ANNALES UMCS
VOL. XXXIV(3) SECTIO EE ZOOTECHNICA 2016

Department of Ethology and Technological Basis of Animal Production
University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin
e-mail: wanda.krupa@up.lublin.pl

JAROSŁAW KAMIENIAK, LESZEK SOŁTYS, WANDA KRUPA,
MONIKA BUDZYŃSKA, MARIA TIETZE

Behavioural reactivity and heart rate of half-bred stallions in a novel stimulus test

Reaktywność behawioralna i tętno ogierów półkrwi w teście nowego bodźca

Summary. The studies were aimed at estimating the behavioural reactivity and heart rate of half-bred Anglo-Arabian stallions subjected to a novel stimulus test. The studies carried out at the Training Centre in Bogusławice involved 129 three-year-old half-bred Anglo-Arabian stallions. All the stallions were exposed to a novel optical and acoustic stimulus generated in a timidity test according to Budzyński's method in an optical, acoustic and optical/acoustic session. Following each session of the test the stallions were rated with regard to respective types of response. They could score from 1 (high behavioural reactivity) up to 10 points (low behavioural reactivity). Heart rate measurements were employed as a physiological indicator of the level of behavioural reactivity. The heart rate of stallions was measured immediately prior to the test (initial heart rate), and then during the optical, acoustic and optical/acoustic session. To calculate the increase in the heart rate for each session, the initial heart rate was deducted from the value measured during respective sessions. A considerable degree of nervous balance was reported for the evaluated stallions. A moving optical stimulus caused the strongest behavioural response. In response to the stimulus the highest increase in the heart rate of the stallions was recorded. A statistically significant difference was found between the mean initial heart rate and the corresponding mean rate recorded during respective sessions of the timidity test. Stallions characterised by high reactivity in the novel stimulus test showed increased values of heart rate. Significant negative correlations between the results of behavioural assessment in the timidity test and the value of the heart rate measured during the test suggest that the novel stimulus test can be used as a fast and objective method of forecasting the suitability of horses for safe and effective use.

Key words: stallions, behavioural reactivity, heart rate, novel stimulus

INTRODUCTION

The contemporary forms of using horses set high-level requirements in terms of the quality of their behavioural characteristics. Various authors have reported a significant

relationship between behavioural reactivity and the breeding value of horses and their behaviour at work [Geringer and Kasprzyk 2000, Geringer *et al.* 2001, König von Borstel *et al.* 2011]. Behavioural characteristics are hereditary [Kaproń 1999]. This enables an effective selection by breeders to eliminate animals which can pass undesired behaviours, such as aggressiveness, onto their offspring. Traits such as nervous excitability or excessive reactivity to stimuli may be conditioned by factors including: gender, age, race, pedigree [Sapuła *et al.* 2002, Hausberger *et al.* 2004, Kamieniak 2006], inbreeding level [Kamieniak 1999], method of breeding and maintenance conditions [Lansade et. 2003].

Reliable and objective behavioural assessment is particularly significant for stallions [Walkowicz and Jodkowska 1995]. Compared to mares, stallions have definitely more numerous offspring. A number of methods have been developed to evaluate the innate and acquired horse behaviour characteristics [Budzyński 1982, Wolff *et al.* 1997, Visser *et al.* 2001]. However, these methods are often underlain by subjective assessment of equine behaviour in various conditions. Methods employing measurements of physiological and biochemical indices are valuable sources of information regarding the behavioural reactivity of horses. One of these methods is heart rate measurement [Mohr *et al.* 2000, Gehrke *et al.* 2011]. Changes in the heart rate reflect the intensity of the response of an organism exposed to novel stimuli and its general physiological fitness [Szarska 2000]. Heart rate measurement provides information about the animal's adaptability to environmental stimuli of various kinds. Increased reactivity to stimuli in some horses can make them difficult to handle and use.

Despite multiple studies being carried out with regard to the behavioural characteristics of horses, a versatile method which would be easy to implement in field conditions has not been found yet.

The studies were aimed at estimating the behavioural reactivity and heart rate of half-bred stallions subjected to a novel stimulus test.

