Coordination processes and Detrended Cross-Correlation Analysis

Didier Delignières  Vivien Marmelat

EA2991 Movement to Health – Euromov, University Montpellier 1, France
E-mail: didier.delignieres@uni-montp1.fr, vivien.marmelat@univ-montp1.fr

In this paper we analyze real-world data, accounting for coordination processes between complex systems (bimanual coordination, interpersonal coordination, and synchronization with fractal metronome), by using a recently proposed method, the Detrended Cross-Correlation Analysis (DCCA, [1]). This method is an extension of the well-known Detrended Fluctuation Analysis (DFA), which was initially proposed as a method for quantifying serial correlations in non-stationary time series. DCCA is based on the analysis of the diffusion properties of detrended covariance over time.

This work was motivated by the strong anticipation hypothesis, which supposes that coordination between complex systems is not achieved on the basis of local adaptations (i.e., correction, predictions), but results from a more global matching of complexity properties [2]. Indeed, recent experiments have evidenced a very close correlation between the scaling properties of the series produced by two coordinated systems, despite a quite weak local synchronization [3]. We hypothesized that strong anticipation should result in the presence of long-range cross-correlations between the series produced by the two systems.

Results allow a detailed analysis of the effects of coordination on the fluctuations of the series produced by the two systems. On the long-term series tend to present similar scaling properties, with clear evidence of long-range cross-correlation.

![Figure 1: DCCA results. Left: Bimanual coordination, middle: Interpersonal Coordination, Right: Synchronization with a fractal metronome.](image)

Short-term results strongly depend on the nature of the task. In bimanual coordination, cross-covariance remained high, even when computed in very short intervals. In contrast, short-term cross-covariance was moderate in interpersonal coordination. During synchronization with a fractal metronome, short-term coupling appeared a little bit closer. These results suggest that despite similar long-term correlation structures, coordination emerges from very different processes in the three situations.

References

