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You know what? I'm happy. Cognitive bias is not related to personality but is induced by pair-housing in canaries (*Serinus canaria*)

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ABSTRACT

Recent studies suggest that cognitive bias could constitute a novel and valid measure of animal welfare. Although interest for a link between personality and cognition is growing, no study to date investigated whether a cognitive bias might be related to the personality of the individuals. We trained 43 domestic canaries (*Serinus canaria*) to discriminate between two sides of a test cage, each side being associated with a different value (attractive or aversive food in a dish). During the test phase, the dish was placed at intermediate locations, representing ambiguous information. Results show evidence of an “optimistic” bias (flying faster to the dish at the ambiguous location) in birds housed in pairs, compared to birds housed singly, suggesting an influence of social context (living conditions) on canaries’ emotions when tested individually. We also studied six traits of individuals’ personality and found that aggressiveness, neophobia, one sociability index and obstinacy were repeatable across social context and/or day-light schedule, whereas the other sociability index, boldness and locomotion were not. No correlation between the birds’ optimism and any of their personality traits was found, suggesting that cognitive bias may be a matter of social context rather than of individual personality.

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Recently, a growing number of studies suggested that cognitive bias could be used as a novel and effective measure of animal welfare (Mendl et al., 2009, 2010b; Paul et al., 2005). A cognitive bias occurs when an individual's affective state modulates its decision-making in an ambiguous situation (Boissy et al., 2007). Cognitive bias has been studied in many species. In humans, for instance, depressed people tend to interpret ambiguous verbal or visual information more negatively than people not affected by depression (Eysenck et al., 1991; Richards et al., 2002, 2007), and rhesus macaques interpret ambiguous visual stimuli more negatively when they have just experienced a stressful situation (Bethell, 2009). In dogs, individuals showing separation-related anxiety (which includes particular vocalisations and destructive behaviours, such as biting, chewing or scratching any non-food related objects, when the owner is away) exhibit a pessimistic bias compared to others (Mendl et al., 2010a). Similarly, in sheep (Doyle et al., 2011a) and in rats (Burman et al., 2009; Harding et al., 2004; Brydges et al., 2011), going through a stressful treatment or living in an anxiogenic environment (or even just a non-enriched one) appears to induce a pessimistic bias. The existence of cognitive bias has also been shown in bird species, like hens (Lindström, 2010; Salmeto et al., 2011) and European starlings (Bateson and Matheson, 2007; Matheson et al., 2008). These studies suggest that an enriched environment may influence the animal's affective state and induce an optimistic bias.

Most of the experiments involving cognitive bias use a Go/NoGo procedure. The subjects are first trained to discriminate between two stimuli, each associated with a different outcome: an attractive one and an aversive one. Then, during the test phase, an intermediate stimulus representing ambiguous information is presented to the subject. An intermediate location (relative to the two locations used during the training phase) is often used as ambiguous stimulus. Individuals living in good conditions are supposed to consider the ambiguous stimulus more positively than individuals living in poor conditions. Their emotional state would modulate their decision-making and make them associate the intermediate stimulus preferentially to the attractive one, which is considered as an "optimistic" choice (Mendl et al., 2009). Therefore, here we consider that responses to an ambiguous item in the same manner as to those items previously associated with reward reflect more optimistic-like behaviour. Becoming more optimistic would reflect a more positive affective state and, thus, a greater welfare of the individual.

We investigated the possible effects of social context (living in a pair or being singly housed) and individual personality on cognitive bias in canaries, *Serinus canaria*. This species is a good model organism for the parameters we chose to study. Indeed, canaries are monogamous birds showing demanding biparental care. The choice of the reproductive partner is particularly important and has fitness consequences: females invest more or less energy in their eggs according to the attractiveness of the mate (Garcia-Fernandez, 2009), and males learn to improve their songs at every reproductive period to increase attractiveness. Canaries have well characterized personality traits (Ung, 2014).

To study the effect of social context, half of the individuals were housed in reproductive pairs (male-female), and half were singly housed. In the third test phase of this experiment, we reversed canaries' social context (the paired ones being then housed alone and the singly housed ones being then paired). We hypothesised that being singly housed would constitute a social impoverishment, which could modulate individuals' affective state, making singly housed individuals more pessimistic than those living in a pair. We also measured females' preferences among four males, and then half of the females were paired with their favourite mate while the other half were paired with the least preferred one. Indeed, Garcia-Fernandez (2009) found that female canaries are sensitive

to being paired with the male they preferred during the previous mate choice or with the least preferred one (investing more testosterone in their eggs in the former case). A high level of testosterone in the eggs influences positively the development of chicks, by improving sexual ornament, song quality, and general muscle development (therefore improving the attractiveness of male offspring for the investing female). Therefore, we could expect a higher level of optimism in female canaries paired with their favourite male than in females paired with the least preferred one. Besides this, we measured, around the different testing periods, partner attachment level of each member of each pair to study its possible link with female preference and its potential influence on cognitive bias.

We aimed at testing the possible link between personality and affective states. In particular, we asked whether affective states (and therefore welfare) in canaries could be related to individual personality traits or if they only depend on the living conditions (social context). We refer to personality as to a set of individual differences in behaviour, which are stable over time and across contexts (Lessells and Boag, 1987; Bell, 2007), and which vary so as to form a continuum within the population (Koolhaas et al., 1999). It has been shown in various bird species that personality traits remain stable even after changes in the social context (Harvey and Freeberg, 2007). Different personality traits have been shown to be consistent in birds, such as aggressiveness (Verbeek et al., 1996), neophobia (Fox and Millam, 2004), obstinacy (David et al., 2011), boldness (Réale et al., 2007), exploration (Verbeek et al., 1994; Martins et al., 2007), and sociability (Harvey and Freeberg, 2007). We measured these six personality traits for each canary to characterize their behavioural type (Sih et al., 2004). We hypothesised that if a canary's affective state is somehow related to its personality, at least one of these personality traits would correlate with cognitive bias measures (whether alone and/or in pair). More precisely, we predicted that individuals that are more aggressive, obstinate, more explorative and bolder would also be more optimistic, as these traits are often correlated and linked to decision making, with aggressive-bold individuals typically showing a high risk-taking behaviour (Sih and Del Giudice, 2012). On the other hand, neophobic subjects would be relatively risk-averse and pessimistic. We also predicted that sociability, which is not related to risk-taking behaviour (Ung, 2014), would not be necessarily correlated to cognitive bias.

1. Methods

1.1. Subjects and housing

This study involved 43 domestic canaries (*Serinus canaria*), 21 males (from two to eight years old) and 22 females (from two to seven years old). Two weeks before the familiarisation phase (see Fig. 1), half of our individuals (22 canaries, 11 males and 11 females) were housed in pair (*i.e.*, a male with a female canary, see *Mate choice & attachment*) and half (21 canaries, 10 males and 11 females) were singly housed. Birds were kept in two different housing rooms, each containing 5–6 pairs and 10–11 singly housed canaries. Being singly housed involved being physically isolated but with visual and acoustical access to conspecifics. Birds were housed in a 60 × 50 × 50 cm cage including two perches, one cuttlebone, and seeds, sand, and water *ad libitum*. During this experiment, birds were subjected to different photoperiods: a short-daylight schedule, ("short DL", representing 8:16 h light:dark) for six months and a long-daylight schedule ("long DL", representing 16:8 h light:dark), which stimulates reproductive activity (Leboucher et al., 2012), for three months. The room temperature was maintained at 18 ± 1 °C in short DL and at 22 ± 1 °C in long DL. For all the phases of this exper-

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