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Jacob Clarke
Mary E. Cain

Environmental enrichment effects on reward sensitivity

Introduction

- Environmental enrichment during rearing produces a variety of neurobiological and behavioral changes:
  - When compared to isolated condition (IC) rats, enriched condition (EC) rats are less sensitive to psychostimulant-induced locomotor activity
    - Only at low unit doses
  - Environmental enrichment decreases responding for psychostimulants, and also for visual stimuli (Bardo & Dwoskin, 2004)
  - EC rats engage in more goal-tracking whereas IC rats engage in more sign-tracking in Pavlovian conditioned approach task (Beckman & Bardo, in press)

Introduction

- Environmental enrichment appears to provide a "protective effect" against addictive behaviors
  - This may be due to:
    - Reduced incentive learning
    - Reduced reward sensitivity/discrimination
    - Impaired motivational processes
    - Impaired reward prediction/anticipation

Method: Overall timeline

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Rats arrive

21 Days 

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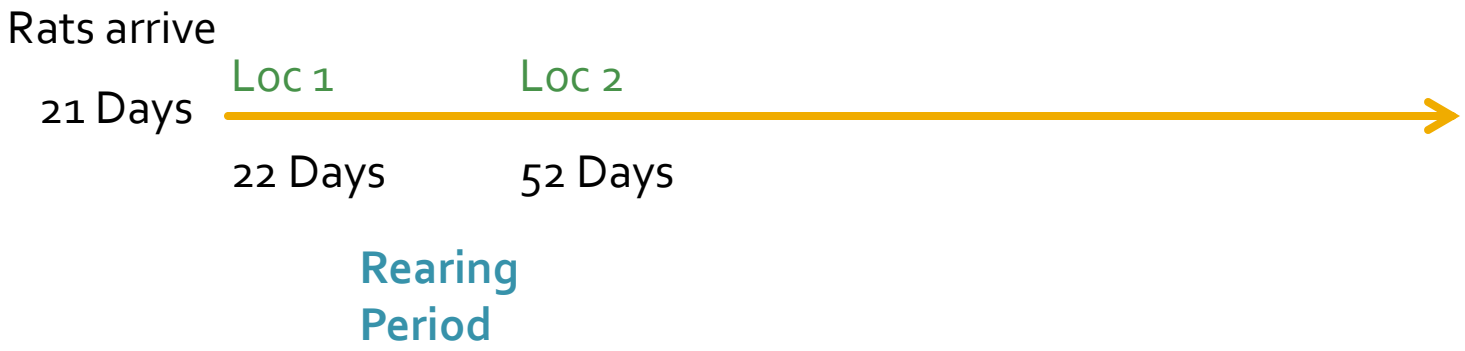

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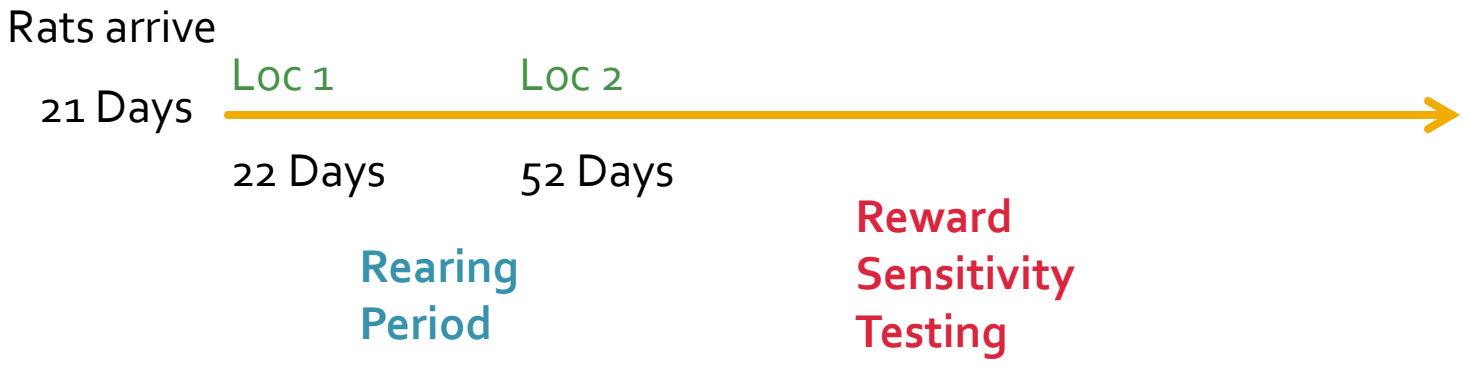

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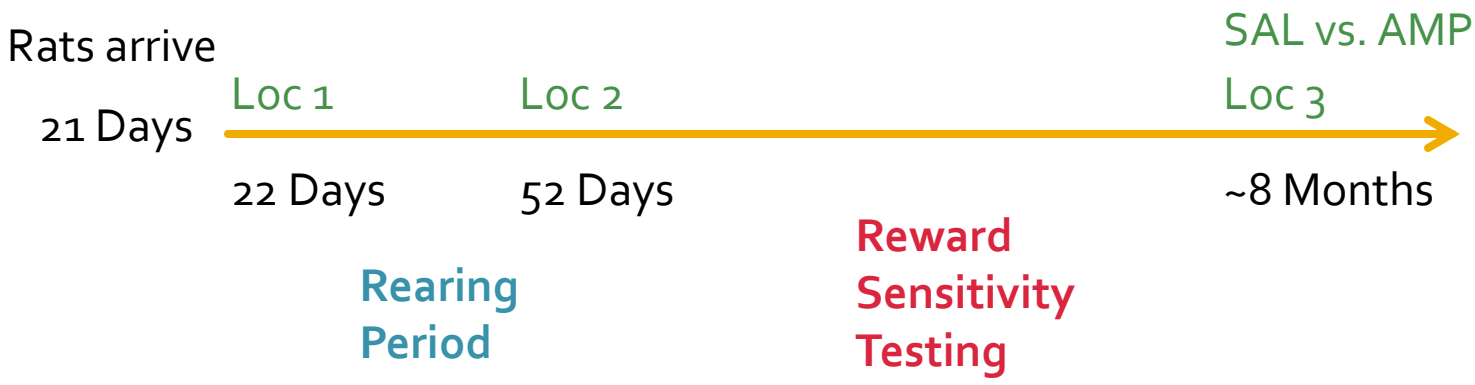

