

# I smell a rat! Can behavior indicate reproductive receptiveness in Texas Kangaroo Rats (*Dipodomys elator*) to aid captive breeding?



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## Introduction

- ❖ Small solitary nocturnal rodent with long four-toed hind feet and long white-tufted tipped tail (Fig. 1)
- ❖ Populations have been declining since the 1970s and are threatened by habitat loss and degradation due to agriculture and unsustainable cattle ranching (Martin 2002).
- ❖ The species was proposed to be listed as endangered under the endangered species act in 2023 (USFWS 2023).
- ❖ Captive breeding is one way to combat population loss (USFWS 2021). A captive population was established at the Fort Worth Zoo in 2018.

- ❖ However, kangaroo rats are territorial and are known to exhibit aggressive behavior (Eisenberg, 1963).
- ❖ Currently, observing physical signs of estrus in females is how mating pairs are made. This however can be imprecise as physical estrus does not always mean behavioral receptivity (Daly et al. 1984).
- ❖ The goal of this study was to determine whether there are any behaviors or frequency of behaviors in either females or males that would indicate reproductive receptiveness by identifying behaviors exhibited only in mixed-sex pairings, and comparing the percentage of time spent exhibiting behaviors in mixed-sex pairings with isolated individuals and same-sex pairings.



Figure 1: A Texas kangaroo rat (*Dipodomys elator*).

- ❖ This study aims to support more effective captive breeding strategies and potentially increase our understanding about the ecology of this species.

## Methods

### Study Species & Enclosure Setup

- ❖ As of November 2024, 12 Texas kangaroo rats with breeding potential were housed in the Texas kangaroo rat captive breeding facility at the Fort Worth Zoo (Fig. 2).

### Behavioral Observation Trials

- ❖ Isolated trials: Solid terminal PVC pipe cap. Served as a control (Fig. 3a).
- ❖ Paired trials: Mesh terminal PVC pipe cap allowing for direct visual and olfactory contact, but not physical (Fig. 3b). Individuals were paired with individuals of the same sex (same-sex pairing) or opposite sex (mixed-sex pairing).

### Behavioral Observation Surveys

- ❖ Green-Backyard Bird Box Cameras HD Network Cable Connection & Network Video Recorder equipped with night vision. Videos were recorded in 1-hr intervals.
- ❖ Trial surveys lasted 2 weeks which were broken into 2 phases spanning 1 week each.

