

Criticality

A holistic principle of brain computation

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R15NS116742
R15NS135396
R01DA060744



NSF1912352

A holistic principle of brain computation

Why seek holistic principles?

1. Making progress on brain disorders demands holistic principles
2. Criticality: a holistic principle of computation

Brain-body interaction

1. Body dynamics as a window into brain computation
2. The body's influence on brain computation

Why seek holistic, general principles?

Fact: Many disorders disrupt a long list of different brain functions, not just one specific computation.

Status quo: Cottage industry, siloed approach.
One lab studies one function.

Proposal: A fundamental rule of computation that generalizes across long lists of brain functions will help us diagnose and understand disease.

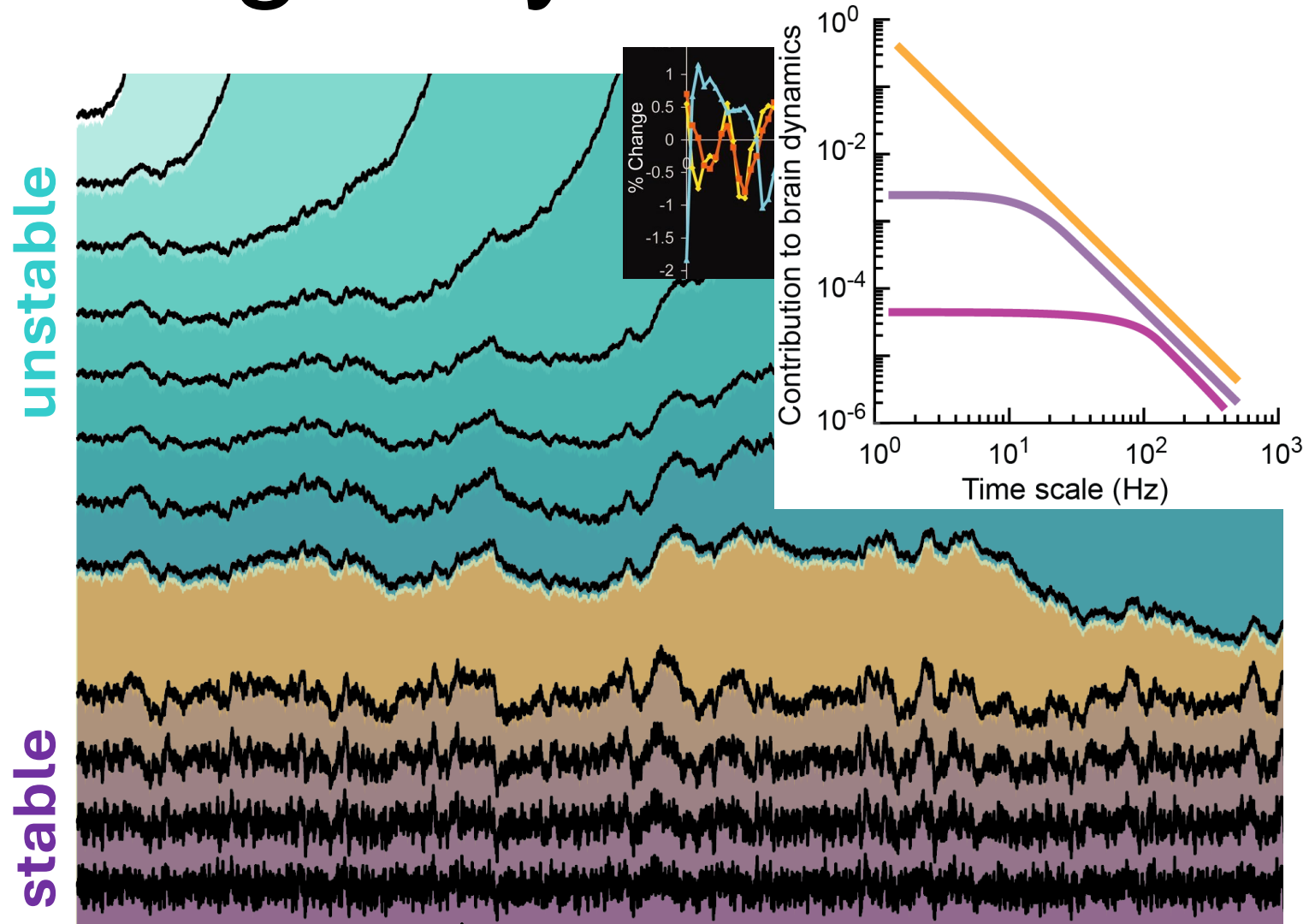


Criticality: the marginally stable brain

Fact 1. The brain is a dynamical system.