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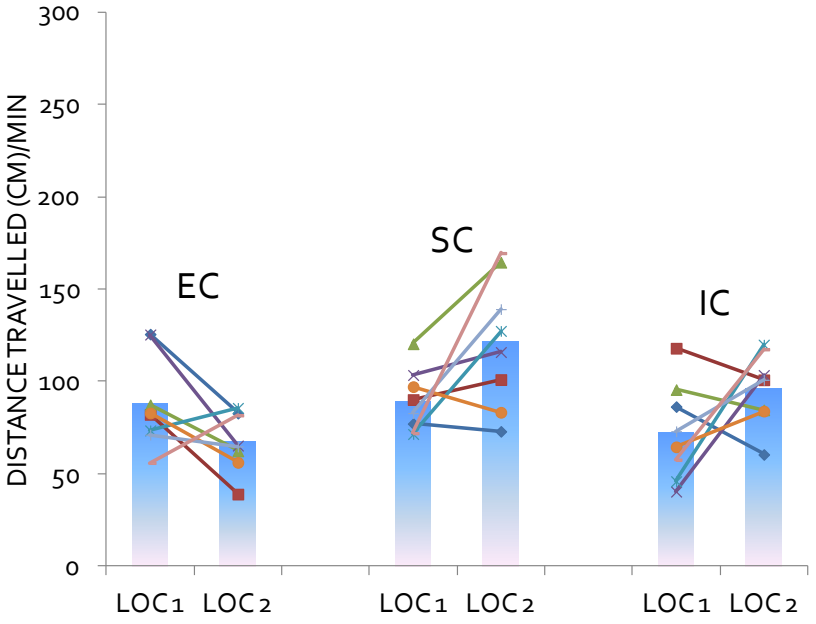
  - Standard condition (SC, n=8)
  - Isolated condition (IC, n=8)
- Testing in locomotor chamber for 60 min before and after rearing
- Used different bedding in two tests to maintain novelty

Rearing condition modulates locomotor activity in a novel environment

- No group differences prior to rearing period
- EC decreased locomotor activity
- IC and SC increased locomotor activity
- Interaction between rearing condition and test (LOC 1 vs. LOC 2)



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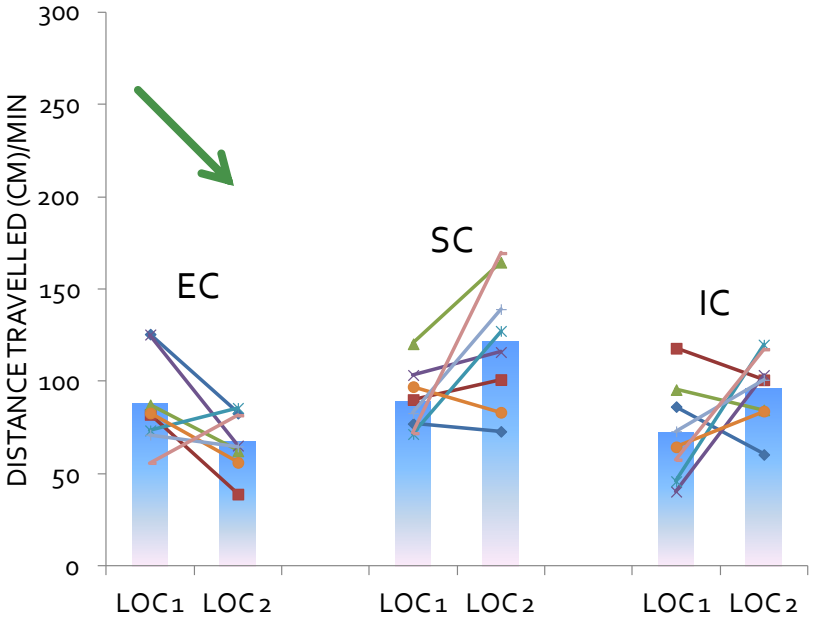

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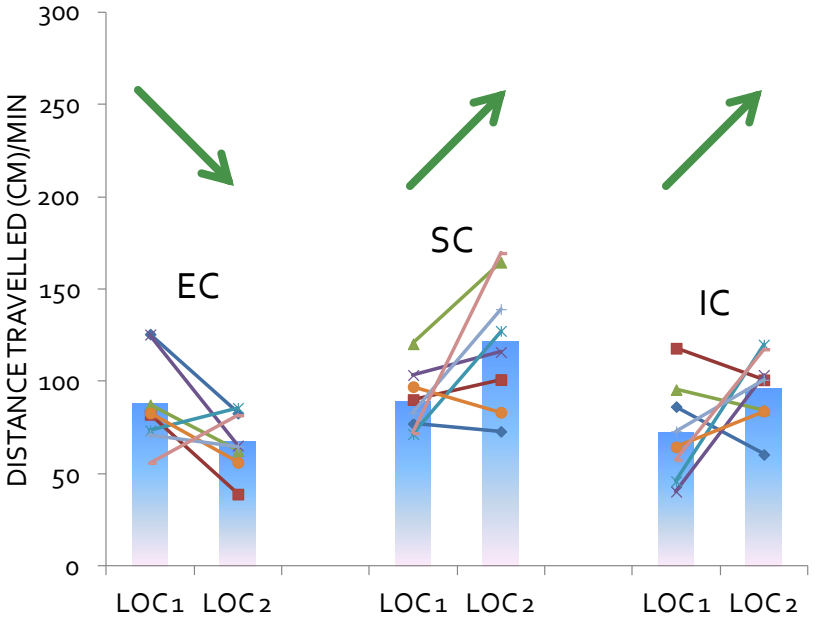