MATERIAL AND METHODS

The studies involving 129 three-year-old half-bred Anglo-Arabian stallions were carried out at the Training Centre in Bogusławice. The response to new stimuli (optical, acoustic) in the examined horses was evaluated using the timidity test method developed by Budzyński [Budzyński 1982]. The test was performed in three sessions:

I – optical – a horse led in hand by man walked between two screens and then returned along the same path. Behind the screens 1m × 1m black and white squares rotated at a speed of 40 revolutions per minute (moving optical stimulus);

II – acoustic – a horse led in hand by man, walking between two screens behind which there were motionless black and white squares and then returning along the same path, was exposed to an acoustic stimulus of 80 tones per minute generated by a tonometer (acoustic stimulus);

II – optical/acoustic – a horse led in hand by man, walking between two screens behind which there were black and white squares in motion and then returning along the same path, was exposed to an acoustic stimulus of 80 tones per minute generated by a tonometer (optical stimulus and acoustic stimulus combined).

Following each session of the test the stallions were rated with regard to respective types of response. They could score from 1 (high behavioural reactivity) up to 10 points (low behavioural reactivity) separately for their passage back and forth. The behavioural assessment in every session of the test was the total number of points scored for the stallion's passage back and forth between the screens, within the range of 2 to 20 points. The ratio expressing the level of physiological reactivity of stallions, resulting from the perception of stimuli used in the test, was the heart rate measurement. To this end, telemetric apparatus Hippocard Polar Sport Tester PEH 4000 was used. The heart rate of stallions was measured immediately prior to the test (initial heart rate), and then during the optical, acoustic and optical/acoustic session. To calculate the increase in heart rate for each session, the initial heart rate was deducted from the value measured in respective sessions. The results were analysed by statistical methods using Statistica 6.0 software. Due to the lack of normal distribution of the analysed characteristics, the resulting data were log transformation. The linear correlation between the studied characteristics was determined by calculating the Pearson correlation coefficients (r_{xy}) and regression coefficients (b_{yx}). The significance of differences between the studied characteristics was estimated in a t-Student test.

RESULTS AND DISCUSSION

The results of the timidity test (Tab. 1) point to a considerable degree of nervous balance in the evaluated stallions. The lowest level of response was recorded during the optical/acoustic session of the timidity test. The mean score given to stallions was the highest (16.25 ±3.75 pts) in this session. On the other hand, the stallions scored lowest (15.13 ±3.64 pts) in the optical session. Statistically significant differences ($p \leq 0.01$) were proved to exist between the mean score of stallions in the optical session and the

Table 1. Behavioural assessment, heart rate and increase in heart rate (X ±SD) of stallions subjected to a timidity test (n = 129)
Tabela 1. Ocena behawioralna, wartości tętna oraz przyrost wartości tętna (X ±SD) u ogierów poddanych testowi lękliwości (n = 129)

Behaviour score Ocena behawioralna (pkt)	I session/ I sesja	15.13 ±3.64^{AB}
	II session/ II sesja	16.14 ±3.55^{A}
	III session/ III sesja	16.25 ±3.75^{B}
Mean heart rate (bpm) Średnie wartości tętna (ud./min.)	basal heart rate/ tętno początkowe	66.98 ±28.91^{CDE}
	I session/ I sesja	94.30 ±33.93^{C}
	II session/ II sesja	85.74 ±27.26^{D}
	III session/ III sesja	88.04 ±32.70^{E}
Mean increase heart rate (bpm) Średnie przyrosty tętna (ud./min.)	I session/ I sesja	26.33 ±39.35 ^{f}
	II session/ II sesja	17.77 ±32.10^{f}
	III session/ III sesja	20.06 ±36.73

The mean values with identical letters are significantly different; upper case letter with $P \leq 0.01$, lower case letter with $P \leq 0.05$
Średnie oznaczone tą samą literą różnią się istotnie; duża litera przy $P \leq 0,01$, mała litera przy $P \leq 0,05$

