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Motivation and ability to learn in relation to behavioural reactivity in horses

Motywacja i zdolność uczenia w kontekście reaktywności behawioralnej koni

Summary. The aim of the study was to assess the relationships between the learning ability and other behavioural profile traits in horses as well as to answer the question whether motivation to undertake a specific task facilitates the problem solving process and influences the learning rate. The study involved 31 Małopolska breed horses at various ages. The learning rate test consisted in moving or lifting the trough lid to achieve a reward. Additionally, all the horses were subjected to a series of behavioural tests. It was found that motivation to perform a specific task does not facilitate execution thereof and does not influence the speed of solving the problem. Similarly, the degree of horse's arousal and the emotional reactivity do not exert impact on the speed of solving the problem and are not associated with the motivation for activity in a specific situation.

Key words: *Equus caballus*, learning, mobilising factor, emotional reactivity

INTRODUCTION

Horses are livestock animals used by man in a variety of ways. Simultaneously, they are most intensively trained and involved in close cooperation with humans of all livestock species. In addition to their ability to remember, the motivation to learn may be of great importance in the horse training system. This trait is often ignored although it can play an important role in the learning process. Motivation for activity varies in time and depends on the absence or availability of the resource. It is influenced by many factors, e.g. the breed, age, sex, and individual temperament traits [Lansade and Simon 2010]. The ability to learn and the learning rate is an individual feature, which is undoubtedly associated with other temperament traits such as with fearfulness [Visser et al. 2003]. Appropriate training methods adapted to horses' temperament

allow achievement of the intended goal within a substantially shorter time at increased effectiveness of training [Nicol 2002, Visser et al. 2003]. Knowledge of the broad-sense learning process, including the interrelations between learning and behavioural reactivity, can largely facilitate selection of appropriate training methods to achieve the intended effect in the shortest possible time and concurrently to improve equine welfare. The aim of the study was to assess the relationships between horses' learning ability and other behavioural profile traits and to answer the question whether motivation to undertake a specific task facilitates the problem solving process and influences the learning rate.

MATERIAL 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 investigations involved 31 Małopolska breed horses, including 21 mares and 10 geldings, aged from 3 to 17 years.

Horses

The horses were kept in two equestrian recreational centre's. All the horses were ridden; they were maintained and fed in accordance with the current standards. In both centre's, the individuals who handled the horses every day were at the same time animals' owners and trainers. Due to the specific profile of the centre's, the horses were in daily contact with many riders exhibiting varied levels of riding skills. The average maximum workload for one horse in the equestrian centre during the observation period was 4 hours a day.

Training and learning test

All horses were subjected to a learning ability test. Two suspended troughs with different colors and special lid-lifting systems specially designed for this experiment were used. The experiment was divided into two stages: training and testing, each lasting two days. The training was introduced deliberately to prevent neophobia and to make sure that the troughs contained oats. The training only consisted in supplying oats to the new troughs without any lid. In the test, the troughs were covered with lids, which had a different system of opening depending on the different colors of the trough. One trough was blue and its lid had to be moved to be open. The other trough was red with a lid that had to be lifted up. Both the training and the tests were carried out before morning and evening feeding, which was a motivation to look for feed. Crushed oats, which served as the basic roughage in both centre's, were placed in the troughs. To get the feed in the morning test, the horse approached the blue trough with the movable lid. In the evening test, the horse had to approach the red trough and to lift the lid up to get the feed. The exact course of the experiment is shown in Table 1.

Table 1. Scheme of the experiment evaluating horses' ability to learn
Tabela 1. Przebieg doświadczenia oceniającego zdolność do uczenia się koni

Stage Etap	Day Dzień	Type of task Rodzaj zadania	Time of day Pora dnia	Measurement: time (s) Pomiar: czas (s)	Lid-opening system System unoszenia pokrywy
I (training) (trening)	1	training 1	morning – rano	latency* czas latencji	no lid brak pokrywy
		training 2	evening – wieczór		
	2	training 3	morning – rano		
		training 4	evening – wieczór		
II (test)	3	test 1	morning rano	latency* czas latencji	move przesunąć
				time of solving the task** czas rozwiązania zadania	
		test 2	evening wieczór	latency* czas latencji	lift unieść
				time of solving the task** czas rozwiązania zadania	
	4	test 3	morning rano	latency* czas latencji	move przesunąć
				time of solving the task** czas rozwiązania zadania	
		test 4	evening wieczór	latency* czas latencji	lift unieść
				time of solving the task** czas rozwiązania zadania	