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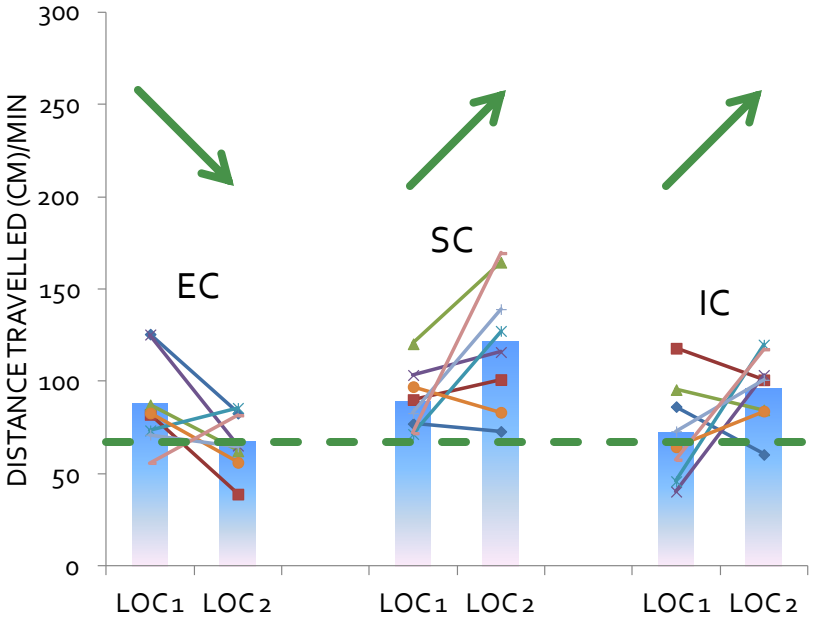
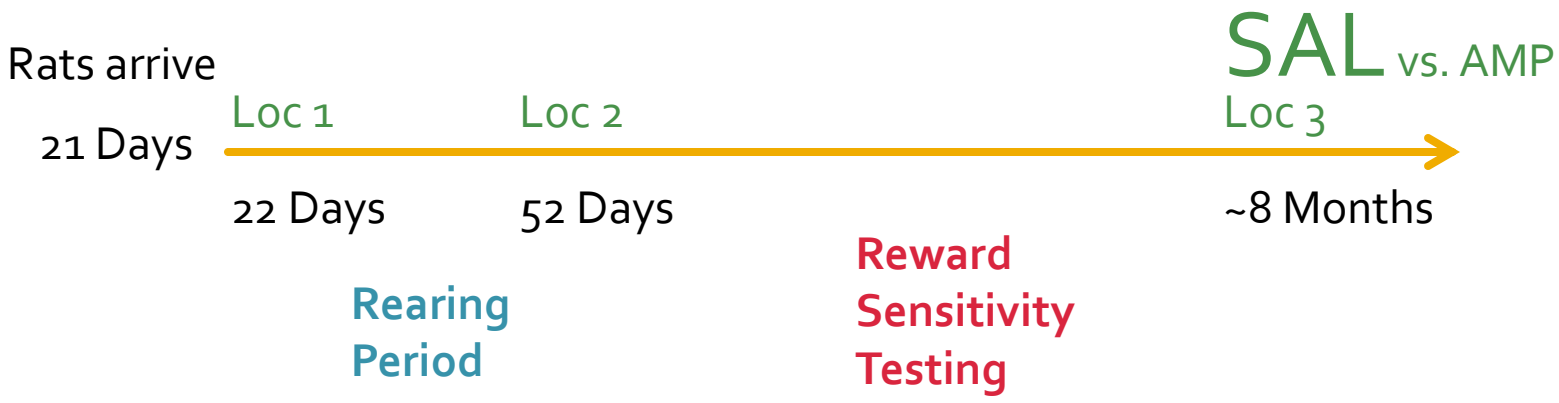


Method: Long-term effects of environmental rearing



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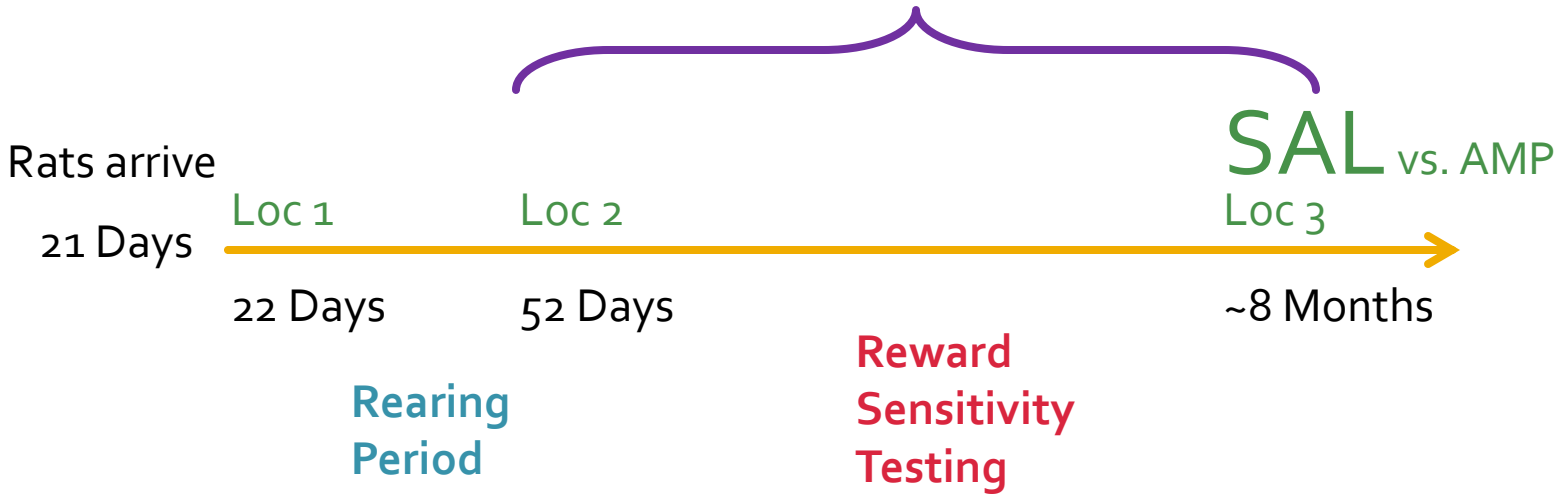
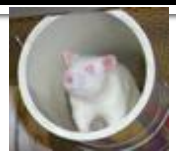
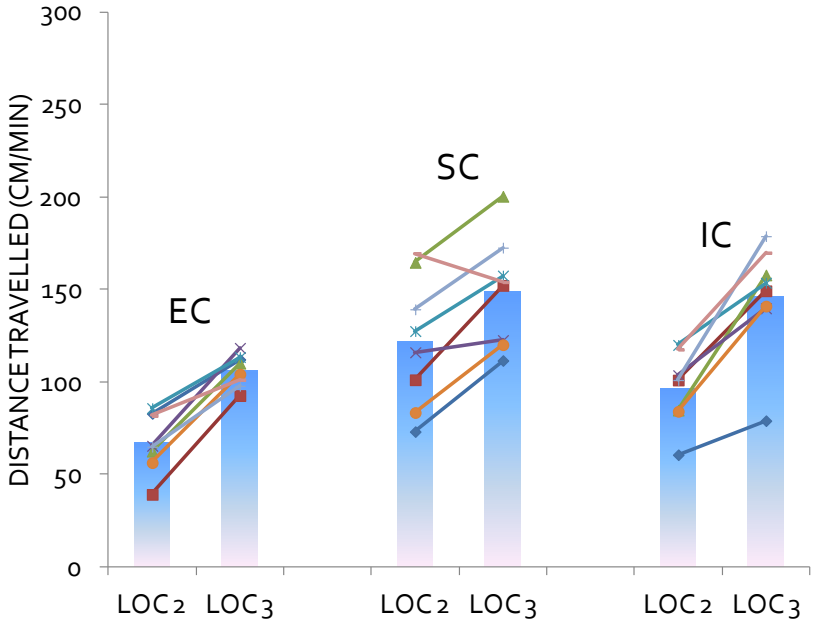


