

# Does $C/t$ Ratio and Sign-tracking Increase Efficacy of Conditioned Reinforcers?

Sophia Sperber, Saba Mahmoudi, Sara Peck, Joshua Jones, & Gregory J. Madden  
Utah State University

## Introduction

- Conditioned reinforcers are commonly used in behavior analysis<sup>1</sup>
- One method to establish conditioned reinforcers is through Pavlovian training
- During Pavlovian training, non-human subjects will engage in two types of approach behavior<sup>2</sup>
  - Sign-tracking, which is the tendency to interact with the conditioned stimulus (CS)
  - Goal-tracking, which is the tendency to approach the reward delivery area
- Studies have shown the CS is a more effective conditioned reinforcer for sign-trackers compared to goal-trackers<sup>3</sup>
- Separate studies have shown that large  $C/t$  ratios promote more sign-tracking<sup>4</sup>
- This study has two aims:
  1. Manipulate and assess the effect of three different  $C/t$  ratios on sign-tracking
  2. Assess the effects of group assignment of different  $C/t$  ratios on conditioned reinforcement efficacy of the CS

## Methods

- This study commenced in a series of stages designed to evaluate how changing the  $C/t$  ratio affected levels of sign and goal tracking in 45 female Long Evans Rats. This evaluation was conducted using operant conditioning chambers with interchangeable levers, pellet dispensers, and nose pokes.
- **Magazine Training:** Rats underwent one day of magazine training intended to teach them to eat pellets from the pellet feeder.
- **Group Assignment:** The rats were then divided into three groups of 15. Each group of 15 rats was assigned one of three  $C/t$  ratios (1.75 seconds, 3.5 seconds, or 12 seconds) using block randomization.
- **Training:** The operant conditioning chamber was arranged so that there was a lever on each side of the pellet dispenser. A lever was presented according to a variable time (VT) schedule (14, 28, or 96 s) for 8 seconds before food was delivered. This phase lasted for 8 sessions, each session consisting of 25 trials.
- **Test of Conditioned Reinforcement:** The operant conditioning chamber was arranged so that the pellet dispenser was replaced with a lever, and the levers on either side were replaced with nose pokes. The first day of the test employed a fixed ratio of one nose poke activation per lever presentation. The second day employed a variable ratio (2).

## References

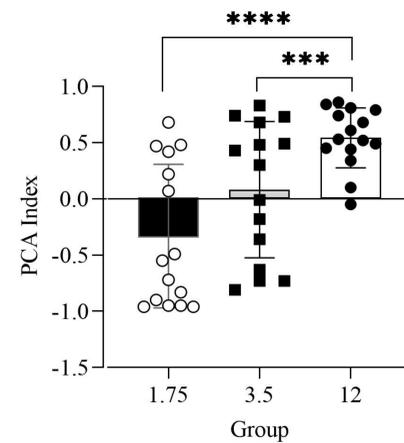
1. Hackenberg, T. D. (2018). Token reinforcement: Translational research and application. *Journal of Applied Behavior Analysis*, 51(2), 393–435. <https://doi.org/10.1002/jaba.439>
2. Meyer, P. J., Lovic, V., Saunders, B. T., Yager, L. M., Fligel, S. B., Morrow, J. D., & Robinson, T. E. (2012). Quantifying individual variation in the propensity to attribute incentive salience to reward cues. *PLoS ONE*, 7(6). <https://doi.org/10.1371/journal.pone.0038987>
3. Robinson, T. E., & Fligel, S. B. (2009). Dissociating the predictive and incentive motivational properties of reward-related cues through the study of individual differences. *Biological Psychiatry*, 65(10), 869–873. <https://doi.org/10.1016/j.biopsych.2008.09.006>
4. van Haaren, F., van Hest, A., & van de Poll, N. E. (1987). Acquisition and reversal of a discriminated autoshaped response in male and female rats: Effects of long or short and fixed or variable intertrial interval durations. *Learning and Motivation*, 18(2), 220–233. [https://doi.org/10.1016/0023-9690\(87\)90012-9](https://doi.org/10.1016/0023-9690(87)90012-9)