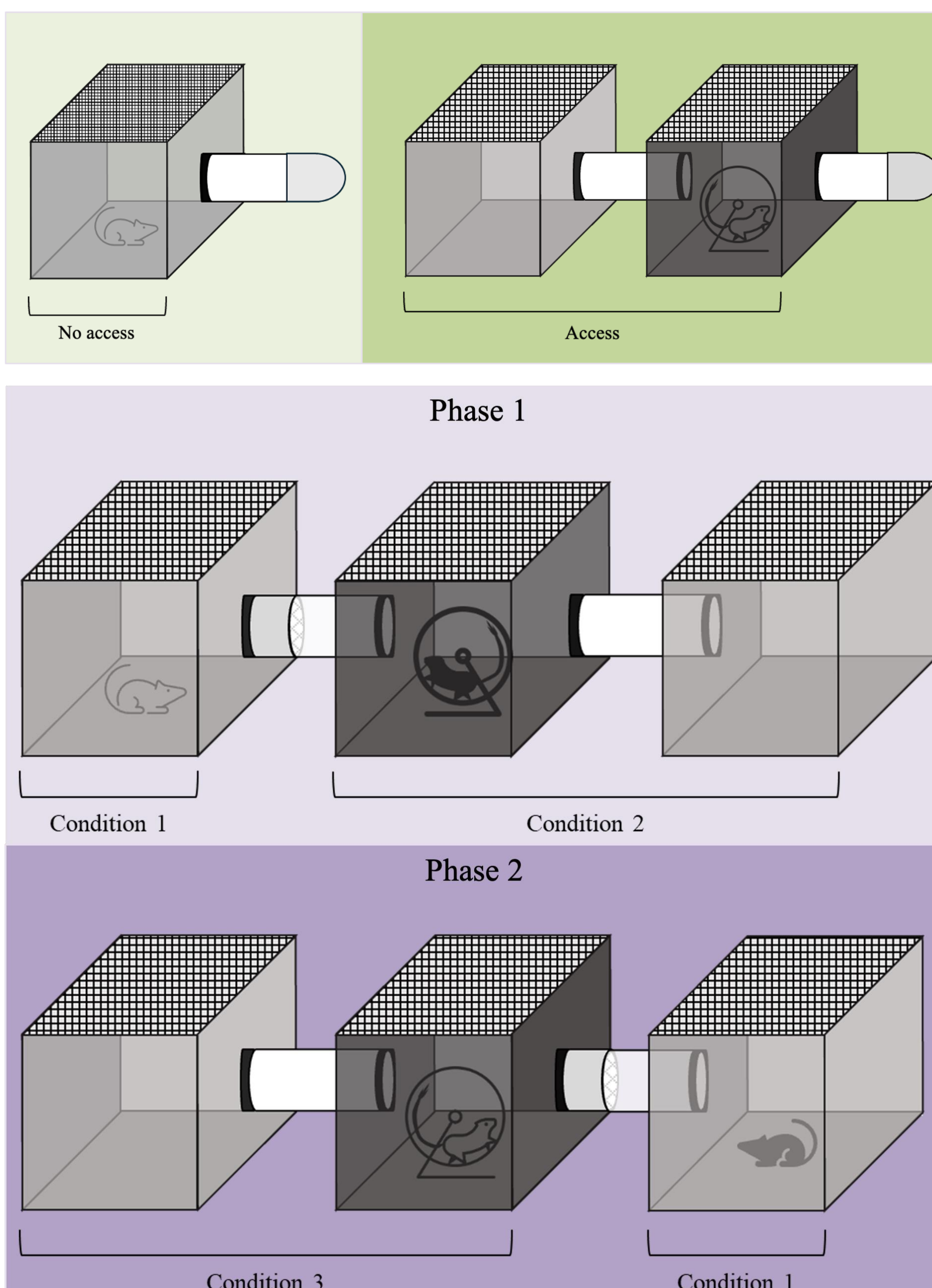


Figure 3: Conditions for the Texas kangaroo rats (*Dipodomys elator*) during a) isolated and b) paired behavioral observation trials.



Figure 2: An individual enclosure (left) and neutral enclosure (right) for Texas kangaroo rats (*Dipodomys elator*) at the Fort Worth Zoo.



Figure 4: Video analysis software used in data processing. Vosaic (left) was used for No Access and Condition 1 and StudioCode (right) was used for Access, Condition 2, and Condition 3.

### Data Processing & Analysis

- ❖ Footage was collected weekly and only night footage was converted.
- ❖ 17 baseline behaviors were established from 6 individuals, using Vosaic video analysis software (Version 1.1.3686, Studiocode Business Group, Lincoln, NE) for No Access and StudioCode (version 5, Studiocode Business Group, Sydney, AU) for Access (Fig. 4).
- ❖ We then used a behavior accumulation curve (BAC) to determine the number of days required for each individual to exhibit at least 95% of all their behaviors.
- ❖ Timeline data was collected from each remaining video (isolated and paired) with behavior names and duration of each behavior. This was then converted into percentage of time spent exhibiting each behavior.
- ❖ Data analysis proceeded using chi-square test following the steps listed in Figure 5.