Enrichment effects on locomotor activity are maintained under AMP



- Comparison of LOC 2 vs. LOC 3 (SAL) conditions:
  - Locomotor activity was higher in LOC 3
  - Rearing effects were maintained (EC lower than both IC and SC)
  - Significant correlation between LOC 2 and LOC 3 activity scores



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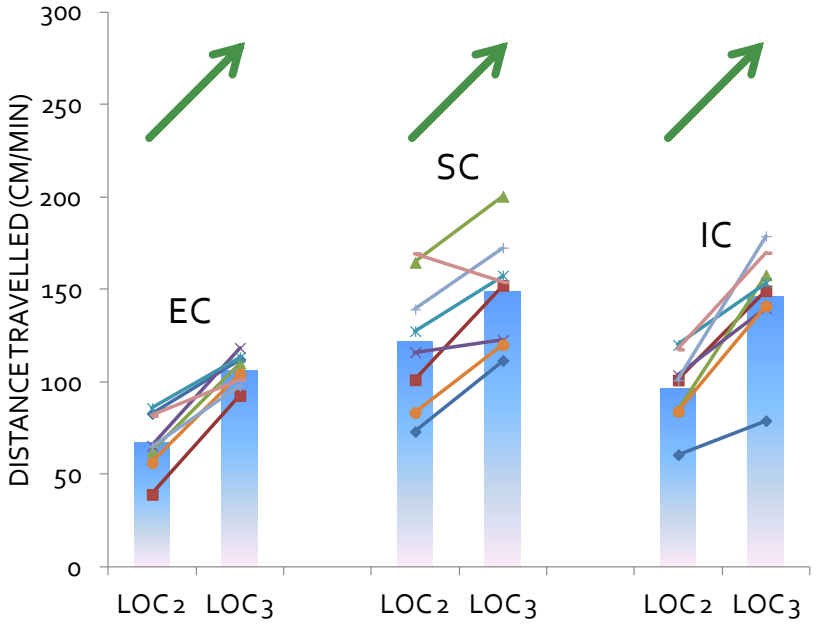

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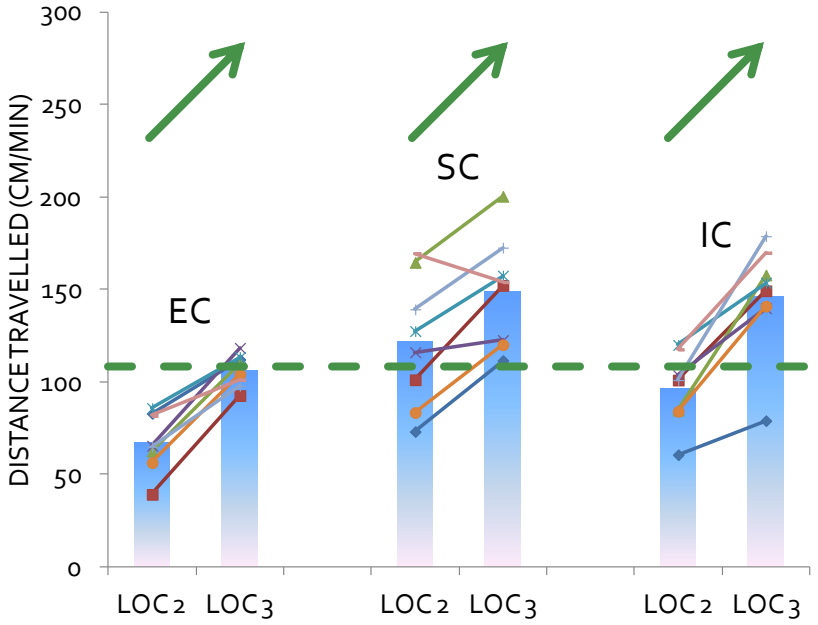