Fact 2. Dynamical systems can be **stable**, **unstable**, or balanced on the edge – near **criticality**

Fact 3. Most aspects of brain computation require a wide range of time scales

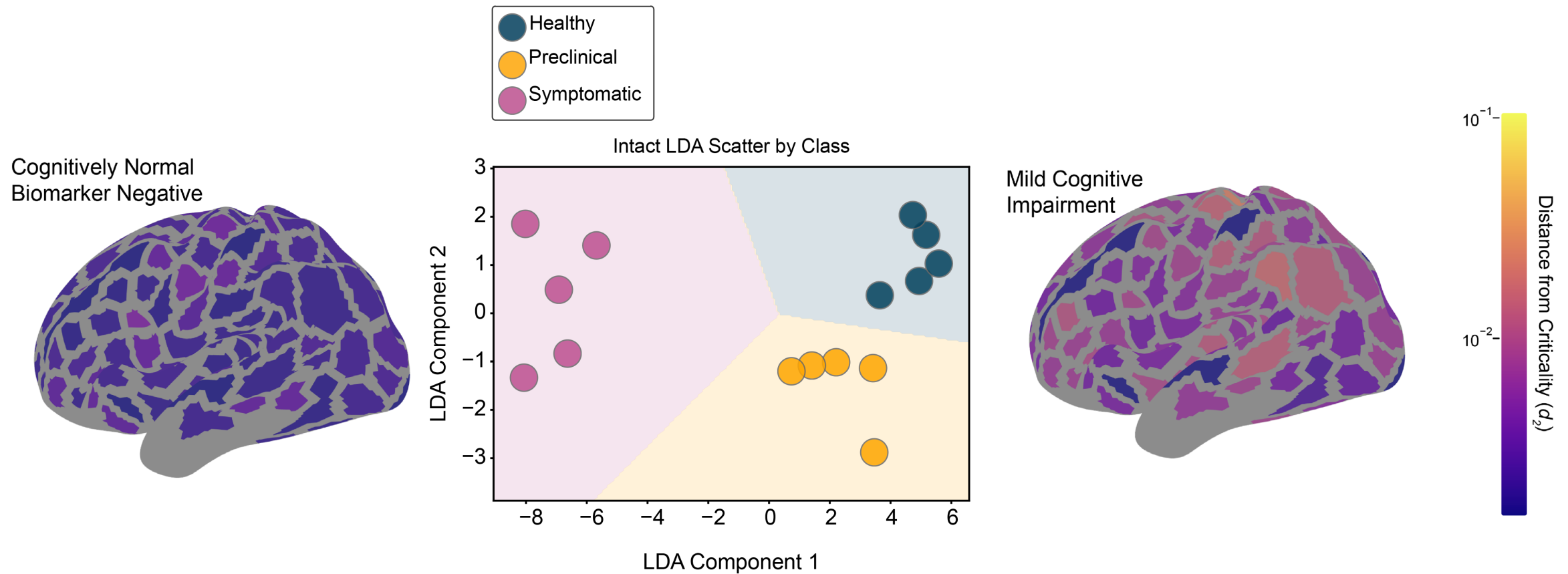


Criticality

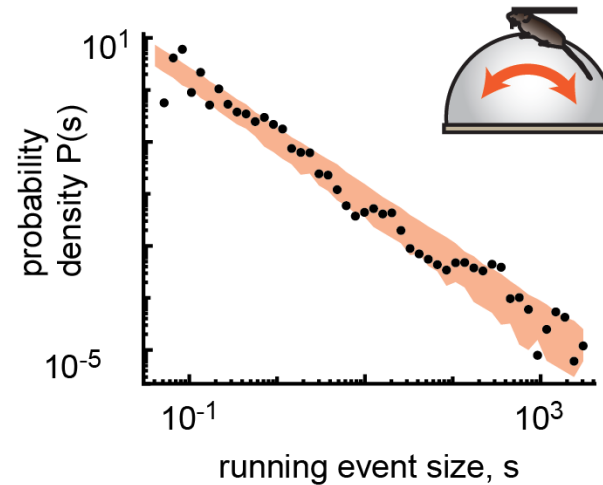
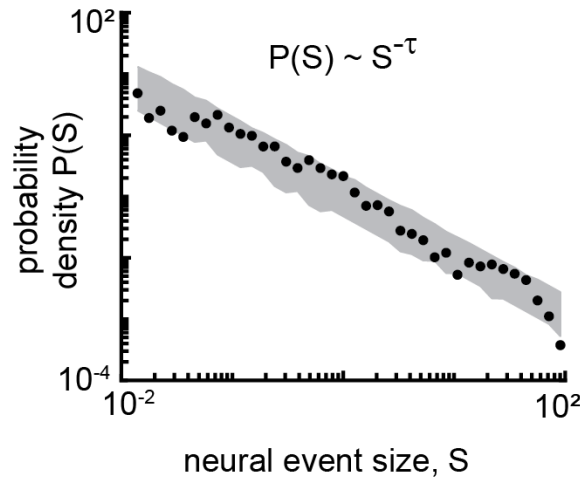
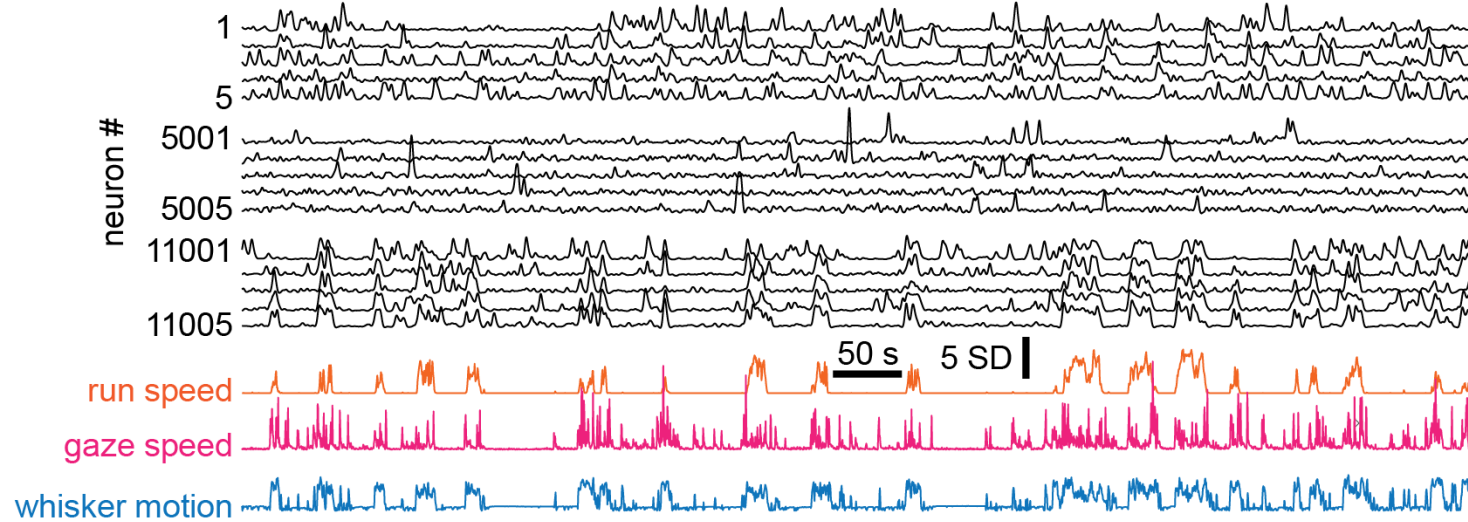
A holistic principle of brain computation