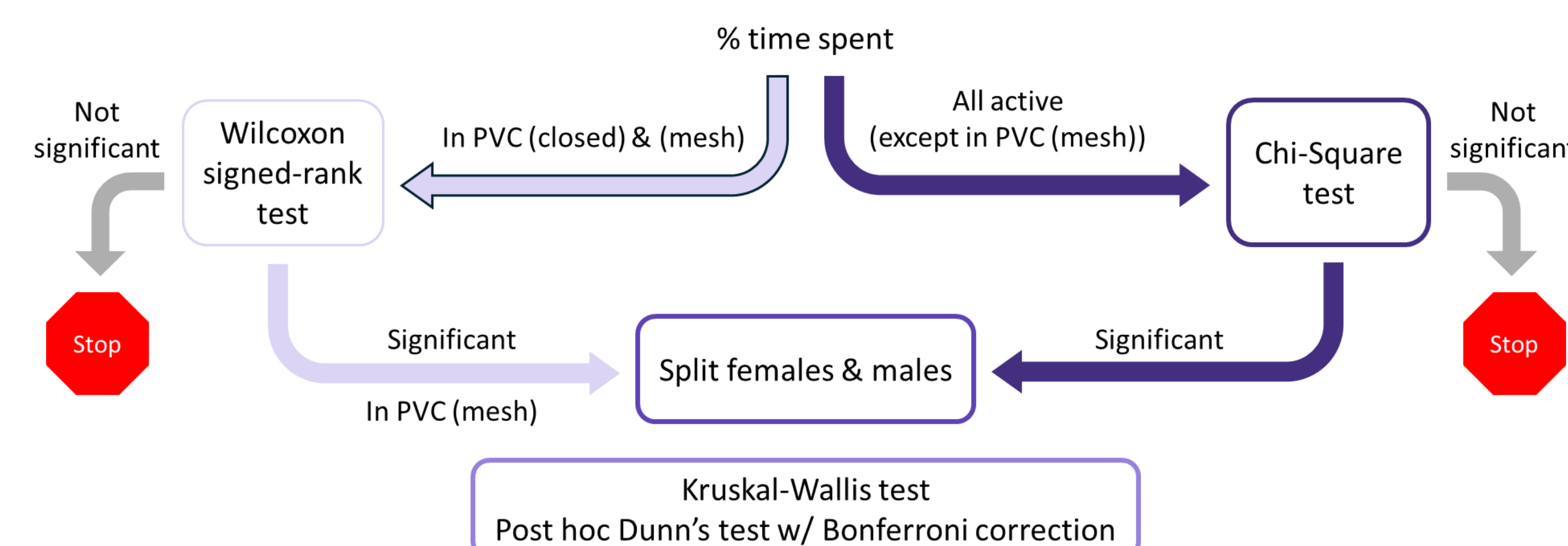


Figure 5: A flowchart illustrating the data analysis process for the percentage of time spent exhibiting a behavior.

## Results

- ❖ From our behavioral observation surveys, we captured **66,000 hours of video footage** across all enclosures collected between 5 November to 3 December 2024 during the isolated trials and between 11 February to 2 July 2025 for paired trials. We subsequently reviewed a total of **6,153 hours of footage (1,650 in isolated trials and 4,503 in paired trials)**.

- ❖ We identified that there were **no behaviors observed exclusively in mixed-sex pairings** (Fig. 6).

- ❖ We found that **individuals spent significantly more time in the PVC (mesh) than the PVC (closed) during the paired trials** ( $W = 3081, n = 79, P < .001$ ; Fig. 7). However, we found no significant variation between trial conditions for either females or males.

- ❖ Of the other behaviors observed, **eight showed significant variation in frequency across trial types**. However, only one behavior, time spent with enrichment, showed discernable variation across both females and males (Females:  $H = 39.223, df = 7, P < .001$ ; Males:  $H = 39.892, df = 7, P < .001$ ). **Individuals spent significantly more time with enrichment items when given access to a neutral enclosure** (Fig. 8). Individuals has access to a running wheel (which was classes as enrichment) in the neutral enclosure that was not available in the individual enclosure.

