

A comparison of fitness between horses with different exercise history

Anna BE Barker[1] and AK Warren-Smith[2]

[1]Faculty of Rural Management, University of Sydney, Orange NSW, 2800 Australia

[2]Faculty of Science and Agriculture, Charles Sturt University, PO Box 883, Orange, NSW, 2800, Australia

awarrens@orange.usyd.edu.au

Contents

Abstract. Anecdotal evidence suggests that a horse's prior fitness level has an effect on the horse's ability to return to that previous level of fitness. This trial aimed to test this assumption which would benefit horse trainers to create individual fitness programs for horses. Standardised exercise testing was used to compare the progress of two groups of horses during weeks three and seven of a 14-week training program. Group A had undergone a similar training program twelve months previously and Group B had not. Plasma lactate samples and heart rate monitoring were used to assess the levels of fitness of the horses. Analysis of variance showed that there was no significant difference in post-exercise plasma lactate concentration between the groups. The horses with previous training experience (Group A) had lower (115.7 v 130.6 bpm) but non-significantly different heart rates than those without previous training experience (Group B) at week 3. This trend did not change after an additional 4 weeks of training (115.5 v 128.4 bpm; Group A and B respectively). Irrespective of training history or speed of each incremental step, there was no improvement in heart rate between week 3 (123.1 bpm) and week 7 (122.0 bpm).

***Keywords**:* horse, fitness training, heart rate, blood lactate.

Introduction

Evans (2000) described fitness as the physical ability of a horse to perform in an event or race. A horse's fitness is dependent on its inherited physiological traits and the extent to which its structure and function have been manipulated during training (Evans 2000). Anecdotally, many trainers believe that a horse's prior fitness level has an effect on the horse's ability to return to that previous level of fitness.

Standardised exercise testing (SET) is used by researchers to judge the fitness level of horses. It comprises a series of incremental steps, with each step completed at a different predetermined speed. Serrano *et al*. (2001) found that a basic four-step test provided a successful measure of fitness in horses. These four steps consisted of each horse completing a 450 m distance at progressively increasing speeds (250, 350, 450 and 650 mpm, respectively) with a recovery phase of 400 m trot in between each step of the test.

The most important factor of a SET is that it is repeatable. While it is easier to standardise an exercise test by running the horse under controlled conditions (for example, on a treadmill), data collected from treadmill tests do not truly reflect the horse's response to field exercise. Similarly, field training is often favoured as it produces results similar to that which a horse would achieve in competition or racing. Horses are generally exercised and competed in the field or an open space, introducing other factors such as the rider, weather and terrain that are not present in treadmill testing (Serrano *et al*. 2001) and differences between treadmill and field training have been shown in heart rate and blood lactate concentrations of the horse (Persson 1983; Sloet van Oldruitenborgh-Oosterbaan 1988; Valette *et al*. 1992; Barrey *et al*. 1993; Barrey and Valette 1993; Courouce *et al*. 1997). Treadmill training is often not considered due to the factors above as well as the expensive equipment required (Serrano *et al*. 2001).

Heart rate has been shown to be a reliable method of monitoring the effects of training (Wilson *et al*. 1983; Courouce 1999) and studies have found that training will decrease the horse's heart rate in response to exercise (Marsland 1968; von Engelhardt 1977; Bayly *et al*. 1983; Persson 1983; Evans and Rose 1988; Foreman *et al*. 1990; Seeherman and Morris 1991; Aquera *et al*. 1995). Heart rate monitors can be used to measure the heart rate of a horse throughout an exercise test and can indicate the level of fitness of the horse and changes in the horse's fitness over time (Rose 1990; Rose and Christley 1995; Courouce *et al*. 1997). Likewise, they are an accurate method of monitoring the cardiovascular responses of the animal during exercise (Amory *et al*. 1993; Marlin *et al*.

1995; White *et al*. 1995; Courouce 1999) and are well suited to field-testing (Kobayashi *et al*. 1999).