* Time in which the horse approached and touched the trough with the muzzle/ began to eat.
* Czas, w jakim koń podszedł do żłobu i dotknął pyskiem/ zaczął jeść.
** Time in which the horse managed to open the trough.
** Czas, w jakim koń poradził sobie z otwarciem żłobu.

The analysis of horses' behaviour helped to determine their ability to learn by measuring the time (s) within which the horse solved the task. The training and the test lasted 600 s. The latency duration was measured, i.e. the time from perception of the object to the approach and touching the trough with the muzzle followed by the beginning of feeding. A horse that did not approach the object was scored 600 points. Additionally, the duration of task solving was analyzed: it was the time from perception of the object to the moment of accomplishment of the task, i.e. lifting or moving the trough lid (tab. 1). A horse that did not complete the task during the test time was scored 600 points. The assessment of the relationships between the ability to learn and behavioural reactivity was based on the observations from tests 3 and 4, because learning defined as the ability to remember specific experiences should not be assessed when the animal is

performing the task for the first time. Therefore, the results from the tests performed on the second day (tests 3 and 4) reflected the horses' ability to learn.

Behavioural test

Next, the horses were subjected to a series of behavioural tests divided into 3 groups. Group I comprised handling tests (approaching the horse, brushing, bridling, and leg rising), group II included human-horse interaction tests (leading the horse from and to the stable, approach in a paddock, unfamiliar human approach, familiar passive and active human in the box), and group III consisted of novelty tests (novel object, sound test, unknown surface test). All tests followed the procedure described by Kozak et al. [2018]. The behavioural tests were performed twice at a three-week interval. Tests from the same group were applied on the same day in all horses from the same centre.

The analysis of emotional arousal was based on:

1. Assessment of emotional arousal indicated by changes in the heart rate, i.e. the number of beats/min – Heart Rate (HR) [Jezierski et al. 1999, Wilk et al. 2016]. Telemetric HR measurement was performed using a POLAR® S 810i YO ELECTRO device, Finland. The device was attached to the skin of the horse near the heart 10 min before the test.

2. Measurement of the time (s) of completion of the task, voluntary approach to the object, and duration of latency with a handheld stopwatch The results of all the tests were analyzed statistically with Spearman's rank correlations. This allowed assessment of the relationships between animal's motivation for accomplishment of the task and the learning ability and between the learning ability and selected behavioural profile traits determined in the handling, human-horse interaction, and novelty tests.

RESULTS

There was a highly significant correlation between the latency of the first approach to the object (Training 1) and the latency of the approach in the second training (Training 2), where the object differed only in the color (0.60) – tab. 2. Each subsequent presentation of the stimulus triggered different animal reactions from those noted in the first training.

The rank correlations decreased to 0.38 in the third trial (Training 3), and no significant correlations were observed afterwards. The time during which the horse approached the object in the first training (Training 1) was significantly correlated with the task performance time in Test 3 and Test 4. However, the rank correlations ranged merely from 0.35 to 0.48. The rank correlations between tests 1 and 3 was only 0.35, while the analogous correlation between tests 2 and 4 was as high as 0.76. The correlation between tests 1 and 2 reached a value of 0.32 and was almost twice as high (0.62) between tests 3 and 4. A highly significant correlation was found between the latency in the first test (Test 1 latency) and the latency in the second test (Test 2 latency). The rank correlation in this case was 0.60. Slightly lower but equally significant values were found between Test 3 latency and Test 4 latency. There was a significant correlation between the time of

solving the task in Test 2 and Test 3. The rank correlation for the horses was over 60% in this case. Concurrently, it was significantly higher than the correlation between tests.

