PHYSICAL POWER, TECHNICAL AND AESTHETIC EXECUTION QUALITIES IN DRESSAGE RIDING – A PRELIMINARY INVESTIGATION

Elizabeth J. Bradshaw[1], Wendy Hamerton[2], Andrea Raves[2] and Bill Noble[2]
[1]Australian Catholic University, Melbourne, Australia
[2]Dressage, New Zealand

The current study examined the anthropometric and physical performance qualities of Dressage riders both off and on the horse. Each rider (n = 10) completed an Intermediate competition test on their own horse, and a 10 min strange horse test where they were asked to work the horse through extended and collected gaits. Both tests were graded by two Grade A trainers using four observation categories. All tests were filmed using a 50 Hz camera to obtain a qualitative assessment of the riders' posture during each of the gaits, and a measure of the collected trot and canter velocities during the strange horse test. The riders also had their anthropometric measurements taken and completed strength and power tests. The key qualities that indicated Dressage riding aptitude were a lower brachial index, high concentric leg strength, and reduced tricep strength.

INTRODUCTION: The equestrian discipline of Dressage requires a high level of locomotor control by the rider through exercising and collecting the horse's gaits (walk, trot, canter). In the Dressage test, the horse executes a series of exercises including gait variations and gait transitions. A panel of judges scores the Dressage test subjectively. The horse must exhibit a balanced and supple appearance. Further, the execution of the collected gaits is a specific technical characteristic that can be a critical determinant of successful competition performance (Duel, 1995; Burns and Clayton, 1997). A collected gait includes high elevation (amplitude) of the limbs, a slow stride frequency, and a long swing phase. The horse should place its hind limbs as far as possible under itself; hence, suppleness in the joints of the hind quarters is essential. To perform this task, the rider and horse must be able to communicate well with each other kinaesthetically for the execution of correct mechanical technique and movement harmony.

The rider communicates with their horse kinaesthetically through the seat, contact from the legs and feet, and through the reins. To achieve sensitive rein aids the forearms should be aligned with the reins and the bit, with the hands closed (but not clenched) and the knuckles vertical. If the forearms drop below this alignment, for example, the reins pulls downwards on the bit and provoke the horse to move against the hand, above the bit (Putz, 2002).To generate a good seat the rider should be able to maintain an upright sitting position in the saddle with the ear, shoulder, hip, and ankle all aligned (Schils *et al*, 1993; Wies and Miesner, 2001). This enables the hips to open and the legs to act like a shock absorber, reducing the forces acting upon the rider and the horses back. The rider then has greater capacity to direct their horse kinaesthetically through small changes in their body position and corresponding impulses. The horse learns to follow the rider by keeping the centre of gravity under the rider's weight (Weis and Meisner, 2001). Whilst it is important to have good riding posture, the rider also needs to attain suppleness known as 'positive tone' so that the rider's movement on the horse does not become stiff and jarring (Weis and Meisner, 2001). This requires good flexibility, strength, and balance whilst being able to breathe deeply and maintain good vision of the arena (Putz, 2002).

The sport of Dressage is physically demanding for both the rider and the horse. Specifically, the rider must be able to communicate and control the horse's movement whilst maintaining good posture without stiffening in the seat. Despite the wealth of knowledge on the characteristics of gifted athletes in other Olympic sports (e.g. gymnastics, rowing), limited research to date has addressed the question of whether there are any common qualities that describe a talented Dressage rider. Talent identification programs have typically involved one-off proficiency measures that do not consider an individual's potential to learn. The sport of gymnastics, however, has recently begun to examine the performance qualities for specific apparatus (Bradshaw and Le Rossignol, 2004). The advantages of this new approach in gymnastics are that it encourages training development opportunities in the sport, enabling

gifted individuals to reach their full potential (Abbott and Collins, 2004). Dressage trainers regularly rely upon a learned ability to recognize qualities in a rider that may enable them to train a horse to international level (e.g. commitment, eagerness to learn, physical ability). Trainer observations may provide a better measure for ascertaining the quality of the riders' current technique and performance, in preference to one-off performance scores from traditional judging methods.
The purpose of the current study was, therefore, to examine the anthropometric, physical power, technical and aesthetic execution qualities that are related to superior riding technique and performance.

