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BRIEF COMMUNICATION: Linear scoring for life after racing: A pilot study in performance trait evaluation

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Abstract

Thoroughbred horses are prepared for a second career as a sport or recreation horse after completing their racing career. This study aimed to characterise and assess desirable phenotypic traits of Thoroughbreds during re-training after racing. Fourteen traits associated with equestrian sport success and market appeal were described using a linear scoring system. Thoroughbred horses (n=32) were graded both upon entry and sale from a recognised re-trainers facility. The horses were five (IQR 4-7) years old, 162 (IQR 157-165) cm high and 510 (IQR 478-539) kg on arrival. Time to sale was 17 (IQR 7-43) days. Traits associated with behaviour and trainer interaction were changeable and had a tighter distribution around the mid-point of the scale between entry and sale assessments. Body condition score increased and was collinear with body shape, indicating a change in muscle mass distribution. Principle Component Analysis (PCA) assessed the variance between the linear traits. Willingness to work (loading = 0.9), herd bound (loading = -0.7), reactivity (loading = 0.7) and response to bit (loading 0.7) contributed to most of the variation in PC1. Jump scope (loading = 0.8) was the most influential trait in PC2. When horses were grouped by sale time, ease of riding and handling appeared more desirable than high sport potential.

Keywords: Racehorse, Thoroughbred, rehoming, welfare, retraining, body condition score

Introduction

The primary focus in the Thoroughbred industry is to produce a horse for flat racing. In New Zealand, Thoroughbreds typically enter race training as two-year-olds and have a racing career of one to two years (Legg et al., 2021). At the completion of their racing career, well-performing mares, or those with high perceived genetic merit, are retained within the industry for breeding. Geldings and the remaining mares start a second career, often as sport horses (eventing, show jumping, showing etc) or as recreation horses (non-competitive riding horses) (Shrestha et al., 2021; Stowe & Kibler, 2016). This second career typically starts when the horse is five years old and continues until the horse is retired from sport or recreation at 15 – 18 years old (Anderson et al., 2024; McGowan, 2011). Thus, a Thoroughbred may spend the first five years of its life as a racehorse and another 10 to 15 years of their functional life in their second career.

Economically, the greatest return on investment for the Thoroughbred industry is to focus on the production of successful horses for racing. However, public acceptance of the industry as both a sport and commercial activity has a growing focus on the welfare of racehorses after racing (Heleski et al., 2020; Legg et al., 2019). Given that 50 to 70% of the Thoroughbred foal crop will have a second career, as either a sport or recreation horse after racing (Legg et al., 2023; Shrestha et al., 2021), it is important to identify the phenotypes (traits) that are important for successful second careers. In the UK, 61% of Thoroughbred re-trainers reported they had previously had horses that they were unable to rehome or resell, (Hockenhull et al., 2024), highlighting the importance of characterising the desirable traits to maximise the chances of having a successful second career.

Much of the consideration of the important traits and market appeal for equestrian sport has originated from the breeding programmes of European sport horses (Duensing et al., 2014; Koenen et al., 2004). Within this population, the phenotypic and genetic variance components have been estimated for many of the traits currently included within the programme of selection for breeding stallions (Thorén Hellsten et al., 2006). Since 1989, the Netherlands has evaluated sport horse breeding stallions using a linear assessment scale (from 1 to 9), similar to that used within the New Zealand dairy industry for traits other than production (Koenen et al., 1995). The advantage of linear scoring is that it provides information on the magnitude of change and the direction of change in phenotype and whether certain traits are able to be changed or influenced through a re-training programme. This is an important consideration when evaluating the suitability of Thoroughbreds for sport when the primary selection focus has been on traits considered important for racing.

At present, there is a lack of information on the desirable phenotype for sport and recreation horses in New Zealand. Thus, it is important to examine if the traits utilised in European sport breeding programmes are of similar value to the New Zealand market. Moderate scores on the linear scale (around the ‘norm’ of 5) indicate horses that are likely manageable, trainable and suitable for a wide range of buyers. Horses scoring at the extremes of the scale may be more suited to higher levels of specific equine disciplines but could be less appealing to the broader market. Quantification of the phenotypic variance and the ability to modify these traits during the process of re-training the horse could alter industry level breeding objectives. If some second career phenotypes were resistant to change, then the industry should consider if these could be optimised by inclusion in the early education process or via the selection programme for Thoroughbreds.