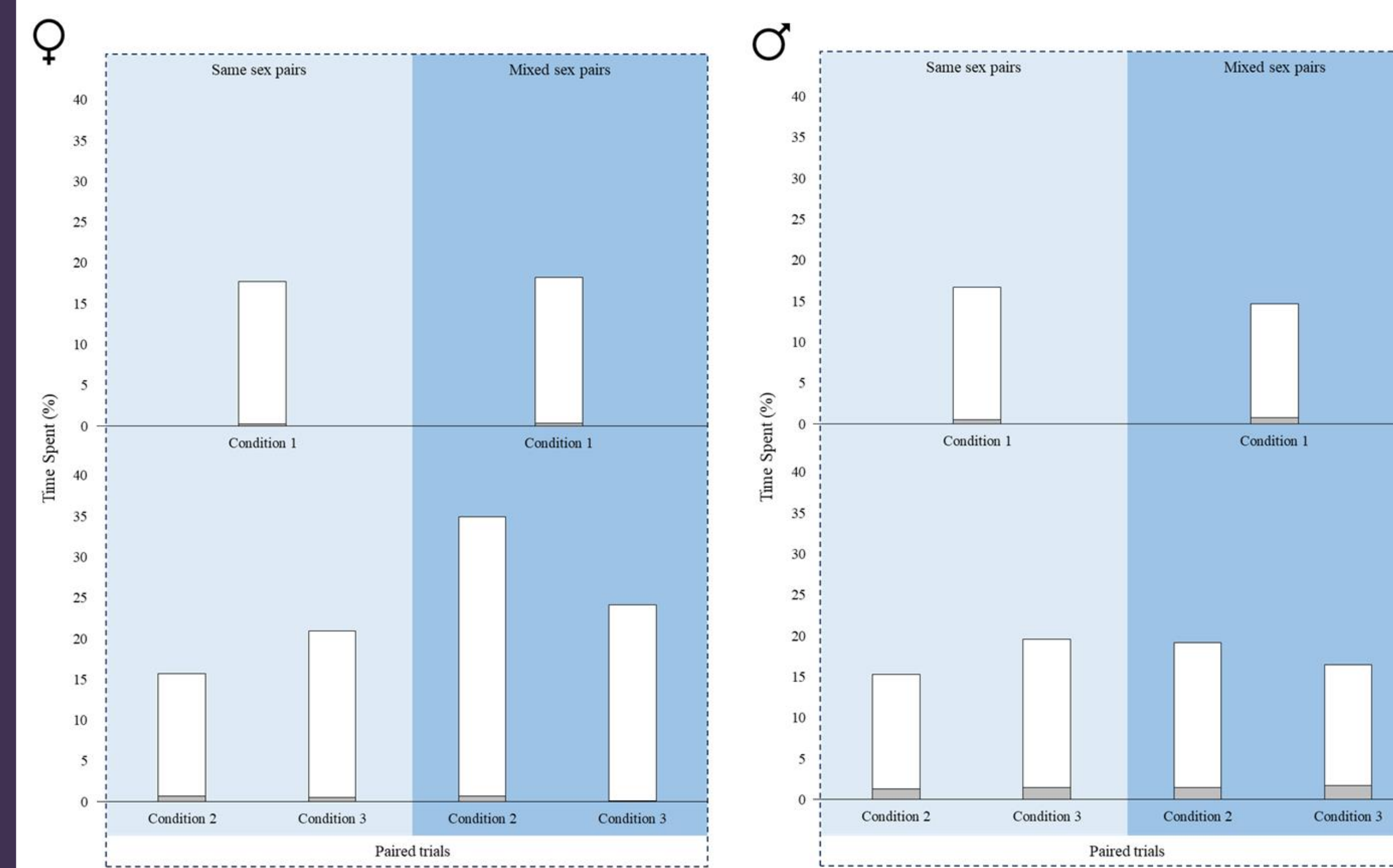


Figure 7: Average percentage of time spent in PVC (closed) (grey) and in PVC (mesh) (white) by (a) female and (b) male Texas kangaroo rats (*Dipodomys elator*) during conditions 1, 2, and 3 among same-sex and mixed-sex paired trials.

