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Research report

Bottlenose dolphins engaging in more social affiliative behaviour judge ambiguous cues more optimistically

Isabella L.K. Clegg[a,b,*], Heiko G. Rödel[a], Fabienne Delfour[a,b]

[a] Laboratoire d'Ethologie Expérimentale et Comparée E.A. 4443 (LEEC), Université Paris 13, Sorbonne Paris Cité, F-93430 Villetaneuse, France
[b] Parc Astérix, Plailly, France

HIGHLIGHTS

- First cognitive bias test application to a marine mammal or zoo-housed species.
- Stable individual differences in judgements of ambiguous cues were found.
- Dolphins performing more synchronous swimming made more optimistic judgements.
- Longer-term behavioural data suggest results reflected a transitory affective state.
- Results support hard-to-measure link between social affiliation and positive affect.

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ABSTRACT

Cognitive bias tests measure variation in emotional appraisal and are validated methods to assess animals' affective states. However, the link between social behaviours and cognitive bias has not yet been investigated. Bottlenose dolphins are a gregarious species for whom welfare research is increasing in importance, and thus are a good model to test such an association. We adapted a spatial location judgement bias test for eight captive bottlenose dolphins to investigate the link between cognitive bias and social behaviour, where we conducted behavioural observations outside of training sessions and did not experimentally induce an affective state. Subjects showed stable individual differences in cognitive biases across the three test days. Furthermore, dolphins showing more synchronous swimming, a fundamental affiliative behaviour, judged ambiguous cues significantly more optimistically. Our longer-term data showed cognitive bias and synchronous swimming frequency were significantly associated for up to two months preceding the test, but disappeared prior to that, suggesting that here cognitive bias differences were reflected by transitory affective states rather than longer-term traits. We hypothesise that the frequency of synchronous swimming may induce affective states and/or be induced by them; either way, it has strong potential as an indicator of affective state in this species and beyond.

1. Introduction

Cognitive bias has been the subject of recent interest due to its successful application to animal welfare investigations, and describes the effects of emotional experiences on cognitive functioning (chiefly attention, memory and judgement, [1]). In many animal species there is evidence to support the experience of emotions, which when grouped together are thought to form various affective states [1–3]. Welfare can be generally described as the balance between positive and negative affective states [4] and welfare indicators are sought in order to measure characteristics of these states [5]: therefore the fields of animal emotion, welfare and cognitive bias research are all closely interlinked.

Cognitive biases are most likely adaptive: for example, individuals in environments, which induce anxious or fearful emotions may enhance their fitness through biased attention or judgement towards negative stimuli [1]. In humans, certain cognitive biases in perhaps a more complex form are known as optimism and pessimism [6], and a congruent finding is that being more optimistic is correlated to better subjective well-being (see reviews by [7,8]). Soon after the first animal judgement bias paradigm was applied to laboratory rats (*Rattus norvegicus*, [9]), a handful

* Corresponding author at: Laboratoire d'Ethologie Expérimentale et Comparée E.A. 4443 (LEEC), Université Paris 13, Sorbonne Paris Cité, F-93430 Villetaneuse, France.
E-mail address: isabella.clegg@leec.univ-paris13.fr (I.L.K. Clegg).

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of other mammalian and bird species were tested, and in the last few years the number of studies has increased exponentially (latest reviews by [10,11]). In the vast majority of studies an experimental condition was imposed to induce a certain affect, with results convincingly showing that animals with induced negative affective states/poorer welfare judge ambiguous stimuli more "pessimistically" [1] (hereafter discussed as animal optimism and pessimism without forgetting the caveat that this is an anthropocentric concept).

Many cognitive bias studies have induced affective states through imposing conditions involving physical stress [12], pharmacological treatments (e.g. [13]), and chronic environmental and psychosocial stress (e.g. [14,15]). Although past results have mostly concurred with the predicted affect being induced, some studies have reported surprising directionality in cognitive biases [1,10]. It has recently been asserted that the individual's moods and affective state, occurring independently from the affect induced experimentally, might also be impacting cognitive bias results [16,17]. Affective states are defined as combinations of discrete emotions which result from the opportunities for threats or rewards in the surrounding environment, and moods are the longer-term result of experiencing affective states [5,18]. Since performance of behaviour is in response to current threats or rewards [19], measuring an animal's behaviour in its home environment might indicate its affective state/mood and thus also be correlated with cognitive bias results [20]. A strong candidate for such behaviours would be those involved in social interactions: for example, affiliative social behaviour (e.g. gentle tactile interactions, play, allogrooming) is thought to be rewarding and associated with long-term positive affective states [2,5,21]. Furthermore, it was recently recommended that cognitive bias tests be used specifically to investigate the contribution of social interactions to affective state [16]. When investigating the correlations between behaviours and cognitive biases, longer-term data would be invaluable for conclusions on whether temporary affective states or more stable behavioural traits are being seen [11]: very few past studies have tested the long-term persistence of their results [10].

