EXPLORING BODY BOUNDARY PERCEPTION IN RATS USING THE RUBBER TAIL ILLUSION

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INTRODUCTION

- The rubber tail illusion (RTI) investigates body boundary perception of a rubber tail in rodents by manipulating multisensory integration of visual, somatosensory, and proprioceptive stimuli. A fake rubber tail produces the perception of being part of body boundaries by synchronous stroking of the real tail which is hidden and the rubber tail which is seen.
- To date, support for RTI has been found only in mice (Wada et al., 2016; Buckmaster et al., 2020).
- Previous studies have investigated the robustness of RTI by manually measuring head withdrawal on a three-point scale using blinded inter-rater reliability and intra-rater reliability.
- **Hypothesis**: Rats will respond more to rubber tail grasping following synchronous stroking compared to asynchronous stroking because of the potential threat to perceived body boundaries.

METHODS

- **Restraint Habituation**: Prior to testing, 24 male and female rats were habituated for 3 minutes each day over 5 days.
- **Body Elongation**: Measured using EthoVision® XT which detected the rat's shape expressed in a percentage which ranges from 0% (when the rat's shape is perfectly circular) to 100% (when the subject's shape is a line). For each trial, body elongation percentage was averaged over an interval of 2 seconds immediately following tail grasping.

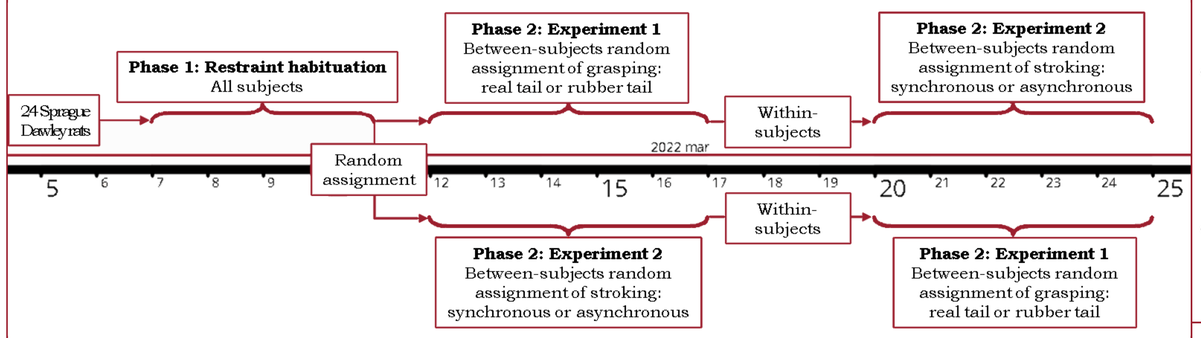
Fig. 1: Restraint Apparatus

METHODS (cont.)

Data Analysis

- Average body elongation percentage scores for each animal over 12 testing days was obtained: 525 trials for grasping and 557 trials for stroking. The means for each condition per day were analyzed using a repeated measures ANOVA.

