Animal Behaviour 96 (2014) iii–iv

Contents lists available at ScienceDirect

Animal Behaviour

journal homepage: www.elsevier.com/locate/anbehav

In Focus

Featured Articles in This Month's *Animal Behaviour*

Robots Influence Cognitive Task Performance in Children

Interactions with animals are often used as therapy for anxiety in humans. The fear of being judged in the presence of humans, or even realistic representations of humans, affects the emotional and cognitive state of a human individual. By contrast, animals are not expected to make judgements and hence their presence does not tend to have a stressful impact. This has stimulated the design of both virtual, two-dimensional, and embodied, three-dimensional, animated objects to keep humans company and assist them in different tasks. Behaviour studies are badly needed to understand the defining qualities and design features that would make such animated objects acceptable to humans. Previous results have demonstrated that mobility is very important for inducing positive responses and the way robots move, look and express emotions influences whether humans pay attention, smile or speak. The emphasis so far has been on emotional reactions. Less is known about the influence of animated objects on the behaviour and performance of humans in cognitive tasks. A paper in the present issue (pp. 69 – 77) explores whether the perceived ability of an animated object to make judgements affects its influence on humans during cognitive tasks.

Vanessa André (Université Rennes 1, France), Céline Jost (Université de Bretagne-Sud, France), Martine Hausberger (Université Rennes 1), Brigitte Le Pévédic (Université de Bretagne-Sud), Ronan Jubin (school teacher), Dominique Duhaut (Université de Bretagne-Sud) and Alban Lemasson (Université Rennes 1 and Institut Universitaire de France) hypothesized that the animated object's appearance plays a major role in its effect and that animal-like objects are perceived as less judging and more amusing. To test this hypothesis they carried out experiments on the impact of three types of animated object on 51 school children of 10–11 years of age during a mental arithmetic test. The animated objects were a virtual human character projected on a white screen, a humanoid robot made of metal and an animal animated object, which was the humanoid robot dressed in a bespoke bird-like costume. One of the three objects was placed to the left of the computer on which each pupil had to write the answer to the test question (Fig. 1). The control condition was just the computer without an animated object next to it. Each pupil was tested with each of the three objects and the control. The authors measured cognitive performance through two variables: the latency to give the answer and the number of calculation errors. In addition, to assess the effect of the animated object more generally, they recorded several behavioural variables.

André and coauthors found that children showed more positive behaviour, such as smiling and making positive comments, in the presence of an animated object, particularly when it was a three-dimensional one, that is, the humanoid robot and the animal robot as opposed to the human character. However, the animated objects, and the animal robot in particular, were distractions from the cognitive task. Their presence reduced attention level and failed to improve performance. In fact, children took longer to give the answer to the mental arithmetic question when the object was the animal robot.

These results suggest that children accept animated objects, at least in some of their characteristics, as interaction partners and are in agreement with earlier work in the context of leisure activities. The main novelty in the present study is the demonstration of this effect in a more constrained context, namely when solving a cognitive task. The presence of life-like creatures is likely to have a stimulating effect and could potentially be a better source of assistance in a cognitive task than a computer. Nevertheless, it is possible that the animated objects were perceived simply as amusing toys since they failed to improve cognitive performance. Alternatively, such lack of improvement could be explained by the absence of a direct relationship between the interactions with the animated objects and the actual mental arithmetic test.

Therefore, the study by André and coauthors also sheds light on the way children perceive robots. The animal robot had a negative effect on some aspects of the children's cognitive task performance whereas the human robot did not. One explanation is that children perceive animals as nonjudging partners. Another could be that the plush cover of the animal robots made them more akin to soft tissue objects, which are good substitutes for objects of attachment. This is one of the reasons why domestic pets are good for bonding and improving social skills in children.

Future work will focus on long-term studies to explore whether the effects observed here are maintained or whether there is also an effect of novelty, which wears off with time and increased

Figure 1. The experimental environment in which the children had to interact with the robot during the mental arithmetic test. Photo: Vanessa André.

http://dx.doi.org/10.1016/j.anbehav.2014.09.001

familiarity. Overall, the present study by André and coauthors contributes to our better understanding of how humans perceive interaction partners, be they human or animal, and informs the design of robots for helping humans with different tasks.

