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Do horses learn how to reach for feed depending on the time of day?

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Abstract: The aim of the study was to assess the ability of horses to learn how to open feeder boxes in a direction associated with the time of day. The study involved 10 horses. The first stage of the study consisted in learning how to complete the task. The second stage involved the test and was followed by a control stage. The results indicated the highest number of failed attempts in the leftward movement test. The mean time required by the horses to complete the task of the leftward opening (10.27 s) was twofold longer than in the rightward direction test (5.06 s). It was observed that horses did not learn to open their feeder boxes in the correct direction according to feeding time. Although the results confirm that horses learn new tasks easily, the method employed does not facilitate examination of the problem of the impact of the memory of past events on the modification of behaviour depending on the time of day.

Keywords: Małopolska horse, feeding, learning, leftward direction, memory

1. Introduction

Like other mammals, horses learn quickly and efficiently [1,2]. Understanding and application of learning theory can help horse trainers and users to work with their animals in a way that facilitates and optimises the learning process, and thus improves the relationships between humans and horses and the well-being of these animals [3]. The learning ability is regarded as one of horses' personality traits [4,5]. However, for the learning process to be fast and effective horses must use memory efficiently, similar to other species that are capable of fast learning, regardless of whether it will be episodic or semantic memory. Episodic memory and semantic memory are two types of declarative memory. Episodic memory is remembering what happened where and when, whereas semantic memory is the memory for general facts of the world [6,7]. The dispute whether nonhuman species use episodic or only semantic memory has not been clearly resolved [8–11].

However, regardless of whether episodes are remembered from own experience or learned through repetition, individuals should be sensitive to the passage of time and modify their behaviour depending on the time of day to achieve an effective learning process [12]. Time-place learning (TPL) is the time-place discrimination or time-place association. In daily TPL paradigms, the location of a resource depends on the time of day, and animals are trained over multiple days at fixed time-points, so that they can learn to visit or avoid specific locations at specific times of the day [13]. TPL in mammals was first demonstrated by Boulos and Logothetis [14] using rats. The research has shown that rats can find food at the correct location when it is made available at two different locations depending on the time of day.

Therefore, the aim of the study was to assess the ability of horses to learn how to open feeder boxes in a direction associated with the time of day. The research hypothesis was the assumption that the time of day can be used as an environmental cue to train horses.

2. Materials and methods

All procedures used during the research were approved by the II Local Ethics Committee for Animal Testing at the University of Life Sciences in Lublin, Poland (Approval No. 8/2015 of 8 April 2015).

The study involved five mares and five geldings of the Małopolska breed aged 10–15 years (average age 12.5). All horses were kept in the same stable and were used for 1–3 h a day for recreational riding. The animals were kept in boxes and fed twice a day with concentrated feed and

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roughage with constant access to water. The feeder boxes used in the experiment were identical to those that the horses always had in their boxes; the only difference was the closure system specially designed for the experiment. The modes of opening the feeder box on the left and right side were the same and did not differ from each other. There was no difference between the ways of supplying the feed during the experiment and on an ordinary day. The horses were kept in boxes with uniform walls, with an openwork fragment at a height of 30 cm from the top. However, this did not allow the horses to see the location of the feeder box. They spent from 3 to 8 h a day in the paddock. The horses were used for recreational purposes for 1–3 h a day and spent the rest of the time in the boxes. All horses were free from diseases and parasites and showed no signs of illness. Their health condition was systematically controlled by a veterinarian. Antiparasitic prophylaxis was carried out systematically. One horse was sold during the experiment; hence, nine animals were included in the analysis.

The analyses were divided into three stages —learning stage, test stage (T), and control stage (C). In the first stage, the horses learnt how to complete the task. This stage lasted 10 days. During that time, the horses were taught how to open the boxes. It was aimed at habituation of the animals to the new feeder boxes to exclude the phenomenon of neophobia. For 10 days, the horses were given concentrated fodder from the new feeder boxes twice a day in the morning and evening. The rightwards and leftwards opening directions were chosen alternately (Table 1). The second stage - test (T) lasted 10 days as well. For the needs of the experiment, a rectangular 35 cm × 25 cm × 20 cm feeder box was constructed. It had a sliding wooden lid equipped with limiters ensuring the appropriate movement of the cover to the left (L) or right (P) side depending on the feeding time. It was established that the lid was going to be opened with a leftward movement during the morning feeding and by moving to the right in the evening. The specific construction of the feeder boxes ensured that the horse was able to move the lid in the established direction. The feeder box was hung in the place where the horse was usually given the concentrated feed. The tests were always carried out at the same time during the morning feeding at 7.00 and evening feeding at 19.00.