Table 2. The coefficients of correlation between the results of behavioural assessment in a timidity test and the increase in the heart rate of the examined stallions
Tabela 2. Wartości współczynników korelacji pomiędzy wynikami oceny behawioralnej w teście lękliwości a wartościami oraz przyrostami tętna u badanych ogierów

Specification Wyszczególnienie		Behaviour score/ Ocena behawioralna		
		session I sesja I	session II sesja II	session III sesja III
Mean heart rate Średnie tętno	basal heart rate tętno początkowe	-0.191[x]	-0.183[x]	-0.185[x]
	session I/ sesja I	-0.653[xx]	-0.584[xx]	-0.634[xx]
	session II/ sesja II	-0.765[xx]	-0.755[xx]	-0.788[xx]
	session III/ sesja III	-0.757[xx]	-0.719[xx]	-0.774[xx]
Mean increase heart rate Średnie przyrosty tętna	session I/ sesja I	-0.423[xx]	-0.369[xx]	-0.411[xx]
	session II/ sesja II	-0.478[xx]	-0.476[xx]	-0.502[xx]
	session III/ sesja III	-0.524[xx]	-0.496[xx]	-0.543[xx]

[x] significant with $P \leq 0.05$/ istotne przy $P \leq 0,05$
[xx] significant with $P \leq 0.01$/ istotne przy $P \leq 0,01$

score in the optical/acoustic session. Such a difference was not observed comparing the score of the acoustic session and that of the optical/acoustic session. The mean heart rates measured prior to the test and during respective sessions, along with heart rate increases, are presented in Table 1. A statistically significant difference was found during the mean value of the initial heart rate and the mean heart rate measured during respective sessions of the timidity test. The stimuli used in session I, II and III of the test stimulated a response manifested in an increased heart rate of the stallions. The highest increase (26.33 ±39.35 beats/min) compared to the initial heart rate was noted in response to an optical stimulus. The stallions responded the least intense to an acoustic stimulus, which was demonstrated by the lowest increase in the heart rate (17.77 ±32.10 beats/min). The difference between the increase in the value of the heart rate both during the optical and the acoustic session, was statistically significant with $p \leq 0.05$. The relationships between the intensity of behavioural response, expressed as the number of points scored during respective sessions of the timidity test, and the measured heart rate and its increase are illustrated in Table 2 and in Fig. 1, 2, 3. The correlation and regression coefficients were negative and statistically significant. Stallions characterised by high reactivity in a novel stimulus test showed increased heart rate values. The results indicate that the applied method of behavioural assessment of horses is reliable and objective. Thus, it can be used as a universal approach to estimating behavioural characteristics in field conditions. A method which enables fast anticipation of horses' responses is particularly valuable in terms of satisfactory use of horses. If animals demonstrating excessive reactivity to novel stimuli are excluded from breeding, the risk of accidents in the human-animal interaction will be reduced. However, the assessment of behaviour must take into account the specific breed, experience and traits specific to individual animals. Despite it is believed that behavioural characteristics are not innate, they are considerably modified by the environment. Numerous authors [Janiszewska *et al.* 2004,

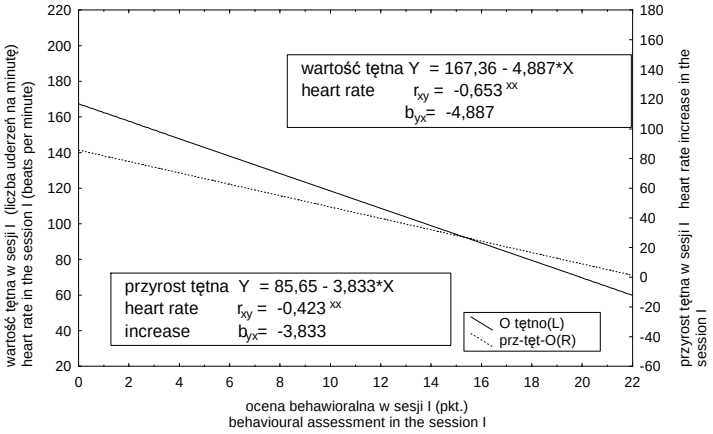

Fig. 1. Regression lines and equations and values of the coefficients of correlation and regression between the behavioural assessment in the session I of a timidity test (score) and the heart rate value and increase (beats per minute) in the examined horses . xx significant with $P \leq 0.01$; (L) – identification of the regression line for heart rate (left axis); (R) – identification of the regression line for heart rate increase (right axis)

