Directional asymmetry of facial & limb traits in *Equus Caballus* *including* a comparison of horse & pony bilateral traits

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INTRODUCTION:

Symmetry of bilateral traits within the athletic physical form is suggested to influence performance capabilities, especially in relation to the Thoroughbred racehorse on which most of the current research has been undertaken. Traits of lesser functional importance are often shown to display greater asymmetry than functional traits (Markow and Clarke, 1997; Moller, 1993). Greater symmetry of functional traits such as the legs was suggested to be due to the mechanical demands placed on these traits (Manning and Ockenden 1994). Watson et al. (2003) reported longer left third metacarpal (MCIII) lengths than right, in 76% of racing Thoroughbreds investigated. This was theorised to be a consequence of human selection rather than imbalances induced by training stresses as the MCIII ceases to grow in length by seven months of age (Thompson, 1995) and should therefore not be affected by subsequent training. Runners on the more common anticlockwise track are presumed to have a mechanical advantage if their outside forelimb is longer. Currently the only data that exists regarding directional asymmetry of horses are based on populations of racing Thoroughbreds. For greater understanding of the existing results, data from a more diverse and representative, general population of *Equus caballus* are needed. The aims of this research were therefore to compare, within a more general equine population, the magnitude and direction of asymmetry within functional and non-functional traits to that previously observed in racing populations.

METHOD:

One-hundred horses over the age of five, and without a competitive record were chosen using convenience sampling from two equestrian centres and two livery yards within Gloucestershire, UK. The sample was investigated both as pooled data and following separation in to horses (>148cm) (n = 57) and ponies (≤148cm) (n = 43). Eleven functional and four non-functional bilateral traits were measured using Invicta metric callipers (1mm accuracy), comparable with previous studies (Manning and Ockenden, 1994; Manning and Pickup, 1998). Three repeated measures were taken by one assessor and absolute asymmetries (A) were calculated by subtracting the mean of the left trait (L) from the mean of the right trait (R) (A = L-R) (Manning. and Pickup, 1998). Directional asymmetries were determined as positive where L>R and negative where R>L. The directionality of the data were examined using two-way classification chi-squared analysis at the $P<0.05$ significance level to test the assumption that if no directional bias exists the distribution frequency of left and right for each trait should be equal. Expected values were set as an equal split of the population demonstrating positive directional asymmetry (PDA) and negative directional asymmetry (NDA).

RESULTS:

Significant differences were found between the observed and expected values for the directionality of asymmetry within the pooled group data ($\chi^2 = 39.8$, df = 14, $P \leq 0.05$) and the pony sub-group ($\chi^2 = 31.3$, df = 14, $P \leq 0.05$) but not for the horse sub-group ($\chi^2 = 18.5$, degrees of freedom = 14, $P \geq 0.05$). Length and width of bilateral facial traits showed prevalence for PDA (Table 1). Mean trait values tended to be greater for the side with greater DA prevalence except for pinna length in the pony sub-group where the mean value for the right side was greater despite PDA, indicating that although fewer individuals exhibited PDA of this trait, the asymmetry magnitude was greater (Figure 1).

PDA was demonstrated for FPP length and width for all groups. MCIII length exhibited NDA in all groups however NDA of MCIII was only exhibited within the horse sub-group. Width and depth of the carpal both presented with NDA. Mean trait values tended to be greater for the side with greater DA prevalence except for MCIII length or carpal depth where the mean value was within the side showing less DA prevalence. Hind limb traits displayed a strong prevalence for DA. Tarsal width and HPP length demonstrated greater NDA for all three groups whereas HPP width expressed PDA. NDA was exhibited for MCIII length whilst width of this trait presented PDA.

Table 1: Directional asymmetry (%) of the pooled, pony and horse groups

	Ponies (%)			Horses (%)			Pooled (%)		
	PDA	NDA	Zero DA	PDA	NDA	Zero DA	PDA	NDA	Zero DA
Pinna length	53	33	15	45	49	6	48	42	10
Pinna width	65	28	8	51	37	12	57	33	10
Nostril length	45	48	8	55	36	9	51	41	8
Nostril width	51	39	10	50	38	13	51	38	11
FPP length	26	16	1	70	23	7	66	29	5
FPP width	22	14	7	53	33	14	52	33	15
MCIII length	10	30	3	25	68	7	24	69	7
MCIII width	15	12	16	40	42	18	38	36	26
Carpal length	7	27	9	39	47	14	29	54	17
Carpal depth	17	21	5	46	49	6	43	49	8
HPP length	18	23	2	48	50	2	45	52	3
HPP width	23	14	6	47	40	13	50	37	13
MTIII length	12	31	0	41	57	2	35	64	1
MTIII width	20	10	13	49	33	18	48	29	23
Tarsal width	8	30	5	42	46	13	31	55	12

