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Human demonstration does not facilitate the performance of horses (*Equus caballus*) in a spatial problem-solving task

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Simple Summary

Horses were confronted with a spatial problem-solving task in which they had to detour an obstacle. Individuals that observed a human demonstrating how to solve the task did not solve the task faster compared with a control group without demonstration. However, horses of both the treatment and control group detoured the obstacle faster over trials. Together with previous research, our results illustrate that horses do not seem to rely on social information when solving a spatial problem-solving task.

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Abstract

Horses' ability to adapt to new environments and to acquire new information plays an important role in handling and training. Social learning in particular would be very adaptive for horses as it enables them to flexibly adapt to new environments. In the context of horse handling, social learning from humans has been rarely investigated but could help to facilitate management practices. We assessed the impact of human demonstration on spatial problem-solving abilities in horses using a detour task. In this task, a bucket with a food reward was placed behind a double-detour barrier and horses (n = 16) received a human demonstration or no demonstration. Horses were allocated to two test groups of 8 horses each, which experienced the two treatments in a counterbalanced order. We found that horses did not solve the detour task faster with human demonstration. However, both test groups improved rapidly over trials. Our results suggest that horses prefer to use individual rather than social information when being confronted with a spatial problem-solving task.

Keywords

detour task; equids; social cognition; social learning; spatial cognition

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INTRODUCTION

The management of horses is key to provide them with adequate welfare [1,2]. An important role in these management practices, such as handling and training, is horses' ability to adapt to new environments and to acquire new information, either individually or from others [3,4]. In the context of horse handling, social learning from humans could help to facilitate management practices but has been rarely investigated yet [5]. As horses often experience frequent interactions with humans, either due to training or general husbandry practices, potential heterospecific information transfer from handlers to horses might thus help to improve their welfare [6].

Animals are able to obtain solutions to novel problems by trial-and-error learning or via social learning, i.e. by observing or interacting with other individuals [7,8]. However, research on social learning in horses found contradictory results on their ability to solve novel problems by the observation of conspecific demonstrators. Horses that observed a conspecific manipulating an apparatus to receive a food reward spent more time close to the test apparatus but did not learn to operate the apparatus more quickly compared with horses that did not receive a demonstration [9]. In addition, horses that observed a demonstrator horse solving a spatial problem were not faster in solving this task than horses that did not receive a social demonstration [10]. Younger, lower-ranking, and more explorative horses showed improved learning abilities when observing a conspecific solving a certain task [11]. Horses also copied specific following behaviours towards humans when a familiar and dominant conspecific was used as demonstrator, but not when the demonstrator was a subordinate or unknown conspecific [12]. However, older and dominant demonstrators did not enhance the performance of observer horses in a spatial problem-solving task in comparison to observer horses with age-matched demonstrators or control horses without a demonstration [10]. Given these ambiguous

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results, researchers have stressed that tasks must be ecologically relevant and, further, that dominance and age effects should be taken into account in social learning [13].

Social learning is not restricted to conspecifics but can also take place with heterospecifics [e.g. 14]. Domestic animals, in particular, might be well adapted to learn from humans through observation [e.g. 15]. When horses were given the opportunity to frequently observe a human solving an instrumental task, more individuals learned the task and further also learned it faster than horses that did not received a human demonstration [16].

Spatial problem-solving tasks are often used to investigate social learning abilities between conspecifics and heterospecifics [17,18]. For example, the ability of dogs to solve tasks in which they have to walk around obstacles to reach a food reward has been widely investigated in the context of social learning [17]. Although horses can solve these so-called detour tasks on an individual level [19–21], a first study on the use of social information in this specific task indicates that horses do not benefit from a demonstration by a conspecific [10].

In the present study, we investigated the effect of a human demonstrator on the performance of horses in a spatial problem-solving task. We presented horses with a series of ten trials with either the presence or absence of a human demonstrator. We expected horses which observed a human demonstration to perform better in the detour task than horses that did not observe a demonstration [17,18]. We further expected horses to improve over trials [17], independently of the presence or absence of a human demonstrator.

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MATERIALS AND METHODS

Subjects and housing

The study was conducted with 16 horses at a riding stable in Switzerland during August and September 2012. The 9 mares and 7 geldings were between 4 to 19 years (∅ 9.9 ± 4.9) old and of various common riding horse breeds. All horses were owned by private owners and used to being handled and exercised on a daily basis. They were housed in individual box stalls (3.5 × 3.5 m) with straw bedding, had several times per week access to a paddock or pasture, and feeding of hay and concentrates took place 2 and 3 times a day, respectively. Routine care remained unchanged during the period of experiments and was provided by stable employees and their owners.

