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Walking at stability's edge JOHN MILTON, DAVID NICHOLS, ADAM COLEMAN, COURY CLEMENS, ANNIE NGUYENTAT, AMI RADUNSKAYA, The Claremont Colleges — During self-paced human walking, the variability in inter- stride intervals exhibit fractal dynamics characterized by long–range correlations having a power-law decay with exponent α. We used diffusion fluctuation analysis (DFA) to estimate α as a function of the roughness of the walking surface for eight (8) healthy subjects (1200-1400 inter- stride intervals for each walking surface). For each subject the highest α (mean 0.96, range 0.88- 1.10) occured for walking on a running track and α was $15-20\%$ lower for walking on either a relatively smoother (tennis hard court) or a rougher (dirt path) surface. These observations are captured by a stochastic discrete time cubic map: $I_{i+1} = a(\xi_i)I_i - bI_i^3 + \eta_i$, where I_i is the i–th inter–stride time, $a(\xi_i) = a_o(\xi) + \xi_i$ describes parametric, colored noise where $a_0(\xi)$ is a constant that depends on surface roughness and ξ_i is colored noise with mean zero, η_i is low–intensity additive white noise, and b is a constant. As the roughness, and hence $a_0(\xi)$, of the walking surface increases, the fluctuations in the inter–stride interval are predicted to obey a power law whose exponent changes non-monotonically: the highest values of α determined with DFA occur when $a_0(\xi)$ is close to the deterministic stability boundary $a = 1$. Thus the neural control of walking appears to involve a dynamical system tuned close to the edge of stability subjected to the effects of parametric noise.

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