Many Thoroughbreds are prepared for a second career as a sport or recreation horse after completion of their racing career through the New Zealand Thoroughbred Racing (NZTR) 'NZTR Acknowledged Re-trainers' programme (Anderson et al., 2024). 'Re-trainers' provide qualitative definitions of the desirable characteristics for a sporting career, but at present, there is a lack of quantitative data. Therefore, the aim of this study was to test the feasibility of collecting linear scoring data to characterise the traits of retired racehorses within the re-training environment.

Materials and methods

Fourteen performance and conformation traits associated with sport performance or market appeal of Thoroughbreds transitioning into a second career were identified based on a review of the published literature and expert opinion. These traits included four traits that described horse temperament; horse reactivity, sociability to handler, herd boundness and willingness to work; six traits associated with body type and movement; leg conformation, foot conformation, body shape (muscularity), body condition score (BCS), quality of paces and movement; and four traits associated with horse performance; response to bit, jump scope, jump technique (forelimbs) and jump technique (hindlimbs).

For each trait, a nine-point linear scoring system (with five considered 'normal' or 'average') was developed by either modifying previously published linear scales (Bonow et al., 2024; Koenen et al., 1995) or by development of a bespoke scale. Body condition score was defined using an adapted protocol of (Henneke et al., 1983). An evaluation guide with descriptors was provided to the 'Re-trainers' to assist with score allocation (Supplementary Information 1).

Between October 2024 and June 2025, every Thoroughbred entering a re-training programme was assessed during the horse's first ride (during their first week of arrival) and again at time of sale using the linear scoring system. Data were also recorded on the horse's age, height, sex, colour, body weight, any observed stereotypies (windsucking/cribbing, weaving, fence walking, pulling back) and the 'Re-trainers' assessment of potential career trajectory for the horse (companion animal, amateur/leisure horse, high sport or polo). Data were recorded on pro forma sheets (Supplementary Information 2).

Descriptive statistics (median and interquartile range, IQR) and histograms were used to describe and explore the data. Normality of the data was assessed using the Shapiro-Wilk tests. Differences between potential career categories were assessed with chi-square test of independence for categorical variables and the Wilcoxon test for non-normally distributed data. The Kolmogorov-Smirnov test was used to evaluate differences in the overall distributions between arrival and sale traits. A significance level of $p < 0.05$ was used for all tests.

Density plots and difference plots described differences between the arrival and time of sale linear assessments. Principle component analysis (PCA) was used to identify combinations of important traits at first measurement that explained the most variation among horses. Suitability for PCA analysis was determined using the Bartlett's test of sphericity ($p<0.05$) and Kaiser-Meier-Olkin (KMO) measure of sampling adequacy (MSA=0.54), indicating acceptable correlation structure but borderline sampling adequacy. Horses were grouped into time to sale categories (of <2 weeks, 2-6 weeks, >6 weeks and unsold) to explore relationships between trait patterns and sale outcomes. All statistical analyses were conducted using R version 4.4.3 (R Core Team, 2025) using packages dplyr, tidyr, rstatix, ggplot2, FactomineR, factorextra, GGally and psych.

Results and discussion

There were 32 Thoroughbred horses entering the re-homing facility, and 26 horses (81%) rehomed during the study period (Table 1). There were no differences in sex, colour, stereotypy, age, weight or sale time for the different career potentials assessed ($p > 0.05$). However, horses deemed suitable for polo had a lower median wither height (155 cm, IQR 152 – 155 cm) than horses suited for other disciplines (162 cm, IQR 160 – 165 cm, $p < 0.05$).

Table 1. Descriptors (median and IQR or relative distribution) of Thoroughbred horses (n = 32) entering a retraining facility between October 2024 and June 2025.

Descriptor		Median	IQR
Age (yrs)		5	(4 - 7)
Height (cm)		162	(157 - 165)
Weight on arrival (kg)		510	(478 - 539)
Weight at sale (kg)		509	(480 - 528)
Sale time (days)		17	(7 - 43)
		n	**(%)**
Sex	Gelding	17	53%
	Mare	15	47%
Colour	Bay	19	59%
	Black	2	6%
	Brown	9	28%
	Chestnut	2	6%
Stereotypy	None observed	27	84%
	Fence walking	1	3%
	Pulling Back	1	3%
	Cribbing	2	6%
Career potential	Amateur	14	44%
	Companion	4	13%
	High sport	7	22%
	Polo	7	22%

Full density plots for all traits are provided in Supplementary Figure 1. The traits of sociability to handler (median 5, IQR 5-6), leg conformation (median 5, IQR 5-5) and movement (median 5, IQR 4-5) were very tightly distributed in the mid, or 'normal' range, with no difference between arrival and sale values. Reactivity, quality of paces, response to bit, willingness to work, jump technique (fore and hind limb) and jump scope were not different ($P>0.05$) between arrival and sale assessments (Supplementary Figures 1-14). Jump scope was colinear with jump technique in the forelimbs ($R^2=0.9$) and jump technique in the hindlimbs ($R^2=0.9$).