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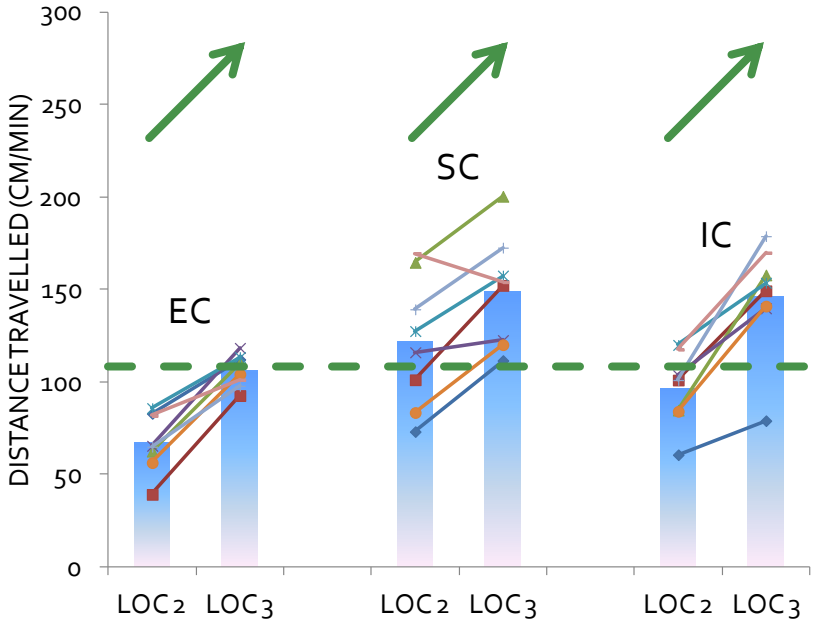
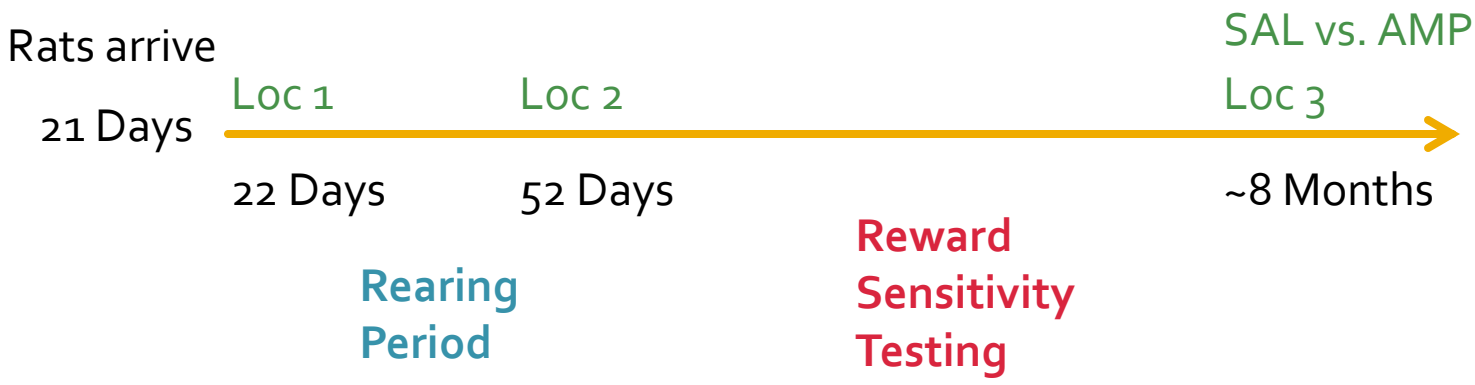


r = .81

AMP effects on locomotor activity



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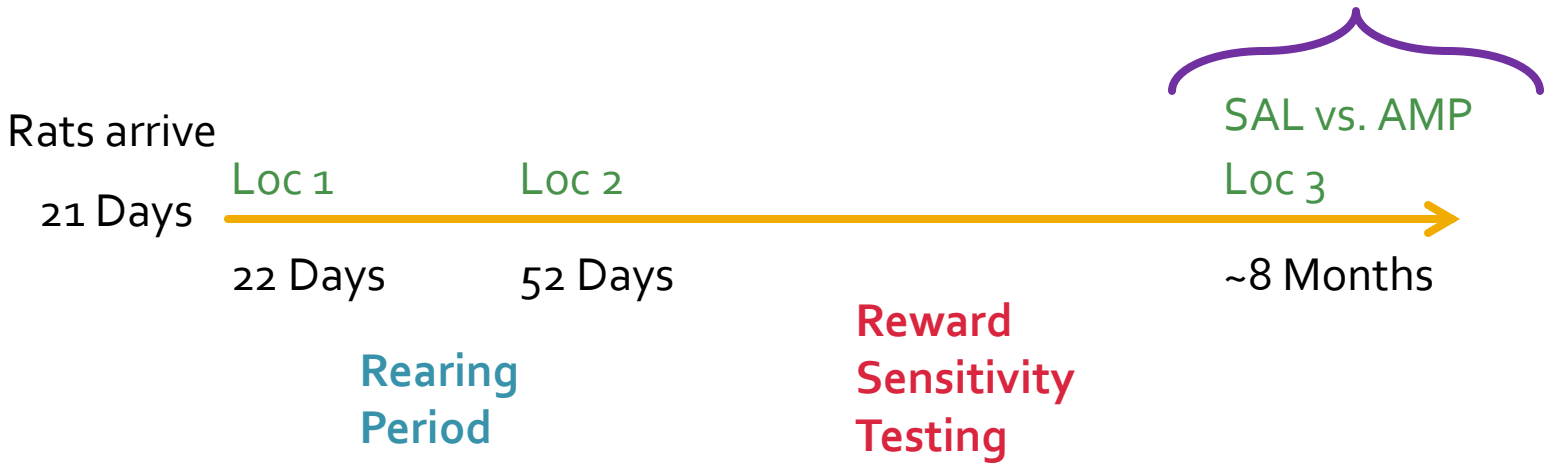
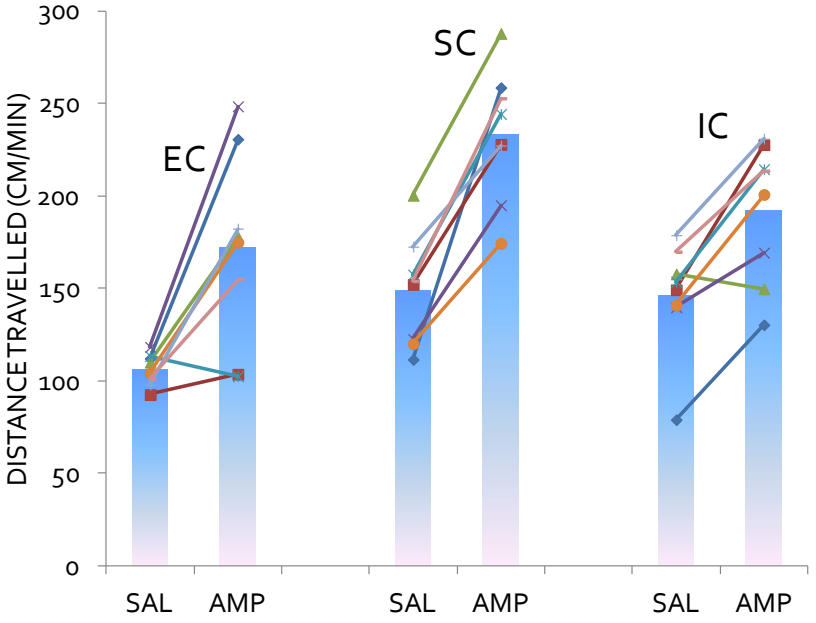