Rys. 1. Proste i równania regresji oraz wartości współczynników korelacji i regresji pomiędzy oceną behawioralną w sesji optycznej testu lękliwości (pkt) a wartością i przyrostem tętna (liczba uderzeń na minutę) u badanych koni. xx – istotny przy $P \leq 0,01$; (L) – oznaczenie prostej regresji dla wartości tętna (lewa oś); (R) – oznaczenie prostej regresji dla przyrostu tętna (prawa oś)

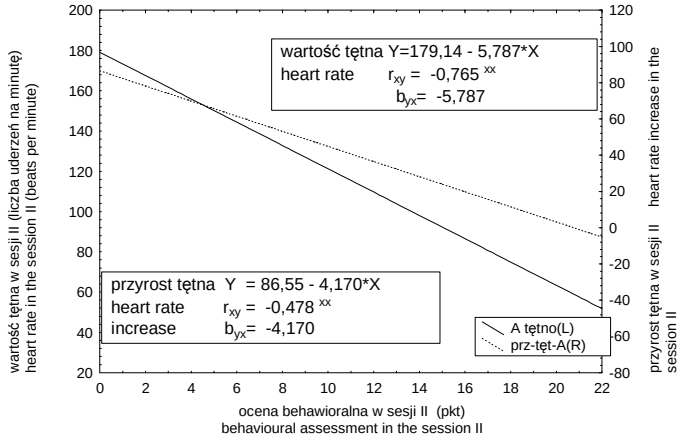

Fig. 2. Regression lines and equations and values of the coefficients of correlation and regression between the behavioural assessment in the session II of a timidity test (score) and the heart rate value and increase (beats per minute) in the examined horses, xx significant with $P \leq 0.01$; (L) – identification of the regression line for heart rate (left axis); (R) – identification of the regression line for heart rate increase (right axis)

Rys. 2. Proste i równania regresji oraz wartości współczynników korelacji i regresji pomiędzy oceną behawioralną w sesji II (pkt) a wartością i przyrostem tętna (liczba uderzeń na minutę) u badanych koni. xx – istotny przy $P \leq 0,01$; (L) – oznaczenie prostej regresji dla wartości tętna (lewa oś); (R) – oznaczenie prostej regresji dla przyrostu tętna (prawa oś)

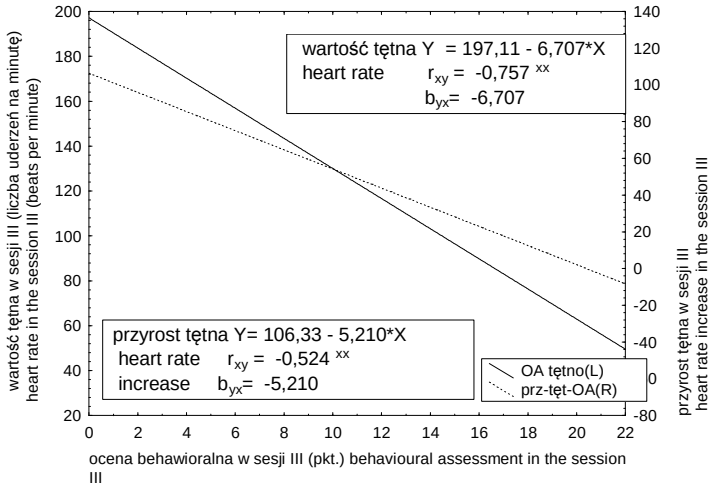

Fig. 3. Regression lines and equations and values of the coefficients of correlation and regression between the behavioural assessment in the session III of a timidity test (score) and the heart rate value and increase (beats per minute) in the examined horses . xx significant with $P \leq 0.01$; (L) – identification of the regression line for heart rate (left axis); (R) – identification of the regression line for heart rate increase (right axis)

