

Live Mouse Tracker: a tool to draw individual profile of mice living in a group

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Introduction

Mouse models are useful to study the causes and the mechanisms leading to physiological and behavioral features linked to human diseases. An increasing level of comprehensiveness and precision is needed in phenotyping methods to capture the complexity of behavioral affections in the panel of disorders. Understanding complex behavioral traits such as decision-making or social interactions in mice requires high precision long-term individual follow-up of individuals. Reliable data in these domains could be obtained with the most reduced intervention by the experimenter. For this purpose, the Live Mouse Tracker was developed to follow individual mice within a group over days or weeks and automatically extract more than 30 behavioral events (de Chaumont et al. 2019).

This system is of high interest to characterize mouse models of disorders affecting social behaviors, such as autism spectrum disorders. We characterized a mouse model for one of the most frequent form of this disorder, the 16p11.2 deletion syndrome. Previous characterization suggested that 16p11.2 Del/+ displayed atypical social behavior on a mixed genetic background (Arbogast et al. 2016). We quantified in details the changes in individual and social behaviors over long-term recordings in home cage-like environment.

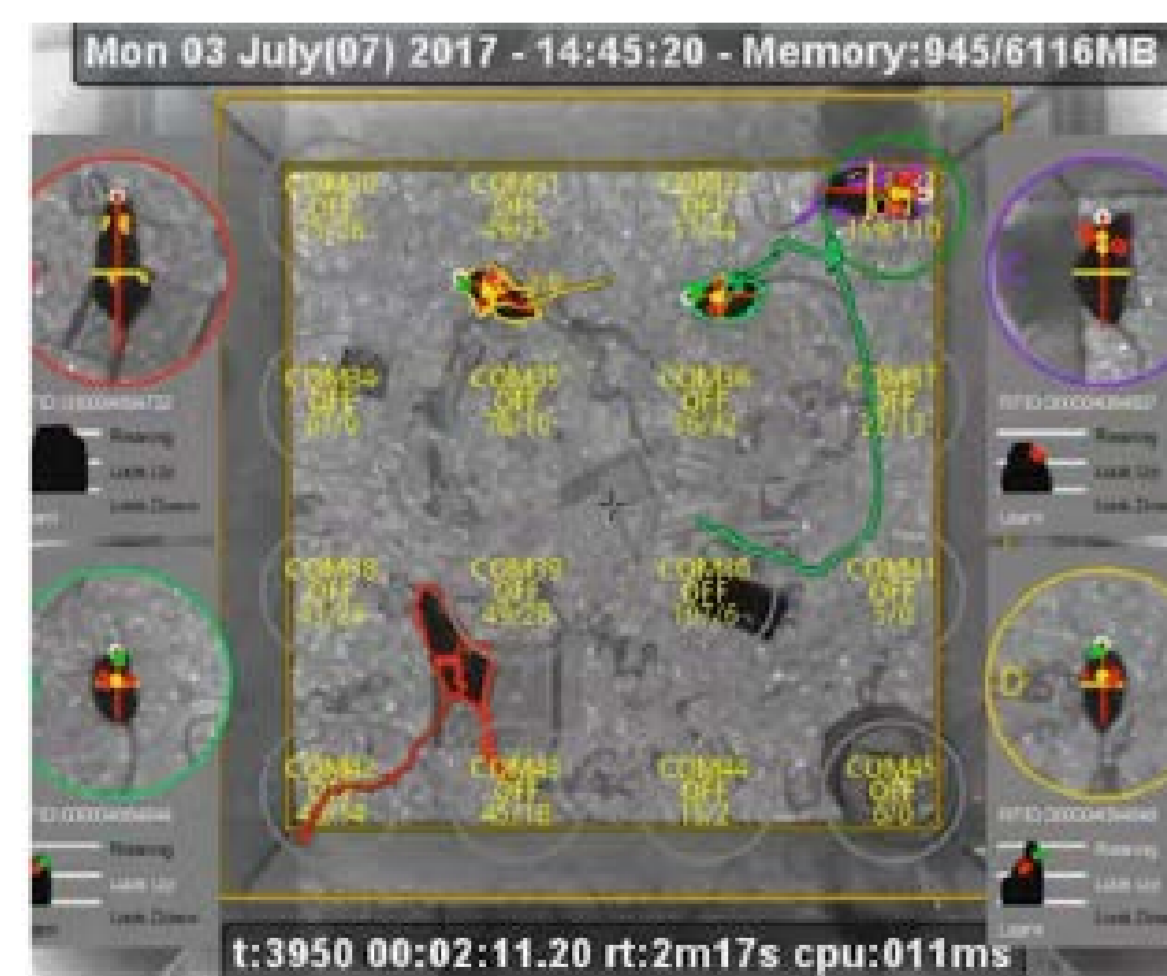
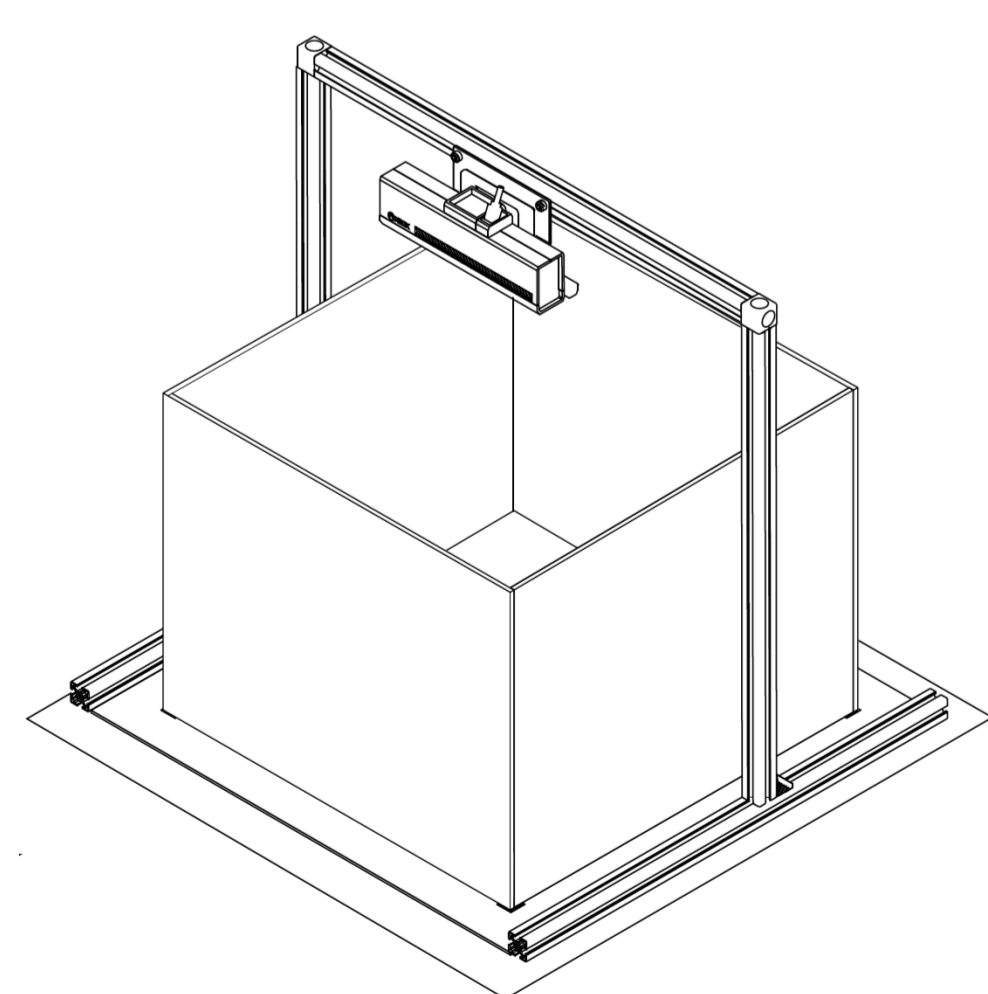
Methods