AMP-induced locomotor activity occurs in all rearing conditions

- Comparison of LOC 3 (SAL) and LOC 3 (AMP)
  - AMP increased locomotor activity
  - Rearing effects were still present, event under AMP



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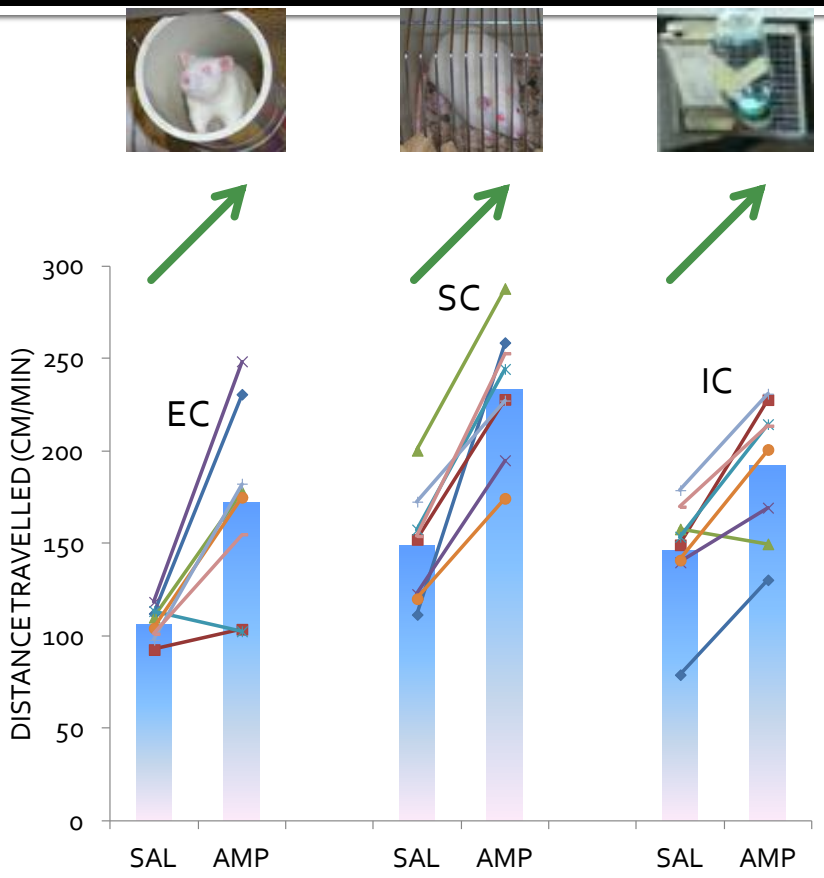

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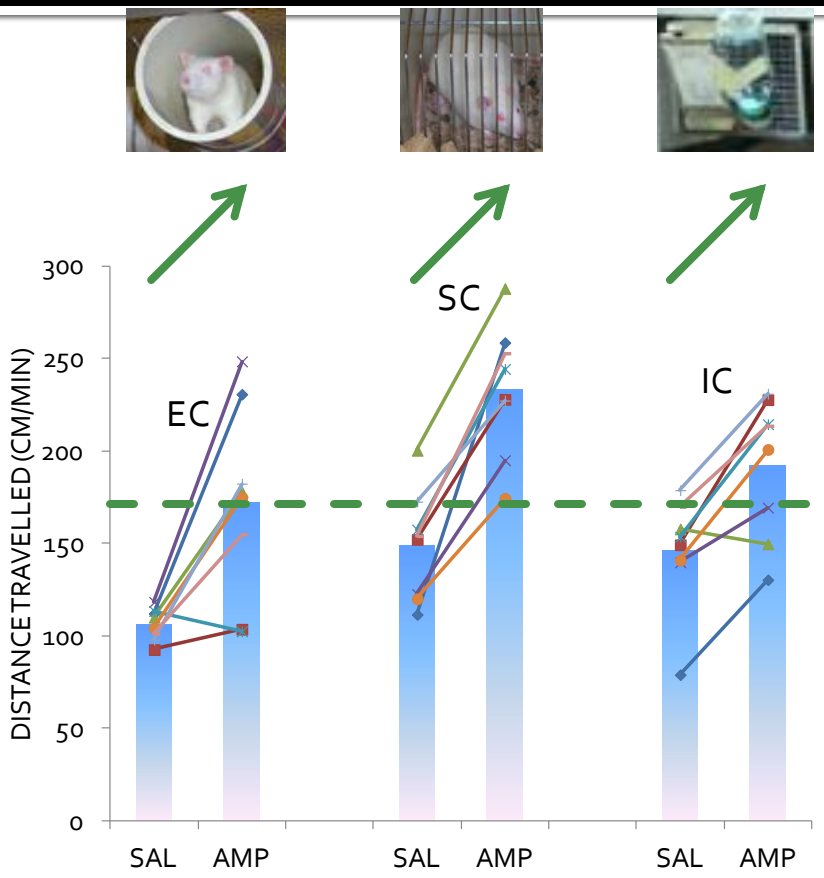

Locomotor activity: Summary

- Enrichment reduced locomotor activity post-rearing, whereas standard and isolated conditions increased activity
- The effects of rearing condition were maintained over a period of more than 6 months
- AMP increased locomotor activity, but the effects of rearing condition were still apparent

Reward Sensitivity Testing: Method

- Discrete-trial, two-lever, VI 30-s schedule
  - Only one lever inserted at a time
  - 120-s Inter-trial interval

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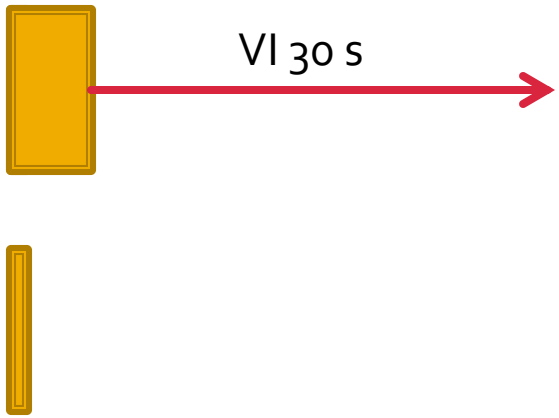

