The Effect of Alternating Exercises on Habituation of Wheel Running in Rats

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Introduction

- Certain stimuli evoke reflexive responses (e.g. jumping in response to a loud noise) but not all stimuli are followed by harm (e.g. a bird pecking on a tree).
- Habituation is the reduction in response to an eliciting stimulus after repeated presentations.
- Research has found that habituation is also involved in regulatory behaviors, such as eating (McSweeney & Swindell, 1999) and exercise (Aoyama & McSweeney, 2001).
- The response can recover (dishabituate) if a different stimulus is presented before the next presentation of the habituated stimulus (e.g., the buffet effect).
- Wheel running in rats has been found to decrease within daily sessions.
- Aoyama and McSweeney (2001) demonstrated dishabituation of running by switching the wheel midway through a session.
- Habituation of dishabituation occurs when an organism habituates to the dishabituating stimulus (Rankin et al., 2009). For example, if the Aoyama and McSweeney (2001) repeated the wheel change over sessions, dishabituation would gradually disappear.
- Previous research in our lab has found that changing the context (e.g., smell and visual cues) of the running wheel did not reduce habituation within session.
- The current experiment investigated whether varying the order of two types of exercise within session would reduce habituation *within* sessions.
- It is hypothesized that the animals with an exercise order that changed across days would demonstrate less habituation (i.e., more running) within sessions compared to animals that experienced the same exercise order across days.

Method

Subjects: 16 female Long-Evans rats

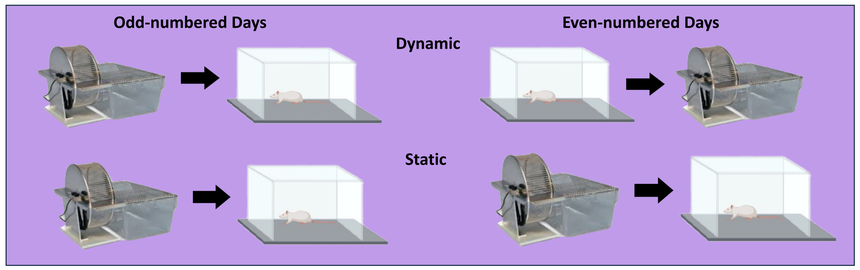
Apparatus

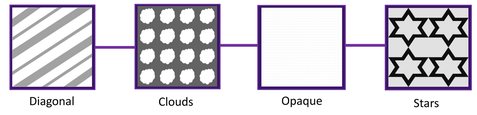
Running Wheel: Four different wheels were placed in the corners of a room. All stations consisted of a running wheel (with a plastic holding cage, steel bars, cob bedding, wheel) surrounded by patterned poster boards (clouds, stars, diagonal lines, opaque). Wheel counters attached to each wheel measured the number of wheel rotations. Number of rotations was analyzed at 10-minute intervals during each 20-minute session.
Open Field (OF): Four OF arenas were placed in the center of the same room. The sides of the open field boxes were surrounded by cardboard to prevent rats from seeing one another.

Procedure

Baseline: A baseline measure of wheel running was taken (days 1-4) with a median split being preformed on the total number of wheel turns. An equal number of high and low runners were assigned to both groups (i.e., experimental and control group).
Experiment proper: Rats were given daily 40-min sessions in which they were given access to 20 min of wheel running (in one of four wheels) and 20 min to explore an open field (OF) apparatus for 14 days. For rats in the dynamic groups, the order in which they were exposed to each apparatus alternated across sessions (see Figure 1 and Table 1 for examples). The static control groups were exposed to each apparatus in the same order for all sessions.

Figure 1. Sampling Dynamic Group 1 and Static Group 1





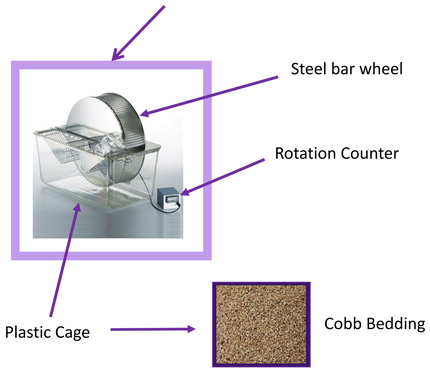


Table 2.

