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Jumping parameters on different distances of the obstacle combination in free jumping test (preliminary study)

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Abstract

The aim of presented study was to examine the influence of distance between obstacles in combination for free jumping test on some linear and temporal parameters of the jump. A group of halfbred stallions (14 horses) tested on performance test stations were filmed during free jumping test on different distances in obstacle combination between main doublebarre and last cross-pole obstacle. Horses were filmed during their regular work in the training centre one week before performance test. Jumping parameters were obtained on spread obstacle of the size 1m height and 0.8m width. Data were analysed by analysis of variance. In the range of 6.8-7.0 meters between last two obstacles in free jumping combination the task on shorter distances stimulate higher jumps.

INTRODUCTION

Distances are accepted to be a fundamental part of difficulty on sport tournaments in modern course design and should fit into the level of training possibilities of horses that are expected to enter the competition (Gego, 2006). Young horses bred for show jumping sport are word wide checked on the basis of free jumping performance tests. Free jumping tests are used for testing mares and stallions on their performance test obligated for breeding use in most sport horse associations. In Germany and in the Netherlands free jumping is also popular as a separate kind of competition. Basic conditions of free jumping test could be found in performance test programs, but detailed information is not obvious. The effect of distance on the free jumping style of young horses was not investigated even free jumping tests are commonly used. Instructions for the stallion performance tests in Polish Horse Breeders Association allow to keep the distance from 6.5 to 7.2m between 2nd and 3rd obstacle by free jumping combination. These regulations allow to put the distance in the way most suitable for horses. Such attitude allows to demonstrate horse technical skills in the best way according to their training status, however pays a lower attention on other skill – "ability to react". The ability to learn and respond to different stimuli usually directly influences the horse usefulness and value to human (Mc Call 1990). Measurements of horse reaction on different jumping stimuli should have a direct application to training methods commonly utilised in the horse industry. Aim of the study was to investigate the horse reaction on different distance in obstacle combination measured as linear and temporal kinematical response of the jump.

METHODS

Horses

Investigated group consist from 14 stallions attended test for Polish halfbred riding horses. Basic conformation measurements of investigated groups were height at withers 165.3cm (with standard deviation SD 2.6), circumference of the chest 192.3cm (2,5), circumference of the cannon bone 21.6 (0,6). Horses were evaluated by the official commission and received following marks for free jumping skills in trainers opinion 7.0 points (SD 0.8) and in judges opinion respectively: 7.15 (0.8). Horses were in the age of 1241 days (SD 121).

Testing procedures

Horses taking part in investigations were trained for obligatory 100 days stallion performance test. The training consists from 6 days of exercise about 30 minutes work daily. From the beginning of the training period horses performed mostly dressage exercises and two days of free jumping exercise. In the end of test three days dressage, two days jumping under the rider and one day free jumping were used as the scheme.

Both groups of horses were filmed during their regular free jumping work in jumping corridor. According to the instructions of Polish Horse Breeders Association free jumping corridor consists from elements placed on the longer side of riding hall:

- the guard-pole on the ground (then the distance 2,5m to the next obstacle)
- the cross-pole obstacle (5,8m-6,5m)
- the next cross-pole obstacle (6,8m-7,2m)
- the doublebarre obstacle with the height 70cm to 130cm.

Heights of first and second parts of doublebarre obstacle were 1m and 0.85m respectively with width of 0.80m. The distance between cross-poles was 6,4m. Investigated distance between 2nd (cross-pole) and 3rd (doublebarre) obstacles was 6,8m and 7m.

The warming up for both groups consists of 15-20 minutes of longing (mostly trot) outside the riding hall, then horses were allowed to run in riding hall about 1-2 minutes in the jumping corridor. During the test horses jumped from 5 to 7 times. First jump was always performed on vertical obstacle with the height of 0.85m. In case of any problem this kind of entrance jump was repeated. After vertical jump the obstacle was changed for the spread doublebarre obstacle. Vertical obstacle jumps as well as next two successive jumps on the doublebarre obstacle were completed for the first investigated distance – 6.8m. Then the distance was changed to the second investigated. Parameters on vertical obstacle were not taken into analysis. Group of 14 stallions performed 56 jumps on doublebarre. Jumps were filmed by digital camera Panasonic AG-EZ35 (operating 25 frames per second) standing in the middle of the riding hall and filming last doublebarre obstacle. The linear data were obtained by video image analysis using digitalisation of frames and measurement on the selected frames by manual MultiScan program. The scale for measurement was obtained by measuring the distances between natural marks on the wall behind the filmed combination. The temporal data were received from counter of frames by using 25 frames per second (Motion DV Panasonic program, VW-DTM22E).

Temporal and linear jumping parameters

Following linear measurements were measured:

- taking off and landing distances
- height of lifting of leg above obstacle for each leg separately (the lowest point of leg above the highest pole of the second part of doublebarre)
- height of selected points of horse silhouette above the obstacle (withers, croup, head) measured as “bascule points” (measured on the frame when highest point of withers together with the lowest points of croup and head were observed, if the bascule position was observed at more then one digitalised frame, measurements let to identify one frame when the bascule position described as the highest position of wither with the lowest positions were available).
- position of the head measured as a head angle.