**The brain must be near criticality
to do most of its functions**

Alzheimer's incurs deviation from criticality



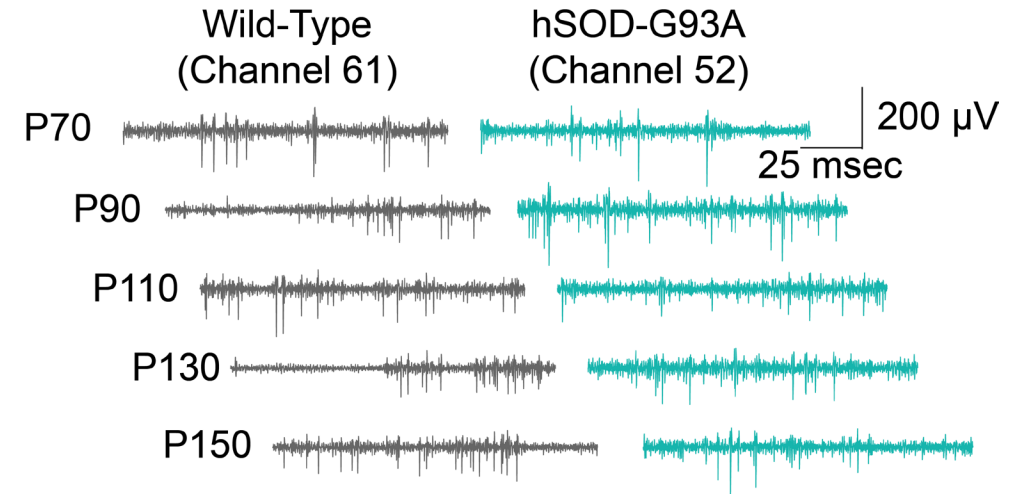
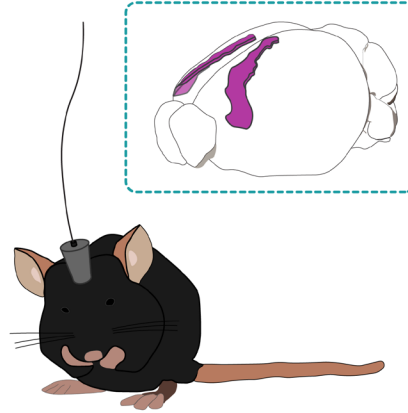
Body: window into computation