Group	Baseline	Experiment Proper	
		Odd-numbered Days	Even-numbered Days
Dynamic Group 1	4 days of 20-min access to running wheel	Wheel-First	Wheel-Second
Dynamic Group 2		Wheel-Second	Wheel-First
Static Group 1		Wheel-First	Wheel-First
Static Group 2		Wheel-Second	Wheel-Second

Results

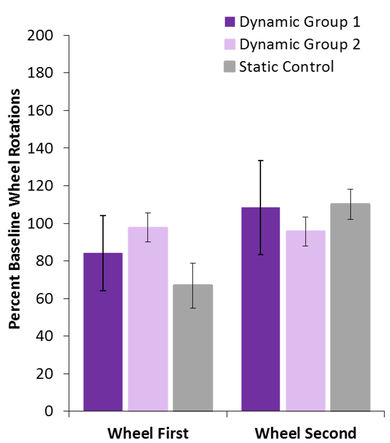


Figure 1. Mean percent baseline wheel rotations across all experimental sessions. Percent baseline wheel rotations was calculated by dividing the number of wheel rotations on each experimental session by the number of rotations from the final day of the baseline phase and multiplying by 100. Two one-way analysis of variances (ANOVAs) with group (Dynamic Group 1, Dynamic Group 2, and Static Control) as the between-subjects factor performed on the wheel 1st condition and on the wheel 2nd condition revealed no main effect of group, $Fs(2, 9) < 1.20$, $ps > .34$. To evaluate changes across days with different orders, three ANOVAs compared percent baseline wheel running across the different orders (wheel 1st vs. wheel 2nd) for each group. Within Dynamic Group 1, there was a main effect of order, $F(1, 3) = 11.57$, $p = .04$, but no effect of order was found for Dynamic Group 2, $F < 1$, or for the Static Controls, $F(1, 6) = 3.79$, $p = .11$.

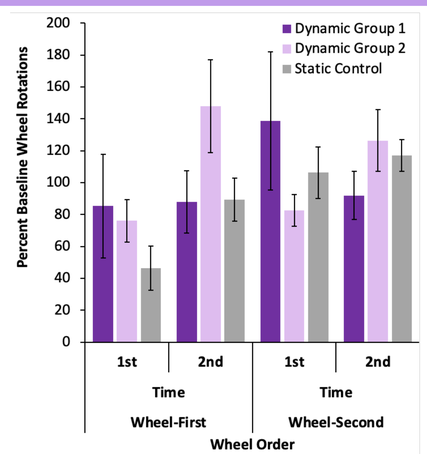


Figure 2. Mean percent baseline wheel rotations in the first half (first 10-min) vs. second half (second 10-min) of the session across all experimental sessions. A repeated measures ANOVA performed on percent baseline wheel rotations within the Wheel 1st condition with time (first half vs. second half) as the repeated measure and group (Dynamic Group 1, Dynamic Group 2, and Static Control) as the between-subjects factor revealed a main effect of time, $F(1, 9) = 5.40$, $p = .05$, but no other effects, $Fs(2, 9) < 2.00$, $ps > .21$. This same analysis with the Wheel 2nd condition revealed no significant effects, $Fs < 2.40$, $p > .15$. To evaluate changes across orders, separate ANOVAs were performed. Percent baseline wheel rotations within Dynamic Group 1 revealed a main effect of order, $F(1, 3) = 9.44$, $p = .05$, and a marginal order by time interaction, $F(1, 3) = 6.06$, $p = .09$, but no main effect of time, $F < 1$. Follow-up tests revealed that during the first half of the session, percent baseline wheel rotations were marginally higher on Wheel 2nd sessions than on wheel-first sessions, $p = .06$, but the two did not differ during the second half of the session, $p = .59$. A comparison of Control Static Wheel 1st vs. Control Static Wheel 2nd revealed a similar pattern, with a marginal effect of time, $F(1, 5) = 5.18$, $p = .07$, and a main effect of order, $F(1, 5) = 7.31$, $p = .04$. No significant effects were found for Dynamic Group 2, $Fs(1, 3) < 3.19$, $ps > .17$.

Discussion

Mean Baseline Rotations

- The results showed there was no difference in the average percent of baseline rotations between groups across all sessions.
- There was a main effect of order for Dynamic Group 1, which had a higher percent of running on Wheel-second days.
- No differences in overall percent baseline running between the two static groups.

Within Session Habituation

- Results showed no difference between groups for both Wheel-first and Wheel-second conditions. However, within the Wheel-first condition, all groups had a higher percent baseline running during the second half of the session compared to the first. In contrast, within the Wheel-second condition, percent baseline did not change across the session.
- When comparing within each group across time in session, Dynamic group 1 ran marginally more in the first 10-min of the Wheel-second session compared to the first 10-min of the Wheel-first session. Rats in the static control groups had marginally higher percent baseline in time 2 compared to time 1 and rats in the Static Group 2 (Wheel-second) had a higher percent baseline than static animals that always experienced the wheel first. This was not seen in Dynamic group 2.

Conclusions

- No group showed within-session habituation regardless of the order of exercise. In fact, running *increased* when the wheel was first.
- This is interesting given our reliable finding of habituation, as well as published reports.
- These data indicate more overall wheel running in the two groups when the wheel was second, likely due to suppression during the first 10-min when the wheel was first.

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