METHODS: Ten female Dressage riders (age: $\bar{X}$ = 23 years SD ± 9, height: 173.7 cm SD ± 5.0, weight: 63.0 kg SD ± 6.5) completed a series of on and off horse tests. The on horse tests included a NZ Equestrian Federation intermediate competition test, and a 10 min strange horse test where the rider was asked to work an unfamiliar horse through the extended and collected equine gaits. All on horse tests were filmed using a 50 Hz digital camera for the purpose of qualitative and quantitative video assessment, and were judged by two Grade A Dressage NZ trainers. Both of the on-horse tests were graded out of 40 points using four observation categories of desire and physical ability to create harmony for the horse during the competition test, their ability to deal with circumstances that arose during the test, as well as their ability to ride a strange horse. During the off horse tests the riders had their anthropometric dimensions (height, weight, sitting height, 6 bone lengths/breadths), and 1 repetition maximum (rpm) seated row, 1 rpm tricep extension, and 1 rpm v-sit press strength measured. Leg power was assessed on a Kistler 'Quattro' force plate operating at 500 Hz during a series of jump tests (squat, countermovement, 30 s continuous bent leg). The single jump test force curves were analysed to obtain the vertical displacement, and peak take-off force and power. The continuous jump test force curves were analysed to obtain the average vertical displacement and force for the first five and last five jumps. The strange horse test was analysed using Silicon Coach Pro software to obtain collected trot and canter velocities by digitizing known arena markers and the horse's elbow (olecranon) joint. The rider's posture during the competition test was analysed qualitatively for each side (left, right), rein (left, right), and gait (walk, trot, canter) (trunk, leg, forearm posture; each scored as correct = 2 points, minor fault = 1 point, major fault = 0 points). The posture score was averaged for each gait (max score = 6 points) and then combined to obtain a total posture score (total posture score out of 18 points). The trainer's evaluations of the on-horse tests provided a performance score (the dependent measure) in order to statistically assess the 18 independent measures as predictors of Dressage riding talent. Separate linear regression models were developed in SPSS 11.0 to determine whether there was a significant relationship ($p < 0.01$) between each of the predictor measures (e.g. squat jump force, collected canter velocity) and the outcome variable of average trainer score or performance rank (1 = best, 10 = lowest). One-way analysis of variance (ANOVA) was utilized to determine if there was a significant group effect between the top 5 and lower 5 riders for the predictor measures.

RESULTS AND DISCUSSION: The present study attempted to provide insight into the qualities related to superior riding technique and performance by comparing on and off horse measures with trainer observations. The judgements of the trainers in this study for each rider's competition and strange horse test revealed the large discrepancy in human observations ($r = 0.226$, $r^2 = 0.051$, ns). Trainer 1 awarded an average test score of 17.70 points (SD ± 0.82) and 7.00 points (SD ± 1.33) for the competition (max = 30 points) and strange horse (max = 10 points) test scores respectively (total score of 24.49 points (SD ± 2.12). Trainer 2 gave an average of 18.90 points (SD ± 2.23) for the competition test and 7.25 points (SD ± 1.16) for the strange horse test (total score of 26.15 points SD ± 2.88).
People can only make judgements about movement if they have internally stored knowledge and experience from which to judge it (Scully, 1986). An individual's internal model (the picture in their head) of a specific movement can be greatly influenced by the people and, in

this case, the horses around them. Each of the trainers had different cultural backgrounds from which they received their technical training and experience (England, Germany). This can influence their preferences for what the key characteristics are for the development of correct movement actions. Further, the sensitivity of the human eye for movement (~2 Hz) limits the level of detail from which people can observe and judge movement, particularly when the movement is fast. Superior performance in a Dressage test, however, requires the rider and horse to execute a routine that adequately convinces all of their human observers. Whilst flawless technique is fundamental for this task, solitary trainer observations are not a suitably finite measure for judging performance and/or identifying talented riders. Anthropometric and other performance measures that relate to the observations of both trainers may provide better insight into the qualities relating to Dressage riding ability.

Table 1 The key predictors of Dressage riding aptitude. All linear regression models are statistically significant (p = 0.001).

		Equation	r	r^2
Performance Score	=	0.100 x 1RPM Tricep Extension – 0.483 x Brachial Index + 55.717	0.97	0.93
Performance Rank	=	0.726 x Brachial Index – 1.192 x SJ Forcer – 45.281	0.93	0.86

The anthropometric and physical performance test results and predictor equations are presented in Tables 1 and 2. A low brachial index was the key predictor of Dressage riding performance (r = 0.92, r^2 = 0.85, p = 0.001) revealing that gifted riders have shorter forearms in relation to their upper arms, similar to soccer players, power lifters and gymnasts (Norton and Olds, 1996).

Table 2 On and off-horse measures for the ten Dressage riders. Brachial index is the length of the forearm (radius) as a percentage of the upper arm (humerus). The abbreviation * denotes a significant (p < 0.01) difference between groups (top 5 riders, bottom 5 riders).

Rank	Score (n)	Trot Velocity (m/s)	Canter Velocity (m/s)	Overall Posture Score (n)	Brachial Index (%)*	1RPM Tricep Extension (kg)	1RPM V-Sit Press (kg)	SJ Force (BW)
1	28.50	2.46	2.70	13.00	66.9	50.0	17.5	2.19
2	27.75	2.73	3.01	10.83	67.6	48.0	15.0	1.87
3	26.75	2.64	2.85	12.42	71.9	51.0	6.0	1.80
4	25.50	2.80	3.26	12.75	73.3	53.0	12.5	2.28
5	25.25	2.68	3.10	9.83	71.2	45.0	12.5	1.85
6	25.00	2.80	3.30	9.50	75.0	46.0	10.0	1.40
7	24.50	2.80		14.75	75.0	60.0	12.5	1.95
8	24.00	2.98	3.13	10.25	74.4	50.0	12.5	1.62
9	23.50	2.81	3.02	13.50	78.5	58.0	12.5	2.12
10	22.00	2.47	2.89	12.00	77.1	36.0	4.0	1.79
Top 5 ($\bar{X}$)	26.75	2.66	2.98	11.77	70.2	49.4	12.7	2.00
Top 5 (SD)	1.40	0.13	0.22	1.37	2.8	3.0	4.3	0.22
Bottom 5 ($\bar{X}$)	23.80	2.77	3.09	12.00	76.0	50.0	10.3	1.78
Bottom 5 (SD)	1.15	0.19	0.17	2.19	1.7	9.7	3.7	0.28
Group ($\bar{X}$)	25.28	2.72	3.03	11.88	73.1	49.7	11.5	1.89
Group (SD)	1.97	0.16	0.19	1.73	3.8	6.8	4.0	0.26

