An automated approach to quantifying mouse olfactory behavior

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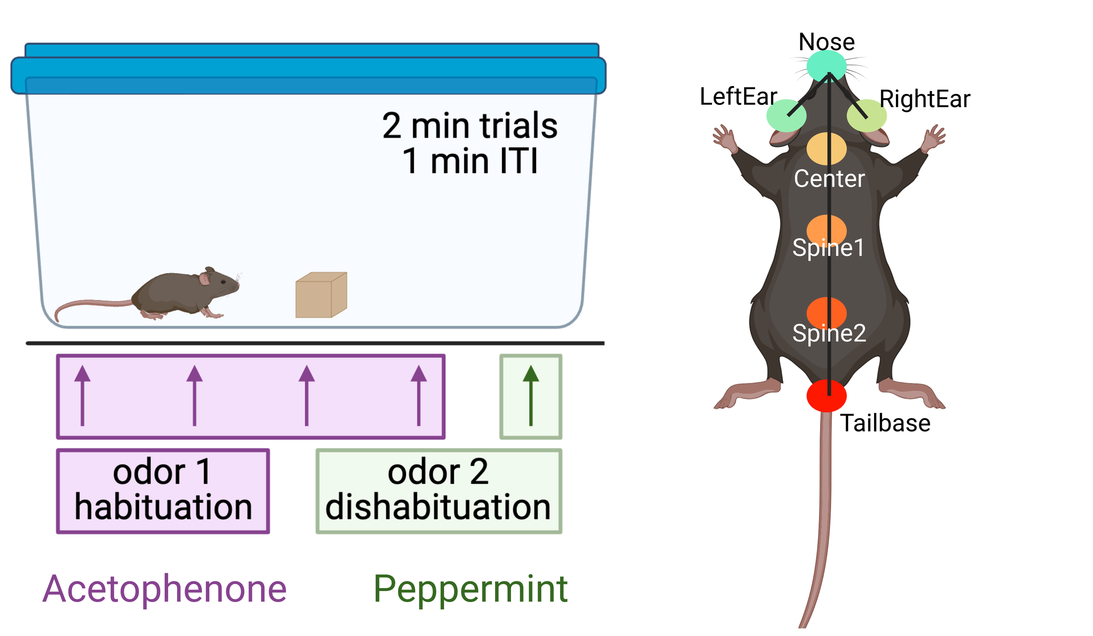
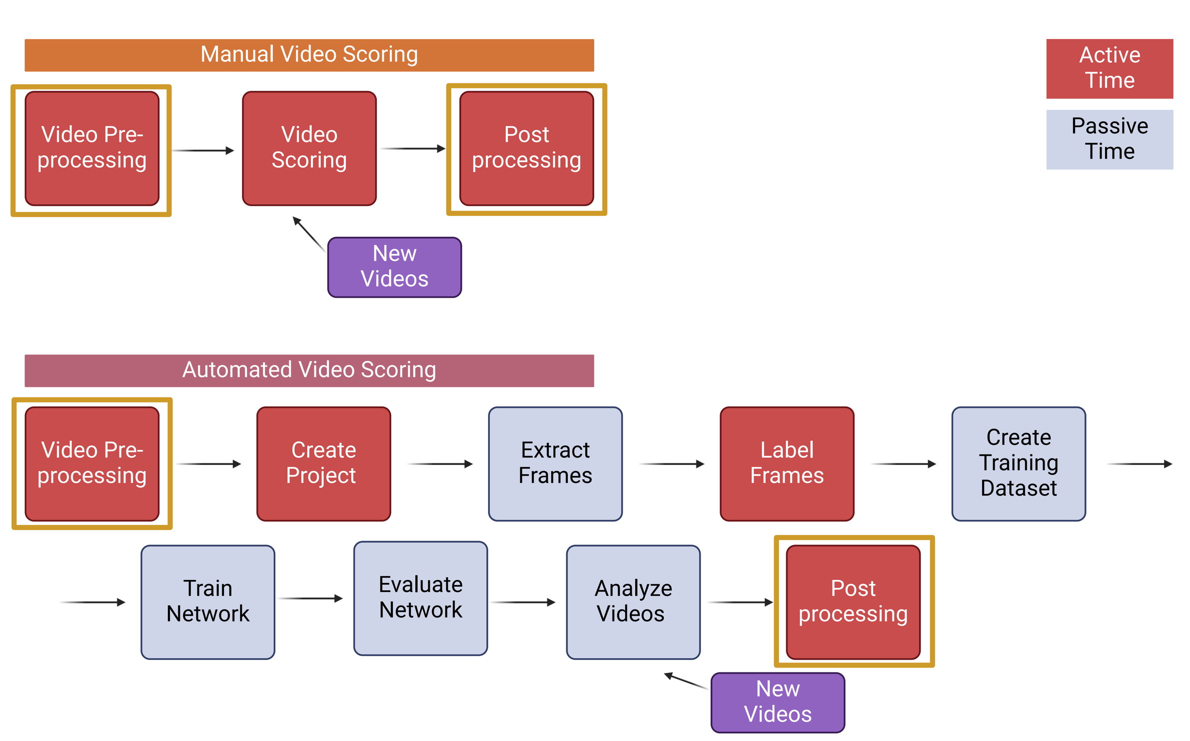
INTRODUCTION

