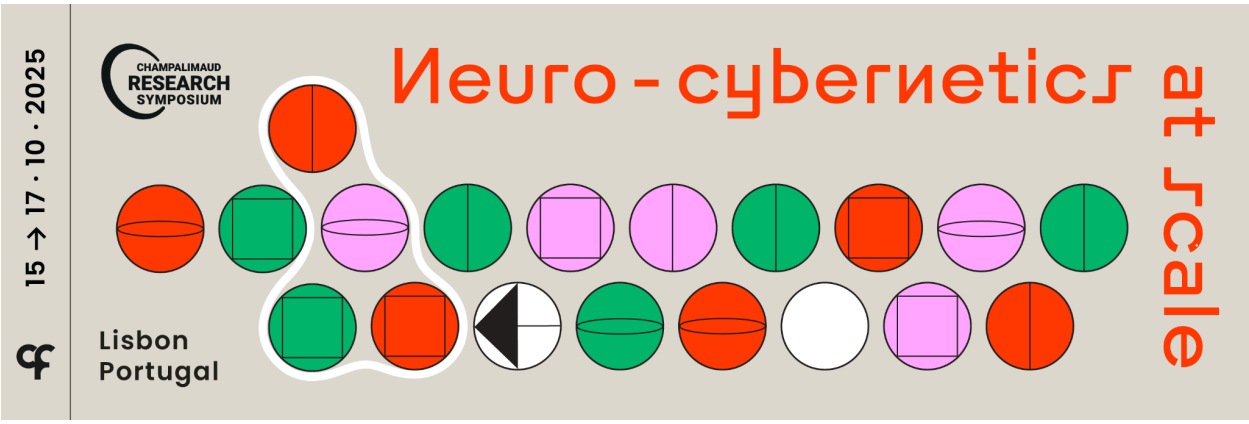

Sml sensory neurons regulate reproductive motor output in Drosophila

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Complex behaviors emerge through sophisticated control systems that integrate sensory information with motor output across distributed neural circuits. Using Drosophila egg-laying as a model to study the neuronal circuits responsible for flexible innate behaviors, we identified and characterized a minimal sensory input of 6 neurons in the reproductive system that, when manipulated, leads to marked behavioral output changes. This system exemplifies how sparse neural populations can regulate behavioral control through multi-level circuit interactions.

Using split-Gal4 intersectional genetics, we identified a genetically accessible population of sensory neurons ("Sml") that form a direct sensory-to-central pathway from the uterus to the abdominal ganglion (Abg) of the ventral nerve cord (VNC) of the fly, where abdominal motor control is processed. Trans-synaptic labeling revealed that these 6 uterine sensory neurons interface with a high number of neurons in the Abg forming a complex network: local Abg interneurons, ascending projections to brain centers, and descending motor control pathways - forming a distributed circuit architecture. Optogenetic activation of this minimal sensory input triggered coordinated motor outputs, while circuit silencing reduced reproductive output by ~66%, demonstrating the functional significance of this feedback loop.

The circuit architecture suggests a control system where uterine sensory neurons likely monitor internal reproductive state (potentially egg position/movement), relay this information to central processing networks, which then modulate motor programs that influence egg progression. The dramatic behavioral complexity arising from activation of just 6 sensory neurons illustrates how distributed neural networks can amplify minimal sensory signals into coordinated motor responses through circuit-level computation.

Drosophila, innate behavior, reproductive behavior, neuronal circuits, ventral nerve cord