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Following human-given cues or not? Horses (*Equus caballus*) get smarter and change strategy in a delayed three choice task

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ABSTRACT

To date, horses have seemed capable of using human local enhancement cues only when the experimenter remains close to the reward, since they fail to understand the communicative meaning of the human as momentary local enhancement cue (when the human is not present at the moment of the animal's choice). This study was designed to analyse the ability of horses to understand, remember and use human-given cues in a delayed (10 s) three-choice task. Twelve horses (experimental group) had to find a piece of carrot hidden under one of three overturned buckets after seeing the experimenter hide it. The results were then compared with those of a control group (twelve horses) that had to find the carrot using only the sense of smell or random attempts. At the beginning, the experimental horses made more correct choices at the first attempt, although they took more time to find the carrot. Later the same horses were less accurate but found the carrot in less time. This suggests that the value of the proximal momentary local enhancement cues became less critical. It seemed, in fact, that the experimental and control group had aligned their behaviour as the trials proceeded. Despite this similarity, in the second half of the trials, the experimental group tended to first approach the bucket where they had found the carrot in the immediately preceding trial. Our findings indicate that horses are capable of remembering the location of food hidden by the experimenter after a delay, by using the human positioned close to the target as valuable information. The same horses are also capable of changing their decision-making strategy by shifting from the accuracy inferred from human given cues to speed. Therefore, horses are able to decide whether or not to use human given-cues, depending on a speed-accuracy trade-off.

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1. Introduction

The ability to acquire information from the environment through the communicative gestures of conspecifics and members of other species has adaptive advantages and raises intriguing questions regarding the mental states and sensitivity of the receiver (Proops et al., 2010). Such information could also have practical implications in caring for domestic and captive animals.

Understanding human pointing gestures and local enhancement cues has been investigated in several animal species, including wolves (Virányi et al., 2008), cats (Miklósi et al., 2005), goats (Kaminski et al., 2005), South African fur seals (Scheumann and Call, 2004), bottlenose

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dolphins (Pack and Herman, 2004), jackdaws (von Bayern and Emery, 2009), ravens (Schloegl et al., 2008), ferrets (Hernádi et al., 2012), foxes (Barrera et al., 2013), and elephants (Smet and Byrne, 2013). Dogs outperform all other species, spontaneously following human cues without training (Hare and Tomasello, 2005; Udell and Wynne, 2010). Studies on primates have shown different results and in some cases poor performances (Barth et al., 2005; Byrnit, 2009; Mulcahy and Hedge, 2012). This may be due to environmental factors and testing procedures (Lyn et al., 2010; Mulcahy and Call, 2009). However, other studies have shown that some primates are fully able to understand and use human pointing gestures (Hare and Tomasello, 2004; Mulcahy and Call, 2009), even without previous experience with humans (Byrnit, 2004).

Although the influence of domestication and ontogenetic development on the animal understanding of human cues is still debated (Miklósi and Topál, 2013), an explanation of such skills is based on the animal's ability to use the emitted signal as a simple environmental stimulus (Povinelli and Vonk, 2003). Cognitive theory instead predicts that animals are able to understand the meaning of an emitted signal (Tomasello et al., 2003). If decoding human signals presumes some cognitive abilities in the receiver, it is likely that the receiver would be able to extend this ability to everyday communication with humans, as well as to the test situation (Maros et al., 2008). Furthermore, cognitive involvement could entail an appraisal process in which the value of information acquired by an environmental stimulus (human-given cues in this case) plays a role in the decision making process (Adams et al., 2012).

Despite the history of Clever Hans (Pfungst, 1965), horses' ability to understand human gestures has been investigated only recently (Krueger et al., 2011; Maros et al., 2008; McKinley and Sambrook, 2000; Proops et al., 2010; Proops et al., 2013). Data on horses have shown a performance similar to data reported for goats and cats (Proops et al., 2013). Horses can understand a number of cues, including pointing gestures (Maros et al., 2008; Proops et al., 2010), however they can use human local enhancement cues only when the experimenter remains close to the reward (Krueger et al., 2011). Excluding partial results (Maros et al., 2008), horses seem unable to use the human momentary pointing cue (when the human is not present at the moment of the animal's choice). As is the case with goats, horses seem to be able to use human-given cues to find food even though they cannot understand the communicative meaning of the cue itself (Proops et al., 2013).

Several factors could be involved in their inability to understand these cues (Miklósi and Soproni, 2006). Maros and co-workers (2008) have suggested that a possible factor may be the lack of short-term memory in horses. However, the storage of information is one of the fundamental elements of the cognitive process (Adams et al., 2012), and more recent findings clearly indicate instead that horses (Baragli et al., 2011a; Hanggi, 2010) and donkeys (Baragli et al., 2011b) do use short-term memory in searching-for-food tasks.

If horses are thus able to interpret the meaning of a human given cue, we predicted that the horses in the test would reach the goal even if the experimenter did not remain close to the target after giving the cue (momentary local enhancement cue) (Prediction 1a). Consequently, because of their short-term memory, the horses exposed to the momentary local enhancement cue should be more accurate in finding food than the horses that do not have such information available (Prediction 1b).

The extent to which animals use human cues has been effectively studied by applying a food-searching paradigm. Foraging strategies in animals have been recognized to be complex and influenced by several factors in both testing and ecological conditions (Zhang and Hui, 2014). In foraging, both previous experience (Marshall and Kirkpatrick, 2013) and time between feeding bouts (Mazur and Biondi, 2011) can influence the decision-making process. In addition, when choosing between different resources of approximately equal magnitude, the decision makers often prefer immediate to delayed outcomes (Hayden and Platt, 2007; Wikenheiser et al., 2013). Several studies have also focused on animal behavioural and cognitive plasticity (Sih and Del Giudice, 2012), which is often driven by the speed-accuracy trade-off (Chittka et al., 2009). Thus, results found by Maros et al. (2008) between the first and second halves of the trials could be a consequence of a different strategy implemented by horses. We also expected that the horses in the experimental group would tend to modify their behaviour over the course of the trials, by minimising the time required to get the reward (Prediction 2).

We tested our hypotheses by using the human presence as a proximal momentary local enhancement cue for food (Miklósi and Soproni, 2006) in a delayed three-choice task. The horses in the experimental group had to find a piece of carrot hidden under one of three overturned buckets after seeing the experimenter hide the carrot. We then compared the results of the experimental group with those of a control group that had to find the carrot using only smell or random attempts.

2. Materials and methods

2.1. Animals

We recruited 25 adult horses (8 mares and 17 geldings of different breeds, with a mean age of 14.9 ± 6.2 years). The experiment was performed at "Il Quadrifoglio" stable (Udine, Italy). The horses were stabled in individual stalls and had paddock turnout at least three times a week. They showed no stereotyped behaviour and were fed according to the same schedule.

2.2. Training phase

To implement a test that analyses the choice between equal targets according to an added stimulus, familiarization with the generic target is required (Maros et al., 2008). All of the horses were thus trained to approach an overturned pink bucket (truncated cone shape, 40 cm high) and find a carrot hidden under it. First we presented only the overturned bucket with the carrot close beside it on the ground, to familiarise the horse with the situation. The carrot was then progressively concealed under the overturned

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