Long term correlations in the magnitude of peak impact and active vertical ground reaction forces during running.

Long term correlations have been shown to exist in the stride intervals of both walking (Hausdorff *et al.*, 2001: *Physica A, 302*, 138-147). These long term correlations disappear when walking in time to a metronome, suggesting that these complex correlations reflect supra-spinally mediated timing control. Running is associated with large peak impact and active forces compared to walking. It was hypothesised that the magnitude of these forces is controlled to avoid injury, and that this control would be indicated by the presence of long term correlations in the time series of the peak impact and active forces.

Eight healthy experienced runners mean age 24.6 years, *s*=3.5, mean mass 63.9 kg, *s*=6.3 performed an eight minute running trial on an instrumented treadmill at their preferred running speed. The magnitudes of the peak impact and active vertical ground reaction forces for each footfall, and the timing of these two peaks were determined. A Detrended Fluctuation Analysis (Peng *et al.*, 199: *Chaos, 5,* 82-87) was performed on the time series of each parameter over the eight minute trial to determine the alpha value (α). White noise is indicated by α=0.5; 0.5<α<1 indicates the presence of long-term correlations. The mean α for each parameter are shown in table 1.

The values of α assocated with the magnitude of the impact and active forces were consistently and significantly higher than those associated with the times to impact and active peaks (p<0.001). The alpha values assocated with all four active peak time series were significantly higher than those associated with the four impact peak time series (p=0.028).

The alpha values associated with all four time series were consistently and significantly higher for one foot than for the other (p<0.01).

Table 1: Dimensionless alpha value for each time series analysed.

Foot	Impact		Active	
	Time	Force	Time	Force
1	0.571 ±0.024	0.700 ±0.030	0.609 ±0.022	0.743 ±0.034
2	0.514 ±0.013	0.677 ±0.027	0.559 ±0.230	0.718 ±0.030

These results indicate that the timing of the impact and active peaks is close to random, whereas the magnitude of the forces exhibit long term correlations. This suggests that the size of the impact and active forces are more controlled than the timing of the peaks. This control may reflect a centrally mediated injury avoidance control strategy during steady state running.