Higher concentric leg force and reduced tricep strength were further qualities that related to Dressage riding aptitude. In regards to on-horse performance, the findings for the squat jump test may indicate that the more talented rider has greater capacity in the legs for a good seat.

A less talented rider may extensively raise or lower their forearms to control the horse by contracting the triceps, leading to increased strength in these muscles. A more talented rider may predominantly change the tension on the reins by contracting the back musculature and keeping a relatively stable forearm position. No significant differences were revealed, however, between groups for the 1 rpm seated row test (top 5 - 40.4 kg SD ± 6.5, top 5 - 40.2 kg SD ± 7.1). Whilst good posture such as a vertically upright torso is a known characteristic of superior riders (Schils et al, 1993), in this study, posture measures were not revealed to be a useful talent identification measure, possibly because there is minimal variation between riders of a certain performance level (beginner, intermediate, advanced) (Schils et al, 1993). Post-hoc analysis revealed, however, that high concentric leg (squat jump force) and abdominal strength (1 RPM v-sit press) were prerequisites for good riding posture ($r = 0.91$, $r^2 = 0.83$, $p = 0.005$).

A horse and rider's ability to perform the collected gaits is one of the main determinants of success in Dressage. Although not statistically different, a slower collected trot (3.97%, ns) and canter (2.93%, ns) was revealed between the top five and the lower five riders when riding an unfamiliar horse. Compared to reference data provided by Barrey (2001) the riders collected trot was slower (current study - 2.72 m/s SD ± 0.16; reference data – 2.80 m/s) but their collected canter was faster (current study – 3.03 m/s SD ± 0.19; reference data – 2.90 m/s). The amplitude of the collected canter movement is arguably difficult to control, particularly when riding a strange horse. It would be reasonable to expect that at the intermediate stage of Dressage development, the riders may have not yet mastered the production and control of this gait with complete suppleness. The attributes of the horse, such as the suppleness of the hind quarters, may also limit the performance of this movement.

CONCLUSION: Whilst trainer observations were revealed to not be a suitably finite measure for judging performance and identifying talent, the study did reveal key qualities that may provide a guide for assessing and/or training a rider both on and off the horse to reach their full potential in Dressage. The key qualities that indicated Dressage riding aptitude included a lower brachial index, high concentric leg strength, and reduced tricep strength. Future research is required to monitor the identified qualities of these riders with training, both off and on the horse, in the long term.

REFERENCES:

Abbott, A. & Collins, D. (2004). Eliminating the dichotomy between theory and practice in talent identification and development: considering the role of psychology. *Journal of Sport Sciences*, 22, 395-408.

Barrey, E. (2001). Inter-limb coordination. In; Back, W. & Clayton, H. (2001). *Equine Locomotion*. Harcourt Publishers, London, 77-94.

Bradshaw, E.J. & Le Rossignol, P. (2004). Anthropometric and biomechanical field measures of floor and vault ability in 8-14 year old talent-selected gymnasts. *Sports Biomechanics*, 3, 249-262.

Burns, T.E. & Clayton, H.M. (1997). Comparisons of the temporal kinematics of the canter pirouette and collected canter. *Equine Veterinary Journal*. Suppl. 23, 54-57.

Duel, N.R. (1995). Dressage canter kinematics and performances in an Olympic three-day event. In, *Proceedings of 46th Annual Meeting of the European Association for Animal Production,* Horse Commission, H-2.3, 4, Prague.

Norton, K. & Olds, T. (1996). *Anthropometrica. A textbook of body measurement for sports and health courses*, UNSW Press, Sydney, Australia.

Putz, M. (2002). The rider's seat. *Dressage New Zealand Training Squad Handout*, Palmerston North.

Schils, S.J., Greer, N.L., Stoner, L.J., & Kobluk, C.N. (1993). Kinematic analysis of the equestrian – walk, posting trot and sitting trot. *Human Movement Science*, 12, 693-712.

Scully, D. (1986). Visual perception of technical execution and aesthetic quality in biological motion. *Human Movement Science*, 5, 185-206.

Weis, R. & Meisner, S. (2001). Der sitz des reiters und sein einfluss auf das pferd (The posture does the riding). *German Equestrian Federation Lecture Tour.*