Preclinical research relies on animal monitoring and behavioral analyses to understand brain function. The standard in behavioral analysis has been manual scoring as well as the utilization of commercial platforms, though these methods are time consuming or costly (Sturman et al, 2020). Recent advances in deep learning by high precision tracking of the body parts in freely moving rodents have shown success in behavioral analyses to a level of human accuracy (Mathis et al, 2018; Sturman et al, 2020; Wahl et al, 2022). The objective of this project was to compare an automated method of analyses by DeepLabCut with manual scoring in the quantification of mouse olfactory behavior in an odor habituation/ dishabituation assay. Performance in odor discrimination ability was compared amongst three mouse lines (M72*tau*LacZ, OMP*gfp*, M72*tau*GFP) and 2 dietary treatment groups.

METHODS

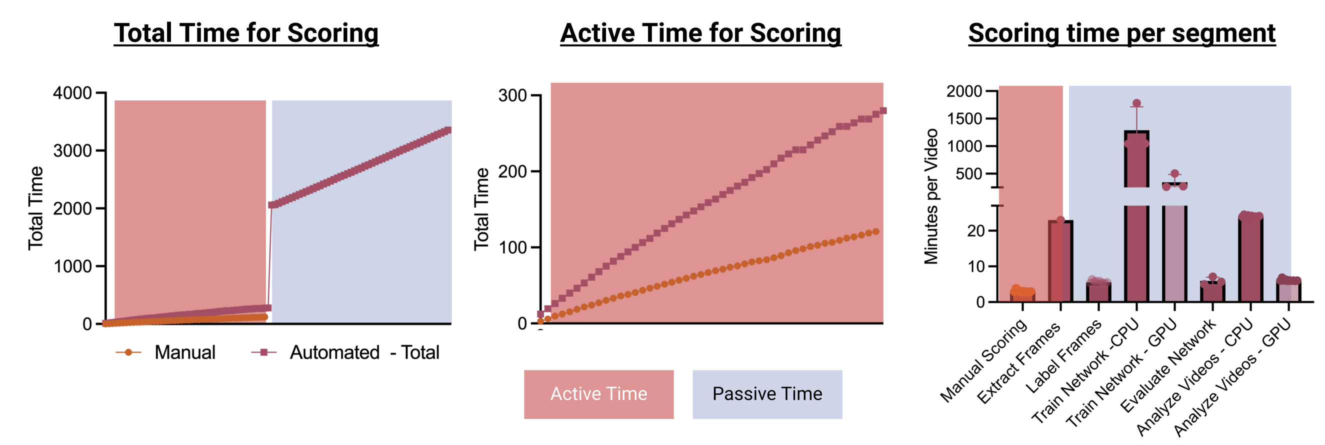
All mice in our study were housed in the **Florida State University** (FSU) *vivarium* with reverse 12/12-hr light/dark cycle (lights off at 9 am and on at 9 pm). Experiments were approved under protocol number #2020000036 by the FSU **Institutional Animal Care and Use Committee** (iACUC). Animals were fed either a control diet (12.5% kcal/fat) or moderately high fat diet (32.5% kcal/fat) for 5 months following weaning. Habituation/Dishabituation tests were performed on approximately 6-month old male M72*tau*LacZ, OMP*gfp*, and M72*tau*GFP mice.



