

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.

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 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.

Materials and methods

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.

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 bucket, until the horse had to move it with its muzzle to get the carrot. To be included

in the experiment, each horse was required to find the carrot five times consecutively with no time limit. Only one mare was unable to tip the bucket to get the carrot and she was excluded from the study. The training phase was carried out in the same enclosure in which the test would take place, but in a different area. This was done to avoid location biases for target position and tipping only the bucket that was located at a preferred point in the test area.

Experimental design

General description

After the training phase, the horses were randomly divided into two groups of 12 horses each: the experimental group (group Ex, 4 mares and 8 geldings, with a mean age of 15.1 ± 6.3 years) and the control group (group C, 3 mares and 9 geldings, with a mean age of 14.3 ± 6.4 years). In each group, the horses had to find the carrot under one of the three overturned buckets placed in front of them. The horses in group Ex saw a person approach one of the overturned buckets and hide the carrot under it, while the horses in group C did not see the person hide the carrot, but had to find it without additional information.

Test facilities

An important factor that can affect the results is the subjects' familiarity with the environment in which the test is performed ([Miklósi and Soproni, 2006](#)). We thus chose a testing area familiar to the horses because it was one they frequented regularly. The testing area was also located in the horse's home environment, thus uncontrolled environmental stimuli were not new and thus less distracting ([Maros et al., 2008](#)).

The entire experiment was conducted in a rectangular enclosure (15 × 35 m) which was divided by a rope into the area of effective application of the test (testing area) and the service area, in which a wooden panel was installed to hide the experimenter ([Fig. 1](#)). The buckets were of the same size and colour as those used in the training phase and were positioned in front of the starting area, at the same distance (3 m) from the point where the horse was freed. Two persons were required for the test: (1) the caretaker (a man who led the horse to the test area) and (2) the experimenter (a woman who hid the carrots and managed the data sheet).

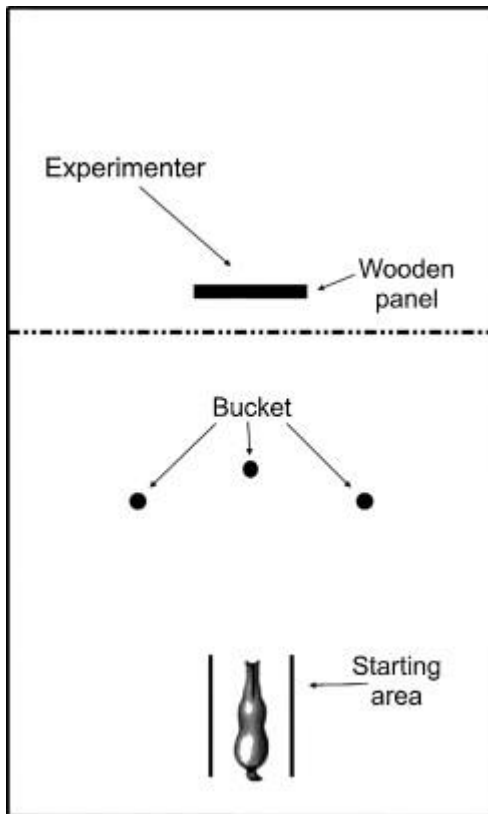


Fig. 1. Testing scenario.

Procedure

Each horse in group Ex was led to the starting area and held by the caretaker using a halter and rope in front of the three buckets. The caretaker was trained not to interact with the horse and a specific strategy was employed to prevent the Clever Hans effect. After the horse had been positioned at the starting area, the caretaker, holding the horse, turned his body away from the buckets (Fig. 2a). At that point the experimenter came out from behind the wooden panel and headed for one of the overturned buckets (Fig. 2b) under which she hid the carrot (Fig. 2c). The carrot was of sufficient size to be totally contained in the experimenter's hand, therefore it was not visible to the horse while the experimenter approached the bucket. She then retreated behind the wooden panel (Fig. 2d) and the horse was freed after about a 10 s delay (measured with a stopwatch, Fig. 2e and f). Hence the caretaker could not see the experimenter as she hid the carrot under one of the three buckets.

