prompting a response from the system. Stability is lost when switching between gaits and behaviour is attracted towards a second stable region. A consequence of this model is that it is expected that a transition coincides with a temporary loss of stability that is recovered after the transition.

In this study, we first describe the kinematical changes involved in a trot to canter transition. The forelimb that becomes the leading limb takes a stride that is shorter in duration and length, while the trailing (opposite diagonally) hind limb takes a stride that is longer in length. We also test the HKB model by using joint angle variability as a measure for stability. This approach pinpoints the trailing hind limb as a potential candidate by which to follow the dynamics systems theory and therefore is potentially the joint that determines when the transition will occur.

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12:55 Saturday 30th June 2012

A1.33 Towards a unified notion of gaits
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While a variety of definitions of ‘gait’ have proved useful in experimental biology, there are many superficially disparate definitions of ‘gait’, both in the literature and among practicing biologists. At times these definitions are contradictory, for example a definition of gait that required a discrete jump in some quantity (as occurs for the walk–trot transition in dogs) could imply that walking and running are indistinct in some birds; yet, these are intuitively different modes of locomotion. Here we propose a unified conception of gait and show how the hierarchical nature of our definition solves this difficulty and highlights important questions relating to control and the determinants of locomotion.

We propose to define ‘gait’ as ‘a parametrically-related family of non-dimensional kinematic observations of a locomotor behaviour that can persist indefinitely’. We arrived at this definition by identifying the commonalities between existing definitions, and highlighting the utility of distinctions, such as the scale-free nature of gait metrics, the cyclic nature of most familiar ‘gaits’ and the natural hierarchies of gaits. We show how existing definitions are embedded in ours. We also highlight the practical utility of our definition in terms of both pedagogy and research.

Our definition conceptually clarifies theories of gait by highlighting the relations between gait hierarchies and locomotion model hierarchies. Our approach sharpens the ability to formulate biomechanical research hypotheses about all forms of locomotion in both species-specific and comparative studies. The resulting language can also be used to describe gaits in non-cyclical locomotion.

Funding: HFSP RGY0062/2010.

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13:50 Saturday 30th June 2012

A1.34 Bigger birds work harder to stand up
Jeffrey W. Rankin (Royal Veterinary College, UK), Andrea S. Pollard (Royal Veterinary College, UK) and John R. Hutchinson (Royal Veterinary College, UK)

Almost nothing is known about how any animal, except perhaps humans, stands up from a sitting position. Yet this behaviour is not only vital for the daily lives of most land animals but also biomechanically demanding, because it should require near-maximal joint ranges of motion (ROM) and thus greater musculotendinous work, as well as potentially large tissue stresses, due to the poor mechanical advantage of a crouched limb pose. There are no general principles formulated for how this behaviour should change with anatomy, size, limb number/posture or other factors that change during ontogeny and phylogeny.

As a first step toward establishing the mechanical principles of the sit-to-stand transition (STST), we hypothesized that larger birds would need to move their limb joints through larger ROM because they would go from similarly crouched to more upright poses. To test our hypothesis, we obtained three-dimensional pelvic limb kinematics from six species of birds, ranging from 0.2 kg quail to 120 kg ostriches using motion-capture or high-speed video (250 Hz), for two to three individuals doing the STST (10 trials per animal with good STST data). Our findings indicate that the STST strategy varies across bird species, with size-related changes in both individual joint ROM as well as joint coordination (i.e. changes in the relative timing between joints) observed. These changes seem to require relatively greater amounts of mechanical work in larger birds, although joint timing might ameliorate some of these effects.

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14:05 Saturday 30th June 2012

A1.35 Strategies in running: How human runners adapt their centre of mass to visible and camouflaged ground level changes
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When humans run in nature, they routinely negotiate varying ground and unpredictable perturbations. The strategies they use can be revealed by analysing their centre of mass (CoM). Our first study investigated adaptations while running up and down a single or a permanent visible step of 10 cm height. Our second study focused on adaptations while running across single drops (10 cm in depth) that were either visible or running across single drops (10 cm in depth) that were either visible or camouflaged, where the drops occurred by chance. For both studies, the relative adaptations in the vertical oscillation of the CoM compared to the undisturbed situation were analysed. We found significant variances in the vertical oscillation for the visible and camouflaged situations. Runners adapt their CoM in preparation for a visible step up or down by lifting it about 50% of step height or lowering it by about 40% of drop height. After the contact on the changed ground level, different adaptations occur depending on the situation (100% for plateau, 60% for a single step up or down). Similar adaptations were found in preparation for a camouflaged step. In the subsequent flight phase, however, the CoM is lowered by about 90% of drop height if runners encounter a camouflaged drop and is almost unaffected if there is no drop. The adaptations show that runners use active strategies to smoothen the CoM trajectory while running on uneven ground. They also indicate that runners rely on passive self-stabilizing mechanisms if the terrain is not accurately predictable, showing that active and passive parts jointly contribute to successful running.

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14:20 Saturday 30th June 2012

A1.36 Three-dimensional biomechanics of the human hip joint: Insight from an integrative analysis of the pelvic-femoral complex
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