Post-exercise blood lactate concentration can also be used to indicate the fitness of the horse (Serrano *et al*. 2001). As a horse's fitness increases, post-exercise blood lactate concentrations should decrease (Seren *et al*. 1977; Art *et al*. 1990). Courouce *et al*. (2002) found that training affected blood lactate concentration during a SET, where blood lactate concentration decreased after exercise as training duration increased. However, Hamlin *et al*. (2002) found that acute overtraining was related to an increase in post-exercise blood lactate concentration.

The aim of this study was to clarify anecdotal evidence that a horse's previous training will impact upon its current performance using standardised exercise testing. The use of heart rate monitors during testing and post-exercise blood lactate concentrations enabled the level of the animal's fitness to be quantitatively assessed.

Materials and Methods

Horses

As part of an undergraduate educational program at the University of Sydney, 6 horses (5 geldings (G) and 1 mare (M), mean age ± se 10.3 ± 1.7 yrs) of mainly thoroughbred (TB) breeding (5 TB and 1 TB x stock horse [SH]) were trained following a 14-week interval training program (Table 1, see Appendix). The horses were divided into two groups dependent on whether they had previously undergone a similar training program within the previous twelve months (Group A) or not (Group B). The horses were housed at the University of Sydney, Orange Campus Equine Centre and were fed a commercial concentrate (Horsepower Equestrian Pellets, Horse Power Equine Nutrition Systems, PO Box 975, Windsor, NSW, 2758, Australia) and hay (lucerne and pasture) to meet National Research Council (1989) equine nutritional guidelines. All horses had access to pasture for at least 30 min per day.

The interval training program was aimed at preparing the horses to the desired fitness level such that they would be able to complete the speed and endurance phase of a Novice Level Three Day Event (3DE). The duration of the training program was a total of 14 weeks and all horses underwent the same training. During weeks three and seven of the training program, the fitness of the horses was assessed by means of a Standard Exercise Test. Heart rates during exercise and post-exercise blood lactate concentrations were used to compare the fitness levels of the horses.

The Standardised Exercise Test (SET)

The SET used in this trial consisted of a 30 min warm-up of walk, trot and canter. This was followed immediately by a 5 min trot then four distances each of 450 m completed at speeds of 250, 350, 450 and 650 metres per minute (mpm) respectively. After completing each 450 m distance the horses were trotted at 220 mpm for 310 m whereupon the next 450 m distance was commenced. All exercise tests were performed on the same dirt track (Highlands Paceway, Orange, NSW) and all horses were tested in pairs. The testing procedure was conducted during weeks three and seven of the 14-week training program.

Samples and measurements

<u>Heart Rate Monitoring</u>

Polar Accurex heart rate monitors (Polar Accurex II, Baumann and Haldi, Switzerland) were fitted to the horses with lubricated electrodes placed on clipped patches of the horse under the saddle (off side wither) and girth area (near side). Each horse’s heart rate was continuously recorded during the SET.

<u>Blood Lactate</u>

Venous blood samples were collected by jugular venipuncture using 21 gauge needles into 5 ml vacutainers containing potassium oxalate sodium fluoride (Vacutainer Systems, Becton Dickinson, New Jersey, USA) prior to the 5 min trot (Pre-SET) and immediately after (Post-SET) the final 450 m distance (650 mpm) for plasma lactate assays. All blood samples were immediately placed on ice until they were centrifuged (8 min at 3000 rpm) and the plasma separated. All plasma samples were then stored at -20^{0}C until assayed. Plasma lactate concentration (mmol/L) was assayed using a Dade Behring "Dimension RxL" biochemistry analyser.

The experimental protocol was approved under Protocol Number OAC/6-2004/3/3929 (Animal Care and Ethics Committee, University of Sydney, Australia).

Data Analysis

The heart rate data were tested by analysis of variance of a 2 (Group) x 4 (Speed) x 2 (Week) factorial experiment with randomised blocks (3 replicates). The blood lactate results were analysed using a two-way (Group and Week) analysis of variance. Data were separated using the standard error of the difference of the means (SED).