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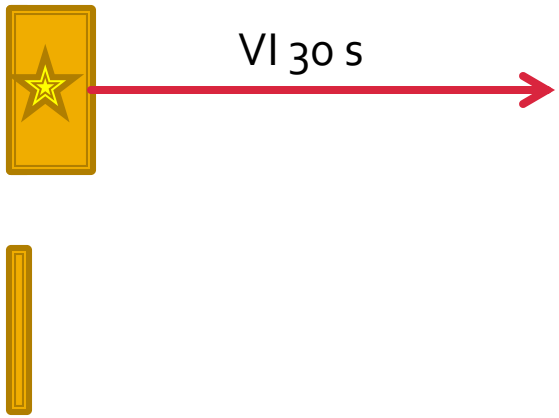

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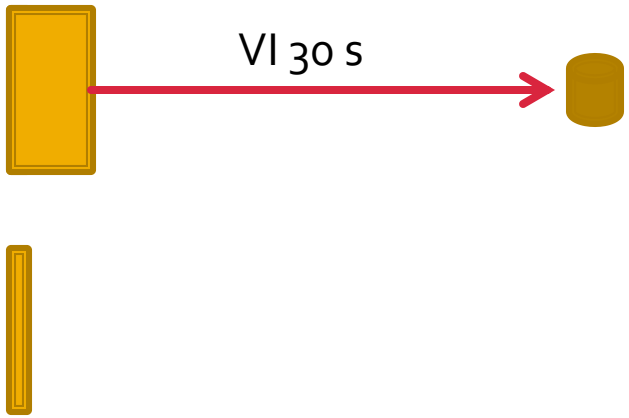

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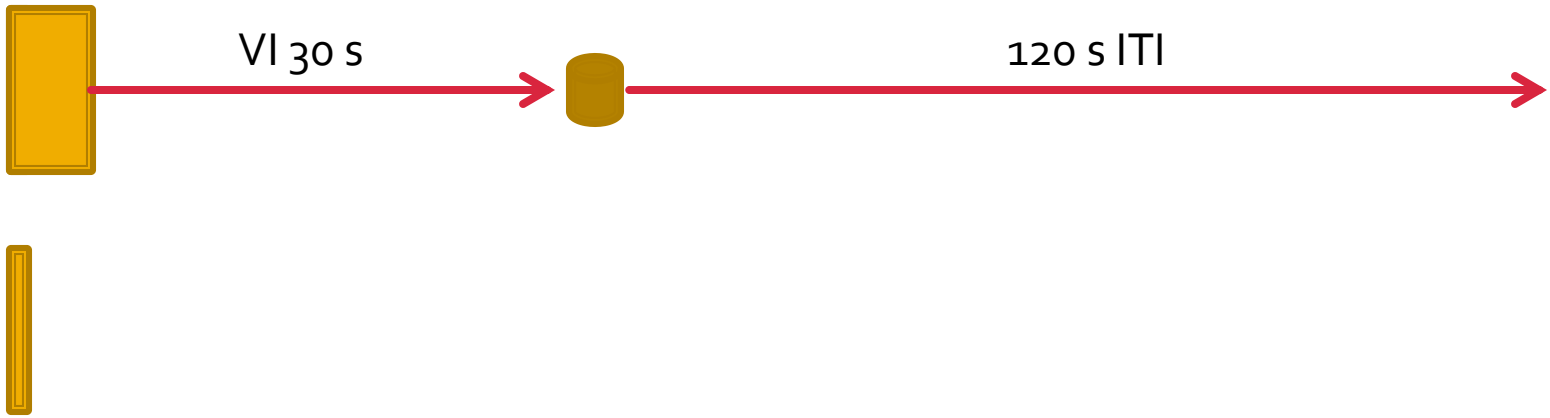

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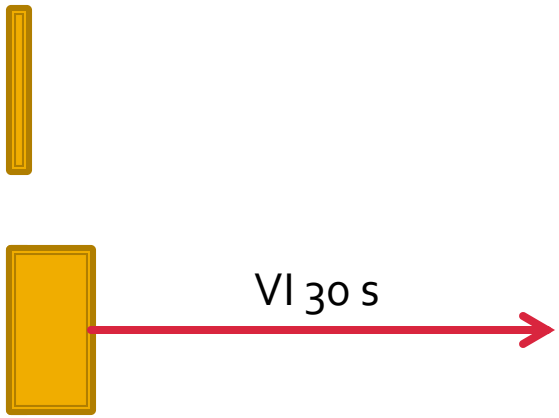

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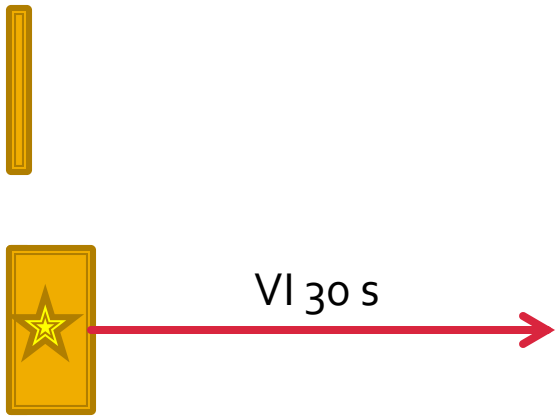

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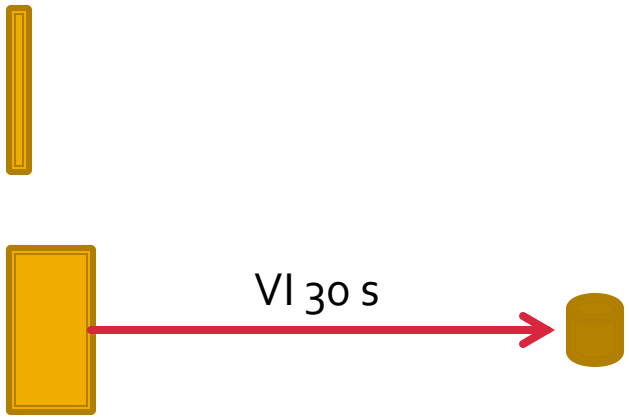