Ethical Note

Animal care and experimental procedures were in accordance with the Swiss animal welfare legislation [22,23]. Daily experimental procedures took place in a familiar environment and lasted no more than 20 min per horse. The experiments would have been terminated if a horse had shown signs of stress (e.g. increased alertness, locomotion, or vocalization) but all individuals adapted well and participated voluntarily.

Experimental set up

The experiments were conducted at the stable's indoor riding arena (20 × 40 m), which was familiar to all horses. A double-detour task was set up by two nested U-shapes (Fig. 1). Equestrian jump standards, wooden rails, and barrier tape were used as barriers for the labyrinth (Fig. 2). The starting point was marked with two cavaletti jumps, which were positioned in an intermittent V-shape (Fig. 1). A bucket with a reward (a hand full of concentrates) was placed in the middle of the labyrinth (Fig. 1, 2).

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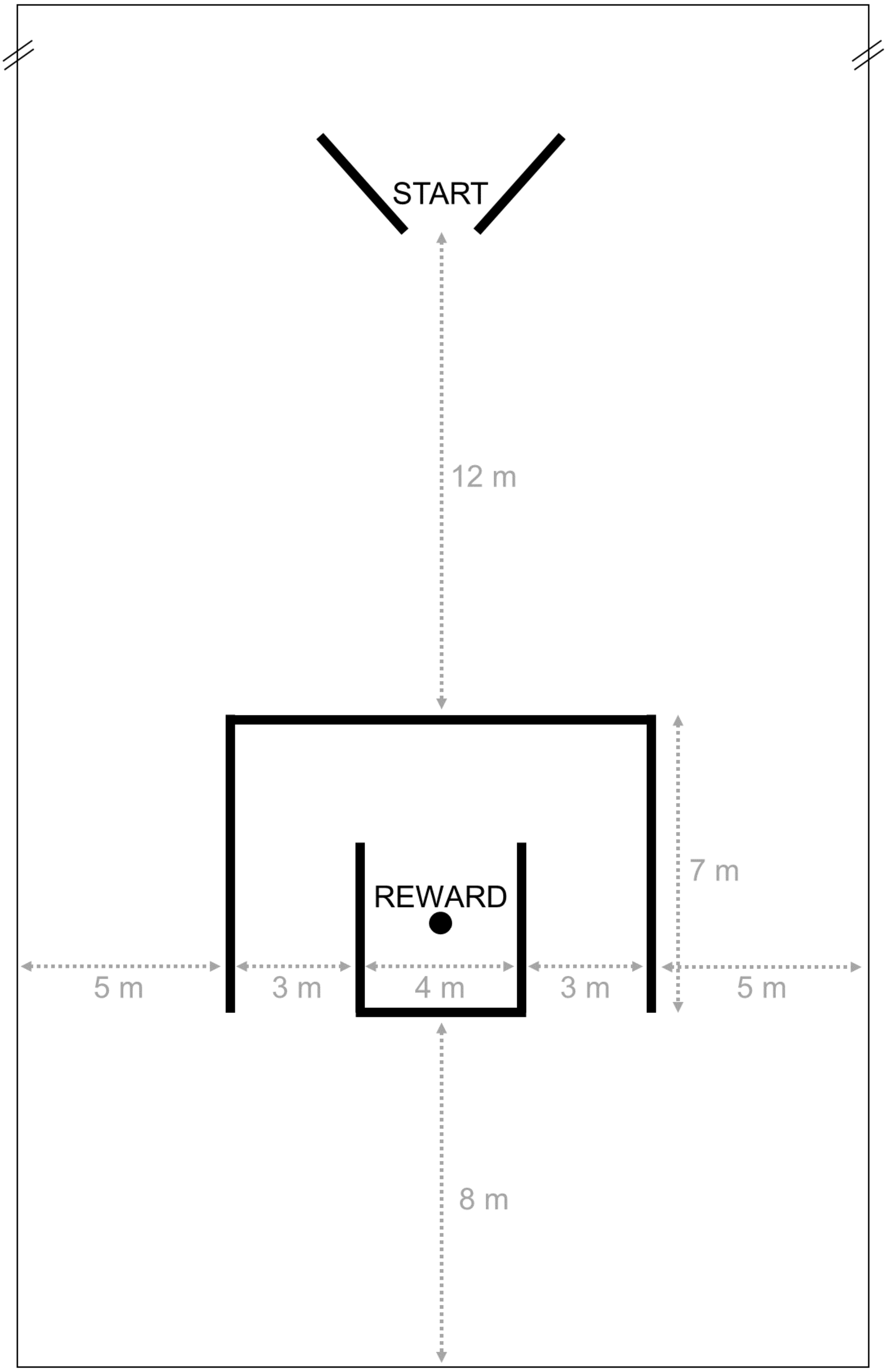

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116 **Figure 1:** Overview of the experimental set up in the test arena.