The analysis of the test and control recordings involved measurement of the following parameters: latency, task completion time, total time required to complete the task, number of attempts made by the horse, and number of failed attempts. The method and units of measurement are shown in Table 2.

Two months after completion of the test stage, a control stage (C) was carried out. It was established that the direction of opening the feeder box required from the horse would be selected randomly by tossing a coin by the same person during the entire experiment. The result of the toss for each horse was recorded in the table. This stage lasted 5 days. Each horse was tested at each feeding time, i.e. 10 times.

At all stages, the behaviour of the horses was recorded using a video camera from a distance of 2 m by an experimenter (always the same person) standing in the stable corridor.

The significance of differences between the groups was verified with the multivariate analysis of variance, the GLM procedure. The data analysis for this paper was generated using SAS 9.4 software [SAS Institute, Cary, NC, USA, 2013]. In the initial stage of modelling, the significance of the effect of horses' age and sex, the interactions between the direction of opening the feeder and the test stage (control, test), and regression on the next testing day was checked. However, such factors as the sex and age of the horses were not significant and were therefore excluded from the model. Ultimately, the model included the fixed effect of the factor: the interaction between the direction of the opening of the feeder and the test stage (control, test) and the regression on the next testing day. Least squares means (LSM) and standard errors (SE) were calculated as an indicator of the reliability of the estimate.

3. Results

Table 3 shows the mean values of the analysed parameters in relation to the direction of opening the feeder boxes in the test and control assessment. There were more attempts to open the feeder box in the leftward direction during the test. Additionally, there was a significant difference in the numbers of failed attempts to open the feeder box by the leftward movement between the test and control assessment. There were no significant differences in

Table 1. Results of random assignment of the feeder opening direction to the horses in the control stage.

Horse / Opening direction	1	2	3	4	5	6	7	8	9
Left	7	7	4	4	7	6	2	5	5
Right	3	3	6	6	3	4	8	5	5

Table 2. Parameters assessed in the tests, measurement methodology, and units.

Parameter	Method of measurement	Unit
Latency	Time between perceiving the feeder by the horse and touching with the nose at the object	Seconds (s)
Task completion time	Time between touching the object and opening the feeder and starting to eat	Seconds (s)
Total time required to complete the task	Sum of the latency and the task completion time	Seconds (s)
Number of attempts	Number of all attempts to open the feeder	Number
Number of failed attempts	Number of attempts in the wrong rightward/leftward direction or attempts to open the feeder in the upward/downward direction	Number

Table 3. Least squares means (LSM) and standard errors (SE) of the analysed indicators in relation to the feeder opening direction and testing stage

Direction	Test stage	Number of attempts		Number of failed attempts		Latency (s)		Task completion time (s)		Total time (s)	
		LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE
Left	C	2.73^{A}	0.34	1.73^{A}	0.34	1.46	0.01	6.69^{B}	1.60	8.16	1.60
Left	T	3.58^{B}	0.21	2.58^{B}	0.21	1.37	0.06	10.27^{B}	1.12	11.65^{B}	1.12
Right	C	2.01^{A}	0.33	1.01^{A}	0.33	1.48	0.01	5.35^{A}	1.66	6.83^{A}	1.66
Right	T	2.43^{A}	0.22	1.43^{A}	0.22	1.35	0.06	5.06^{AB}	1.14	6.43^{A}	1.14

$^{A, B,C}$ – means marked with different letters differ significantly in columns at $p < 0.05$.
C- Control, T-Test.

latency between the feeder opening directions in the case of the opening the feeder box with the rightward movement.

There were no significant differences in the values of the latency between the feeder opening directions during the test and control assessment. However, the mean time required by the horses to complete the task of the leftward opening (10.27 s) was twofold longer than in the rightward direction test (5.06 s) (Table 1). There were significant differences in the control stage. The mean time required for the rightward opening was by 1 s shorter than the mean time required for leftward opening (Table 3). The highest number of failed attempts made by the horses was noticed in the leftward opening test (3.58).