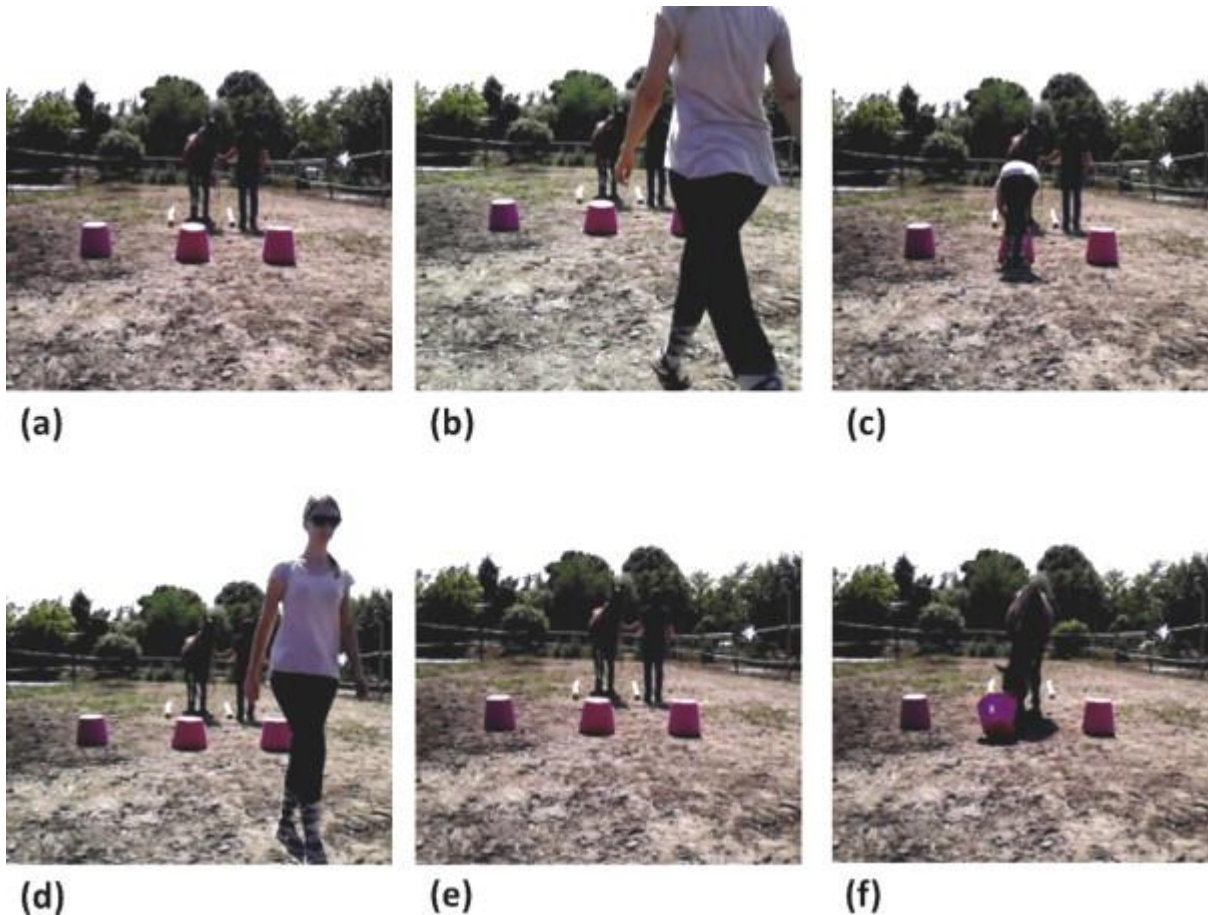


Fig. 2. Sequence of actions in the delayed three-choice task: (a) the horse and the caretaker in the starting position; (b) the experimenter heading towards the bucket selected; (c) the experimenter hides the carrot; (d) the experimenter goes back behind the wooden panel; (e) the horse stands during the delay; and (f) the horse is freed and searches for the carrot.

The strategy used to control the Clever Hans effect was deemed unnecessary for group C because the carrot had been hidden under one of three overturned buckets before the horse and the caretaker had entered the testing area. However, to be consistent, for group C the caretaker behaved in the same way as for group Ex. The caretaker was thus blind to the position of the carrot for both groups Ex and C and waited until the experimenter said “go” to unhook the rope from the halter and release the horse.

Both groups had to find the carrot by using the sense of smell or through random attempts, however group Ex also had available information provided by the experimenter's movement as she approached the bucket to hide the carrot.

Each horse performed 10 trials consecutively on the same day (from trial 1 to trial 10), starting about three hours after the morning meal. Each day 4 horses from group Ex and 4 horses from group C were tested alternately. The whole experiment therefore took three days. The overturned bucket under which the carrot was hidden was chosen by applying a semi-random criterion (by rolling a dice with 1 and 2 for bucket 1; 3 and 4 for bucket 2; and 5 and 6 for bucket 3) with the limitation that the

carrot could not be hidden under the same bucket more than twice in a row. If no choice had been made within 3 min the trial was repeated. The trial was considered successfully completed when the horse knocked over the bucket or moved it enough to eat the carrot. The parameters analysed were recorded on a data sheet by the experimenter.

