Degeneracy, Long-Range Correlations and Accuracy Constraints

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Degeneracy is a ubiquitous property of complex adaptive systems, which refers to the ability of structurally different components to perform the same function in some conditions, and different functions in other conditions [1]. This work is based on the hypothesis supposing a causal link between the level of degeneracy in the system and the strength of long-range correlations in its behavior [2].

In this experiment, we manipulated degeneracy through accuracy constraints: we supposed that accuracy constraints should reduce the number of relevant behavioral solutions, and thus decrease degeneracy in the system involved in the production of performance. Additionally, we hypothesized that accuracy constraints should have a selective effect on variables directly affected by accuracy, but not on other variables.

Participants performed a reciprocal aiming task, with 3 levels of difficulty differing only in target size (Figure 1, left). They performed 512 successive reciprocal pointings, and we analyzed long-range correlations in the series of movement time (MT), movement amplitude (MA), and error.

Figure 1: Left: experimental task. Right: DFA exponents for Movement Time (MT), Movement Amplitude (MA), and Error, according to task difficulty (white: ID = 3, grey: ID = 4, black: ID = 5)

As hypothesized, results showed that the increase of accuracy constraints whitened long-range correlations in MA and Error series, but had no effect on MT series (Figure 1, right). These results are consistent with the hypothesis linking degeneracy and long-range correlations. They also suggest that degeneracy in biological networks should be considered a task-specific property, characterizing the networks involved in the production of a given outcome.

References