These parameters were concluded as repeatable horse characteristics (Lewczuk 2006).

In order to describe the silhouette of horse above obstacle in more detailed way additional parameters were calculated from the basic measurements:

- symmetry of jump – ratio of the taking off distance to the landing distance
- symmetry of front legs – difference between the heights of lifting of front left and front right
- symmetry of hind legs - difference between the heights of lifting of hind left and hind right
- work of head – difference between the elevations of height of wither and height of head
- work of croup - difference between the elevations of height of wither and height of croup
- bow of upper line - difference between the elevations of height of croup and height of head
- work of front legs - difference between the elevations of height of wither and mean of the heights of lifting of front legs
- work of hind legs - difference between the elevation of height of wither and mean of the heights of lifting of hind legs.

Following temporal measurements were achieved (in frames of film):

- difference between leg placements at hind legs by taking off
- time from the last hind limb contact to the bascule position

- account of frames when the bascule position could be observed (amount of frames that were considered as possible bascule frame)
- time from the bascule position to the first front leg contact
- difference between leg placements at the front legs by landing.

All measurements were made by the full contact of the hoofs.

Analysis

The error of data measurements was calculated from 0,17 to 7% for these kind of linear measurements (Lewczuk 1996). The errors calculated by other researchers reached from 3% to 5% (Hole et al.2002, Denoix 2005). Three dimensional equipment (Denoix 2005) allows to receive more precise measurements, however is not always useable in the field condition of investigations.

Statistical analysis for both investigated groups of horses were analysed separately. Statistical analysis of data was performed by analysis of variance – SAS v9.1 by using GLM procedure. The statistical model included fixed effects: successive jump on every distance (1^{st} on 6,8 and 2^{nd} on 6,8m and 1^{st} on 7m and 2^{nd} on 7m), distance between obstacles (6,8m and 7m) as well as the random effect of the horse. Effect of the horse was used to reduce the influence connected with individual animal, also variation caused by previous interaction with humans suggested by McKinley and Sambrook (2000).

RESULTS AND DISCUSSION

The effect of horse was statistically significant for almost all traits. Only symmetry of front legs and symmetry of hind legs as well as the work of hind legs were not influenced by this random effect. The effect of successive jump was statistically significant for lifting of hind legs above the obstacle ($p<0,05$). Heights of hind legs above the obstacle were 4-5cm lower in second jump.

The effect of distance between second and third obstacles is presented in table 1. Significant differences between investigated distances were noticed for linear parameters of lifting of hind legs above the obstacle as well as for elevation of the croup above the obstacle. Height of back part of horse body was lower by longer distance about 5 cm. The symmetry of jump was closer to 1 by closer distance. The lower elevation of croup measured in case of longer distance caused higher value of the work of croup as well as the bowl of upper line. Both additional parameters were different by investigated distances ($p<0,05$).

Temporal measurements were affected by the distance only in case of elevation time. Elevation time was shorter by longer distance about 0,4 frame.

The linear jumping parameters - taking off and landing are mostly discussed in instructions and books for parcours designers, however data given in these books are much more created for adult sport horses. The calculations of distance basically is conducted on the calculations that the average foule of the horse (being mentioned as 3.5 m) and required landing and taking off distances that are given according to class of the parcours (Vademecum Gospodarza Toru 1994). Last instructions took into account that second foule in the combination is mostly shorter (Koziarowski and Jankowski, 2002). These differences between strides before and after obstacle were scientific proved (Kniesel and Leofler, 1982).

In comparison with biomechanical research data - the average length of canter stride given in that instruction is close to that observed by dressage competition for foule of canter from 2 to 3.47m by speed of 3.27 to 5.97 m/s (Clayton 1991; Clayton 1995 a, 1995 b; Back and Clayton 2001).

According to the Polish equestrian instructions following distances for taking off and landing could be given (Vademecum Gospodarza Toru 1994):

vertical obstacle	up to 1.35m high – taking off about 2.0 m, landing about 50% longer
	from 1.35 m high – taking off about 2.5 - 3m, landing 50% longer.
spread obstacle	taking off about 1.5 m, landing 1.6-2.4 m.

From the last Polish course-design instructions for the obstacles being about 1.5m following distances are used (Koziarowski and Jankowski, 2002):

- vertical obstacle – 1.9m taking off and 2.6m landing
- spread obstacle – 1.6m taking off and 2.1 landing
- triplebarre -1.2m taking off and 2.1m landing
- water jump -0.5m taking off.