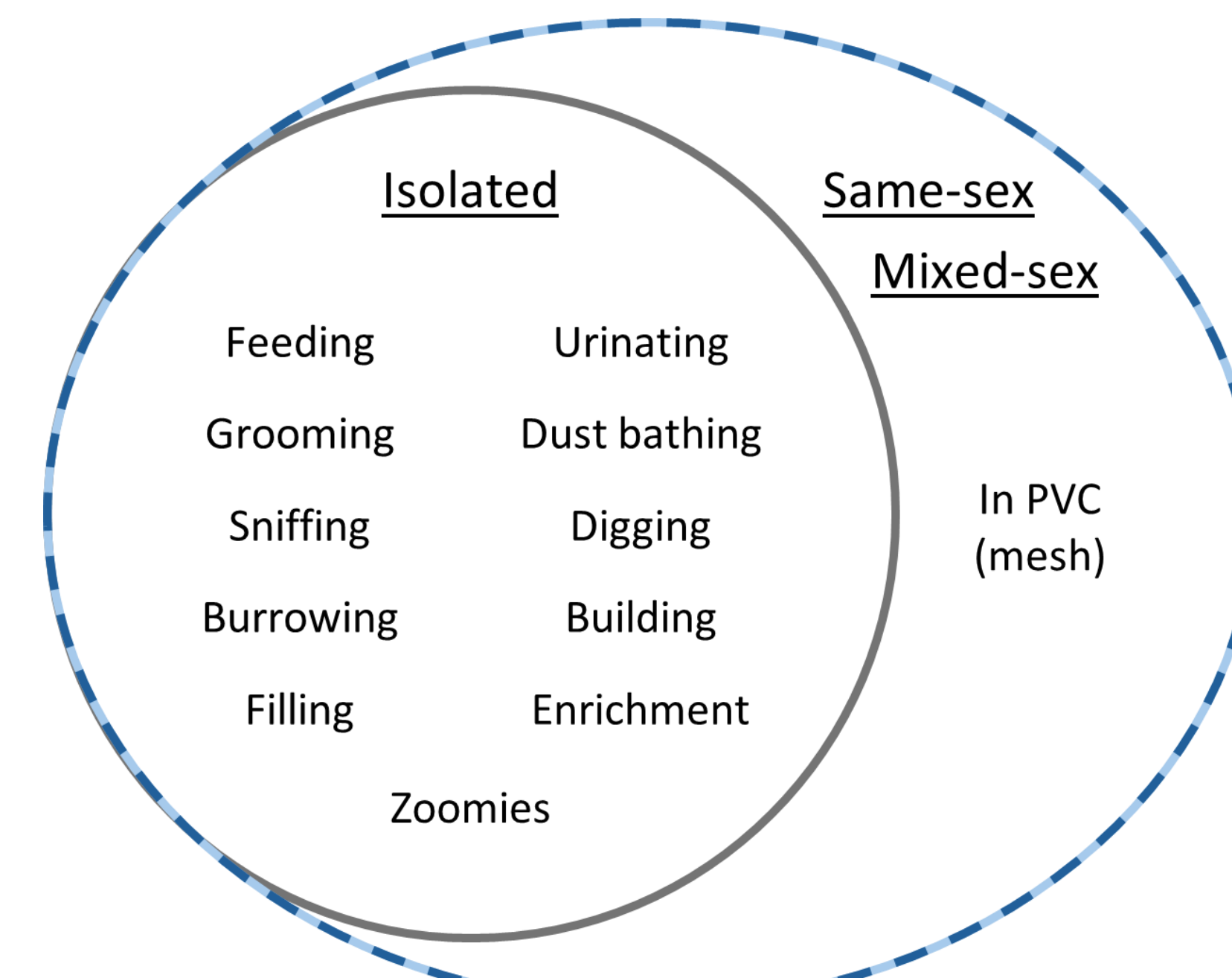


Figure 6: A Venn diagram indicating during which trial types behaviors were exhibited.