Both brain
dynamics and
body movements
reveal criticality

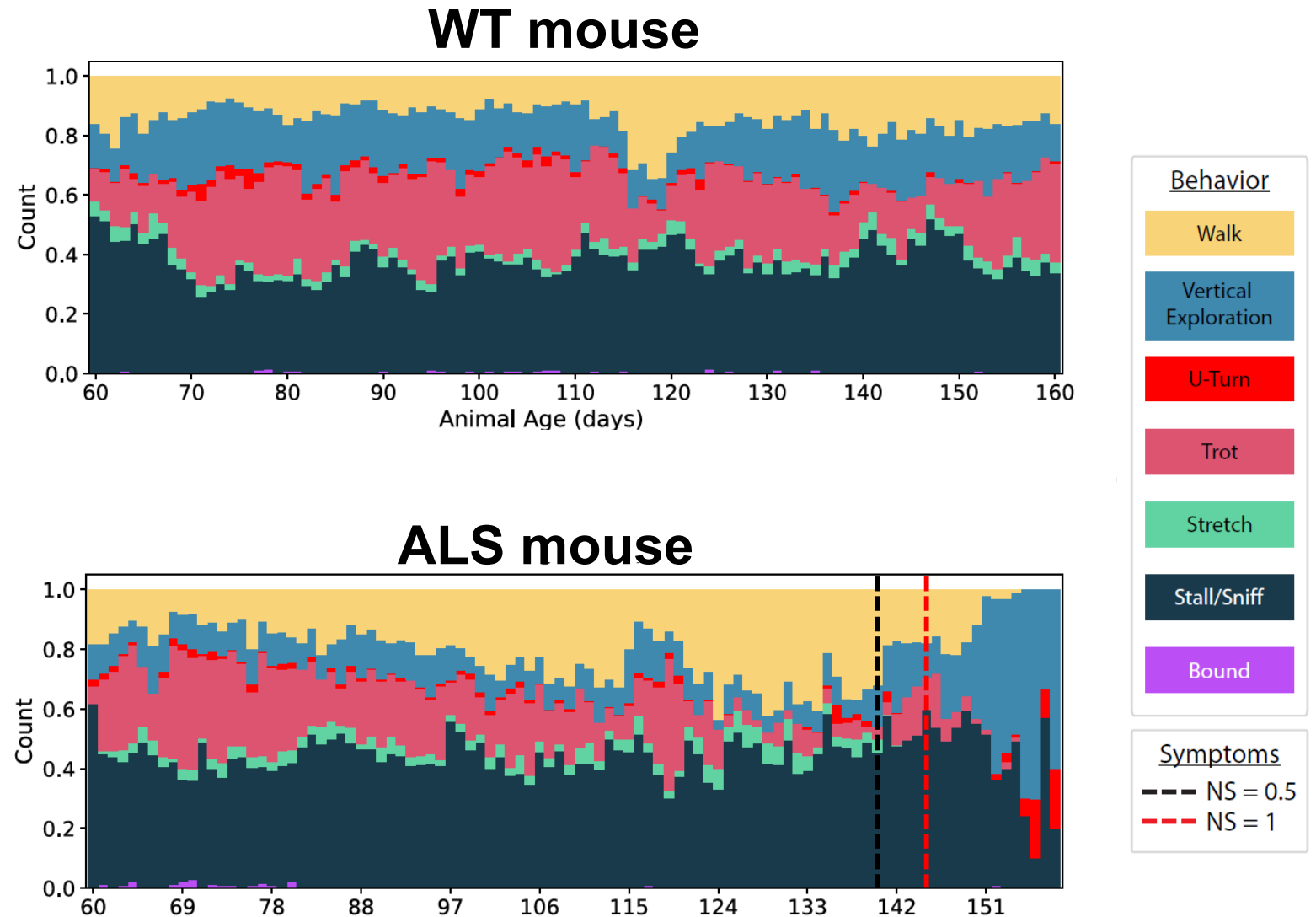
Body: window into brain disease

Neurodegeneration
in ALS mouse
entails deviation
from criticality



Body: window into brain disease