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Figure 2: Horse feeding from the rewarded bucket after successfully completing the detour task.

Training phase

Horses were habituated to the barriers of the labyrinth by leading them through an L-shaped labyrinth each 10 times on 5 days; no food reward was present during the habituation. The operant conditioning to the neon-green bucket (Ø 28 cm) was carried out during a period of 4 weeks by feeding each horse a hand full of concentrates from the bucket once a day in their individual box stalls.

Experimental procedure

Horses were tested individually in the same order every day. Experiments always took place between 2 h after the last and 1 h before the next feeding time. During testing, subjects were visually isolated from other conspecifics but remained in auditory and olfactory contact. Each horse was tested in two test phases of two consecutive test days, which were 3 weeks apart from each other. Each test day consisted of five consecutive trials; resulting in 10 trials per

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horse and test phase. For each trial, the horse was led with a lead rope to the starting point by the experimenter and an assistant (re)filled the food reward in the bucket visibly to the horse and then positioned himself at the wall sideways from the starting point. After waiting for another 5 s, the horse was released by removing the lead rope from the headcollar. During a test phase, all horses experienced one of two different treatments:

- No demonstration: After releasing the horse at the starting point, the experimenter stepped back sideways behind the cavaletti jumps marking the starting point.
- Human demonstrator: After releasing the horse at the starting point, the experimenter immediately started walking towards the rewarded bucket without further interacting. As soon as the human demonstrator started moving, the horses were free to solve the detour in their own pace and choose their own direction, i.e. left or right side of the detour task. The human demonstrator always chose the direction to the right of the barriers and reached the reward bucket within and approximate latency of 30 s.

The 16 horses were allocated to two test groups of 8 horses each, which experienced the two treatments in a counterbalanced order. One test group completed the first test phase with no demonstration and the second test phase with a human demonstrator, whereas the other test group completed the first test phase with a human demonstrator and the second test phase with no demonstration.

Data recording and analysis

Latency time between the release of the horse at the starting point until the horse touched the reward bucket served as outcome variable. If a horse was not successful to obtain the food reward within 180 s, the trial was terminated by leading the horse back to the starting point and a latency of 180 s was recorded for the unsuccessful trial. All data were recorded directly by one observer; all trials were video recorded for controls. Statistical analysis was conducted in

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R (version 3.4.3; [24]). The outcome variable 'latency' was analysed using linear mixed-effects models (lmer; package lme4; [25]). The explanatory variables included treatment (factor with 2 levels: no demonstration, human demonstrator), test day (factor with 2 levels: 1, 2), trial (factor with 5 levels: 1, 2, 3, 4, 5), and their interactions (3-way and all possible 2-way) as fixed effects and, to account for dependencies in the data structure, test day nested in the test phase nested in the horse nested in the test group as random effect. The p-values were calculated using parametric bootstrap (PBmodcomp; package pbkrtest; [26]). For the bootstrap, the number of 1000 samples was chosen. Therefore, a p-value of 0.001 is the lowest value that could result from this method, although the actual p-value might have been even lower. Model assumptions were checked by graphical analysis of residuals (normal distribution, homoscedasticity); the outcome variable was log transformed. The final model was accomplished by a stepwise backwards reduction (the smallest model included the main effects only) with a p-value of 0.05 as criterion of exclusion and model estimates and 95% confidence intervals of the fixed effects were calculated.

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RESULTS

In the first test phase, 14 trials by 4 horses (test day 1: 10 trials by 3 horses; test day 2: 4 trials by 3 horses) were unsuccessful (i.e. horses did not detour the obstacle within 180 sec) in the test group that received no demonstration, whereas only 1 horse was unsuccessful once (in the first trial on test day 1) in the test group with a human demonstrator. In the second test phase, all trials were successful in both test groups. Horses did not show shorter latency in solving the detour task with a human demonstrator in comparison with no demonstrator ($p = 0.061$; Fig. 3a); there was no effect by any interaction between treatment, test day, and trial ($p = 0.55$), treatment and test day ($p = 0.37$), or treatment and trial ($p = 0.42$). However, in both test groups, the latency to reach the reward bucket decreased from trial 1 to 3 and levelled off from trial 3 to 5 on test day 1, whereas it remained on an equivalent level in trial 1 to 5 on test day 2 (test day × trial: $p < 0.001$; Figure 3b).

