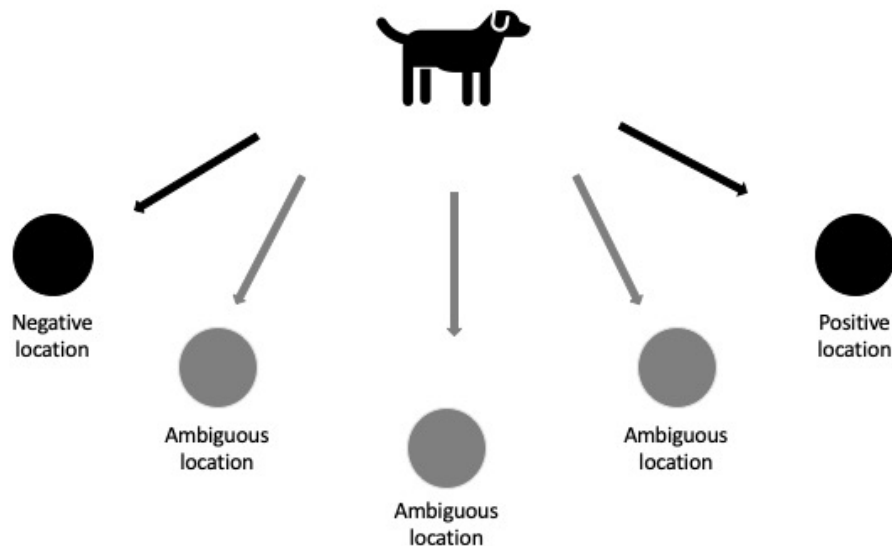

Figure 1. A simple visualisation of how a cognitive bias test using the spatial location task is performed. The dog is trained to associate a bowl at the positive location with a reward and a bowl at the negative location to the exclusion of a reward. In the actual test, the bowl is placed at one of the ambiguous locations.

Duranton and Horowitz (2019) investigated the impact of enrichment, in the form of a natural behaviour, on the performance of dogs in a cognitive bias test. The natural behaviour in this case was allowing the dogs to use their olfactory sense when performing nosework activities. Duranton and Horowitz (2019) described nosework as an independent act of dogs searching for hidden scents or treats, without help from their owners. In this study, one group of dogs practiced nosework, while another practiced heelwork. Heelwork training consisted of the owners training their dogs to follow and perform tricks while receiving treats as rewards. The method used for the cognitive bias test was similar to the spatial location task used by Mendl et al. (2010) and the dogs were tested in the cognitive bias test once both before and once after practicing nosework/heelwork for two weeks. The results showed that dogs that had practiced nosework were faster to reach the bowl in the ambiguous location than they were before having practiced nosework. This was not observed in the heelwork group, indicating that the nosework group had become more optimistic than the dogs that performed heelwork. Hence, by allowing the dog to perform more of its natural behaviour, such as being allowed to use its olfactory

sense more, a positive emotional state may be induced in dogs (Duranton & Horowitz, 2019).

4.3 Cognitive bias and the association with personality traits

Another aspect of what may influence cognitive bias in dogs is personality. This is something that Barnard et al. (2018) have investigated. They determined personality traits by using a Dog Mentality Assessment test (DMA) and the Canine Behavioural Assessment and Research Questionnaire (CBARQ). The DMA is a standardised behavioural test that is developed by the Swedish Working Dog Association (Svartberg et al., 2005). The basic principle of the test is to study the reaction of the dog in different standardised situations, such as contact and cooperation with a human (Svenska Brukshundklubben, 2019). The CBARQ is an owner-based survey in which dog owners rate the behavioural responses of their dogs in certain situations that occur in their everyday environment. Cognitive bias was studied using the spatial location task, previously used by Mendl et al. (2010) and the results showed that dogs that exhibited a more optimistic approach to the ambiguous stimulus in the judgment test displayed more sociability in the DMA test (Barnard et al. 2018). Optimistic dogs were also rated as more excitable or less likely to display social fear in the CBARQ. In addition, they found that dogs that displayed separation-related problems or traits of dog-directed fear or aggression exhibited a more pessimistic approach to the ambiguous stimulus. Barnard et al. (2018) suggests, with these results in mind, that personality traits in dogs are indeed connected to cognitive bias and need to be considered when evaluating judgment bias results.