Dolphins (family *Delphinidae*) are gregarious marine mammals with complex societies and supposedly advanced cognitive abilities, and thus have long stimulated the interest of cognition researchers [22,23]. Thus far the meaning and effect of social behaviours on the dolphins themselves has not been explored: for example the influence of dolphin play on affective state [24; as with other species,25]. The relationship between agonistic behaviour and affective state is thought to be complex in dolphin group interactions, with certain emotions often hard to pinpoint in the animals' multi-modal displays [26]. Dolphin behaviours such as gentle tactile interactions and synchronous swimming are some of the more direct indicators of social affiliation [26,27], and therefore could be linked to positive emotions as well. There is very little research available on emotions and their indicators in dolphin species [26], but interest for their discovery in other animals [2,5] is likely to stimulate an analogous increase in such studies, fuelled further by questions over their welfare status in captivity [28,29].

Despite bottlenose dolphins (*Tursiops truncatus*) being the most studied cetacean species [30], and more pertinently the most commonly kept in captivity [31], cognitive bias tests have not yet been conducted with them, or indeed any marine species or animals kept in zoos. Such tests could increase our knowledge of dolphin affective states and how social behaviours might impact them. In the only previous study linking cognitive bias and social behaviour, Lalot and colleagues recently found that pair-housing was linked to optimistic judgements in domestic canaries (*Serinus canaria*) [32], while two other studies using cognitive bias tests have suggested links between dominance rank and optimism in two primate species [20,33]. These studies have started to provide evidence of the 'emotional consequences of social behaviour' [33], but it would be useful to delve deeper into which aspects of social behaviours are linked to emotions, for example through studying the opportunistic performance of various behaviours in the social repertoire. Cognitive bias testing in dolphins would be readily applicable and useful for research on this group for a number of other reasons: conditioning to the chosen task would likely be feasible since captive dolphins are highly trainable using positive reinforcement methods [34], it has the potential to validate potential welfare indicators, and the results may enhance our knowledge of dolphin emotions and affective states, which is lacking at present.

Consequently a study was designed to investigate cognitive bias in a group of Atlantic bottlenose dolphins at Parc Astérix dolphinarium (Plailly, France). The two aims of this research were: (*i*) to test whether individual differences in judgement biases were present and repeatable over testing days. Although they have not been investigated with dolphins before, we expected cognitive biases to be present since they are found in many other species. Finding individually repeatable responses would show that the methodology is eliciting more than a chance phenomenon. In part (*ii*) we wanted to test whether the cognitive bias results were correlated with measures of social behaviour taken around and prior to the testing period. The social behaviours were chosen to reflect the most common social interactions likely to take place, and included social play, synchronous swimming, and agonistic behaviour. We predicted that a higher frequency of synchronous swimming may be associated with optimistic judgements: it is a common social behaviour where two animals or more swim in (near) unison with each other [35,36] and is likely a proxy indicator for higher affiliation and social bonding in the group [35]. Social play is generally affiliative and thus higher levels might also be linked to more optimistic judgements, with agonistic behaviour perhaps correlating with pessimistic judgements if it is indeed an indicator of stress [37]. The results could make headway towards understanding dolphin affective states, and integrating data from cognitive and behavioural measures is a more accurate approach to assessing emotions, and therefore welfare, as opposed to using just one category [2,38]. We also took social behavioural data in the months prior to testing, since the persistence of links to cognitive bias results would reveal importantly whether transitory affective states, or stable behavioural traits, were being measured.

2. Material and methods

2.1. Study animals and facility

Our study involved eight Atlantic bottlenose dolphins (*Tursiops truncatus*) housed at Parc Astérix in an outdoor pool conjoined to two indoor pools, with a total volume of 3790 m^3 of water where access was always free between pools. The age range of the study subjects was from 4 to 43 years old, and consisted of 4 females: all adults of 11 years or over (age classification taken from [39]), and 4 males: 2 adults and 2 juveniles; not all animals were related, and three were wild caught while the remaining five were captive born. A female calf of 6 months was also present in the group but not included in the study as she was too young to participate in training sessions. The dolphins' diets consisted of a variety of fish and squid species, and during multiple sessions each dolphin received between 5 and 12 kg per day depending on individual needs. The park was closed to the public for the duration of the experiment. "Training sessions" involved completing tasks conditioned using positive reinforcement (see [40] for explanation), and could involve medical training, show practice, novel behaviours, free-feeds, and play sessions.