Effects of Predator Odor Stress on Habit Learning in Long-Evans Rats

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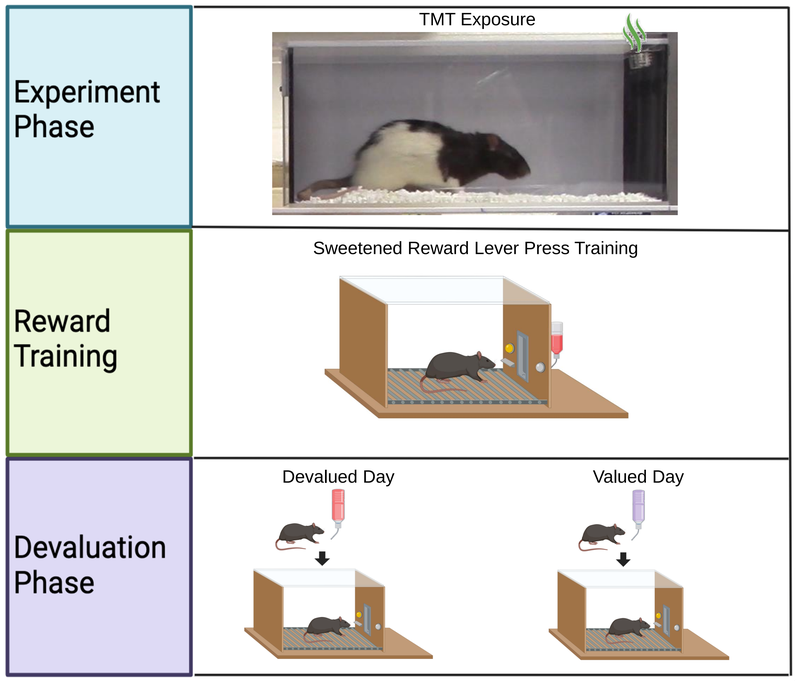
Introduction

- PTSD (post-traumatic stress disorder) impacts a subset of individuals who experience a traumatic event[1]
- The rodent model of PTSD used in this experiment involves a 10-minute exposure to 2,3,5-Trimethyl-3-thiazoline (TMT), which is a component of fox feces[2]
- Rats exhibit different types of coping strategies when presented with the predator odor stressor[2,3]
- Active coping is defined as defensive digging in the cage bedding
- Passive coping is defined by immobility and freezing
- Individual differences in coping strategies promote different long-term effects of predator odor stress on the brain and behavior[2,3]
- Other stressors, like chronic stress, can promote reliance on habitual behavior instead of goal-directed behavior[4,5]
- Goal-directed behavior is contingent on the value of the outcome
- Habitual behavior is automatic and occurs independent of outcome value
- Unlike chronic stress, PTSD results from a single stressful event[1]
- In this experiment, rats were exposed to predator odor exposure before being trained to press a lever for a rewarding sweetened solutions, and then we evaluated the expression of habitual or goal-directed behavior

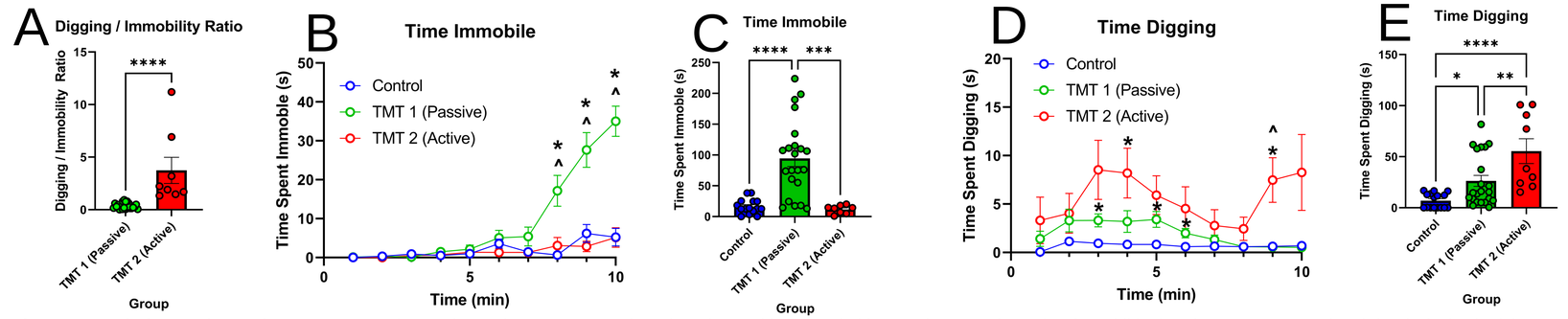
We hypothesize that the exposure to the TMT predator odor will promote the expression of habitual behavior

Methods

- Adult Long-Evans Rats (n=48; 24 males and 24 females)
- TMT Exposure/Experimental Group (n=32); Water Exposure/Control Group (n=16)
- 11 days of self-admin (grape sucrose Kool-Aid or cherry maltodextrin Kool-Aid)
  - Lever presses were reinforced on increasing random ratio (RR) schedules of reinforcement, which typically promotes goal-directed behavior in long-evans rats[6]
  - For example, RR5 means each lever press has a 1 in 5 (20%) chance of reinforcement
  - Rats (n=10) were excluded from analysis if they failed to obtain rewards on the final 3 days of self-administration
- 2 Devaluation testing days, separated by one day of self-administration