The Live Mouse Tracker is an integrated system that tracks and monitors the activities of four mice in an enriched housing environment. This system determines the outline mask and orientation of each mouse, independently of its coat color and of the light conditions. It is robust to the presence of food, water, sawdust, brown crinkle paper, white compressed cotton cylinders, toys and house (either transparent to infrared or opaque). The tracking is performed by using an RGBD camera, filming the mice from the top.

Mice are segmented from the background. These detections are filtered by a dedicated machine learning and then processed to separate mice that are in contact. The identity of tracks is retrieved in real-time by combining machine learning with Radio Frequency Identification (RFID). Detection, tracking, and RFID reading information are stored in a database and can be queried live during the tracking, or later via open source python scripts.

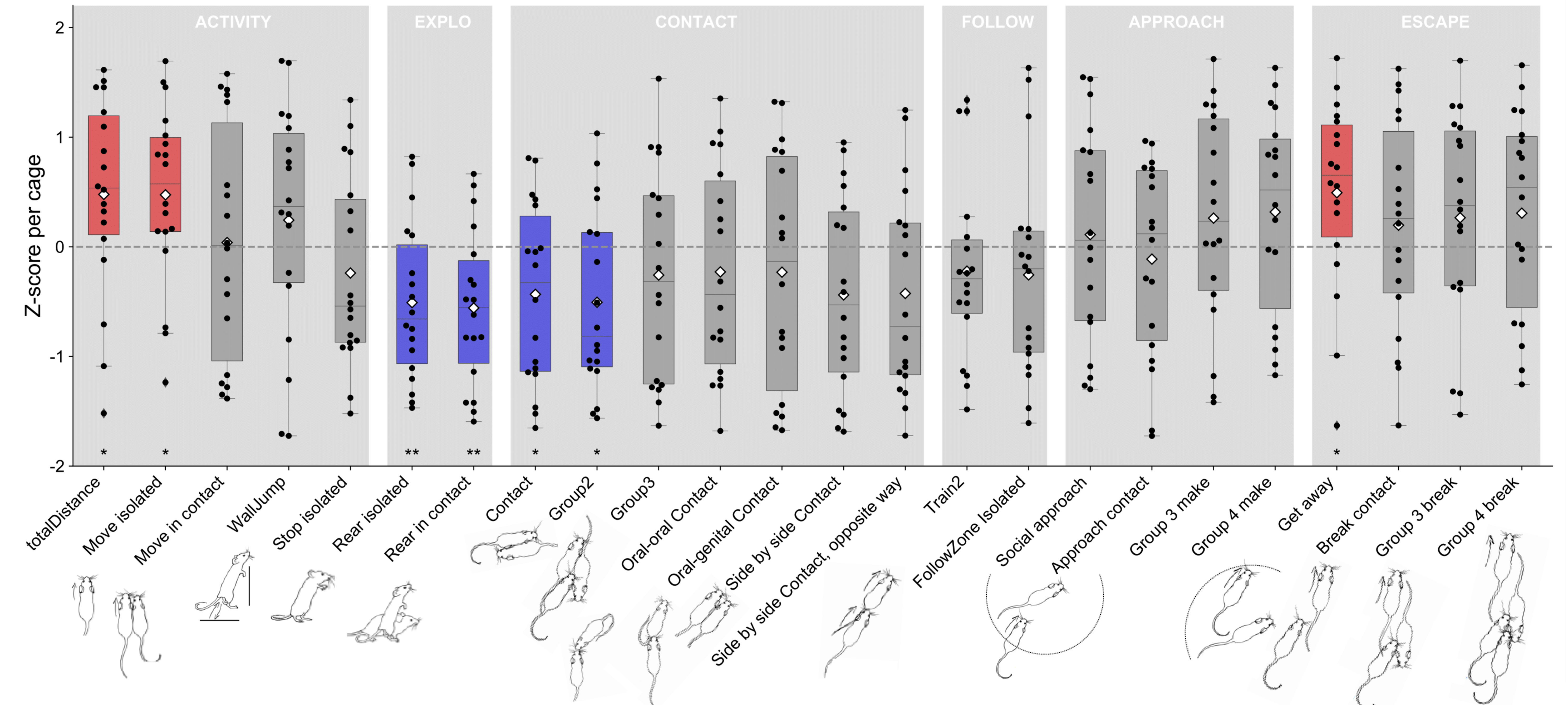
You can find more information about Live Mouse Tracker here:

<https://livemousetracker.org/>



Setup scheme and screenshot during the acquisition where four mice are tracked.

Results



Behavioral profile of a mouse model of autism carrying a deletion of the 16p11.2 region (generated on a F1 C57BL/6N x C3B background). 16p11.2 Del/+ female mice displayed hyperactivity (increased total distance and total duration of the move isolated behavior), reduced vertical exploration (decreased rearing behaviors), decreased time spent in contact with others (decreased contact and group2) and increased escape behavior (increased get away) compared to wild type littermates. Two mutant and two wild-type mice were housed in the LMT system for 3 days; the behavioral data (here total duration of each behavior) for each mutant were normalized (centered and reduced) on the behavior of the wild-type mice within the same cage. Nine cages of four animals were tested (one-sample T-test, * : p-value < 0.05; ** : p-value < 0.01).

Conclusion and perspectives

The Live Mouse Tracker system provides one of the most complete behavioral profile automatically generated. In the present study, we highlighted robust deficits in the activity and social domain in 16p11.2 Del/+ female mice generated on a mixed background compared to their wild-type littermates in home cage-like conditions. The same methodology will be used in therapeutic trials to highlight the effects of pharmacological treatments on social deficits in this model, for instance the fasudil treatment, that restored cognitive functions on this model (Martin-Lorenzo et al. 2021).

The Live Mouse Tracker system opens the ways for large comparative studies on a comprehensive behavioral profile in other mouse models. A user-friendly application called LMTxpManager is currently under development to manage the storage of the SQLite data files generated by LMT and to automatize the analyses.