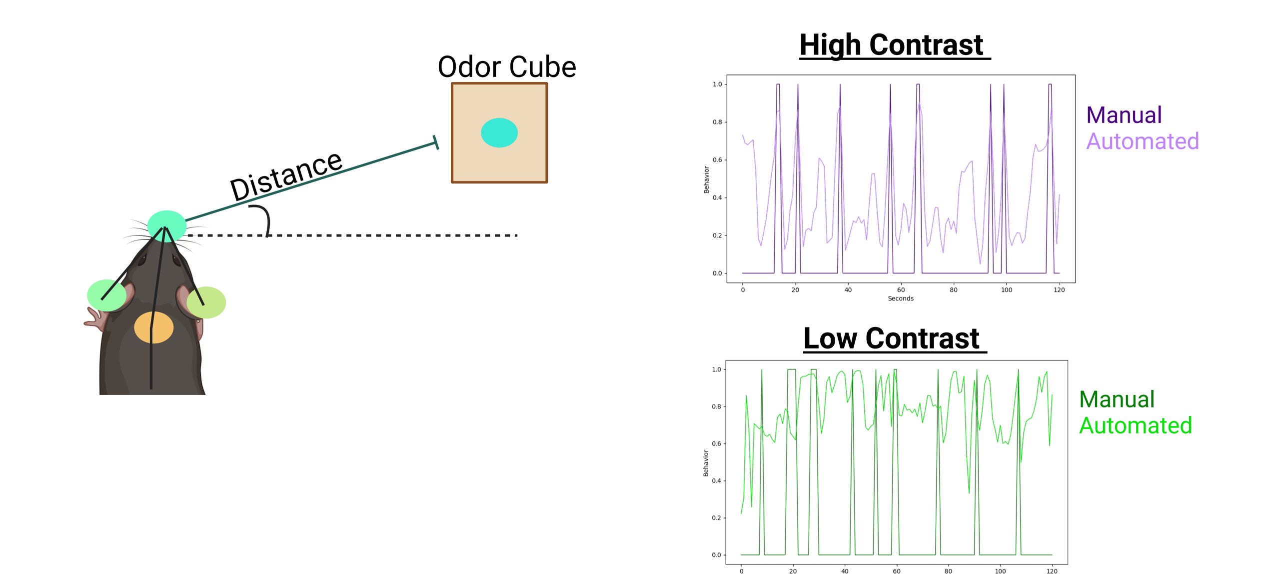


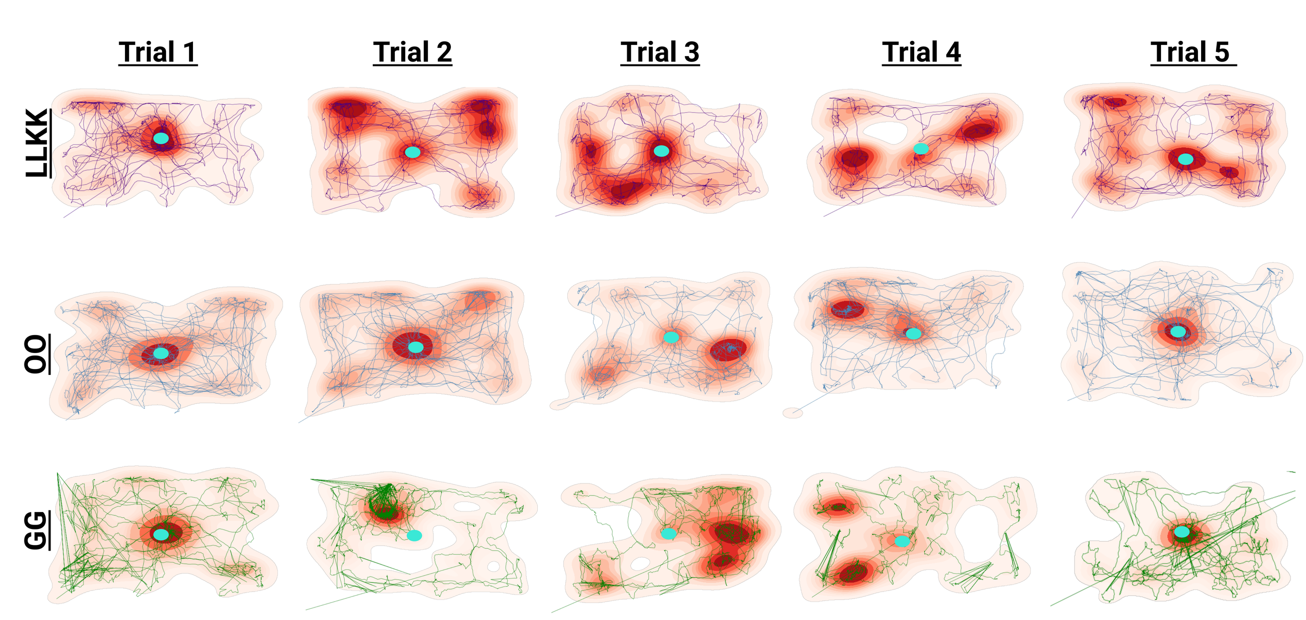
RESULTS

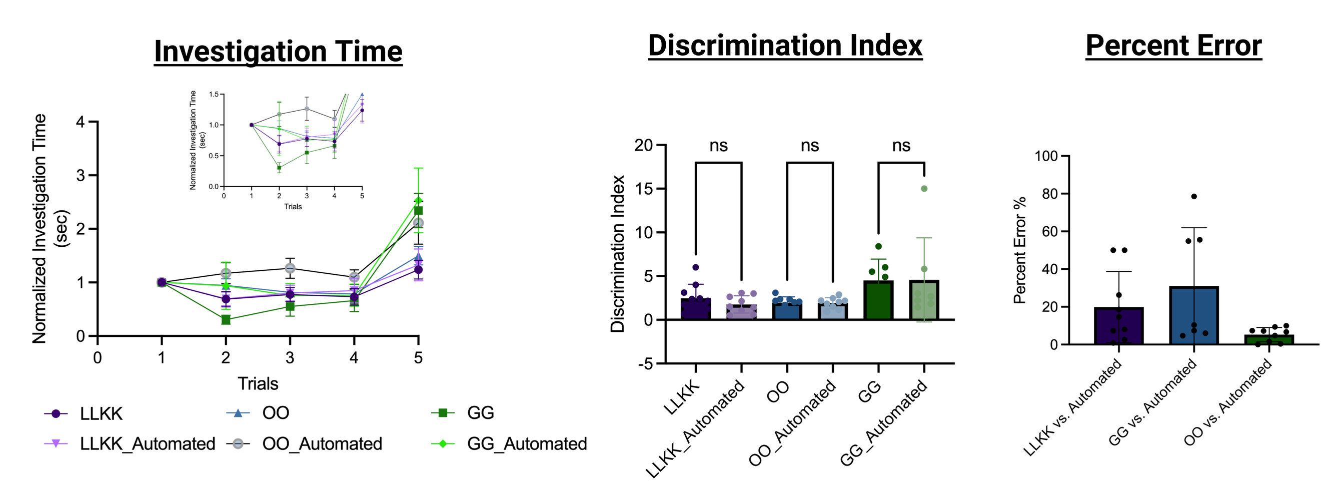
Automated Analysis Requires More Passive Time