Investigating darting responses during active avoidance learning in rats.

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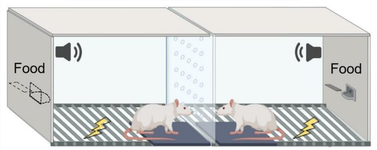
Introduction

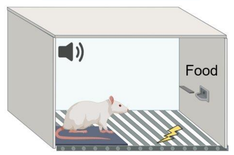
- Women are twice as likely to develop anxiety-related disorders compared to men[1].
- Previous fear conditioning studies have reported that female rats exhibit “darting” four times more than male rats[2], however, it is unclear if darting is present in other aversive learning tasks.
- We therefore assessed the presence of darting in male and female rats during acquisition of platform-mediated avoidance (PMA)[3] under social and solitary conditions.

Methods

Social Partner PMA



Solitary PMA



- 9 trials per day for 10 days
- VI-30 reinforcement of bar pressing
- Tone: 30 sec, 4 kHz, 75 dB
- Shock: 2s, 0.4 mA[5]

Darting: An active fear response characterized by a rapid movement across the chamber reaching a velocity of greater than 23.5 cm/s and lasting a maximum of 1 second.

Results

1. Rats show greater freezing and lower pressing in social conditions when compared to solitary.

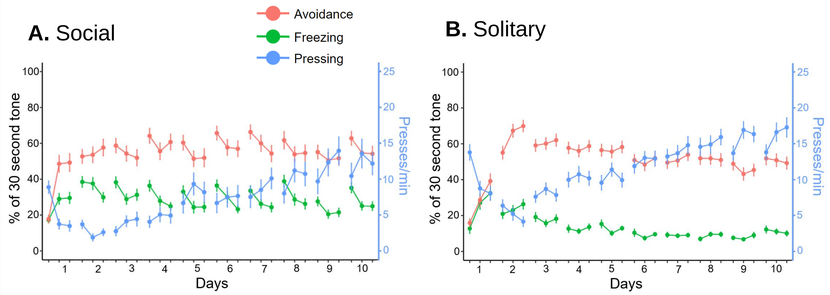


Figure 1. (A) Percentage of time spent avoiding (red) and freezing (green) during the tone and pressing during the intertrial intervals (ITI) at pre-tone (blue) across 10 days of training in social conditions (n=42). As rats increased avoidance, freezing decreased, and ITI pressing returned to baseline levels. Data shown as mean ± SEM, trials shown in blocks of 3. **(B)** The same context as in (A) under solitary conditions (n= 59).

2. More darting occurred under solitary conditions when compared to social.

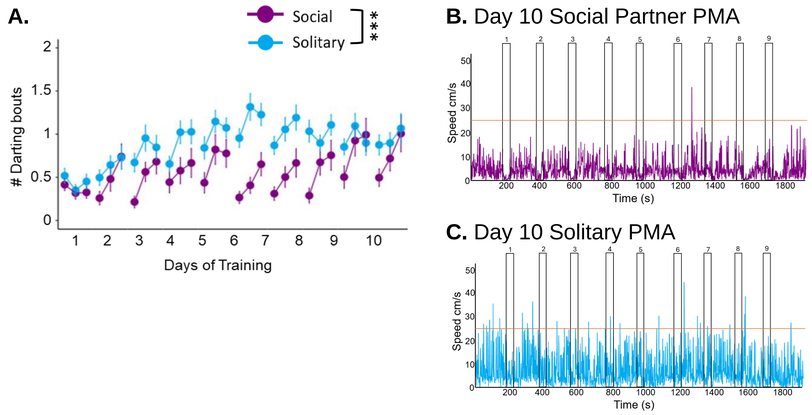


Figure 2. (A) Number of darting bouts in social (purple) and solitary (blue) conditioned rats. A multilevel regression showed darting bouts increased across days ($p < 0.001$) with rats in solitary conditions (n=59) exhibiting more darting bouts than rats in social conditions (n = 42; $p < 0.001$). Data shown as mean ± SEM, trials shown in blocks of 3. **(B)** Velocity of a social-conditioned rat on Day 10. Orange line indicates darting threshold (23.5 cm/s) with the black rectangles indicating the 9 tones. **(C)** The same context as in (B) under solitary conditions.***$p < 0.001$.