Body shape (muscularity) was co-linear with body condition score ($R^2=0.9$). Body condition score increased between arrival and sale ($P<0.05$) but body shape did not change ($P>0.05$) (Figure 1). Horses became less herd bound (when removed from other horses) between their arrival and sale times ($p=0.01$, Figure 1). The 'willingness to work' of the horses on arrival was variable (median 6, IQR 5-7) but tended towards a tighter distribution around the 'norm' (with the horse calmly responding to aids) by the time of sale (median 5, IQR 5-6, Figure 1). Likewise, response to bit had a wider distribution on arrival, which narrowed around a 'norm', indicating a softer, more responsive contact at sale. The hooves of horses were slightly flatter and wider upon arrival but tended towards more 'normal' after application of shoes by the regular farrier by the sale time.

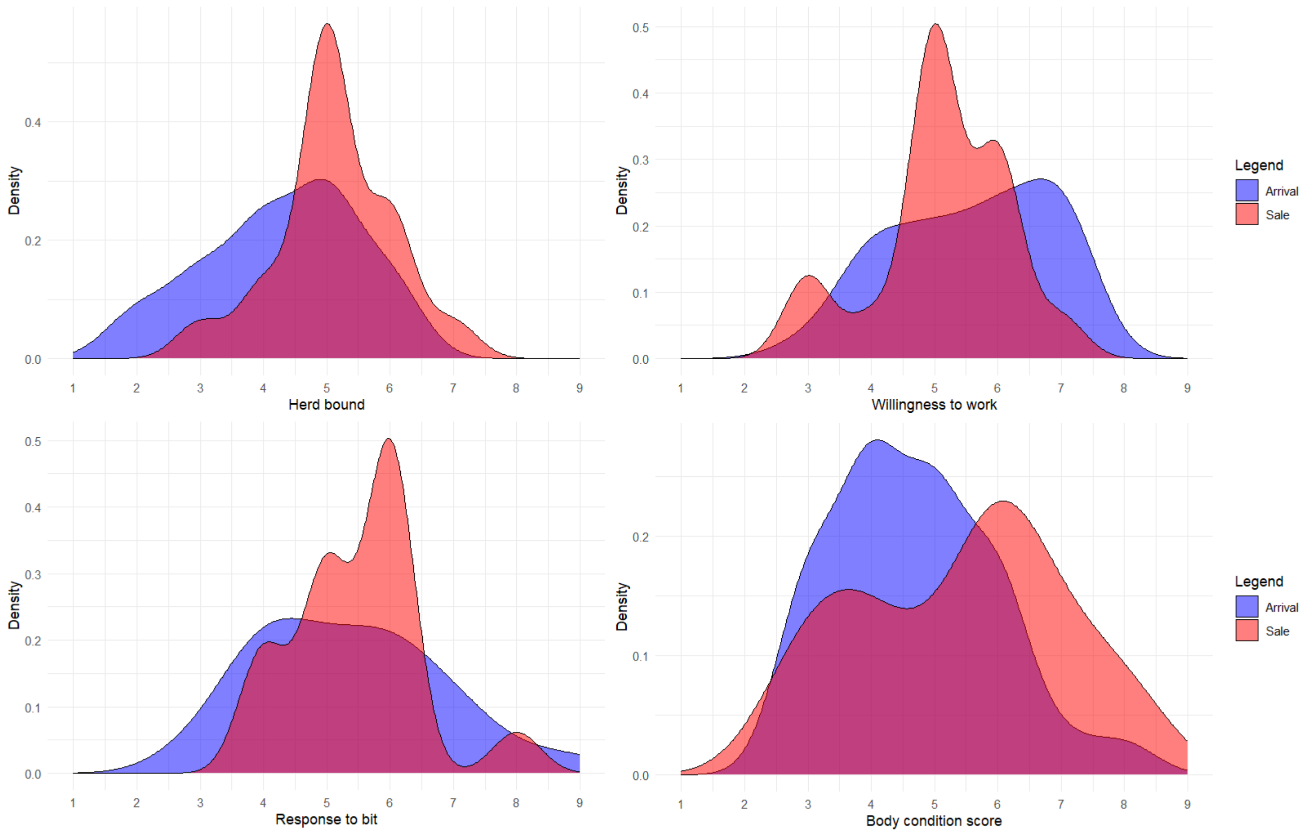

Figure 1. Density plots of the traits of herd boundness, willingness to work, response to bit and body condition score of horses on arrival (n=32) and at sale (n=16).