Results

Heart Rate

The horses with previous training experience (Group A) had lower (115.7 v 130.6 bpm) but non-significantly different heart rates than those without previous training experience (Group B) at week 3 (Table 2, see Appendix). This trend did not change after 4 additional weeks of training (115.5 v 128.4 bpm; Group A and B respectively). Irrespective of training history or speed of each incremental step, there was no improvement (Table 2, see Appendix) in heart rate between week 3 (123.1 bpm) and week 7 (122.0 bpm) of the training program.

The rate of progress of each step significantly ($P<0.001$) affected the heart rate of the horses, increasing from 99.0 bpm at 250 mpm to 121.1, 134.3 and 135.9 bpm (at 350, 450 and 650 mpm respectively). No interactions between the three factors (Group, Week and Speed) were observed in the heart rate data.

Blood Lactate

No significant differences in plasma lactate concentration were observed between horses that had previous training or had not (Figure 1, see Appendix), irrespective of testing time (week three or week seven; $P=0.918$). Conversely to that published in the literature, post-SET plasma lactate concentration tended to increase, though not significantly, as the horses progressed through the training program, regardless of previous fitness training.

Discussion

The experiment reported here was designed to substantiate anecdotal evidence that a horse's previous fitness history influenced the ability to regain fitness. The horses used in this trial were being trained using a 14-week interval training program and standardised exercise testing was conduced on weeks three and seven of this program. The parameters of heart rate during testing and post exercise blood lactate concentration were used to assess the horse's levels of fitness. As there were no significant differences between the horses and within these parameters, we conclude that, under the experimental conditions used in this trial, fitness history had no effect on regaining fitness.

However, in addition to the variables associated with field testing (Serrano *et al*. 2001), differences between the treatments may also have been masked by the small number of horses used (three per group). Combined with the variation in age and to a lesser extent the variations in breed and sex, these have contributed to an overall experimental coefficient of variation (CV) of 8.6%. Using the data of Berndtson (1991), this indicates that only treatment differences greater than 25% could be statistically detected in this trial, assuming an experimental power (the probability that a treatment effect will not go undetected) of 90%. It is likely that the differences to be detected by the treatments imposed in this trial would have been much lower than this (25%) and thus, for future studies of this nature, greater numbers of horses should be used.

Irrespective of previous training history, the horses in both groups showed no improvement in fitness as measured by heart rate during the training period. This may indicate that the training regime was insufficient to increase the fitness of the horses. However, when considered in conjunction with the blood lactate data collected Post-SET, it may be indicative that the horses had in fact been overtrained in the testing period (Hamlin *et al*. 2002). Hamlin *et al*. (2002) showed that post-exercise blood lactate concentration increased if horses experienced overtraining which can occur in a horse when it is excessively exercised before its body is adapted, through training, to cope and that the resultant fatigue causes an increase in the activation of *Type IIb* muscle fibres leading to increased lactic acid production.

There was however, a trend for the horses with previous training history to have lower heart rates during the standardised exercise testing. While this was not significant, and taking into consideration the small sample sizes used in this trial, it highlights the need for further research of this nature to be conducted in order to ascertain whether this trend is in actual fact meaningful.

Conclusion

The data from this trial show that previous training history has no effect on a horse's ability to regain fitness. However, given that there was a trend for those horses with previous training experience in the preceding 12 months to have lower heart rates, there is a need for this type of trial to be repeated with greater numbers of horses to fully confirm the anecdotal reports of the horse's ability to regain fitness.

Acknowledgements

The authors wish to thank Central West Pathology (Orange Laboratory) for the analysis of samples. Bob Jenkins from The Highlands Paceway for allowing us to conduct the testing at the Paceway. Dr Greg Jones for his comments on an earlier manuscript. Students enrolled in the unit Training and Conditioning with The University of Sydney, Faculty of Rural Management who were responsible for the training and care of the horses used in the trial. The assistance for conducting this research and analysing the results were acquired from the undergraduate subjects *Research Methods*

and Statistics and *Research Project* from The University of Sydney, Faculty of Rural Management.