In the equestrian books except taking off and landing points also the term "jump stride zone" is discussed (d'Orgeix 1986). Following foreign and Polish information was found in books written by sport practitioners:

height of obstacle 0.8 m – 1–2 m before and behind the obstacle (d'Orgeix 1993)
height of obstacle 1.0 m – 2 m before and behind (d'Orgeix 1993)
height of obstacle 1.0 m – 1,5 – 2 m before and 1,8-2,4m behind (Holz 1996)
height of obstacle 1.2 m – 2 – 3 m before and behind (Becher 1987)
height of obstacle 1.5 m – 1.75 – 2.25 m before i 2.05-2.65m behind (Holz 1996)
height of obstacle 2.0 m – 2–2.5 m before i 2.3 – 2.9 m behind (Holz 1996).

That data was not confirmed by science except the average length of the jump about 5m written in German books (Zasady jazdy konnej 2004) and measured by German scientists (Kniesel and Leoffler 1982). The jump stride zone is considered as a speed dependent variable (d'Orgeix 1986). Less is written even in practical books about the influence of obstacle width on jumping parameters, perhaps because it is commonly accepted that height of jump influence jumping parameters more then width of it.

Visualisation of the front of obstacle is an important factor that should be also taken into account. Obstacles with walls or other elements that make the front view of the obstacle more recognisable for horses are expected to influence jumping technique. Horses are expected to jump more “fluent” and “round” (Becher, 1987). The lowest number of mistakes on the wall-kind obstacles was observed in the scientific research on the regional competition (Stachurska et el.2002).

The FEI rules give some regulations according parcours designing for adult sport horses. The article 212 of FEI Jumping regulations – “Combination obstacles” gives a big range of the distance from 7m to 12 m. Except some special competitions (Hunting, Speed and handiness – art.262 and 263 FEI - that required two or more successive efforts) values below 7m between obstacles are not allowed. The National Regulations are in accordance with FEI rules.

Studied equestrian literature gives limited amount of information about the effect of distance on jumping parameters. Mostly the importance of the theory that horses should be trained to jump from different distances is underlined but without detailed information (Skulicz 1992, de Nèmethy 1997, Królikiewicz 2000, Pollmann-Schweckhorst 2002).

On the basis of the conducted study it is possible to conclude that the effect of distance was statistically significant for jumping parameters for both groups of horses. Investigated group of horses did not change the length of the jump, only the take off point was placed closer to the obstacle by shorter distance. The effect of distance was not important for front part of silhouette of horse body (height of head and croup by bascule and front legs above the fence were not effected). However this effect changed heights of hind part of horse body because height of croup and hind legs above the obstacle were influenced by this effect.

Differences observed by jumping technique in investigated group of horses depended on horse effect. The general conclusions required more investigations, but it seemed obvious that horses jumping style is distance dependent. The distance between obstacles influences jumping parameters. It is possible to conclude that the shorter distance the higher the jump, so by evaluation of horses skills knowledge about distances on which they are proved should be important part of information. Better understanding of the nature of horse free jumping seems to be of a great importance for evaluation of jumping horse skills. More research seems to be necessary in the field of practical usage of effect of horse perception on their performance level.

Table 1. Results of the effect of the distance in first investigated group

Parameter		Distance			
		6,8m		7m	
		LSM	SD	LSM	SD
Linear measurements	Taking off	**283,7**	3,6	**292,9**	3,7
	Landing	**250,6**	4,5	**239,7**	4,5
	Lifting of FL	**30,5**	1,6	**28,1**	1,7
	Lifting of FR	**27,4**	1,6	**29,1**	1,7
	Lifting of HL	**32,5** [a]	1,5	**27,5** [a]	1,6
	Lifting of HR	**34,8** [a]	1,5	**30,1** [a]	1,5
	Elevation of head	**148,6**	2,1	**150,4**	2,1
	Elevation of withers	**158,4**	1,2	**156,3**	1,2
	Elevation of croup	**142,8** [a]	1,4	**137,8** [a]	1,5
	Angle of head	**26,1**	0,6	**26,2**	0,7
	Symmetry of the jump	**1,16** [a]	0,03	**1,27** [a]	0,03
	Symmetry of front legs	**3,0**	1,6	**-1,0**	1,7
	Symmetry of hind legs	**-2,2**	0,8	**-2,7**	0,9
	Work of head	**9,8**	2,0	**5,8**	2,1
	Work of croup	**15,6** [a]	0,8	**18,4** [a]	0,8
	Bowl of the upper line	**-5,9** [a]	2,0	**-12,6** [a]	2,0
	Work of front legs	**129,4**	1,4	**127,6**	1,5
	Work of hind legs	**109,1**	0,6	**109,0**	1,6
Temporal measurements	Difference hind legs	**0,11**	0,05	**0,07**	0,05
	Elevation time	**8,4** [a]	0,17	**7,8** [a]	0,17
	Bascule	**1,07**	0,02	**1,03**	0,02
	Landing time	**7,4**	0,14	**7,3**	0,15
	Difference front legs	**1,0**	0,0	**1,0**	0,0
	Total time	**16,8**	0,26	**16,2**	0,26

[a] - differences statistically significant for $p<0,05$

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