Complexity matching and restoration of complexity in elderly

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The complexity matching effect refers to the maximization of information exchange when interacting systems share similar complexities. This effect has been interpreted as a kind of "$1/f$ resonance" between systems. A working conjecture states that interacting systems tend to match their complexities in order to enhance their synchronization. This effect has been observed in a number of synchronization experiments, and interpreted as a transfer of multifractality between systems. Finally, it has been shown that when two systems of different complexity levels interact, this transfer of multifractality operates from the most complex system to the less complex (and not the inverse), yielding an increase of complexity in the latter.

This theoretical framework was applied in an experiment that aimed at testing the hypothesis of a possible restoration of complexity in elderly. In young and healthy participants, walking is known to present $1/f$ fluctuations, reflecting the inherent complexity of the locomotion system, providing walkers with both stability and adaptability. In contrast stride duration series tend to present a more disordered dynamics in aged participants, and this whitening process was shown to correlate with the propensity to fall. We hypothesized that if an aged participant was invited to walk in close synchrony with a young and healthy companion, the complexity matching effect should result in the restoration of complexity in the former.

Elderly participants were involved in a prolonged training program (four weeks) of synchronized, arm-in-arm walking, with a young and healthy experimenter. We checked that synchronization in the dyads was dominated by a complexity matching effect. We observed a restoration of complexity in elderly participants after three weeks, and this effect was persistent two weeks after the end of the training session. A control group performed a training program of similar duration and intensity, but without any instructions in terms of synchronization with their healthy companion. In this control group we found no traces of complexity matching, and we did not observe any improvement of complexity in stride interval series.

This work presents the first demonstration of a restoration of complexity in deficient systems. We show that this restoration is related to the prolonged experience of inter-personal synchronization, and the related complexity matching effect, but not (only) to the duration and intensity of the walking training program.