References

Aguera EI, Rubio MD, Vivo R, Santisteban R, Munoz A and Castejon F 1995, 'Blood parameter and heart rate response to training in Andalusian horses', *Revista Espanola de Fisiologia*, no. 51, pp. 55-64.

Amory H, Art T, Linden A, Desmecht D, Buchet M and Lekeux P 1993, 'Physiological response to the cross-country phase in eventing horses', *Journal Equine Veterinary Science,* no. 13, pp. 646-650.

Art T, Amory, H Desmecht, D and Lekeux P 1990, 'Effect of show jumping on heart rate, blood lactate and other plasma biochemical values', *Equine Veterinary Journal Supplement,* no. 9, pp. 78-82.

Barrey E, Galloux P, Valette JP, Auvinet B and Wolter R 1993, 'Stride characteristics of overground versus treadmill locomotion in the saddle horse', *Acta Anatomica,* no. 146, pp. 90-94.

Barrey, E and Valette JP 1993, 'Exercise-related parameters of horses competing in show jumping events ranging from a regional to an international level', *Annales de Zootechnie*, no. 42, pp. 89-98.

Bayly, WM, Gabel AA and Barr SA 1983, 'Cardiovascular effects of submaximal aerobic training on a treadmill in Standardbred horses, using a standardized exercise test', *American Journal Veterinary Research,* no. 44, pp. 544-553.

Berndtson WE 1991, 'A simple, rapid and reliable method for selecting or assessing the number of replicates for animal experiments', *Journal of Animal Science,* no. 69, pp. 67-76.

Courouce A 1999, 'Field exercise testing for assessing fitness in French Standardbred trotters', *Veterinary Journal,* no. 157, pp. 112-122.

Courouce A, Chatard, JC and Auvinet, B 1997, 'Estimation of performance potential of Standardbred trotters from blood lactate concentrations measured in field conditions', *Equine Veterinary Journal*, no. 29, pp. 365-369.

Courouce A, Chretien M and Valette JP 2002, 'Physiological variables measured under field conditions according to age and state of training in French Trotters' *Equine Veterinary Journal*, no. 34, pp. 91-97.

Evans DL 2000, 'Training and fitness in athletic horses', *Rural industries Research and Development Corporation*, Canberra, Australia. 70 pp.

Evans DL and Rose RJ 1988, 'Determination and repeatability of maximum oxygen uptake and other cardiorespiratory measurements in the exercising horse', *Equine Veterinary Journal*, no. 20, pp. 94-98.

Foreman JH, Bayly WM, Grant BDE and Gollnick PD 1990, 'Standardized exercise test and daily heart rate responses of thoroughbreds undergoing conventional race training and detraining', *American Journal Veterinary Research,* no. 51, pp. 914-920.

Hamlin MJ, Shearman JP and Hopkins WG 2002, 'Changes in physiological parameters in overtrained Standardbred racehorses', *Equine Veterinary Journal*, no. 34, pp. 383-388.

Kobayashi M, Kuribara K and Amada A 1999, 'Application of V_{200} values for evaluation of training effects in young thoroughbred racehorse', *Equine Veterinary Journal Supplement*, no. 30, pp. 159-162.

Marlin DJ, Harris PA, Schroter RC, Harris RC, Roberts CA, Scott CM, Orme CE, Dunnett M, Dyson SJ and Barrelet F 1995, 'Physiological, metabolic and biochemical responses of horses competing in the speed and endurance phase of a CCI 3-day–event', *Equine Veterinary Journal Supplement*, no. 20, pp. 37-46.

Marsland WP 1968, 'Heart rate response to submaximal exercise in the Standardbred horse', *Journal Applied Physiology,* no. 24, pp. 98-101.

National Research Council 1989, 'Nutrient requirements of horses', National Academy Press, Washington, DC, USA. 100 pp.