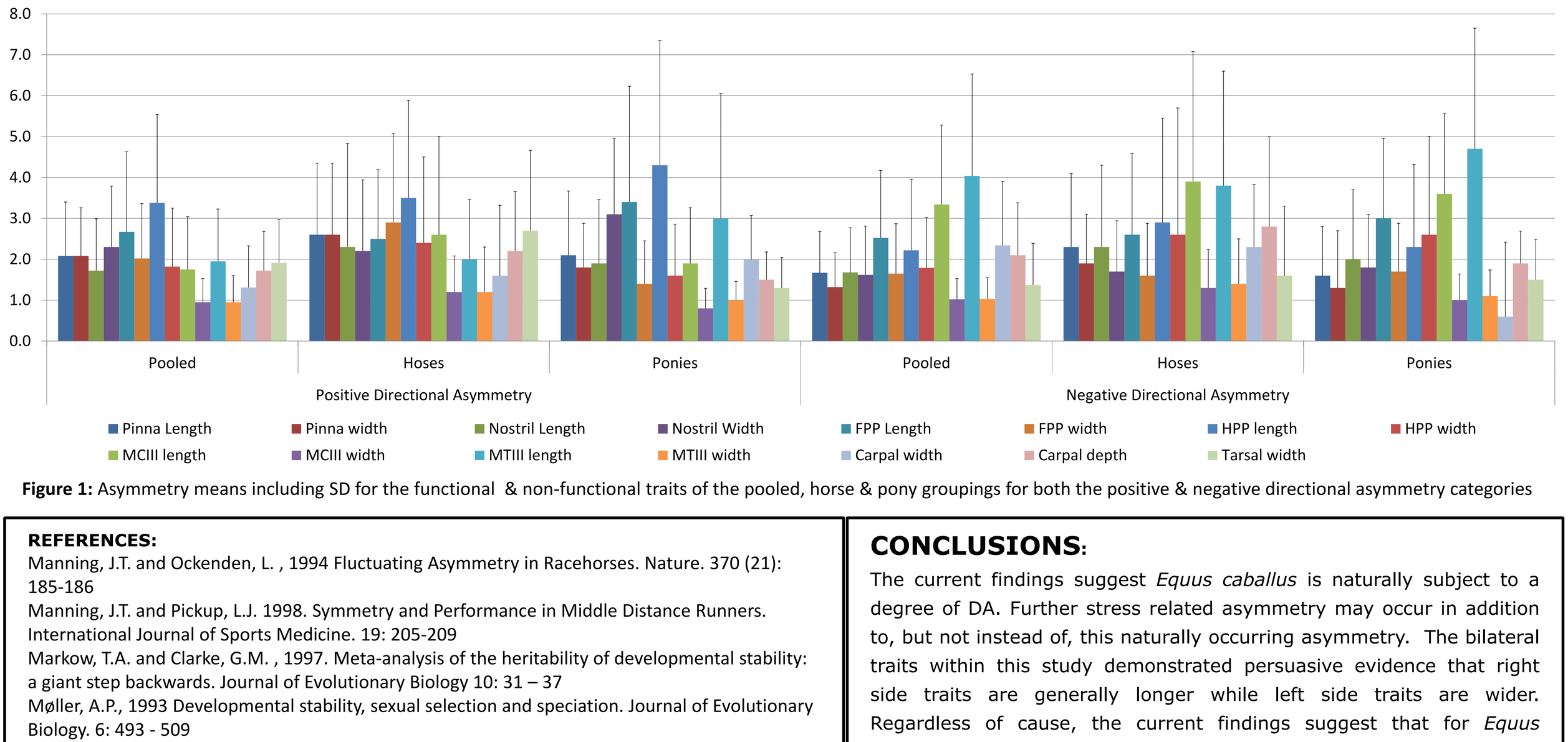

Figure 1: Asymmetry means including SD for the functional & non-functional traits of the pooled, horse & pony groupings for both the positive & negative directional asymmetry categories

REFERENCES:

Manning, J.T. and Ockenden, L. , 1994 Fluctuating Asymmetry in Racehorses. Nature. 370 (21): 185-186

Manning, J.T. and Pickup, L.J. 1998. Symmetry and Performance in Middle Distance Runners. International Journal of Sports Medicine. 19: 205-209

Markow, T.A. and Clarke, G.M. , 1997. Meta-analysis of the heritability of developmental stability: a giant step backwards. Journal of Evolutionary Biology 10: 31 – 37

Møller, A.P., 1993 Developmental stability, sexual selection and speciation. Journal of Evolutionary Biology. 6: 493 - 509

Thompson, K. N., 1995. Skeletal growth rates of weanling and yearling Thoroughbred horses. Journal of Animal Science. 73:2513-2517.

Watson, K. M., Stitson, D.J. and Davies, H.M.S., 2003, Third Metacarpal bone length and skeletal asymmetry in the Thoroughbred Racehorse. Equine Veterinary Journal. 35 (7): 712-714

CONCLUSIONS:

The current findings suggest *Equus caballus* is naturally subject to a degree of DA. Further stress related asymmetry may occur in addition to, but not instead of, this naturally occurring asymmetry. The bilateral traits within this study demonstrated persuasive evidence that right side traits are generally longer while left side traits are wider. Regardless of cause, the current findings suggest that for *Equus caballus*, DA may be the optimum for certain traits; rather than the presumed optimum of symmetry. The naturally occurring DA in this study may help to explain why many horses are reported by riders to be stiffer to the left and softer to the right yet harder to train to the right.

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