Horses selected for polo were removed from the PCA analysis as their selection was based solely on their smaller stature, a trait excluded from the PCA as it is not modifiable through re-training. The final set of traits used for PCA were condensed due to collinearities, lack of variability within certain traits and to improve suitability of the dataset for factor analysis as assessed by KMO test (MSA=0.54). Therefore, the nine traits used for PCA included reactivity, sociability to handler, herd bound, willingness to work, quality of paces, movement, response to bit, jump scope and BCS.

The first two principal components (PC1 and PC2) accounted for half (55%) of the total variance (32.1% and 22.5% respectively) in the initial assessment of the linear traits. Figure 2 depicts patterns in trait contributions, with willingness to work (loading = 0.9), herd bound (loading = -0.7), reactivity (loading = 0.7) and response to bit (loading 0.7) contributing to most of the variation in PC1. Jump scope (loading = 0.8) was the most influential trait in PC2, with movement also having a strong association (loading = 0.7). Horses that sold within two weeks had slight negative associations with PC1 and positive association with PC2, indicating horses that were slightly less forwards, had lower reactivity and were happy to work alone with reasonable movement and jumping ability had a shorter time to sale (market appeal).

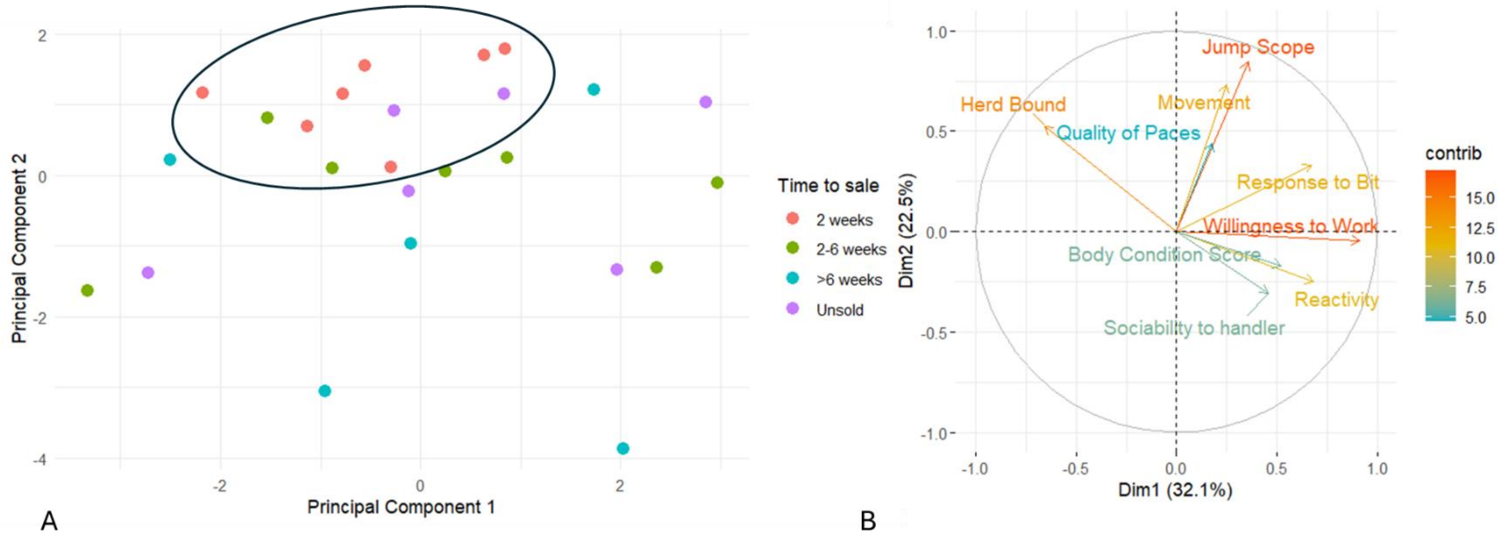

Figure 2. Principal Component Analysis (PCA) biplot of 9 traits measured in 25 horses. The first two principal components explain 32.1% and 22.5% of the total variance respectively. Plot A describes the time to sale of horses relative to their scores on PC1 and PC2. Plot B represent trait loadings on each of the principal components, with vector size and colour indicating the direction and strength of each trait's contribution.