Parameters analysed

The following parameters were analysed:

- (1) Correct choice at the first attempt (the number of times in which the correct choice was made at the first attempt).
- (2) Buckets explored (the number of buckets explored and/or touched before making the correct choice, including revisited buckets).
- (3) Time required to find the carrot (the time, in seconds, elapsed between the horse's release and its finding the carrot).
- (4) First bucket approached (to check for possible location biases, the first bucket explored and/or touched after the horse was released was recorded).

Statistical analysis

Due to the non-normal distribution of data (Shapiro-Wilk test for non-normality, $p < 0.05$) and the small sample size, non-parametric statistics was used ([Siegel and Castellan, 1988](#)). The analysis was conducted at group level. The criterion of [Maros et al. \(2008\)](#) for proximal momentary local enhancement cues was applied. The 10 trials were divided into a first (from trial 1 to trial 5) and a second half (from trial 6 to trial 10). The Wilcoxon matched-pair signed-ranks test ($k = 2$, corrected for ties) was used to compare the first and second halves of the trials within each group. The level of significance was established as 5%. The overall differences between group Ex and C were evaluated by the Mann–Whitney U test ($k = 2$) for independent samples for each parameter studied, as well as differences between groups in the first and the second halves of the trials.

The parameters studied were then considered as independent variables over the course of the trials and the trend was evaluated by the Spearman correlation coefficient with Bonferroni's correction ([Curtin and Schultz, 1998](#)), according to which the threshold of significance was considered as: $0.05/4 = 0.0125$. The Fisher r -to- z transformation was then employed to assess the slope difference between the correlation coefficients of groups Ex and C. In accordance with [Mundry and Fisher \(1998\)](#), exact two-tailed tests were used. Statistical tests were performed with SPSS 20 (Chicago, Illinois) and Vassar College stats website (<http://vassarstats.net/>).

Ethics statements

This study was carried out in accordance with the recommendations of the Italian Animal Care Act (Decree Law 116/92). The protocol was approved by the Ethics Committee on Animal Experimentation of the University of Pisa (no specific permit was required since the proposed protocol was exclusively based on non-invasive behavioural tests). Consent to participate in the test was signed by each horse owner.

Results

The numerical results (median and quartiles) with statistical parameters both between and within groups are reported in [Table 1](#). Delays ranged between 8 and 15 s.

Table 1. Differences between group Ex (12 horses) and group C (12 horses) for all the trails (10 trials for each horse), and between the first (5 trials) and the second (5 trials) halves of the trials.

	All trials (10 trials)	First half of trials (5 trials)	Second half of trials (5 trials)	First vs. Second halves of trials ^a
Correct choice at the first attempt				
Group Ex	5 (4;6)	3 (2;3.5)	2 (1;2.5)	$W = 36.5$ $p = 0.1289$ $n = 60$
Group C	3 (3;4)	2 (1;2)	2 (1;2)	$W = 15$ $p = 0.4258$ $n = 60$
Group Ex vs. Group C ^b	$U = 121.5$ $p = 0.0031$ $n = 120$	$U = 124$ $p = 0.001$ $n = 60$	$U = 77$ $p = 0.7879$ $n = 60$	
Number of buckets explored				
Group Ex	2 (1;2)	1 (1;2)	2 (1;3)	$W = -363$ $p = 0.0232$ $n = 60$
Group C	2 (1;2)	2 (1;3)	2 (1;2)	$W = 120$ $p = 0.4413$ $n = 60$
Group Ex vs. Group C ^b	$U = 6368.5$ $p = 0.0989$ $n = 120$	$U = 1326.5$ $p = 0.0076$ $n = 60$	$U = 1862$ $p = 0.7295$ $n = 60$	

Time to recover the carrot

	All trials (10 trials)	First half of trials (5 trials)	Second half of trials (5 trials)	First vs. Second halves of trials ^a
Group Ex	22 (10;50.5)	35 (14;80.5)	16.5 (9;28.5)	$W = 932$ $p = 0.0006$ $n = 60$
Group C	18 (9;36.5)	20 (9.5;34.5)	16 (9;37.5)	$W = 224$ $p = 0.4009$ $n = 60$
Group Ex vs. Group C ^b	$U = 7850.5$ $p = 0.2262$ $n = 120$	$U = 2357.5$ $p = 0.0034$ $n = 60$	$U = 1689.5$ $p = 0.5616$ $n = 60$	

