# Associations between limb lateralisation & hoof & limb asymmetries in adult horses

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## INTRODUCTION:

Conformation of the horse has a large influence on the athletic performance and the prevalence of injury. Prevalence of conformational asymmetries has been noted amongst different species (Manning and Ockenden 1994) and studies have demonstrated a link between asymmetry incidence and subsequent, comparatively lower performance levels (Manning and Ockenden, 1994; McDonald and Dumbell, 2007). Development of asymmetries has been linked to genetic and environmental factors (Wilson and Manning 1996) as well as lateralised behaviour (van Heel et al 2006). Lateralisation occurs both at population and individual levels, and results in subjects showing a use preference for a specific side (McGreevy and Rogers, 2005). Cerebral hemisphere differences, genetics and environmental factors are all thought to affect the development of lateralisation and handedness (Yetkin, 2002; Murphy et al, 2005; Corbetta et al, 2006) however it is an area of research which is not fully understood. Laterality produces dominant sides, which can result in tissue hypertrophy through increased usage and therefore potentially influence performance. Lateralised grazing behaviour is recognised in horses, and linked to hoof asymmetries in foals where both the hoof and limb dimensions could be considered variable. Little evidence links lateralised behaviour to hooves and distal limb asymmetries of adult horses where skeletal dimensions are fixed, however hoof conformation is still an adaptable anatomic parameter.

## METHOD:

Preference tests were performed on 54 sound horses by recording the protracted limb during stance and forage from a bucket following their un-restrained advance from five meters away; similar to the method described by van Heel et al (2006). Each horse undertook ten repetitions of the preference test and were subsequently split in to three groups; left lateralised (LL) (22), right lateralised (RL) (24) and ambidextrous (8) groups according to their laterality indices (LI)

$$LI = \left| \frac{(LL - RL)}{(LL + RL)} \right| \times 100)$$

Whilst stood squarely on a firm, level surface, measurements of the widths of the top (HT) and base (HB) of the hoof were taken for each of the horses using callipers. Hoof spread (HS) was then calculated (HS = HB-HT). Lateral view digital photographs were taken and toe angle (TA) determined using Dartfish software. Height of the elbow and carpometacarpal joint from the ground (CMC), and width of the proximal region of third metacarpal (MC3W) were measured. Following a Kolmogorov-Smirnov test for normality; measurements from LL and RL groups were compared against their contralateral pair (paired t-test), and against the same trait within the opposite lateralised group (unpaired t-test). Parametric correlation analyses were undertaken between the variables within each group

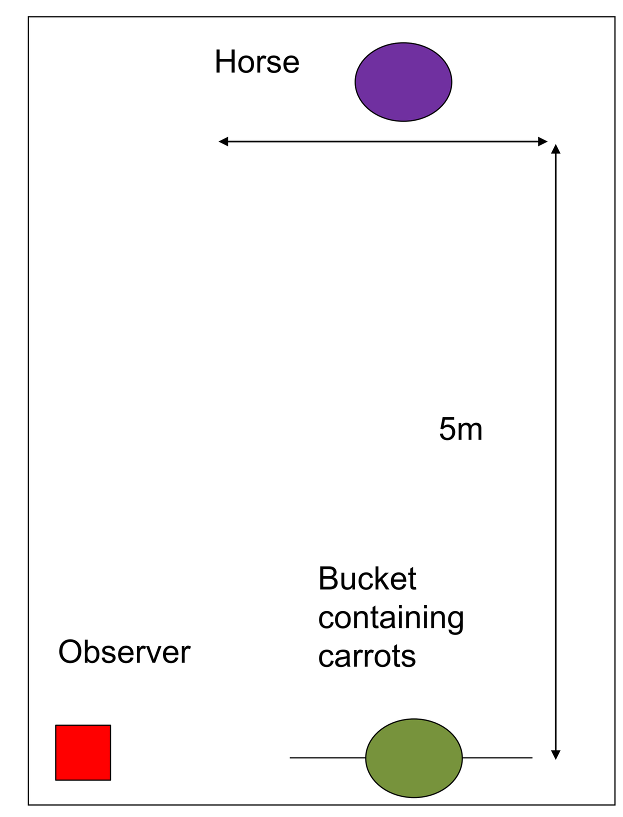


**Figure 1:** Equipment set-up for preference testing

## RESULTS:

For the majority of variables measured, the dimensions of the contralateral pairings correlated (Table 1), as would be expected; as such, as the left side increased in size so did the right side. An exception to this was the TA within the LL group. In addition, the intra-limb measurements of MC3W and CMC measurements, which would be expected to correlate, were not observed to within the RL group. These results illustrate the lack of an expected proportional change in dimensional within these variables. Within the RL group, both limbs exhibited positive correlations between CMC and, HB and HT (P≤0.05). Despite the observed TA correlation within the RL group, a significant difference in TA, with the right TA being significantly larger (P≤0.01) than the left was identified (Figure 2). This finding indicates that although dimensions change proportionally, an asymmetry of this paired trait exists. HS was noted to correlate with HB with both limbs of both laterality groups; however the correlation between HS and HT was only observed within the RL group. These results again indicate a difference in the proportional hoof growth between the LL and RL groups.