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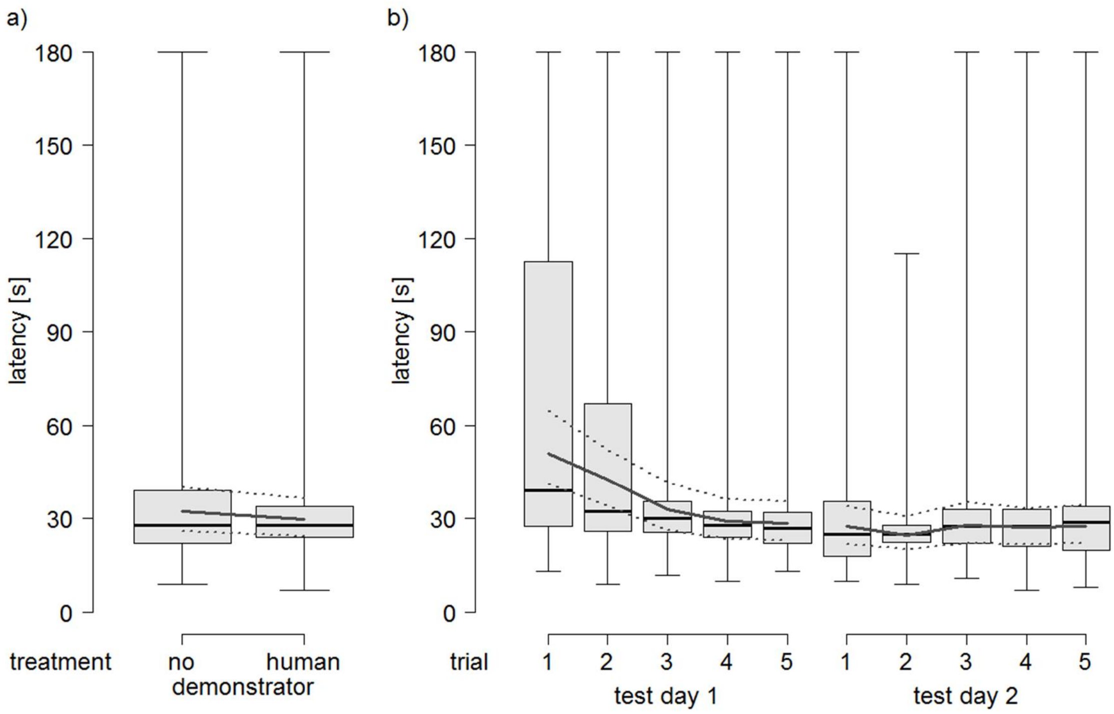

Figure 3: Latency to reach the rewarded bucket in a) the two different treatments and b) trial 1 to 5 on test day 1 and 2.

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DISCUSSION

We investigated the ability of horses to socially learn from humans in a spatial problem-solving task. Contrary to our hypothesis, we did not find that horses which observed a demonstration by a human solved a detour task faster than those without a demonstration [10]. However, horses in both test groups improved over trials; a finding which is in line with previous studies on spatial problem-solving in horses [17,21]. Our results indicate that horses do not prefer the use of social information provided by humans when being confronted with a spatial problem. The use of social information in horses thus seems to be context-specific and limited to instrumental tasks [5,9,11].

Horses are very sensitive in interpreting human communicative and attention cues. They use human pointing gestures to find food [27] and adjust their begging behaviour to the attentive states of humans [28]. Horses also tend to choose a potentially baited container when it was located next to a human, independent of the person's attentive state, indicating that horses can use humans as a local enhancement cue alone [29]. In the current study, seeing a human demonstrating how to detour an obstacle did not affect the horses' detour performance. This is surprising, given horses inclination to attend to even subtle human cues [30]. However, our findings are in agreement with the performance of other domestic ungulates in spatial problem-solving task using conspecific demonstrators; e.g. horses in similar detour tasks [10] or goats in maze learning tasks [31]. Human demonstration, in turn, led to improved detour performance in goats and dogs [17,18], raising the question why horses did not improve with demonstration in a similar task.

A possible explanation for our inability to find an effect of human demonstration on the detour performance in horses might be a potential basement effect of the latency time over trials for

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both test groups. Horses from both test groups rapidly improved in their time to detour the obstacle, with latency times levelling off after the third trial of each test phase. Individual improvement in detour tasks, although on a slower level, has been previously shown for horses [19,21]. One explanation for our negative findings between both test groups might be that a ceiling effect appeared because horses could simply not solve the spatial problem faster, which masked potential treatment effects between test groups. Adding more complexity to a different spatial problem-solving task might improve the detection of potential treatment differences in future studies.

CONCLUSIONS

Our results show that horses do not seem to use information from humans in a spatial problem-solving task. The use of social information in horses thus seems to be context-specific and limited to instrumental tasks.

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AUTHORS' CONTRIBUTION

Joan-Bryce Burla and Janina Siegwart conceived and designed the study, Janina Siegwart performed the experiments, Joan-Bryce Burla analysed the data, Joan-Bryce Burla and Christian Nawroth wrote the manuscript. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare that they do not have any competing interest.

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