4. Discussion

In the present study, the animals were faced with an easily trainable task of opening the feeder box with one simple movement of the head. Such a procedure was selected, as a use of a more complex feeder requiring a more innovative approach from the animals would have drastically reduced (even up to 25%) the percentage of individuals that could complete the task [15]. The 10-day learning period was sufficient for all horses to get accustomed and learn how to open the new feeder boxes. However, the horses did not learn to open the feeder boxes in the directions correlated with the feeding time (Table 1). We observed a nearly two-fold longer feeder opening time in the leftward than rightward direction. The higher frequency of the rightward head movements for opening the feeder box may also be associated with motor and sensory laterality in horses [16]. For instance, it has been observed in mother-offspring dyads in wild horses that juveniles tend to follow their mothers with their left eye during slow locomotion and approach the mare for feeding in the leftward direction, which suggests significant involvement of the right brain hemisphere in social behaviour [17]. In turn, as demonstrated by Baragli et al. [18], in spatial tasks requiring circumvention of an obstacle regardless of its shape (symmetrical vs. asymmetrical), half of the animals tested exhibited strong motor laterality and always turned in the same direction (left or right, but the same in the whole experiment).

The present results indicate an important issue regarding the design of horse experiments. In the two-choice paradigm tests, the subject chooses the answer by moving the body or head. However, if so many animals may have strong motor lateralization, the use of the two-choice paradigm test in behavioural research is questionable not only in studies of horses but also other animals [19].

An important observation from the present investigations is the analysis of the time required to open the feeder boxes during stages (T) and (C). As described in the methodology, the opening direction in the control stage (C) was determined by a coin toss. Interestingly, the horses coped better with opening the feeder boxes with the leftward movement during the random selection of the directions than in the test where the feeder boxes were set to open alternately (leftwards in the morning, rightwards in the evening). This indicates that the horses did not learn to associate the directions with the time of feeding, but only opened the feeder box on a trial-and-error basis. The analysis of the results revealed that the horses preferred the right side, and when they encountered resistance, they tried to move the lid to the left. In the case of the control trial (C), the opening directions often repeated; for instance, horse no. 1 had seven consecutive leftward attempts, and horse no. 7 had eight consecutive rightward attempts. Therefore, the horse tried to open the feeder in a way that had previously ensured a positive result. Importantly, animals have the greatest confidence in the rules and information acquired recently. The longer the period since the last confirmation of the rule, the less important it is to the animal [20]. Hence, the lower number of failed attempts in the control animals trying to slide the lid leftwards may be associated with the successively employed opening approaches. The horses in the test alternately opened the feeder boxes, whereas usually "sequences" of movements: several movements to the left and several to the right were observed in the control group. This may have affected the quickness of opening and the number of failed attempts. There were no differences between the test and control groups in opening the feeder boxes in the rightward direction. In contrast, there were differences in the leftward opening attempts in favour of the control group. This may be explained by the fact that the horses attempted to slide the lid rightwards instinctively, which was not associated with the choice of alternate or successive opening method. In turn, the alternating or successive character of the method may have been important in the leftward opening test.

The evidence collected in the study suggests that the left hemisphere dominates in response to food rewards in horses [21]. Therefore, it cannot be claimed that the horses learned to open the feeder boxes in a direction corresponding to the feeding time. Therefore, we did not confirm our hypothesis that the time of day can be used as an environmental cue in this experiment. Instead, the animals tried to open the feeders rightwards or in a direction that allowed a successful completion of the task. The horses were self-rewarded when they succeeded in reaching the feeder box and eating the oats and tried the opposite direction when they failed. An extremely interesting example was horse no. 7, who made only three mistakes during all tests. During the control stage, the horse made all attempts to open feeders correctly the first time. Interestingly, the ratio of right-left directions for this individual was 8:2 in favour of the right side. This likely influenced the successful completion of the task during the control trial. However, also during the tests, the horse successfully completed 70% of the tasks on the first attempt. It is known that the ability of a horse to learn largely depends on its emotionality [22]. The ability to solve a problem is also determined by the genetic background, intelligence, learning system, previous experience, or social position in the herd [23,24]. Previous experience with novel objects and tasks undertaken by the horse in the past should be considered as well. This leaves an open question of the determinants of such a great success in completion of the task by horse no. 7.

5. Conclusion

In summary, we have found evidence of horse laterality in their preference for rightward movement. Although the results have confirmed that horses easily learn new simple tasks, such as moving the feeder box lid sideways to get food, the method employed does not facilitate examination of the problem of the impact of memory of past events on the modification of behaviour depending on the time of day. Alternatively, a preliminary screening test should be carried out to exclude individuals with high motor laterality from the study or a method minimising the impact of laterality should be used.

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