5 Discussion

Cognitive bias can be a valuable tool in order to assess emotional states in animals. The historical studies on the topic have together provided a solid foundation for cognitive bias tests and repeatedly been developed in order to be adaptable to various species. The most common method to measure cognitive bias in dogs is to use a spatial cognitive bias task. The responses of the dogs to the ambiguous spatial locations in this test can be used to determine whether the dog has a more pessimistic or optimistic bias. Thereby, the emotional state of the dog can be assessed.

Mendl et al. (2010), studied dogs with separation anxiety and tested their performance in a cognitive bias test. Similarly to depressed people (Paul et al. 2005), dogs that did exhibit

separation anxiety had a more pessimistic judgment of the ambiguous locations (Mendl et al., 2010). Hence, cognitive bias tests provide an opportunity to investigate emotional states in dogs with behavioural problems, such as separation anxiety. This might be useful in order to achieve a better understanding of understanding of the mental health of dogs and provide suitable actions to help individual dogs.

Duranton and Horowitz (2019) investigated how the performance of dogs in a cognitive bias test was affected by enrichment in the form of natural behaviour. This was the first study using olfactory behaviour as a natural enrichment in dogs, which was also shown to significantly improve the emotional state of the dogs. Duranton and Horowitz (2019) discussed how dog owners usually do not consider their dogs to be animals in captivity with a need to perform natural behaviours. When put in a welfare perspective, the allowance to perform natural behaviour is highlighted and something that should be considered, also for the domestic dog (Duranton & Horowitz, 2019).

Finally, Barnard et al. (2018) brought the aspect of personality into light and investigated the connection between personality traits in dogs and their performance in a cognitive bias test. The results showed that dogs with more 'positive' personality traits (such as being excitable) had a more optimistic approach toward the ambiguous stimulus, while dogs with more 'negative' traits (such as dog-directed fear or aggression) had a more pessimistic approach. These results are important when it comes to interpreting the results of cognitive bias tests. When performing cognitive bias tests, one cannot solely rely on emotional states to impact the performance since personality too plays a role in this (Barnard et al., 2018).

The previously mentioned studies are of importance because they show how cognitive bias tests can be used to assess emotional states, and hence, mental health, in dogs. This proves useful when it comes to evaluating welfare in dogs with behavioural problems, such as dogs with separation anxiety (e.g. Mendl et al., 2010). Another useful area of a cognitive bias test is to determine the impact of enrichment on emotional states in dogs (e.g. Duranton & Horowitz, 2019). Hence, cognitive bias can be used as an indicator of welfare in dogs, not only companion dogs but also dogs that serve important roles in today's society such as police dogs and different kinds of service dogs. Since their role in the society is expanding, this is more important than ever. By using cognitive bias tests, we can increase our knowledge on the mental health of dogs by evaluating their emotional states.

Research on welfare is often focused on stress and poor welfare. Probably since positive welfare is more difficult to determine. However, cognitive bias tests have repeatedly been shown to reliably assess the mental state and welfare of animals. In conclusion, based upon the results of the studies mentioned in this paper, cognitive bias indeed is a useful method to use when measuring emotional states in dogs, even the positive states.

6 Societal and ethical considerations

The knowledge about how emotional states of dogs affect behaviour and decision-making can be useful both to assess and improve the welfare of dogs in today's society. Since dogs are usually considered beloved family members by their owners, there might be an interest in how to determine and understand how a dog is feeling. Because of the integration of dogs in today's society, this is also useful when it comes to welfare in working dogs, such as police dogs and service dogs. Another aspect of this might be evaluation of shelter dogs. By being able to assess and understand the emotional state of a dog, it can be targeted for improvements, such as enrichments, and thereby increase its chances to a continued life in a new home. Animal welfare and legal requirements were taken into consideration in the experiments included in the various articles.

7 Acknowledgements

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