Table 2. Values of rank correlations between the results of the learning test
Tabela 2. Wartość korelacji rangowych pomiędzy poszczególnymi wynikami w teście uczenia

	I (training)				II (test)							
	Training 1	Training 2	Training 3	Training 4	Test 1 latency	Test 1	Test 2 latency	Test 2	Test 3 latency	Test 3	Test 4 latency	Test 4
Training 1	*	0.60	0.38	0.08	0.00	–0.02	0.16	0.33	0.37	0.48	0.29	0.35
Training 2	0.000		0.25	0.30	–0.24	–0.07	–0.11	0.20	0.23	0.30	0.02	0.40
Training 3	0.035	0.170		0.32	0.00	0.19	–0.05	0.23	0.22	0.40	0.30	0.34
Training 4	0.655	0.105	0.076		–0.32	0.09	–0.33	0.08	0.00	0.06	–0.06	0.24
Test 1 latency	0.988	0.196	0.987	0.079		0.11	0.60	–0.07	0.11	–0.27	0.20	–0.13
Test 1	0.901	0.727	0.308	0.647	0.571		0.11	0.32	0.07	0.35	0.36	0.29
Test 2 latency	0.401	0.558	0.798	0.074	0.000	0.569		0.15	–0.18	–0.12	0.08	–0.14
Test 2	0.068	0.288	0.210	0.670	0.728	0.075	0.423		0.27	0.63	0.44	0.76
Test 3 latency	0.039	0.221	0.235	0.981	0.555	0.705	0.334	0.142		0.26	0.48	0.30
Test 3	0.006	0.097	0.025	0.754	0.137	0.054	0.527	0.000	0.156		0.32	0.62
Test 4 latency	0.108	0.924	0.101	0.729	0.270	0.044	0.650	0.013	0.006	0.076		0.30
Test 4	0.051	0.026	0.060	0.197	0.476	0.114	0.448	0.001	0.106	0.000	0.097	

* Above the diagonal – values of rank correlation, below the diagonal – p-value.
* Nad przekątną – wartości korelacji rangowych, pod przekątną – wartość p.

1 and 3 (0.35), although it could be expected that the rank correlation would be higher between tasks with the same degree of difficulty. The correlations between horses' learning ability and emotional arousal were analyzed (tab. 3). Significant correlations were shown only between the motivation to perform the tasks in test 4 and the HR level during such behavioural tests as the unfamiliar human approach test (0.50), active human test (0.48), and unknown surface test (0.48).

DISCUSSION

Learning is a cognitive process leading to modification of individual's behaviour by acquired experience. This process results in adaptation of the individual to the environ-

ment [Nicol 2002]. In the present study, the ability to learn and the speed of remembering were verified by assessing whether the horse managed to open the container on the second test day, i.e. in Test 3 and Test 4, and the time of performing this task. The time of opening the container is undoubtedly a measure of the ability to remember and solve a specific task. The ability to solve the problem is determined by genetic factors, intelligence, learning system, and social rank in the herd [Bonnell and McDonnell 2016, Krueger and Flauger 2007].

Nevertheless, horse's previous experience with new objects or past tasks should be considered as well. The rearing system is equally important. It has been proved that horses reared in groups learn faster than horses kept in boxes [Rivera et al., 2002, Sondergaard and Ladewig 2004]. This may be caused by the ability to learn through observation [Ahrendt et al. 2012]. However, the horses used in the present study were kept individually in boxes and the tests were carried out individually to prevent animals from mutual observation. The rank correlations between the time of performance of tests 1 and 3 was merely 0.35, whereas the analogous correlation between tests 2 and 4 was as high as 0.76. As shown in Table 1, tests 1 and 3 as well as tests 2 and 4 were comparable tests applied on consecutive days. This indicates that the horses learned the lid-lifting task (Tests 2 and 4) substantially faster than the lid-moving task. This result can be explained by the fact that the former way of opening the container is easier for horses, as it is compatible with the physiological movements of these animals. The vertical up-and-down head movement is often observed in horses in various situations. Therefore, the study result supports the thesis that animals learn to solve specific tasks more quickly if the solution involves their natural reflexes [Zsoldos and Licka 2015].