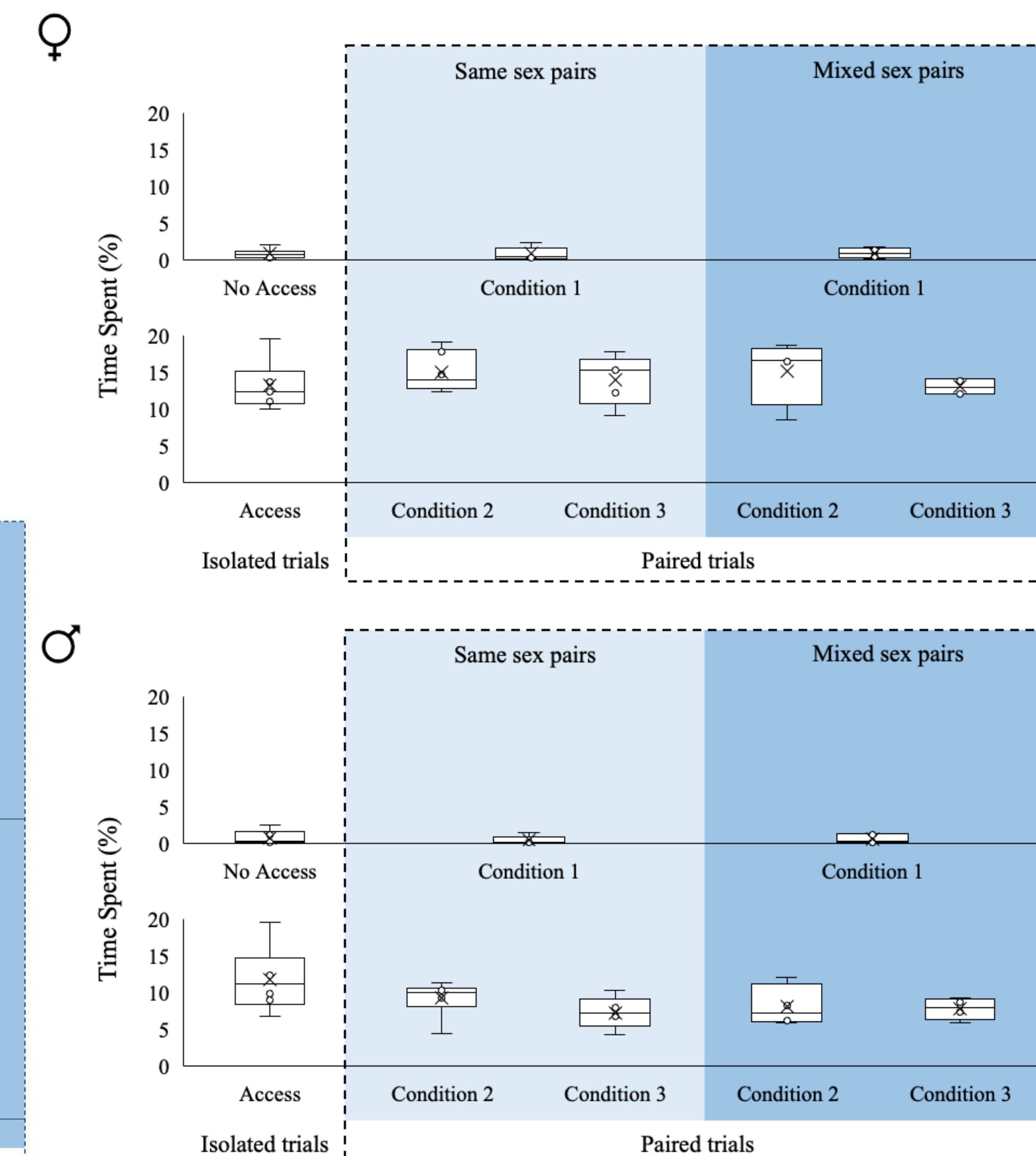


Figure 8: Percentage of time spent interacting with enrichment items by female and male Texas kangaroo rats (*Dipodomys elator*) in isolated trials with and without access to a neutral enclosure compared to conditions 1, 2, and 3 among same-sex and mixed-sex paired trials.

## Discussion & Conclusion

- ❖ Our behavioral study demonstrated that among Texas kangaroo rats in the captive breeding program at the Fort Worth Zoo, **we were unable to identify specific behaviors or frequencies of behaviors that could reliably indicate reproductive receptivity**.
- ❖ Possible explanations for the absence of behavioral indicators of mating readiness may have been associated with **mate choice or oversaturation of olfactory cues** due to the spatial limitations of a captive environment.
- ❖ To better isolate behavioral indicators of mating readiness, we recommend that future studies should aim to **limit prolonged scent exposure** among individuals.

## References

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