Behavioral strategy of stepping-over: differences in obstacle's height and individuals

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The present study aims to describe the dynamics of a human adaptive behavior, stepping-over an obstacle in various environmental conditions. The purpose of our study is to investigate how behavioral strategy changes of stepping-over a horizontal bar changing from zero to 90% height of each participant's leg length. Our study is motivated by the theoretical framework of affordance theory in ecological psychology and the dynamical systems approach (DSA) based on self-organization theory. Our goal is to integrate these frameworks with the present stepping-over experiment.

According to affordance theory, to act safely and adequately in the environment, animals must accurately perceive the relationship between environmental properties and their own body properties. For example, in a stair climbing behavior, the height of a displayed stair is perceived relative to the individual's leg length, and when the ratio of each property (stair height/leg length, called the *pi number*) reaches specific values, qualitative changes occur in the animal's behavioral pattern.

Conversely, within the framework of the DSA, an animal's behavioral pattern at the macro-level of the complex system can be modeled as a motion equation using a *control parameter* and an *order parameter*. The *order parameter* describes the low-dimensional behavior that emerges from the high-dimensional neuromuscular system. The model predicts the behavior of a system comprising numerous mutually interacting components (degrees of freedom) at the micro-level, as the dynamics of a few order parameters.

According to the Ecological approach, we apply the variables defined by elements of an animal-environment system to the DSA framework, that is the *pi number* as a *control parameter*. As an order parameter, in the current presentation, we analyzed the Coefficient of Variation (CV) of the toe clearance at the moment of stepping-over the bar.

As a result, although our hypothesis was not supported, some interesting findings were obtained. The Behavioral strategy of stepping-over changed depending on the obstacle's height. It also varied among individual participants. Some participants rotated their knees of the leading-leg horizontally when they stepped-over the high obstacle, whereas others didn't show such a strategy (they stepped-over the high obstacle with their leading-legs keeping vertically). We compared such differences in behavioral strategy and discussed them in terms of behavioral dynamics. Further investigation should be done empirically in the future. It may lead to better understanding of the safe way to avoid obstacles and have the possibility to obtain new insight into safe stepping-over strategy.