First bucket approached (where the carrot was in the previous trial)

Group Ex	3 (2;4)	1 (0;1.5)	2 (1;3)	$W = 0$ $p = 0.0039$ $n = 60$
Group C	2.5 (2;4)	1.5 (0.5;2)	1 (1;2)	$W = 13$ $p = 0.9375$ $n = 60$
Group Ex vs. Group C ^b	$U = 78.5$ $p = 0.7106$ $n = 120$	$U = 54$ $p = 0.3049$ $n = 60$	$U = 99.5$ $p = 0.1205$ $n = 60$	

Data are expressed as median, lower and upper quartile (in brackets).

a

Wilcoxon matched-pair signed-ranks test ($p < 0.05$); n sample sizes.

b

Mann–Whitney U test ($p < 0.05$).

Correct choice at the first attempt

Compared to group C, group Ex made significantly more correct choices at the first attempt throughout the entire set of trials. The same result was found when limiting the analysis to the first half of the trials; whereas no difference was found between groups Ex and C in the second half of the trials. For both groups, no difference was found between the first and the second halves of the trials. In fact, group Ex became less accurate as the trials proceeded ([Fig. 3](#)), by reducing correct choices at the first attempt over the course of the trials ($r_s = -0.77$; $N = 10$; $p = 0.0105$), while this parameter remained unchanged for group C ($r_s = 0.25$; $N = 10$; $p = 0.4918$).

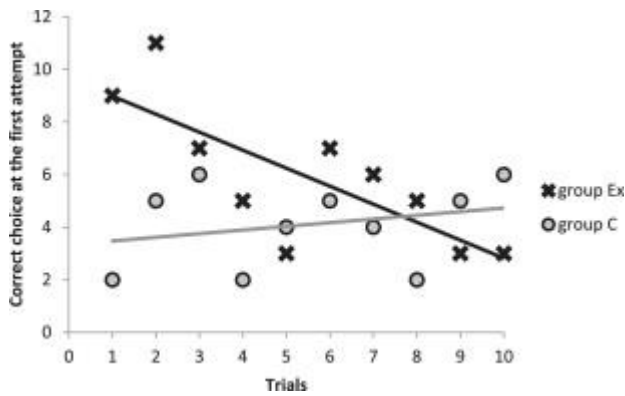


Fig. 3. Trends (from trials 1 to 10) of the correct choice at the first attempt. Data are expressed as the number of times in which horses (summed for each group) found the carrot under the first bucket approached (the two groups showed a significant difference in trends, $z = -2.37$; $p = 0.0178$).

Number of buckets explored

Compared to group C, group Ex explored significantly fewer numbers of buckets in the first half of the trials. This difference was not found in the second half of the trials, nor in the trials as a whole. Group Ex also explored fewer buckets in the first half of the trials compared to the second half, while no difference was found for group C. Group Ex also showed a nearly significant positive correlation between the number of buckets explored and the number of trials performed ($r_s = 0.74$; $N = 10$; $p = 0.0174$), while no correlation ($r_s = -0.22$; $N = 10$; $p = 0.5135$) was found for group C (Fig. 4).

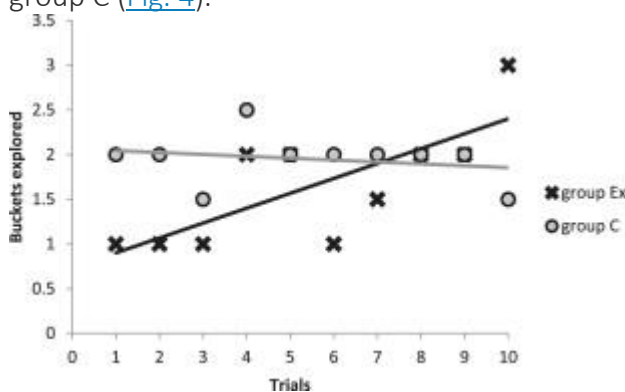


Figure 4. Trends (from trials 1 to 10) of the number of buckets explored. Data are expressed as the median for each group (the two groups showed no difference in trends, $z = 1.36$; $p = 0.1738$).