The subsequent attempts to complete the task, regardless of the type of the test, enabled the horses to solve them. This is confirmed by the comparison of the values of the correlation between the tests applied on the first day when the animals encountered the specific tasks for the first time (Tests 1 and 2) and the correlation observed on the second day (Test 3 and 4). The correlation was insignificant in the former case but its value in the latter case was nearly twofold higher (0.62) and statistically highly significant. There was also a highly significant correlation (0.63) between the time of performance of tests 2 and 3. Simultaneously, it was significantly higher than the correlation between tests 1 and 3 (0.35). This may indicate a progressive learning process. However, it seems that greater importance in the learning system can be assigned to the type of the task than only to the number of repetitions. This is indicated by the present results, where the rank correlation was higher and statistically significant between tasks with the same degree of difficulty (Test 1 and 3 as well as Test 2 and 4), in comparison with the correlation between successive tests (Tests 1 and 2, Tests 2 and 3, and Tests 3 and 4). Therefore, the type of the task has a significant impact on the learning rate [Lansade and Simon 2010].

There was no correlation between the time during which the horse expressed interest in the object and the time of solving a specific task. This implies that horse's ability to solve a particular problem is not associated with the motivation for activity. Animal's motivation to act, here expressed by the time within which the horse approached the object, depends on many factors exerting an effect on the animal, e.g. social affiliation, hierarchy of domination, or emotional excitability, and is a variable phenomenon [Krueger and Flauger 2007]. The present results demonstrate that curiosity, which is the main motivation for activity in this type of tests [Forkman et al. 2007], may be associated with the eagerness to learn but does not influence the speed of the process.

Table 3. Rank correlations between horses' ability to learn and selected behavioural traits
Tabela 3. Zgodność uszeregowania koni pod względem zdolności uczenia się a wybranymi cechami behawioru

Name of the test Nazwa testu	Trait expressed in: Cecha wyrażona w:	Test 3 latency		Test 3		Test 4 latency		Test 4	
		r	p-value	r	p-value	r	p-value	r	p-value
Forced human approach in the box Podejście człowieka w boksie	HR	0.08	0.660	0.11	0.547	0.21	0.254	0.08	0.687
Brushing Czyszczenie	HR	0.05	0.802	–0.18	0.345	0.20	0.290	–0.05	0.785
Bridling Kiełznanie	HR	0.06	0.750	–0.19	0.305	0.21	0.252	–0.18	0.321
Leg rising Podnoszenie nóg	HR	0.02	0.927	–0.18	0.329	0.26	0.164	–0.17	0.372
Lead a horse from the stable Prowadzenie konia ze stajni	HR	–0.08	0.656	–0.12	0.532	0.28	0.134	–0.10	0.601
Lead a horse to the stable Prowadzenie konia do stajni	HR	–0.35	0.056	0.05	0.807	0.32	0.076	0.28	0.132
Forced human approach in the paddock Podejście człowieka na wybiegu	HR	–0.08	0.656	–0.12	0.532	0.28	0.134	–0.10	0.601
Unfamiliar human approach Podejście obcego człowieka	HR	–0.01	0.938	0.08	0.687	0.50	0.004	0.14	0.462
Familiar passive human Test człowieka pasywnego	HR	–0.14	0.438	–0.04	0.832	0.17	0.352	–0.07	0.712
Familiar active human Test człowieka aktywnego	HR	0.06	0.736	0.12	0.509	0.48	0.007	0.09	0.613
Novel object Nowy obiekt	time (s) czas (s)	0.31	0.328	0.39	0.207	0.32	0.314	–0.03	0.918
Novel object Nowy obiekt	HR	–0.02	0.921	–0.05	0.775	0.23	0.210	–0.07	0.699
Sound test Test dźwiękowy	HR	–0.12	0.525	–0.21	0.251	0.11	0.572	–0.30	0.099
Unknown Surface Test nieznanej powierzchni	time (s) czas (s)	0.16	0.397	0.03	0.881	0.39	0.029	0.35	0.055
Unknown Surface Test nieznanej powierzchni	HR	0.06	0.739	0.25	0.182	0.48	0.007	0.33	0.074

