VARIABILITY IN THE DIRECTION OF SUBSTRATE REACTION FORCES IN THE LOCOMOTOR REPERTOIRE OF THE PRIMATE *LEMUR CATTA*

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INTRODUCTION

Long bone cross-sectional geometry has been used in anthropological studies to infer activity patterns of fossil primates (e.g. Trinkaus and Ruff, 1999). However, our knowledge about how activity patterns of living non-human primates translate into loading patterns, and the variability of those patterns, is limited.

The goal of this study was to examine the variability in direction of substrate reaction forces (SRFs) in the locomotor repertoire of the primate species *Lemur catta*. These Malagasy primates travel predominantly on the ground with quadrupedal gaits, while in trees they travel by performing a series of runs and leaps. An attempt was made to experimentally simulate this combined terrestrial and arboreal locomotor repertoire, additionally incorporating quick changes in direction to simulate obstacle or predator avoidance and rapid movement across 3-dimensional arboreal substrates.

METHODS

Three adult individuals of *L. catta*, two females and one male (3.1 ± 0.2 kg) were included in this study. The substrate reaction forces (SRF) of the animals were recorded as they traversed a 10.5m Lexan-enclosed runway with a standard forceplate (Kistler 9281B) embedded in the center. For simulated arboreal locomotion, a 5 cm long piece of 3.2 cm diameter PVC tubing was attached to the force plate and aligned with 2 m long PVC poles of the same diameter on either side. The simulated branch was mounted 15 cm above the runway. Quick changes in movement direction were imposed by installing obstacles along the runway around which the animals were required to move, resulting in a weaving, zig-zag movement. The four test conditions were therefore: 1. linear movement on ground (LinGr, n=39); 2. linear movement on the simulated branch (LinBr, n=45); 3. turning movement on ground (TurnGr, n=26); and 4. turning movement on branch (TurnBr, n=18).

Vertical, fore-aft, and mediolateral force components were recorded digitally at 2700 Hz. Forces were low-pass filtered at 65 Hz and normalized by body weight. The direction of the peak resultant force vector was computed and normalized according to direction of travel and limb side such that a braking force was negative, propulsive force was positive, medially-directed force was negative, and laterally-directed force was positive. The forelimbs and hindlimbs were assessed separately.

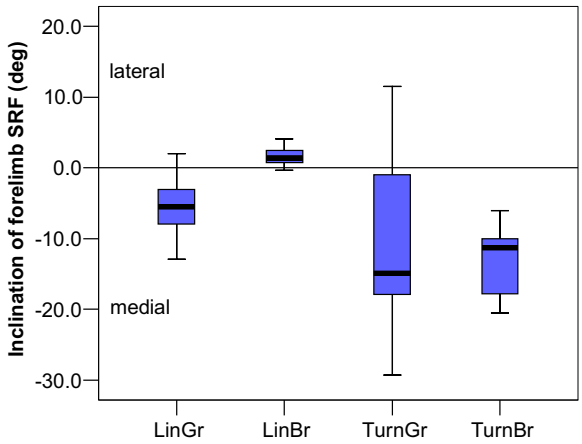

Figure 1: Mean inclination of SRF vector in the frontal plane for the forelimb in the four locomotor conditions.

RESULTS AND DISCUSSION

There is variability in the inclination of the peak SRF vector in both frontal and sagittal planes across substrates and movement tasks. The mean angle of inclination in the frontal plane ranges from -10.6 to 1.7 degrees in the forelimb (Figure 1) and -14.5 to -1.0 degrees in the hindlimb. In particular, angles associated with turning behaviors differ from those associated with linear locomotion. The mean angles in the sagittal plane range from -9.2 to -8.6 degrees in the forelimb and -0.5 to 8.4 degrees in the hindlimb. This suggests that limbs experience a range of substrate reaction force directions indicative of variation in loading regimes.

CONCLUSIONS

These data suggest that treadmill or purely linear locomotion studies of limb loading (e.g., Lieberman, 2004) may not adequately capture the range of limb loadings experienced by animals in their natural habitat. Animals such as arboreal primates with a versatile locomotor repertoire experience a range of substrate reaction force directions and their limb bones are likely exposed to multidirectional bending.

REFERENCES

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ACKNOWLEDGEMENTS

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