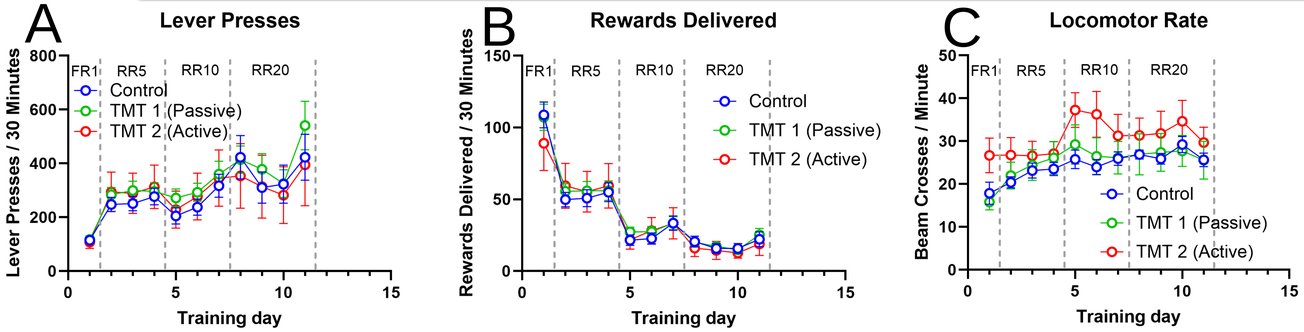


Different Predator Odor Coping Strategies



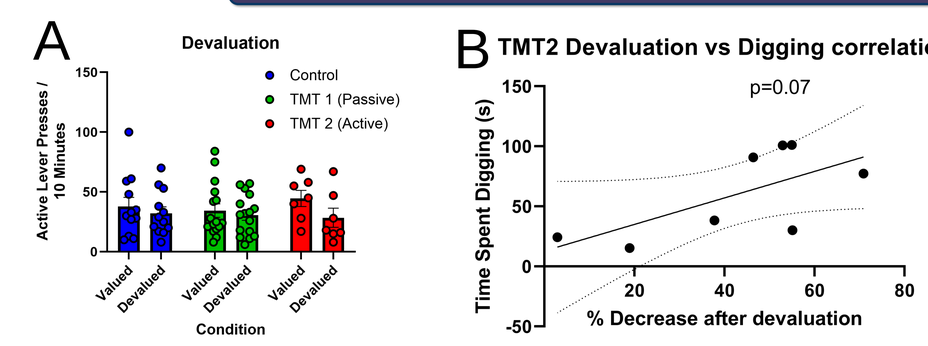
Coping strategy during predator odor exposure: During predator odor exposure, each rat (n=48) was video recorded for 10 minutes to determine the exhibited coping strategy. Rats that defensively dug had time marked as "Digging". "Immobility" was recorded when a rat was stationary for >2 seconds. There were no effects of sex so males and females were combined. The ratio of time spent digging and time spent immobile was calculated and used to separate rats into the passive TMT group (TMT1) and the active TMT group (TMT2). **A)** Rats with a D/I ratio >1 were placed into the TMT2 group, and rats with a D/I ratio <1 were placed into the TMT1 group. There was a significant difference (****p<0.0001) in the D/I ratios determined by each group. **B)** There was an interaction between time and TMT group (****p<0.0001) on time spent immobile during each minute of TMT exposure. (*) indicates that there was a significant difference between the TMT group and controls, and "^" indicates a significant difference between TMT groups. **C)** Combined time spent immobile was significantly greater for the TMT1 group compared to controls (****p<0.0001) and the TMT2 group (***p=0.0001). **D)** There was an interaction between time and TMT group (**p=0.007) on time spent digging during each minute of TMT exposure. (*) indicates that there was a significant difference between the TMT group and controls, and "^" indicates a significant difference between TMT groups. **E)** Combined time spent digging was significantly different between controls and the TMT2 group (****p<0.0001), controls and the TMT1 group (*p=0.0437), and between TMT groups (**p=0.0091).

Predator Odor Does Not Affect Sweetened Reward Learning



Daily sweetened solution self-administration: After predator odor exposure, rats (n=48) were trained to lever press for a sweetened solution for 11 days. There were no effects of sex so males and females were combined. There was a main effect of training day (****p<0.0001) on the number of lever presses **(A)**, rewards delivered **(B)**, and beam crosses per minute **(C)** each day, but there were no effects of TMT exposure or interaction on any of these measures.

Digging May Correlate With Reduced Habit Learning



Devaluation: After initial days of self-administration training, each rat (n=48) went through a devaluation phase composed of 1 devalued day and 1 valued day, each separated by a day of RR20. **A)** There are no statistically significant relationships noted. **B)** Based on the devaluation phase and identified predator odor coping strategy, we had (n=8) rats marked as "Digging" (TMT2). The percent decrease in expected behavior after devaluation was plotted against the time each TMT2 rat dug in seconds. There was a trend toward a positive correlation (p=0.07) between more time spent digging and higher percent decrease after devaluation, which indicates that digging may positively correlate with a reduction in habit learning.

Conclusions & Future Directions

- More time spent digging during predator odor stress may correlate with reduced habit learning weeks after exposure to stressor
- Based on the potential relationship seen between devaluation and amount of time spent digging even with a small sample size, a fully powered sample size may reveal significant relationships
- Opt for rewards of comparable desirability to minimize potential biases in preference that could influence the outcome in behavioral experiments.
- This experiment has potential for the examination of understanding alcohol-related behaviors, given its link between habits, PTSD, and substance use disorders (SUDs)
- Investigate the brain regions involved with habit learning and stress response

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Acknowledgements

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