but More Easily Integrates New Samples



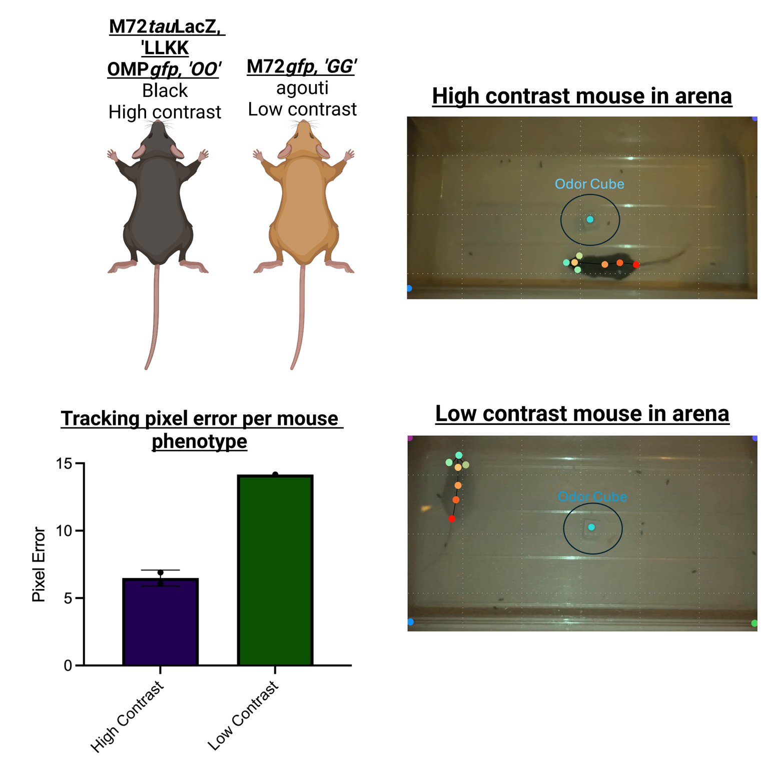
Mouse Olfactory Behavior can be Approximated by Distance to Odor Cube and Head Orientation



