Using Machine Learning to Analyze Individual Differences in Stress Coping in C57BL/6J Mice

Anderson Happel, Evan Doré, Emma Weiser, and Rajani Maiya

Department of Physiology, Louisiana State University Health Sciences Center, New Orleans, Louisiana

LSU Health NEW ORLEANS
School of Medicine
Department of Physiology

MAIYA LAB

Introduction

- Animal pose estimation has remained crucial for studying animal behavior. However, tracking poses manually is tedious, obscure, and subjective.
- Social Defeat Stress (SDS) is a common and ethologically relevant form of stress that leads to increased anxiety-like behaviors, deficits in sociability, and depression.
- DeepLabCut (DLC) is a modern software program that accurately tracks animal poses throughout videos of animal movement. Little research exists to examine the efficacy of DLC on identifying signs of anxiety-like phenotypes in animals.

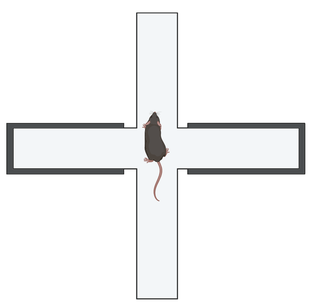
Methods I

Social Defeat Stress (SDS)

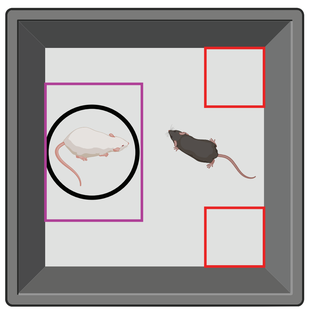
Measuring Anxiety-Like Behavior

Control and SDS mice were placed in the middle of an Elevated Plus Maze and roamed around for 5 minutes.

Percentage of entries into the open arms (up and down) was recorded.



Measuring Sociability Toward Novel Mice

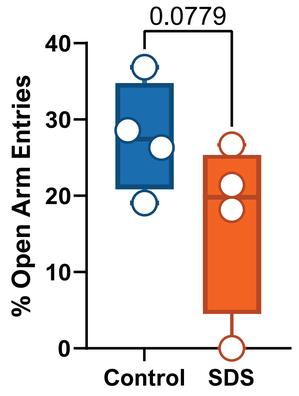


Control and SDS mice were placed inside an open box with an enclosed novel aggressive mouse for 5 minutes.

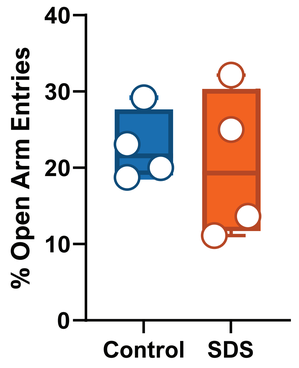
Time spent in the Social Interaction (SI) Zone and the opposite corners (red) was recorded.

Results I

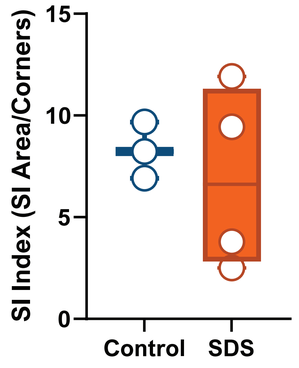
Males



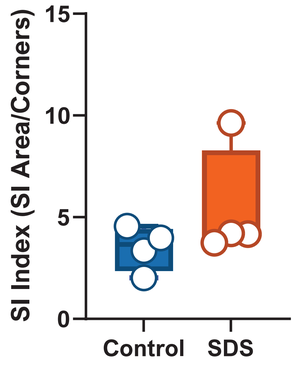
Females



Males



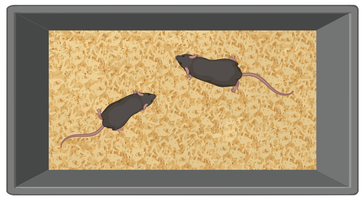
Females



Methods II

DeepLabCut Flowchart

Homecage dyadic interaction between control and stressed mice with a juvenile intruder

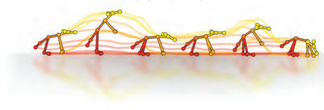


Recording setup used a Raspberry Pi camera in a 3D-printed housing.

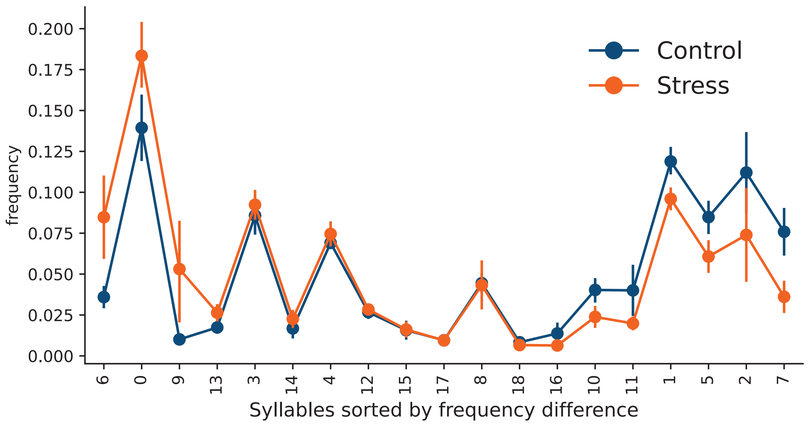
DeepLabCut was used to train a model for automatic mouse pose estimation.

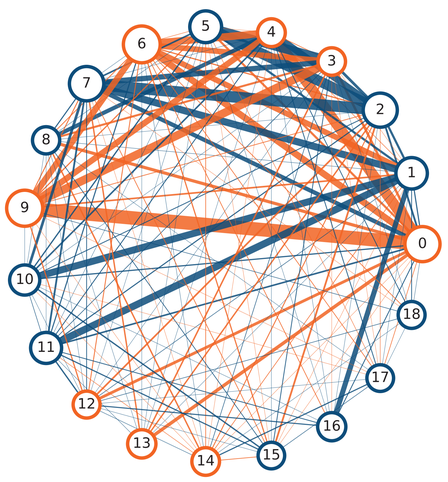
Total Frames Labeled: 2568

Pose estimation data was exported to Keypoint-MoSeq, an unsupervised method for analyzing animal behavior.



Results II





Conclusions

- In the Elevated Plus Maze, stressed mice showed a trend toward increased anxiety-like behavior, with stressed males exhibiting greater individual variability. No overall difference was seen in females, but a bimodal distribution suggested stress-resilient and stress-susceptible subgroups.
- In the open field social interaction test, group-level differences were absent, but stressed males showed high individual variability with a bimodal distribution, supporting distinct stress-resilient and stress-susceptible phenotypes.
- DLC skeleton tracks of dyadic social interaction reveal potential differences in syllable usage and behavioral state transitions between control and stressed mice. Future studies using larger cohorts of male and female mice will confirm these observations and determine if there are important sex differences.

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