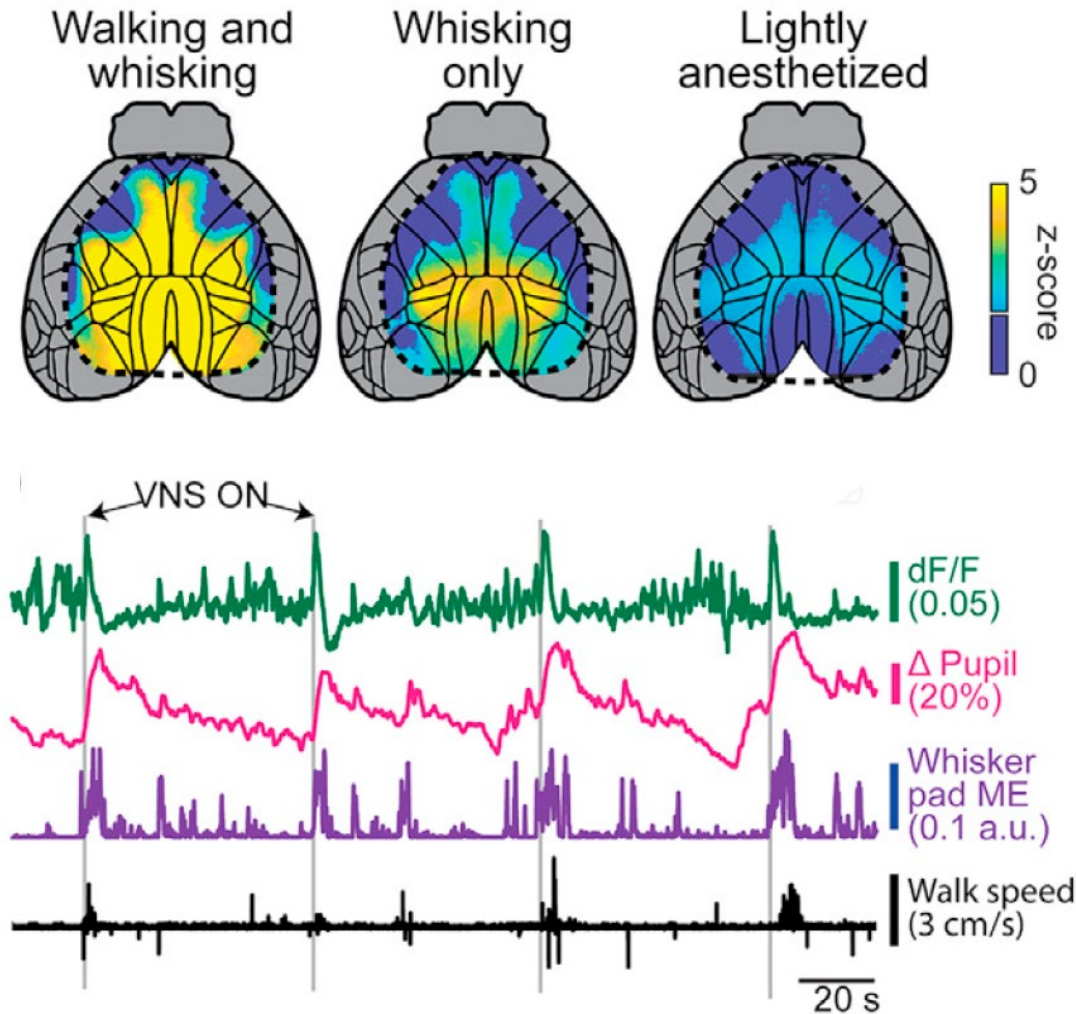
As brain deviates
from criticality,
behavior
becomes limited



Body:
control of
brain

Feedback from
body changes
brain dynamics

Vagus nerve stimulation



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