Rys. 3. Proste i równania regresji oraz wartości współczynników korelacji i regresji pomiędzy oceną behawioralną w sesji III testu lękliwości (pkt) a wartością i przyrostem tętna (liczba uderzeń na minutę) u badanych koni. xx – istotny przy $P \leq 0,01$; (L) – oznaczenie prostej regresji dla wartości tętna (lewa oś); (R) – oznaczenie prostej regresji dla przyrostu tętna (prawa oś)

König von Borstel *et al.* 2011, Leiner and Fendt 2011] recounted that the intensity of the response to a novel stimulus can decrease after training. Janiszewska *et al.* [2004], using the timidity test, evaluated three-year-old stallions of various breeds in terms of nervous excitability after 100-day training in a training centre. The authors demonstrated a significant impact of paternal breed on the nervous excitability of stallions. The best nervous balance was recorded for sons of Holsteiner stallions. The lowest nervous balance was characteristic of sons of Polish half-bred sires. Rothmann *et al.* [2010] claim that the characteristics of any behaviour related to the level of nervous excitability must be regarded as typical of a specific animal and, as a rule, unchangeable over its lifetime. Horses found by their owners as excitable or unstable received similar opinions during the assessment in utility tests after many days of training. Both the duration of training, the trainer as well as the evaluation site did not change the behaviour of horses and had no impact on the level of their nervous excitability. Rothmann *et al.* [2010] reported that excitable horses scored lower for saddle horse characteristics. Stallions with lower nervous reactivity performed better at jumping.

CONCLUSIONS

To sum up, it must be noted that in the studied stallions the most intense behavioural response and the highest increase in the heart rate, compared to levels measured prior to

the test, were caused by a moving optical stimulus. Significant negative correlations between the results of behavioural assessment in a timidity test and the value of the heart rate measured during the test suggest that the novel stimulus test can be used as a fast and objective method of forecasting the suitability of horses for safe and effective use.

REFERENCES

Budzyński M., 1982. Test „lękliwości" zastosowany do oceny stopnia zrównoważenia nerwowego koni. Med. Wet. 40 (3), 156–158.

Gehrke E.K., Baldwin A., Schiltz P.M., 2011. Heart rate variability in horses. J. Equine Vet. Sci. 31, 78–84.

Geringer H., Kasprzyk J., 2000. Badania behawioralne koni półkrwi poddanych próbom wyścigowym na torze. Zesz. Nauk. PTZ 50, 387–394.

Geringer H., Bek-Kaczkowska I., Banasiewicz E., 2001. Ocena behawioralna koni półkrwi biegających na torze wyścigów konnych. Rocz. Nauk. Zoot. 14 (Suppl.), 27–34.

Hausberger M., Bruderer C., Le Scolan N., Pierre J.S., 2004. Interplay Between Environmental and Genetic Factors in Temperament/Personality Traits in Horses *(Equus caballus)*. J. Comp. Psychol. 118 (4), 434–446.

Janiszewska J., Ignor J., Cieśla A., 2004. Einfluss eines 11-monatigen Trainings auf die Ergebnisse des „Ängstlichkeitstests" von jungen Halbblut-Hengsten. Arch. Tierz. 47 (1), 7–13.

Kamieniak J., 1999. Ocena wskaźników pobudliwości nerwowej uwarunkowanych poziomem inbredu koni czystej krwi arabskiej. I. Wpływ inbredu na cechy pobudliwości nerwowej oraz dzielność wyścigową. Annales UMCS, sec. EE Zootechnica 27 (30), 233–242.

Kamieniak J., 2006. Analiza stopnia pobudliwości nerwowej polskich koni czystej krwi arabskiej z uwzględnieniem dotychczasowych kojarzeń. Rozpr. Nauk. AR w Lublinie 312.

Kaproń M., 1999. Metody doskonalenia koni. Wyd. AR w Lublinie.

König von Borstel U., Pasing S., Gauly M., 2011. Towards a more objective assessment of equine personality using behavioural and physiological observations from performance test training. Appl. Anim. Behav. Sci. 135, 277–285.