3. Males and females have similar levels of darting in both social and solitary conditions.

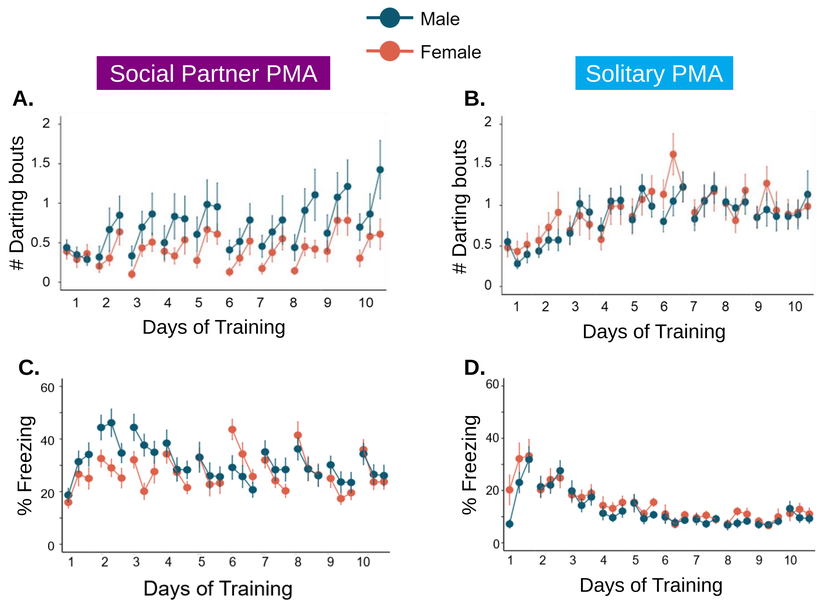


Figure 3: (A) Number of darting bouts under social conditions during the tone across 10 days of training. A multilevel regression revealed that the number of darting bouts for females (n=21, salmon) is not significantly different from the number of darting bouts in males (n=21, teal; $p = 0.375$). **(B)** The same context as in (A) under solitary conditions with no significant darting bout differences in females (n=27, salmon) and males (n=32, teal; $p = .6883$). **(C)** Percentage of freezing under social conditions during the tone across 10 days of training. A multilevel regression revealed no significant sex differences in freezing ($p = 0.501$). **(D)** The same context as in (C) under solitary conditions with no significant sex differences in freezing ($p = .057$).

4. Rats learn to dart more frequently between the food and platform zones.

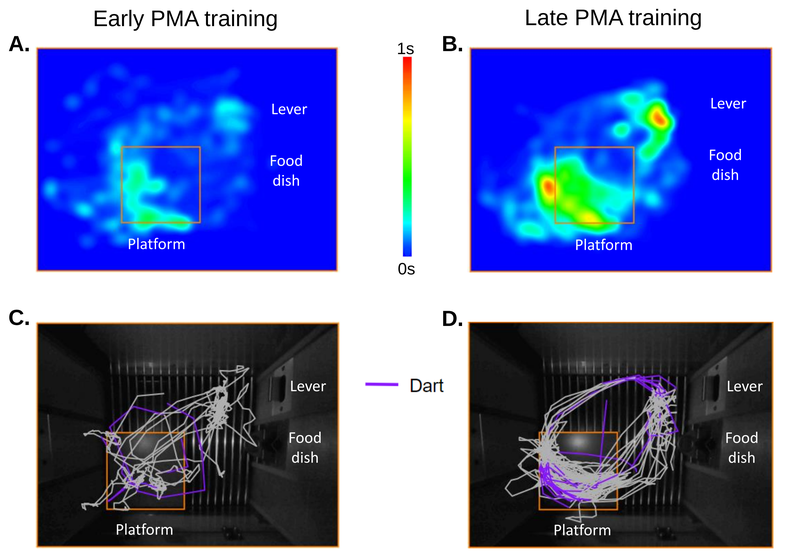


Figure 4: (A) Heat map showing when darting behavior was detected for a subset of rats in the solitary condition (n=16) on day 2 during the tones. **(B)** Heat map showing when darting behavior was detected for the same subset of solitary-conditioned rats on day 8 during the tones. **(C)** Trace map showing individual rat’s movement during the tones on day 1. **(D)** Trace map showing same rat’s movement during the tones on day 8.

Conclusions

- Darting occurred more frequently under solitary PMA vs. social partner PMA, indicating that rats in these conditions may exhibit fear differently.
- No sex differences in darting were observed during avoidance, which is inconsistent with prior studies on darting during fear conditioning[2].
- Freezing was observed earlier in PMA training, whereas darting emerged later in PMA training, indicating that fear may switch from passive to active responding as PMA training progresses.
- Future studies will investigate whether location of darting differs by training condition or sex and whether it correlates with other behaviors during PMA training.

References

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