The present study showed a significant correlation between the time within which the horses became interested in the object in tests 1 and 2 and tests 3 and 4. The rank correlation in both cases was highly significant. In turn, no significant correlations were found between the latency times on the consecutive days. The latency of showing interest in the object is influenced by many factors, e.g. the novelty of the object and the related fear and curiosity emotions. The highest rank correlation was observed on the initial days of the experiment, i.e. the first training day (between training 1 and 2) and the first test day (tests 1 and 2). A lower correlation value was observed in the subsequent tests. This may indicate that the horses exhibited analogous emotions and motivations for a specific behaviour in the first phase of the experiment. Contact with new situations and objects can trigger fear reactions in horses. Exposure to sudden or new stimuli is a common method applied to provoke fear [Desire et al. 2002]. However, each subsequent exposure to the stimulus resulted in the absence of significant correlations. This may indicate that horses that initially exhibited fear and reluctance to explore the object later showed considerable interest and *vice versa*, i.e. the subsequent presentation of the object and the absence of novelty discouraged some individuals from exploration. The results obtained indicate that an individual approach to animals is a very important element in the learning and training process. The time of approaching the new object (Training 1) was significantly correlated with the rate of performance of tests 3 and 4. Depending on the test, 35–48% of the tested animals exhibited a relationship between the response to a novel stimulus and intelligence defined in this case as the speed of solving the task.

The study also verified whether the motivation for activity and the problem-solving rate are associated with horses' reactivity measured as the heart rate in the behavioural tests. The only correlation was found between the motivation to perform test 4 and the HR value during the interaction with a familiar and unfamiliar human and walking on an unknown surface. However, this correlation was found only in 48% of horses in contact with the familiar human and unknown surface and in 50% of horses in the unfamiliar human approach test. This result may indicate that horses classified into a group with enhanced emotional reactivity and characterized by an increased heart rate in the tests quickly respond to a new stimulus in the learning test. There was no correlation between the reactivity and the ability to learn expressed by the time of task performance. As demonstrated by Mader and Price [1980] as well as Lindberg et al. [1999], horses representing races that are regarded as highly reactive learnt more slowly than less reactive horse breeds. Probably, these apparently contradictory findings are associated with the differences in the tasks to be solved by the animals, since the type of task has a significant impact on the learning rate and ability to solve problems, as shown by the present study.

CONCLUSION

In summary, it can be concluded that the motivation to perform a specific task did not facilitate performance of the task and did not influence the speed of solving the problem. An important role in the learning system was played by the type of task to be solved rather than only the number of repetitions thereof. Similarly, horses' emotional reactivity did not exert an effect on the speed of solving the tasks and did not correlate with ani-

mals' motivation to undertake activity. The degree of excitation during contact with a novel stimulus can help to assess the learning speed and willingness to act to some extent. However, this correspondence does not exceed 50%, which implies that it cannot be univocally claimed that horses with low or high emotional reactivity exhibit lower or higher motivation to act or solve problematic tasks with ease or difficulty.

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Streszczenie. Celem badań była ocena powiązań pomiędzy zdolnością uczenia się koni a innymi cechami profilu behawioralnego oraz uzyskanie odpowiedzi na pytanie, czy motywacja do wykonania określonego zadania ułatwia rozwiązywanie problemu i wpływa na szybkość uczenia. Badania przeprowadzono z udziałem 31 koni rasy małopolskiej w zróżnicowanym wieku. Test szybkości uczenia się polegał na przesunięciu lub uniesieniu pokrywy żłobu. Nagrodą za prawidłowo wykonane zadanie była porcja paszy. Dodatkowo wszystkie badane konie poddano serii testów behawioralnych. Stwierdzono, że motywacja do wykonania określonego zadania nie ułatwia wykonania go i nie wpływa na szybkość rozwiązania problemu. Również stopień pobudzenia koni, ich reaktywność emocjonalna nie wpływają na szybkość rozwiązywania problemów oraz nie są powiązane z motywacją zwierzęcia w określonej sytuacji do podjęcia działania.

Słowa kluczowe: *Equus caballus,* uczenie się, czynnik mobilizujący, reaktywność emocjonalna

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