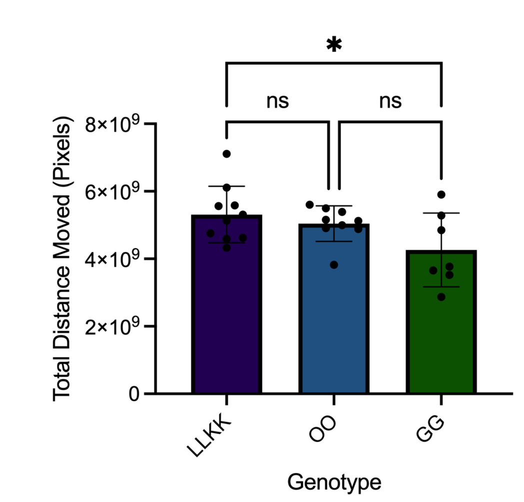




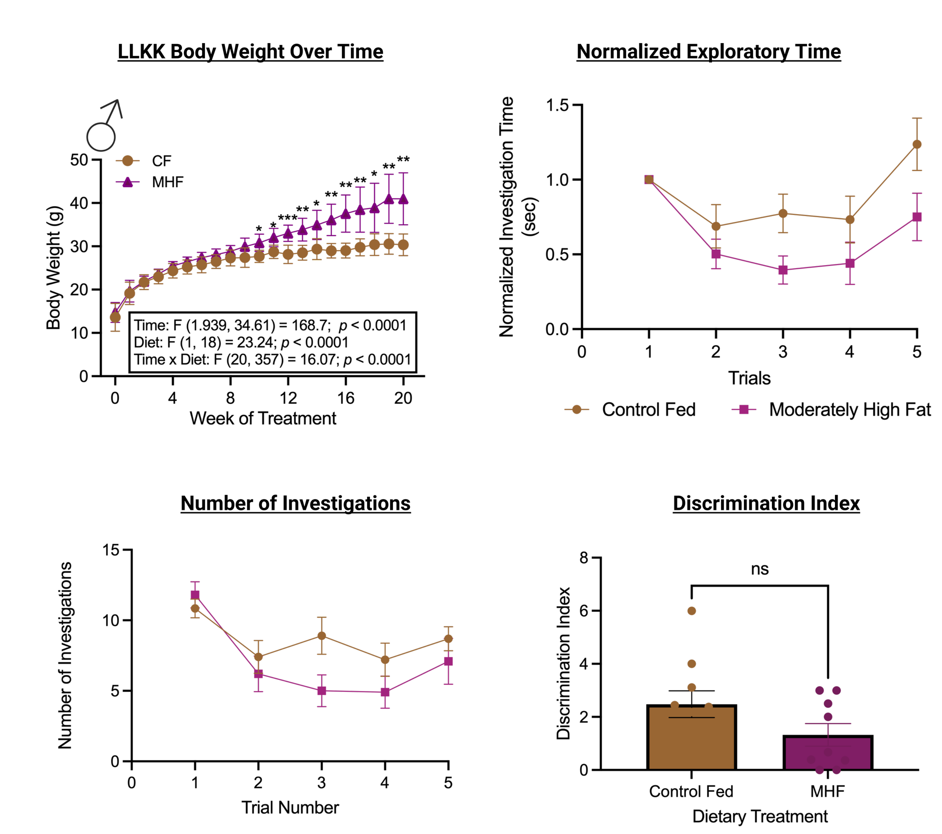
Automated Scoring is Dependent on Mouse Phenotype



M72*gfp* Mice have Decreased Anxiety



A High Fat Diet has No Effect on this Olfactory Behavior Test in M72*tau*LacZ Mice



CONCLUSION

Our results support:

- Automated scoring may not save time but can give more information.
- Automated scoring depends on mouse phenotype, but can accurately score behavior.
- M72*gfp* mice had a higher discrimination index.
- M72*gfp* mice had decreased anxiety behavior.
- A high fat diet has no effect on mouse discrimination.

FUTURE DIRECTIONS

Our next steps are to **compare mouse performance in the habituation/dishabituation assay among genotypes (M72*tau*LacZ, OMP*gfp*, M72*tau*GFP) in obese mice fed a moderately high-fat diet.** We are also interested in the effects of metabolic state and will be comparing odor discrimination ability in these obese mice fed a moderately high-fat diet with mice that are **isocallorically matched** with mice on a control fat diet. These mice are lean but still experience a damaged olfactory circuitry (Chelette et al, 2022).

Implementation of deep machine learning with software such as DeepLabCut should be applied to other behavioral assays which may differ in the types of tracking or manual scoring labor necessary for analysis. Similar object recognition tests are used to assess **short- and long-term memory, and ADHD-like behavior**. Mouse position data (from Deeplabcut) can also assess **anxiety** through behavioral assays (light-dark box, marble burying, and elevated plus maze.

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