The phenotypes of horses passing through the retraining facility were similar to previous reports of horses retiring from racing in New Zealand (Anderson et al., 2024; Legg et al., 2021), indicating that they represent a normal cohort of racehorses entering their second career. However, as the current study was a pilot study, the data collected was restricted to a single trainer and a small cohort of horses. Despite these limitations, there were distinct trends within the linear traits assessed that provide valuable insights into the malleability of certain traits, and which traits appear to be defined based on genetics and the earlier exposure of the horse to race training.

Within the literature, it is commonly reported that the major market for Thoroughbreds during their second career is amateur or moderate-level equestrian sport (Anderson et al., 2024; Bacon et al., 2025; Shrestha et al., 2021). Examination of the time from arrival to sale in this cohort indicated that traits reflecting ease of use for the owner / rider tended towards the 'norm' around a score of 5. These traits included limited herd boundness (independence), a 'soft' response to the bit, calm and relaxed willingness to work and limited reactivity. These horses did not have linear scores for movement or jumping that demonstrated the ability to excel in equestrian sport (linear scores >5), suggesting low level riders preferred rideability over athleticism. The collinearity between body shape and BCS indicated that changes in BCS may reflect both increases in subcutaneous fat and a redistribution of muscle mass away from a racing phenotype towards the more rounded presentation favoured for sport horses (Anderson et al., 2024; Fowler et al., 2020; Verhaar et al., 2014).

There were a sub-population of small stature horses which were quickly sold with the intention to participate in polo. For this cohort, the primary drivers for appeal appeared to be that they were small in stature and mares were favoured, with little clear association with the linear assessment. These horses also spent little time at the re-trainers before sale, which may reflect that these horses were purchased by professional polo yards rather than an individual rider.

PCA was used to explore preliminary patterns in this pilot dataset despite borderline sampling adequacy. However, significant Bartlett's test results support its use, and future analyses with larger sample sizes may provide stronger associations. The traits that scored highly in the PCA as favourable were phenotypes that demonstrated plasticity and converged towards the norm with time spent at the re-trainers. Therefore, changes in training and management can achieve the desired phenotype for second career in equestrian sport. The short training period between racing and presentation for sale provides a challenge for the re-trainer as some traits such as BCS and reactivity will clearly improve with a longer training transition period (Anderson et al., 2024).

Although heritability was not directly assessed in this study, it is relevant to consider the potential genetic basis of the traits examined, particularly when discussing long-term strategies for improving suitability for a second career as a sport horse. At present, the heritability of the traits assessed in the current study can only be based on data published from riding horse breeds (European data), which indicate most are within the moderate range (0.2-0.4) (Koenen et al., 1995). There is little data on the genetic parameters for Thoroughbreds in sport, though jumps racing ability (hurdle and steeplechase) is reported to have moderate heritability (0.15-0.33) (Bokor et al., 2007). Success at jumps racing may therefore provide a proxy for many of the traits desired in riding horses, particularly for the sport of eventing. However, the limitation with this approach is that within New Zealand, only 3% of race horses participate in jumps racing (Gibson et al., 2024; Legg et al., 2020). Due to the limited number of jumps races in New Zealand and the plasticity in traits, it is difficult to justify a dual-purpose

breeding objective (for both racing and sport). Instead, the most effective use of resources for the industry, would be to focus on training techniques (both early education prior to racing, and re-training) that best modify the horse's behavioural phenotype towards the desirable traits.
Linear scoring systems, offer a promising approach for quantifying the key attributes of Thoroughbreds entering a second career in a structured and repeatable manner. Traits related to the behaviour and management of the horses showed a greater saleability and were modifiable towards the norm with time spent in the re-training environment, whereas traits relating to the conformation or movement of the horse were fixed. Traits that resulted in quick sales indicated ease of riding and handling were more important than the potential to excel in equestrian sport. Thoroughbred re-trainers have an important role in transitioning racehorses into a suitable and successful secondary career after racing.

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