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Surviving in the Anthropocene: the study of animal cognitive abilities as a conservation tool

Introduction

The current geological epoch has been defined as Anthropocene, the *epoch of humans*. This definition has been introduced to highlight the impact of human activities on the environment, since humans influence geological, biological, and chemical processes worldwide (Crutzer and Stoermer, 2000; Corlett, 2015). Scientists argue that the Earth is undergoing a sixth mass extinction because the current species extinction rates are much higher than the natural background ones (Ceballos *et al.*, 2015). Extinction is a natural process, but, due to the ever-increasing anthropogenic pressure, ecosystems are not able to recover and species do not have enough time to adapt to constantly changing environment conditions (Wong and Candolin, 2014). To reverse this trend, rapid and intensified conservation initiatives need to be implemented (Ceballos *et al.*, 2015).

This essay will focus on behavioural adaptions developed by different animal species to survive in human-dominated environments and it will discuss the opportunity to implement conservation strategies based on animal cognitive capacities.

Cognitive mechanisms and behavioural flexibility

Humans have been described as 'the world's greatest evolutionary force' (Palumbi, 2001). Indeed, the rapid environmental changes, caused by human activities, translate into novel evolutionary cues and generate selection pressures (Sih *et al.*, 2011). Animals must adapt their behaviour to cope with the new environmental challenges. Since cognitive mechanisms underpin behavioural responses, cognitive adaptations may play a key role in enhancing the chance of survival of many animal species (Greggor *et al.*, 2014).

Recent studies have revealed how different species are already modifying their behaviour to respond to anthropogenic change. An interesting example is provided by a research on problem solving behaviour of wild raccoons (MacDonald and Ritvo, 2016). The study compares the behaviour of urban and rural wild raccoons presented with a familiar food container (a garbage can) and a novel one. Results showed that the novel object was quickly emptied by all the individuals, whereas only urban raccoons reached the food inside the can, adopting strategies not found in the rural subjects (Figure 1). Therefore, findings seem to suggest that anthropogenic pressures could promote the selection of some cognitive traits, like persistence and neophilia, that increase survival and

reproduction of raccoons in urban environment.

Figure 1. Urban raccoons during the garbage can task (left) and the novel object task (right) (MacDonald and Ritvo, 2016, p.55).

Similar cases have been described for other species. British great tits, for example, regulate their egg-laying activity considering changes of temperature and food availability (Charmantier *et al.*, 2008). African elephants distinguish at least two Kenyan ethnic groups using visual and olfactory cues independently, and classify them into different categories according to the level of threat that they represent (Bates *et al.*, 2007). Great apes also flexibly change their behaviour to adapt to disturbed ecosystems (Madden, 2006; Meijaard *et al.*, 2010; Hockings *et al.*, 2012). For instance, chimpanzees are more cohesive during crop feeding than during wild foraging (Hockings *et al.*, 2012) and prefer to feed on crops at night when the risk of human encounters is lower (Krief *et al.*, 2014). Finally, African lions that commonly hunt livestock adjust their behaviour to avoid people in areas close to cattle-posts. Indeed, they preferably move when people are less active and travel at high speed to reduce the time spent in these potentially life-threatening areas (Valeix *et al*., 2012).

Cognitive-based conservation approaches

The study of cognitive capacities can help to understand short- and long-term responses to human pressures and explore new solutions to tackle emerging conservation issues (Greggor *et al.*, 2014; MacDonald and Ritvo, 2016). For example, behavioural responses that lead to a conflict with local communities are considered maladaptive because they expose already threatened species to a greater risk.

The main method currently used to mitigate human-wildlife conflicts is aversive conditioning (AV). AV is an operant technique that uses a stimulus, perceived as unpleasant by the animal, to elicit

pain, fear or avoidance and create a negative association with human resources (Brush, 1971). For example, deterrents, such as pepper spray and rubber slugs, are commonly adopted to reduce the frequentation of developed areas by bear species (Mazur, 2010). Field guardians, noises, and tree barriers are instead used to limit crop feeding by Great apes (Hill and Wallace, 2012). Furthermore, firecrackers, beehive fences (Figure 2), chili-pepper and many other measures are implemented to train elephants to avoid human settlements (Sitati and Walpole, 2006; King *et al.,* 2009).

Figure 2. Beehive fence in Kenya (King, 2019, p.4).

Since these methods become less effective over time due to habituation, learning processes need to be considered to shape subsequent interactions with the stimuli (Greggor *et al.*, 2014). To maintain their effectiveness, deterrents must continuously provide animals with aversive experiences and need to be presented in an unpredictable way or in association with other naturally aversive stimuli (Sitati and Walpole, 2006). A growing body of research is therefore focusing on alternative approaches based on the use of positive reinforcement training. For example, African elephants are involved in preference tests to identify their favoured type of vegetation in order to teach them to select areas unoccupied by humans and, as a consequence, decrease crop raiding (MacDonald and Ritvo, 2016).

Cognitive capacities are also key to successfully manage releasing programmes. For instance, Northern bald ibises were brought back into Central Europe after being imprinted on human foster-mothers that guided them along their historical migration route from Austria to Southern Tuscany

(Fritz *et al.*, 2017). Imprinting can be also used to develop habitat preferences to guarantee that released individuals select suitable environments, as suggested for salmonids by Brown and Day (2002). Finally, subjects can also be trained to perform species-specific behaviours necessary for survival. To name a few, Greater bilbies were thought to categorize cats as threats by associating unpleasant experiences with a multimodal cat stimulus (Moseby *et al.*, 2012), whereas black-tailed prairie dogs learned to avoid different types of predators after repeated exposures to predators paired with alarm vocalizations (Shier and Owings, 2006).

An extensive knowledge of cognitive theory is the key factor to carry out successful conservation projects based on behavioural manipulation. Nevertheless, many conservationists still lack proper skills and training, and conservation actions may fail due to the underestimation of cognitive mechanisms (Greggor *et al.*, 2014). Therefore, educational initiatives aimed to promote the implementation of cognitive-based conservation approaches are needed to actively improve conservation efforts.

Conclusion

Accelerated human-induced biodiversity loss is one of the main factors causing the collapse of natural ecosystems and novel conservation approaches are paramount to address this issue (Ceballos *et al.*, 2015). Since behaviour and cognition are strictly connected, understanding animal cognitive abilities can help conservationists to develop *ad-hoc* strategies based on modification of behavioural responses (Byrne and Bates, 2006; Greggor *et al.*, 2014).

Many species have already developed behavioural adaptations in response to anthropogenic pressure and some conservation initiatives have started to successfully implement cognitive-based techniques. An in-depth analysis of cognitive mechanisms and training opportunities for conservationists should therefore be integrated into conservation projects, bearing in mind that, as emphasized by Corlett (2015), conservation should 'focus on the inevitably novel future rather than the irretrievably lost past'.

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