Time required to find the carrot

In the first half of the trials, group Ex required more time than group C to find the carrot. No differences between the groups were noted instead for the whole set of trials, nor in the second half. In addition, during the first half of the trials, the horses in group Ex required much more time to find the carrot than during the second half. For group C instead, no difference was recorded between the first and the second halves of the trials. In group Ex, a negative correlation was found between the

time required to find the carrot and the number of trials ($r_s = -0.86$; $N = 10$; $p = 0.0016$), while no correlation ($r_s = -0.12$; $N = 10$; $p = 0.733$) was found for the control group (Fig. 5).

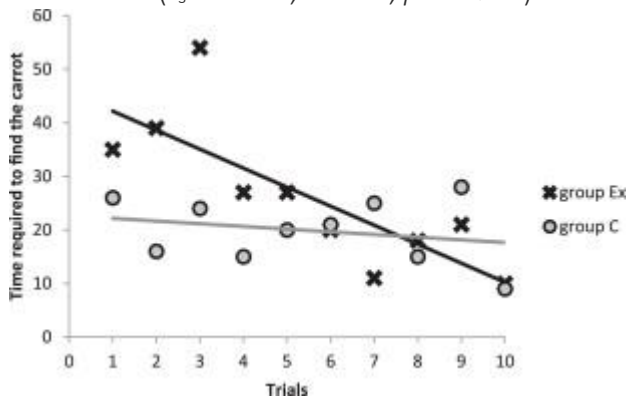


Figure 5. Trends (from trials 1 to 10) of the time required to find the carrot. Data are expressed as the median for each group (the two groups showed a significant difference in trends, $z = -2.23$; $p = 0.0257$).

3.4. First bucket approached

No location biases were found in approaching the first bucket. During the second half of the trials, we noted that horses in group Ex tended to search first under the bucket that had concealed the carrot in the previous trial. This was not the case for group C. No difference was found between the groups considering the trials as a whole, nor in comparing the first or second halves of the trials. Indeed, group Ex showed a positive correlation between the tendency to first approach the bucket that had contained the carrot in the previous trial and the course of the trials ($r_s = 0.90$; $N = 10$; $p = 0.0008$). No such correlation ($r_s = 0.19$; $N = 10$; $p = 0.6073$) was found for group C (Fig. 6).

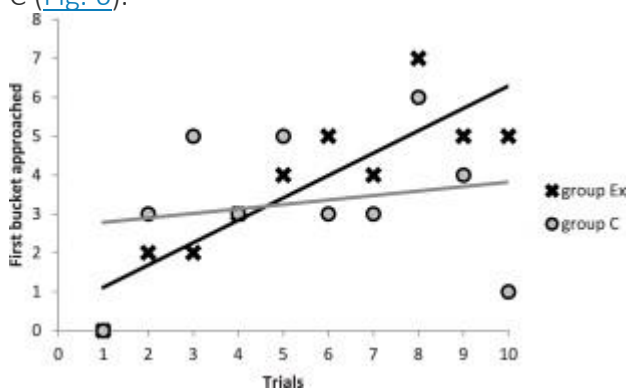


Figure 6. Trends (from trials 1 to 10) of the first bucket approached. Data are expressed as the number of times in which horses (summed for each group) first searched under the bucket that had concealed the carrot in the previous trial (the two groups showed a significant difference in trends, $z = 2.41$; $p = 0.016$), * the first trial was considered zero for both groups.

Discussion

Our findings indicate that horses can use their memory of proximal momentary local enhancement cues to find food. In fact, horses were capable of remembering the location of food hidden by the experimenter after a 10 s delay (Prediction 1a supported). This ability allowed the horses to be more accurate in their choices (Prediction 1b supported), at least in the first half of the trials. It thus appears that horses are capable of understanding the communicative meaning of a human positioned close to the target.

Over the course of the trials, horses found the carrot in less time even though they were less accurate in finding it. This suggests that the value of information provided by the momentary local enhancement cues became less critical as the trials proceeded. Thus following the temporal discount/impulsivity theory, which implies that the value of the reward is diminished by the time intervening between the choice and the reward ([Long and Platt, 2005](#)).