Within the LL group, right CMC was significantly greater (P≤0.001) than left and right CMC correlated with left MC3W (P≤0.05). This analysis signifies that for the left lateralised group the length of the third metacarpal was greater on the right and, as this limb increased in length within the population, the width of the left third metacarpal also increased. LL may therefore be an influencing factor in asymmetry occurrence. CMC in the RL group positively correlated with HB and HT in both limbs (P≤0.05). The only correlations that were observed within the LL group only were inter, and intra-limb correlations between HS and elbow height (P≤0.05), indicating that as the length of the limb increases, so does the HS.

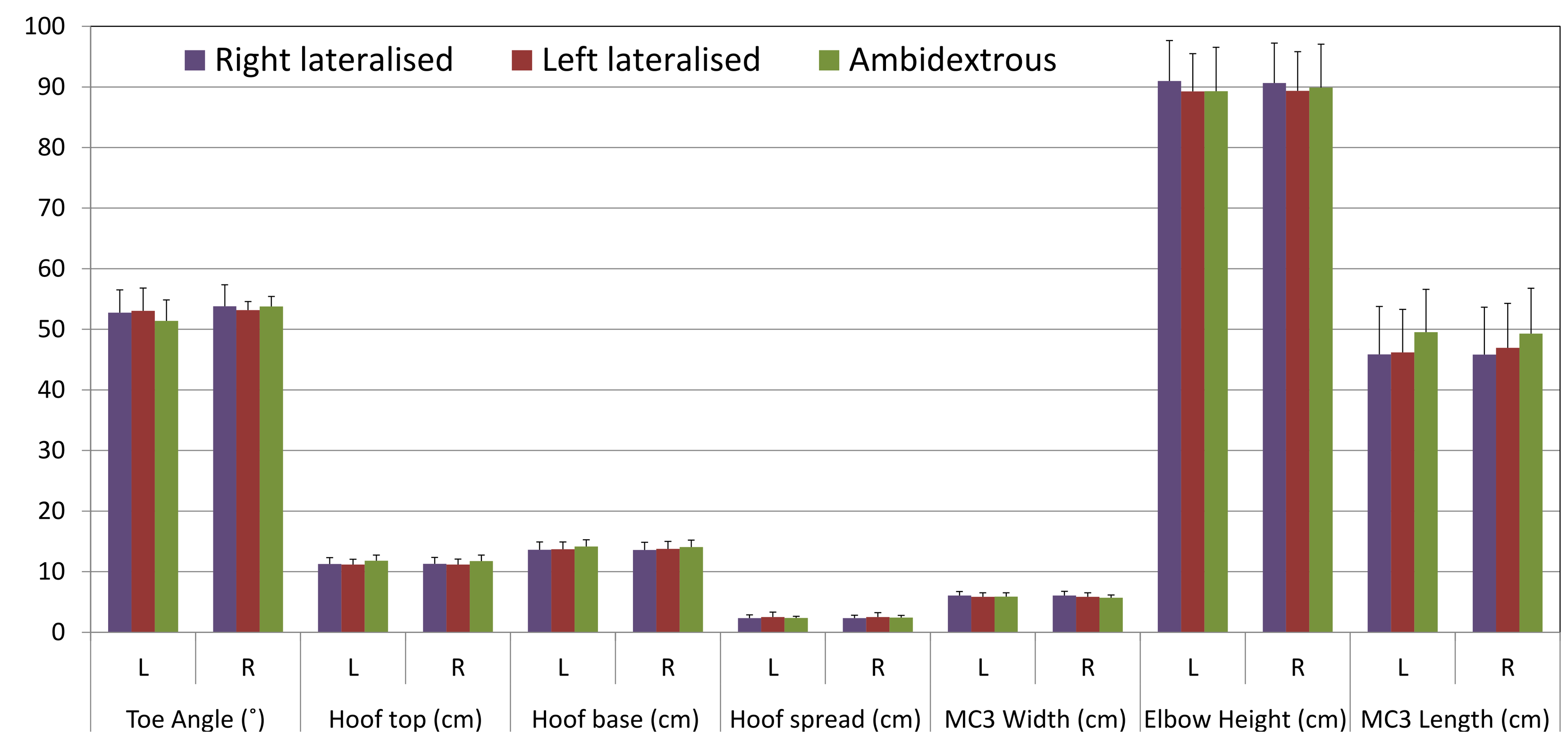


**Figure 1:** Mean and SD of the measured variables for the left and right limbs of the LL, RL and ambidextrous groups

**Table 1:** Significant correlations identified between variables: LL only, RL only, both groups

| | | Toe Angle | | Hoof top | | Hoof base | | Hoof spread | | MCIII Width | | Elbow Height | | MCIII Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | R | L | R | L | R | L | R | L | R | L | R | L | R |
| Toe Angle | L | | P≤0.001 | | | | | | | | | | | | |
| | R | | | | | | | | | | | | | | |
| Hoof top | L | | | | P≤0.001 | P≤0.001 | P≤0.001 | | P≤0.05 | | | | | P≤0.05 | P≤0.05 |
| | R | | | | | P≤0.001 | P≤0.001 | | P≤0.05 | | | | | P≤0.05 | P≤0.05 |
| Hoof base | L | | | | | | P≤0.001 | P≤0.001 | P≤0.001 | | | | | P≤0.05 | P≤0.05 |
| | R | | | | | | | P≤0.001<br>P≤0.01 | P≤0.001 | | | | | P≤0.05 | P≤0.05 |
| Hoof spread | L | | | | | | | | P≤0.001 | | | P≤0.05 | P≤0.05 | | |
| | R | | | | | | | | | | | P≤0.05 | P≤0.05 | | |
| MCIII Width | L | | | | | | | | | | P≤0.001 | | | P≤0.05 | P≤0.05 |
| | R | | | | | | | | | | | | | P≤0.01 | P≤0.01 |
| Elbow Height | L | | | | | | | | | | | | P≤0.001 | P≤0.01 | P≤0.01 |
| | R | | | | | | | | | | | | | P≤0.01<br>P≤0.001 | P≤0.01 |
| MCIII Length | L | | | | | | | | | | | | | | P≤0.001 |
| | R | | | | | | | | | | | | | | |

## CONCLUSIONS:

The differences between the LL and RL groups indicate conformational differences depending on the lateralisation of the horse. This indicates that the repeated stressed placed on the preferred protracted limb differ from those placed down the retracted within a grazing stance. The skeletal asymmetries are fixed following the physeal closure in the young horse and therefore the only structures that can continue to respond to the asymmetrical forces are the hooves. The asymmetries of the hoof are therefore considered to reflect the compensatory growth and dimensional changes that these asymmetric forces generate.