Lansade L., Bouissou M.-F., Pape G., 2003. Characterization of temperament in young horses. Proc. 37th ISAE, Abano Terme, Italy, June 24–28, 2003, 157.

Leiner L., Fendt M., 2011. Behavioural fear and heart rate responses of horses after exposure to novel objects: Effects of habituation. Appl. Anim. Behav. Sci. 131, 104–109.

Mohr E., Witte E., Voss B., 2000. Heart rate variability as stress indicator. Arch. Tierz. 43, 171–176.

Rothmann J., Sondergaard E., Christensen O.F., Ladewig J., 2010. Practical assessment of reactivity and associations to rideability and performance traits. Proc. 61st EAAP, Heraklion, Greece, August 23–27, 2010, 151.

Sapuła M., Kamieniak J., Budzyńska M., Gancarz J., Stefaniuk A., 2002. Ocena zdolności pracotwórczych i pobudliwości nerwowej ogierów małopolskich z uwzględnieniem rasy ojca. Annales UMCS, sec. EE, Zootechnica 20 (35), 249–255.

Szarska E., 2000. Badania laboratoryjne w treningu koni. CREX, Tuchów.

Visser E.K., van Reeenen G.C., Hopster H., Schilder M.B.H., Knaap J.H., Barneveld A., Blokhuis H.J., 2001. Quantifying aspects of young horses' temperament: consistency of behavioural variables. Appl. Anim. Behav. Sci. 74 (6), 241–258.

Walkowicz E., Jodkowska E., 1995. Simple ethological tests in the breeding evaluation of Silesian stallions. Mat. Inter. Symp. 18–20 September 1995, Wrocław, 107–111.
Wolff A., Hausberger M., Le Scolan N., 1997. Experimental tests to assess emotionality in horses. Behav. Proc. 40 (3), 209–221.

Streszczenie. Celem badań było oszacowanie reaktywności behawioralnej i wartości tętna ogierów półkrwi angloarabskiej poddanych testowi nowego bodźca. Badaniami przeprowadzonymi w Zakładzie Treningowym w Bogusławicach objęto 129 ogierów rasy półkrwi angloarabskiej w wieku 3 lat. Wszystkie ogiery eksponowano na nowy, optyczny i akustyczny bodziec, generowany w teście lękliwości, przeprowadzonym zgodnie z metodyką opracowaną przez Budzyńskiego, w sesji optycznej, akustycznej i optyczno-akustycznej. W każdej sesji testu za poszczególne typy reakcji przyznawano ogierom punkty w skali od 1 (wysoka reaktywność behawioralna) do 10 (niska reaktywność behawioralna). Jako fizjologiczny wskaźnik poziomu reaktywności behawioralnej wykorzystano pomiar tętna. Tętno mierzono u ogierów bezpośrednio przed rozpoczęciem testu (tętno początkowe), a następnie w jego sesji optycznej, akustycznej i optyczno-akustycznej. Wyliczono przyrosty wartości tętna w każdej sesji, odejmując od zmierzonej w poszczególnych sesjach wartości tętna wartość tętna początkowego Wykazano znaczny stopień zrównoważenia nerwowego ocenianych koni. Najsilniejszą reakcję behawioralną wywoływał ruchomy bodziec optyczny, na który ogiery reagowały największym wzrostem wartości tętna. Wykazano statystycznie istotną różnicę pomiędzy średnią wartością tętna początkowego a średnią wartością tego wskaźnika uzyskaną w poszczególnych sesjach testu lękliwości. U ogierów charakteryzujących się wysoką reaktywnością w teście nowego bodźca stwierdzono większe wartości tętna. Istotne ujemne korelacje zachodzące pomiędzy wynikami oceny behawioralnej w teście lękliwości a wartością mierzonego w teście tętna wskazują na możliwość wykorzystania testu nowego bodźca jako szybkiej i obiektywnej metody prognozowania przydatności koni do bezpiecznego i efektywnego użytkowania.

Słowa kluczowe: ogiery, reaktywność behawioralna, tętno, test nowego bodźca