## Acknowledgment

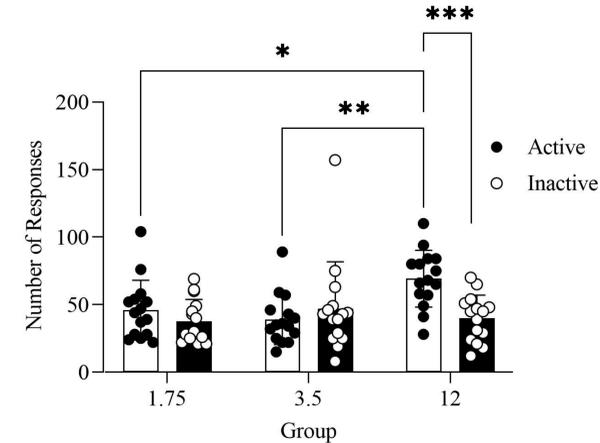
- A special thanks to Saba Mahmoudi and Dr. Gregory Madden for allowing me to work on this study
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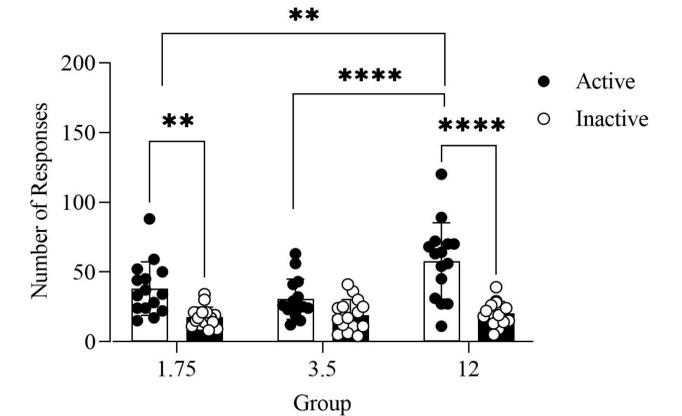
## Results



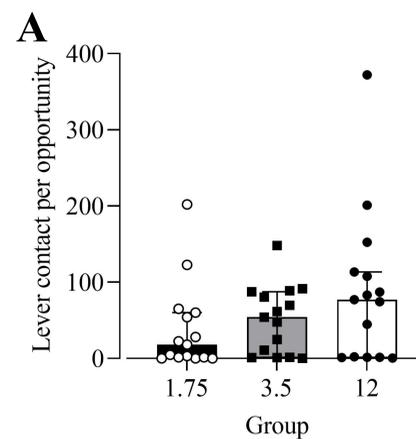
**Figure 1.** PCA Index for the stable sessions. Group  $C/t$  12 engaged the most with the lever



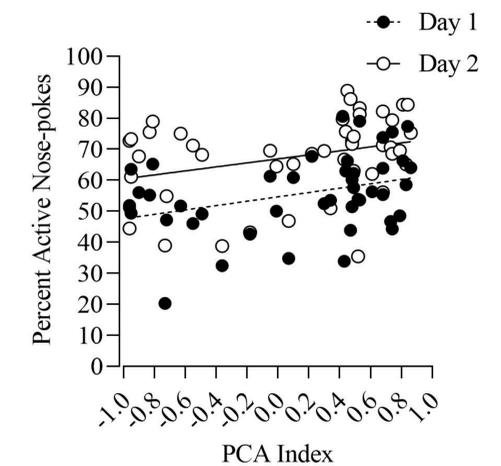
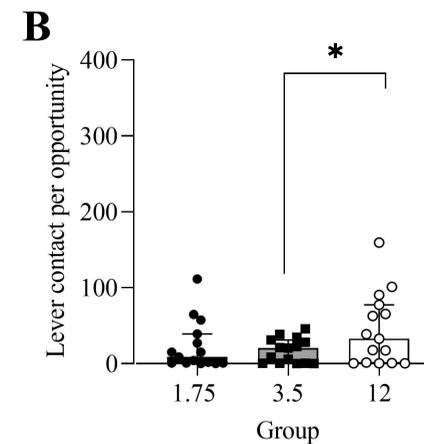
**Figure 2.** Number of responses on the active and inactive port in the first day of test of conditioned reinforcement.



**Figure 3.** Number of responses on the active and inactive port in the second day of test of conditioned reinforcement.



**Figure 4. A)** Lever presses per opportunity in the first day of test of conditioned reinforcement  
**B)** Lever presses per opportunity in the second day of test of conditioned reinforcement



**Figure 5.** PCA Index is positively correlated with percent active nose-pokes in both days of test of conditioned reinforcement

The results were evaluated using a Pavlovian Conditioned Approach (PCA) Index for the last two sessions. As expected, there was a significant difference between the  $C/t$  12 group and the other two groups in rates of sign-tracking (fig. 1) and performance in the test of conditioned reinforcement (figs.2-5). This indicates that the CS lever was a stronger conditioned reinforcer for rats in the  $C/t$  12 group.

## Discussion

- As anticipated the results of the study support the hypothesis that larger  $C/t$  ratios promote higher rates of sign-tracking, and sign-tracking increases the reinforcing efficacy of the CS. The results would suggest to establish an effective conditioned reinforcers researchers and clinicians should use a large  $C/t$  ratio to promote higher rates of sign-tracking
- One limitation of this study was that there was no control group. We initially selected not to include a control group because in prior studies, the lever did not function as a conditioned reinforcer for subjects in the control group, and this study was specifically interested in effect of  $C/t$  ratio on conditioned reinforcement.
- Another limitation of this study is that only female subjects were used. Prior studies have shown the effect of large  $C/t$  ratios and sign-tracking with male and female rats, and other studies have shown the effect of sign-tracking and conditioned reinforcement with males and females. Therefore, in this study we aimed to decrease the number of animals used by using only female rats.
- Future studies should consider:
  - Adding a control group
  - Replicating this study in male rats
  - Assessing if the findings of this study is replicable with human subjects