Both people and animals often prefer immediate over delayed rewards, because seeking environmental information ([Adams et al., 2012](#)), acquiring sufficient visual information on spatial details, and the subsequent decision making involved are time-consuming ([Chittka et al., 2009](#)). The greater time latency of our experimental group in approaching the correct bucket at the beginning of the trials is probably due to the need to retrieve the actions of the experimenter from memory and, consequently, to make a proper decision. As the trials proceeded (i.e., in the second half of the trials), the same horses became less accurate and explored more buckets before finding the carrot, however they took less time to do so. It is probable that the horses change their strategy for finding the carrot by optimizing the speed-accuracy trade-off ([Sih and Del Giudice, 2012](#)). According to the foraging theory, the profitability of the food outcome is defined as the ratio of the amount of food over the delay to food ([Shapiro et al., 2008](#)). Since the amount of food given our horses was relatively constant (a piece of carrot), the variable influencing the profitability of food outcome was limited to time: the longer the time, the lower the profitability. This could be the reason why the horses in group Ex changed their strategy to achieve the task.

Under different conditions, searching for food requires different amounts of time and results in a different level of energy intake, neither of which is fully predictable at the outset ([Shapiro et al., 2012](#)). As the trials proceeded, the horses probably learned that the overturned buckets always hid the same amount of food (a piece of a carrot), which thus represented a predictable factor. In this case, the time required to be accurate could become an unnecessary cost ([Wikenheiser et al., 2013](#)). In addition, in our tasks the carrot was always present under one of three overturned buckets, so that the potential cost of errors was necessarily low. Consequently, the horse's perspective might be to 'guess' the solution quickly, which is likely to result in low decision accuracy ([Stephens, 2008](#), [Trimmer et al., 2008](#)). This interpretation accounts for (1) the similar number of buckets explored before finding the carrot and (2) the same amount of time required, shown by both groups in the second half of the trials (Prediction 2 supported).

Despite this similarity, unexpectedly in the second half of the trials, the horses in group Ex tended mainly to first approach the bucket where they had found the carrot in the immediately preceding trial. Thus, in the second half of the trials, similar behaviour in the two groups resulted from different strategies for solving the task. In general, the horses in group Ex seem to have aligned their behaviour with that of group C, but using a different criterion to approach the first bucket.

This may not be surprising considering that, since choices precede outcomes, actions are driven by stimuli that bear a reliable, predictable relationship to outcomes, and not by the outcomes themselves ([Shapiro et al., 2008](#)). Such predictive stimuli influence the value of the experience in direct proportion to the reward and in inverse proportion to the delay between the predictive event and the outcome ([Stephens and Anderson, 2001](#), [van der Post and Semmann, 2011](#), [Zhang and Hui, 2014](#)), with changes in learning strength each time an outcome is experienced ([Shapiro et al., 2012](#)). We also could not rule out that horses of group Ex tended to commit an A-not-B error as the trials proceeded by searching in the previously rewarded location ([Hoffmann et al., 2011](#)). In such cases horses could have encoded and recovered the spatial location of the carrot hidden in the previous trial from their memory, thus approaching to cluster at Stage 5 of Piagetian's object permanence scale ([Johnson et al., 2015](#)). However, the horses in group Ex seemed able to change their behavioural strategy based on the experience acquired during the trials.

What is unclear is why group C did not shift toward the same criterion (where the carrot was found before) as the trials proceeded. It is possible that these horses had no reason to change strategy because the time-cost and benefit of reward were balanced from the beginning of the trials. The control group also did not experience the proximal momentary local enhancement cues that could have affected the decision making in the experimental group. In the control group scenario, learning could be the consequence of other sensorial inputs, such as smell ([Christensen et al., 2005](#)), which could be the main factor driving behaviour. In addition we also cannot rule out a simpler strategy, such as chance ([Robinson et al., 2011](#)).

These results also highlight that a multi-parameters approach and an accurate analysis over the course of the trials would be useful in providing an adequate overview of the real behavioural strategy adopted by animals in performing a certain task. What we would expect in a cognitive test, in fact, might not match the behavioural solutions implemented by animals. As suggested, studies on cognitive performance should be considered from the animal's point of view and some preliminary questions are necessary ([Healy, 2012](#)).

Conclusions

Horses seem capable of using human beings as a proximal momentary local enhancement cue, and thus of understanding the communicative meaning. Horses are also capable of changing their

decision-making strategy by shifting from the accuracy inferred from human given cues to speed in a delayed three-choice task to find food. In a laboratory context, horses demonstrated a sophisticated behavioural plasticity of the foraging strategy necessary to make the proper choice. A choice based on the following criteria: (i) the costs involved, (ii) the value of the information obtained, (iii) the horse's previous experience and (iv) the subsequent reward.

Take home message

This behavioural plasticity is clearly linked to the learning process. Everyone should thus carefully take into account that actions taken in the daily management could be filtered by horses following the above mentioned criteria, with the horse behaving accordingly.

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