Persson SGB 1983, 'Evaluation of exercise tolerance and fitness in the performance horse', in: DH Snow, SGB Persson and RJ Rose (eds.), *Equine Exercise Physiology 1*, Granta Publications, Cambridge, pp. 441-457.

Rose RJ 1990, 'Exercise and performance testing in the racehorse: problems, limitations and potential', *Proceedings American Association of Equine Practitioners*, no. 36, pp. 491-504.

Rose RJ and Christley RM 1995, 'How useful are submaximal exercise tests to forecast performance?', *Equine Veterinary Journal Supplement*, no. 18, pp. 471-479.

Seeherman HJ and Morris EA 1991, 'Comparison of yearling, two-year-olds and adult Thoroughbreds using a standardised exercise test', *Equine Veterinary Journal*, no. 23, pp. 175-184.

Seren E, Tamanini C, Gaiani R and Bono G 1977, 'Effect of submaximal exercise on blood lactate, creatine phosphokinase and cortisol corticosterone levels in the horse during training', *Archivo Veterinario Italiano*, no. 28, pp. 65-72.

Serrano MG, Evans DL and Hodgson JL 2001, 'Heart rate and blood lactate concentrations in a field fitness test for event horses', *Australian Equine Veterinary Journal*, no.19, pp. 154-160.

Sloet van Oldruitenborgh-Oosterbaan MM, van den Hoven R and Breukink HJ 1988, 'The accuracy of three different heart rate meters used for studies in the exercising horse', *Journal Veterinary Medicine*, no. 35, pp. 665-672.

Valette JP, Barrey E, Auvinet B, Galloux P and Wolter R 1992, 'Comparison of track and treadmill exercise tests in saddle horses: a preliminary report', *Annales de Zootechnie*, no. 41, pp. 129-135.

Von Engelhardt W 1977, 'Cardiovascular effects of exercise training in horses', *Advances in Veterinary Science Comparative Medicine*, no. 21, pp. 173-205.

White SL, Williamson LH, Maykuth PL, Cole S and Andrews F 1995, 'Heart rate and lactate concentration during two different cross-country events', *Equine Veterinary Journal Supplement*, no. 18, pp. 463-467.

Wilson RG, Isler RB and Thornton JR 1983, 'Heart rate, lactic acid production and speed during a standardized exercise test in Standardbred horses', in: DH Snow, SGB Persson and RJ Rose (eds.), *Equine Exercise Physiology 1*, Granta Publications, Cambridge, pp. 487-495.

Appendix

Table 1: The age, breed and sex of the horses allocated to the two groups used in the SET

Group[1]	Horse	Age (yrs)	Breed[2]	Sex[3]
A	1	13	TB	G
	2	8	TB	G
	3	7	TB	G
B	4	16	TB	G
	5	13	TB/SH	G
	6	5	TB	M

[1]Group A = Have had experience in a similar training program in the previous twelve months and Group B had no training experience

[2]TB = Thoroughbred, SB = Stock Horse

[3]G = Gelding, M = Mare

Table 2: Mean heart rates (bpm) of horses that had been previously trained (Group A) or untrained (Group B) recorded on two occasions during a training program (after 3 and 7 weeks of training) at four speeds of travel (mpm) over a 450 metre distance.

Speed (mpm)	Week 3		Week 7	
	Group A	Group B	Group A	Group B
250	92.8	107.7	88.9	106.5
350	112.8	129.3	112.0	130.2
450	126.5	136. 8	135.5	141.3
650	130.8	148.5	128.7	135.4

SED[1] Group (G) 7.68 NS
Speed (S) 4.29 ***
Week (W) 3.03 NS
G x S 9.30 NS
G x W 8.26 NS
R x W 6.06 NS
G x S x W 11.11 NS

[1] SED: Standard error of difference of means

***: P<0.001

Figure 1: Post-SET plasma lactate concentrations (mmol/L) of previously trained (Group A) or untrained (Group B) horses after three and seven weeks of training. Columns with a common letter are non-significant (P>0.05, SED = 2.35).