

## Bimanual coordination: 1/f noise in cycle-to-cycle point estimates of relative phase

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Steady state time series, in biological systems, were often considered as random variations around a mean value. Fluctuations were then generally eliminated by averaging, or filtering. Nevertheless, a number of recent works showed that these apparently random variations could not be considered as uncorrelated (white) noise and exhibited features typical of fractal processes, such as self-similarity and long-term correlation. In particular, this kind of result was evidenced in several cyclical coordination tasks (Chen, Ding & Kelso, 2001 ; Hausdorff, Purdon, Peng, Ladin, Wei & Goldberger, 1996 ; Yamada, 1995). We recently studied series obtained by a continuous estimation of relative phase, during a bimanual coordination task (Delignières, Caillou & Deschamps, 2002). The fractal structure of these series was suggested by a simulation experiment, and confirmed by analyses performed on empirical series: Continuous relative phase appeared underlain by anti-persistent long-term correlation, characteristic of the so-called 1/f noise. Considering that such fractal process is not related to a typical time scale, one could suppose that similar results could be obtained from series of point estimates of relative phase.

In order to test this hypothesis, we analysed a set of series obtained from 10-minute trials in bimanual coordination tasks. Each participant performed at his/her preferred rate one trial according to the in-phase mode, and another in anti-phase. We obtained series of approximately 700 cycles, and a point estimate of relative phase was performed for each cycle. Spectral analyses allowed us to classified these series as (stationary) fractional Gaussian noises. R/S analysis and Dispersional analysis were then applied (Eke et al., 2000), and evidenced long-term correlation, with Hurst exponents around 0.7. These exponents were well defined, with clear linear regressions in the diffusion plots (figure 1).

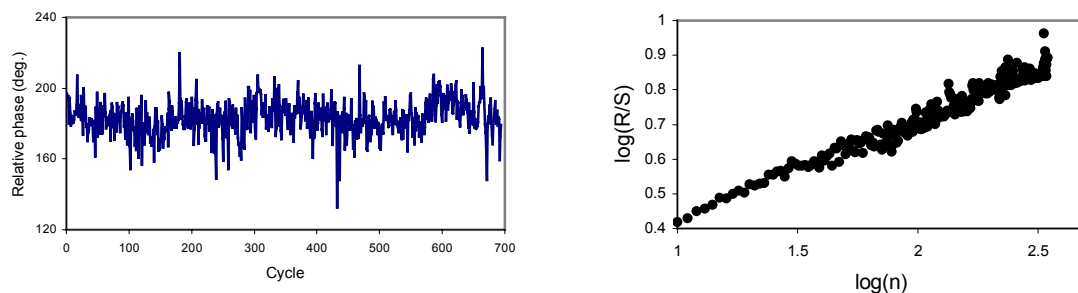


Figure 1: Experimental series (left) and results (R/S analysis diffusion plot, right) for a representative trial.

The results of this pilot study open a new window in the analysis of bimanual coordination, considering the role of fractality in the stability of behavior, and the possible alterations of this fractality by factors such as pathology, learning, or motivation.

### References

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