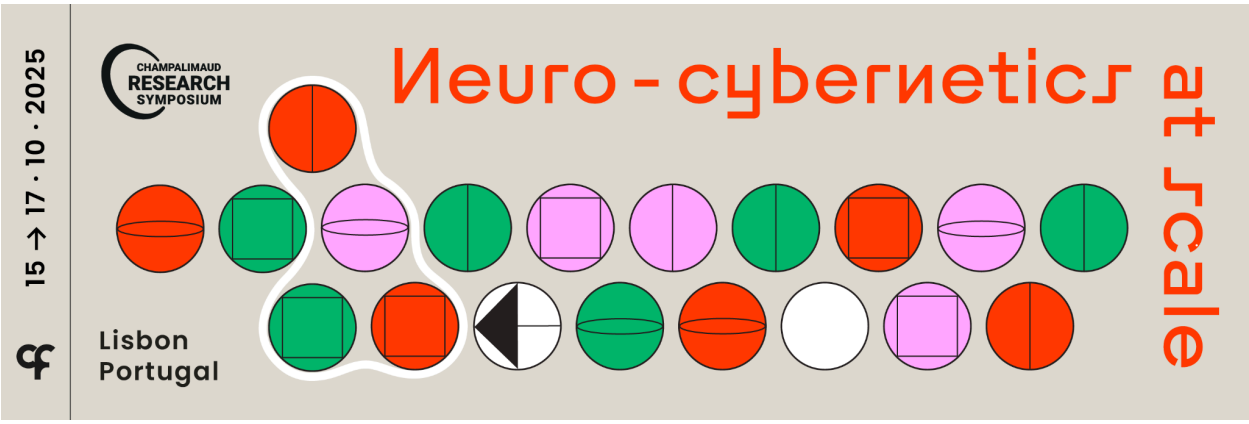


## Mouse lockbox: a sequential mechanical decision-making task for freely moving mice

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Advances in automated tracking tools have sparked a growing interest in studying naturalistic behavior in animals. Yet, traditional decision-making tasks remain the norm for assessing learning behavior in neuroscience. Here, we present an alternative sequential decision-making task to study mouse behavior. We developed a 3D-printed mechanical puzzle, a so-called lockbox, that requires a sequence of four steps to be solved in a specific order. Each mechanism is easily movable by the mice, but requires distinct manipulations, such that the mechanisms cannot be solved by accident. During the task, the mice move around freely, enabling the emergence of complex behavioral patterns.

We observed that mice learned this relatively complex, four-step task surprisingly quickly compared to conventional operant tasks, demonstrating its potential utility of more ethologically relevant challenges. To delineate different contributions to the learning process, we recorded their behavior in a multi-camera setup and developed a data analysis pipeline to automatically detect the interactions of the mice with the different lockbox mechanisms for a large corpus of video footage (> 110 h, 12 mice). Our analysis pipeline allowed detailed quantification of behavior, revealing that learning involved both improvement in object manipulation skills and the emergence of a task-specific strategy. While the rapidly increasing task performance seems primarily due to the improvement in object manipulation, clear signs of a cognitive strategy for the task appear during later trials. The lockbox task therefore could offer a promising paradigm for studying how low-level motor learning interacts with high-level decision-making strategies within a single, ethologically relevant task.

**behavior, decision-making, mice, mechanical puzzle**