Ana Sendova-Franks
Executive Editor

Well-fed Birds Shift Priorities

What do climate change, hormones and mating behaviour have to do with each other? Steroid hormones and the sensitivity of the target tissues are well understood to fluctuate seasonally and to regulate reproductive behaviour but how environmental stimuli are perceived and then influence the endocrine system to then mediate behaviour is less well known but critical to predicting how organisms will react to changing climate, modifications in habitat and food availability. As a short-term adaptation to climate change, behavioural plasticity can moderate some potential effects but plasticity depends on the sensitivity to environmental stimuli and on the proximate mechanisms mediating a behavioural response.

Steroid hormones as the proximate mechanism to translate environmental stimuli into a behavioural response are the focus of the study by Sara Kaiser, Scott Sillett and Michael Webster of Cornell University and the Smithsonian Conversation Biology Institute of the National Zoo in this issue (pp. 19 – 29). Steroid hormones have multiple effects on behaviour, which raises a key question of whether they constrain or allow a plastic response. The individual traits of a suite of traits depending on a shared mechanism may or may not be controlled independently. If they are controlled independently, greater plasticity may be possible. This study on wild populations of black-throated blue warblers (Fig. 2) examined the effects of food availability on testosterone (T) and corticosterone (CORT) and the plasticity of mating and parental behaviours. T influences sexual and aggressive behaviours; CORT affects self-maintenance behaviours and increased levels may promote parental feeding.

In this study, the authors experimentally tested the hypothesis that food availability mediates plasticity in T and CORT responses that, in turn, mediate investment in mating and parental behaviour. They provided supplementary food to some pairs, beginning 2–3 days after the onset of incubation, in three populations, one that had a naturally low abundance of Lepidoptera larvae and two that had a naturally higher abundance. They predicted that (1) fed males would invest more in mating effort and less in parental care and (2) increased mating effort would be associated with higher T and lower CORT. They took blood samples from males for hormone analysis, used residual mass as an index of energetic reserves, used song rate in the vicinity of the nest as an index of mating effort and recorded nestling provisioning by both the male and female.

Figure 2. A male black-throated blue warbler, *Setophaga caerulescens*, singing. Photo: Robert Royse.

Fed males had lower recorded song rates (not higher as predicted) than those of control males especially in the low-quality habitat but song rates did not differ between fed and control males in high-quality habitats. Song rates were higher during the fertile period than during the parental stage. Kaiser et al. interpret the lower song rate by well-fed males as using their greater energy reserves to increase mate guarding when their mates were fertile over seeking extrapair opportunities. Fed males did not differ from control males in nestling provisioning, suggesting that fed males invested their extra reserves in territorial defence or self-maintenance during the parental phase. However, fed females in the low-quality habitat did increase their provisioning rate so males would have benefited indirectly.

Contrary to what was predicted, food supplements significantly reduced T in males during the fertile stage in the low-quality habitat but, overall, males in the high-quality habitat had higher T as predicted. Fed males had lower CORT during the fertile stage but fed and control males had similar concentrations during the parental stage and there were no significant differences between the high- and low-quality habitats. The authors concluded that circulating T concentrations were associated with mating effort but not parental effort; males with high T had higher song rates but T had no association with provisioning. Interestingly though, there was considerable variation within males in T concentrations between the fertile and parental stages, most decreasing but a few increasing. CORT concentrations were not associated with mating effort or parental effort and were not affected by the supplementary feeding. However, CORT and T were positively correlated within males, suggesting that the increased energy demands of increased mating effort were met with increased CORT.

This study demonstrates that males did show plastic patterns of covariation in endocrine measures and mating behaviours but not in parental behaviours in response to food supplementation, especially when food was relatively scarce. Both sexes adjusted their behaviour rapidly in response to increasing resources especially in habitats with low food abundance and these changes in male behaviours covaried with endocrine changes.

As their energy reserves changed, the birds could flexibly adjust their reproductive efforts to reflect the resource conditions that limit reproduction; for example, in the low-quality habitat, males that suddenly gained greater reserves diverted their efforts to mate guarding from pursuing extrapair matings, whereas fed females increased parental effort, freeing males to invest in other activities. An important conclusion of this study is that it demonstrates a link between environmental stimuli (resource availability) and the endocrine mechanisms that mediate reproductive behaviours. Even though steroid hormones have multiple effects, regulation of these effects is somewhat uncoupled. Therefore, adaptive reproductive investment in response to changes in the environment and resource availability are unlikely to be constrained by circulating hormones that mediate competing reproductive behaviours.

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