Fig. 2: Timeline



RESULTS

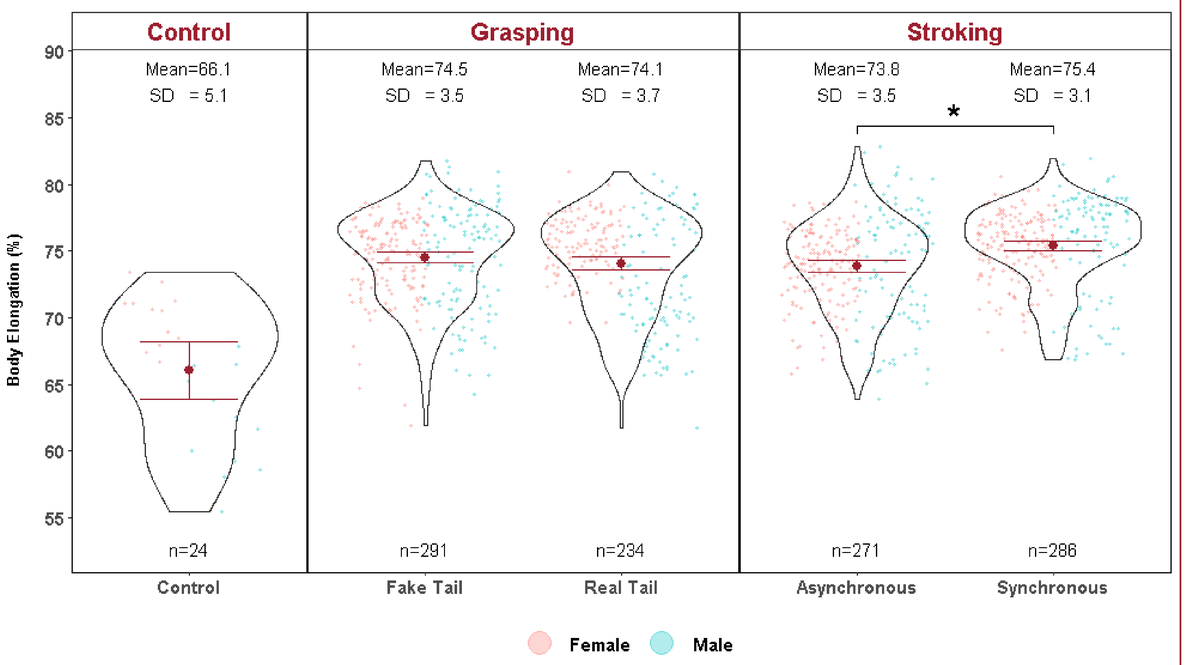


Fig. 3: Three plots where each point represents a trial. Scarlet points and bars represent the mean and 95% confidence interval for each condition.
* *indicates significant difference of stroking at p = 0.022.*

- **Control**: Collected from one day of restraint habituation videos. Rats remained still without tail taped and without rubber tail for a maximum total of 3 minutes per trial.
- **Grasping**: Either real tail or rubber tail grasping without stroking at intervals of 1 minute. Each trial lasted 1 minute for a total of 5 trials each day for 6 days.
- **Stroking**: Either synchronous or asynchronous stroking to real tails and rubber tails was manually administered. At the end of each stroking trial, the rubber tail was grasped. Each trial lasted 1 minute for a total of 5 trials each day for 6 days.

RESULTS (cont.)

- There was no difference between real tail grasping and rubber tail grasping on body elongation percentage.
- Synchronous stroking and asynchronous stroking had a significant impact on body elongation percentage (mean difference: 1.998%).
- In the control condition, males had significantly lower body elongation percentage compared to females (mean difference: 7.90%).
- Results from the stroking experiment support the hypothesis that RTI extends to rats.

CONCLUSIONS

- This experiment is the first to find support of body boundary perception in rats. Similar to previous RTI studies in mice, results also support that rats exhibit a greater response to synchronous stroking compared to the asynchronous stroking.
- Although we expected rats to demonstrate a greater response in the real tail grasping condition, the non-significant difference observed in the grasping experiment might highlight how visual input plays a dominant role over touch and proprioception (Ernst & Banks, 2002).
- Sex differences observed in the control condition may warrant future investigation into a possible sexual dimorphism of body elongation.
- Body elongation serves a risk assessment role to potentially threatening stimuli (Mackintosh & Grant, 1963) but this behavior remains unclear in context of RTI. Future researchers can consider implementing additional measures for body boundary perception like body temperature or galvanic responses (Ehrsson et al., 2007).
- We have manipulated multisensory integration by using RTI in rats for the first time, but further validation is necessary. This research can inform follow-up studies of RTI for measuring body perception in rodents particularly related to pharmacology, disorders, and development.