Understanding Exploratory Behavior Step by Step

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Exploration has been studied in rodents for almost a century. The measures used to characterize it are, however, limited in exposing the dynamics of the exploratory process, leaving the morphogenesis of its structure and meaning hidden. By freeing mice from the constraints imposed by forced introduction into the testing environment and from the confines of small cage and short session we reveal its meaning in the operational world of the mouse. In a new paradigm developed by us - The Dimensionality Emergence Assay (DIEM) - the setup consists of a large arena including a free passage between arena and home cage, and a long session. In this setup exploration consists of sequences of repeated motion. In a novel environment, these sequences show a gradual build up in extent and in dimensionality and complexity. Using advanced computational and exploratory data analysis tools we measure various aspects of the motions (e.g. distance traveled per motion, maximal speed per motion), plot them side-by-side, and compute the dynamics of their growth (actual genesis), as well as their interdependence within the overall developmental sequence (see Figure 1 on the next page).

The measurements provide a freedom of movement metric for the investigation of heretofore evasive issues like arousal and cognition, and for the assessment of drug action in animal models of human diseases of the CNS.

Our general approach to the quantification of behavior has been recently reviewed in a paper titled "Ten ways to improve the description of animal movement" [1]. In the present talk we will emphasize 2 out of the ten recommendations: i) the use of behavioral gradients to uncover animal-centered measures of behavior (the actual genesis of exploratory behavior provides an opportunity for a kind of "electrophoresis" of behavior whereby the various sequences of repeated motion "precipitate" in a prescribed, relatively stable order); ii) measuring kinematic variables (location, speed, path curvature, spatial spread and other variables reflecting the extent and complexity of motions), rather then scoring ad hoc classical behavior patterns or response categories.

The main message of our talk is that what you quantify is as important as how you quantify. A main help comes from the examination of overall statistical properties of the data of individual animals, of the strain, and of data collected across more than a single laboratory (the replicability issue, [2]).

Author Keywords
Mouse behavioral phenotyping, replicability, free exploration, Dimensionality Emergence Assay (DIEM), borderline roundtrips, home-related shuttles, wall-related shuttles, incursions, excursions, neophobia, freedom of movement.

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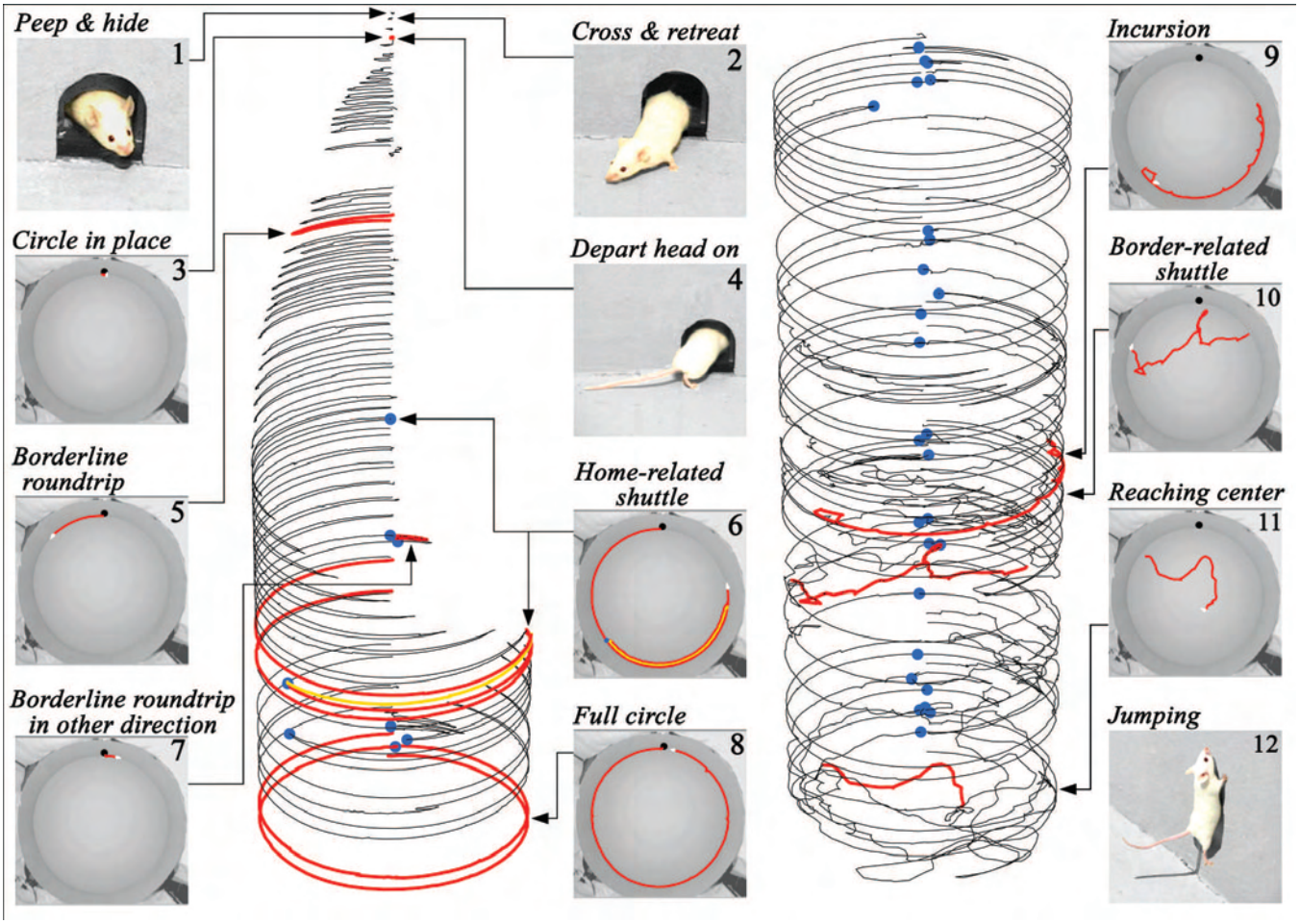

Figure 1. The moment-to-moment developmental sequence of free exploration in a 3 h session of free open field behavior of a selected BALB/c mouse.