The correlation between right CMC with the left MC3W (P≤0.05) and the significantly longer right CMC (P≤0.001) in the LL group reflect asymmetries identified in Thoroughbred racehorses (Watson et al, 2003; Davies and Watson, 2005). Asymmetries reported in racehorses are proposed to support performance on counter-clockwise tracks and therefore have potential biomechanical influences. The cause is suggested to be, in-part through selective breeding for speed and performance and therefore the inadvertent selection for this phenotype. However, the comparable finding in this study also suggest that laterality may be an influence and that LL is preferred within the wider horse population, predisposing limb asymmetry, including that of the hoof.

## REFERENCES:

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

McDonald, K. & Dumbell, L. ,2008. The Relationship Between Fluctuating Asymmetry & Performance in Event Horses In: Proceedings of the 6th International Conference on Equine Locomotion, Cabourg, Normandy :60

van Heel, M.C.V., Kroekenstoel, A. M., van Dierendonck, M.C., van Weeren, P. R. & Back W. 2006. Uneven feet in a foal may develop as a consequence of lateral grazing behaviour induced by conformational traits. Equine Veterinary Journal 38 (7): 591-596

McGreevy, P.D. & Rogers, L.G. (2004) Motor & sensory laterality in thoroughbred horses. Applied Animal Behavioural Science 92 (4): 337 - 352

Yetkin, Y., 2002 Physical properties of the cerebral hemispheres & paw preferences in mongrel cats: Sex-related differences. International Journal of Neuroscience **112** (3): 239-262

Murphy, J., Sutherland, A. & Arkins, S., 2005. Idiosyncratic motor laterality in the horse. Applied Animal Behaviour Science. **91**: 297-310

Corbetta, D., Williams, J., Snapp-Childs, W., 2006. Plasticity in the development of handedness: Evidence from normal development &early asymmetric brain injury. Developmental Psychobiology. **48** (6): 460-471

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

Davies, H.M.S. & Watson, K.M. (2005) Third metacarpal bone laterality asymmetry & midshaft dimensions in Thoroughbred racehorses. Australian Veterinary Journal 83 (4): 224 - 226

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