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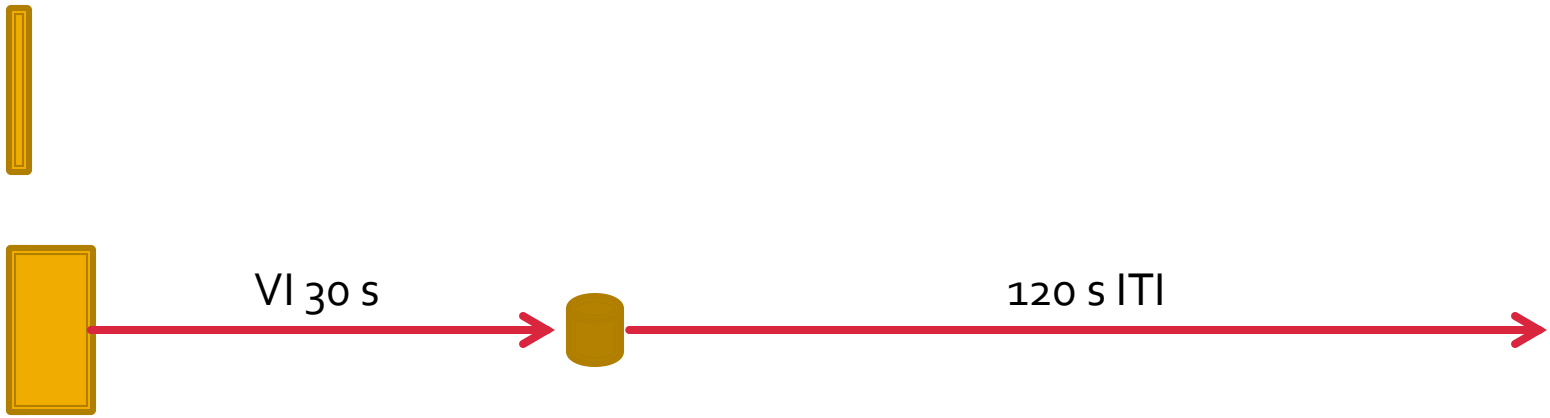

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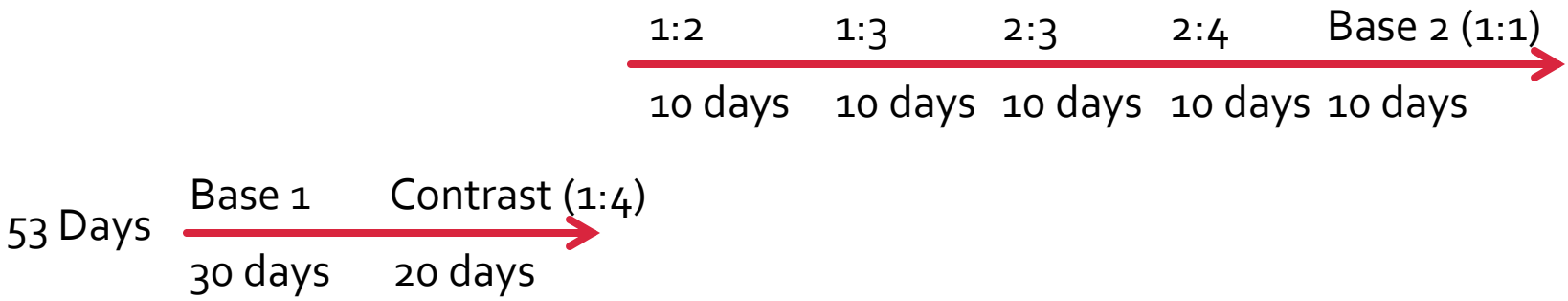

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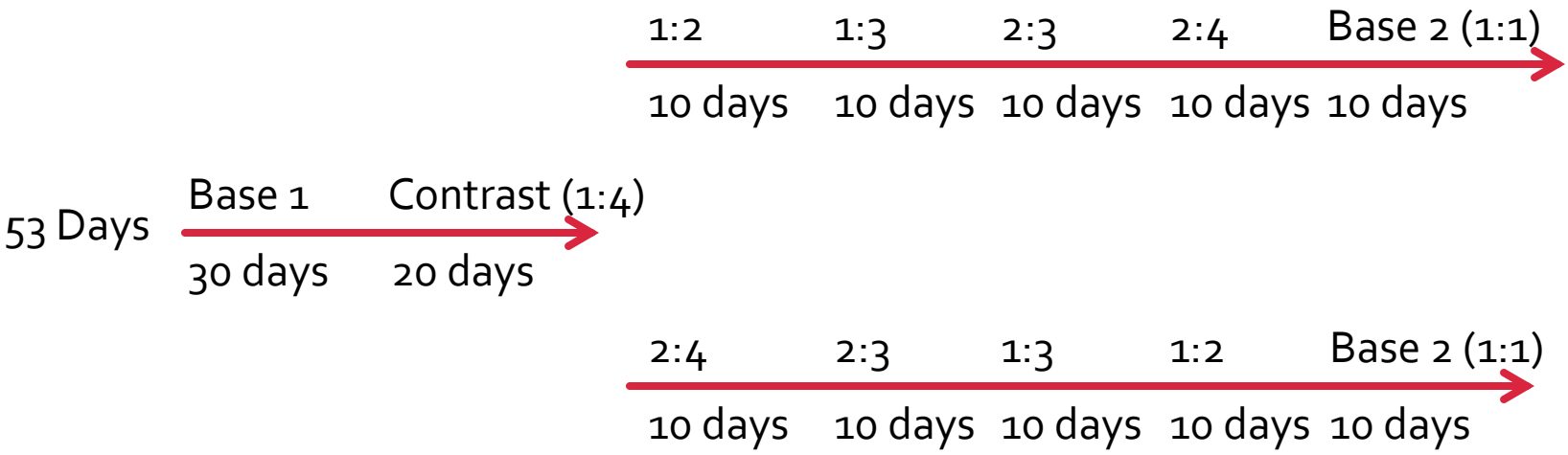

Contrast and Reward Sensitivity Test: Method

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SM

LG

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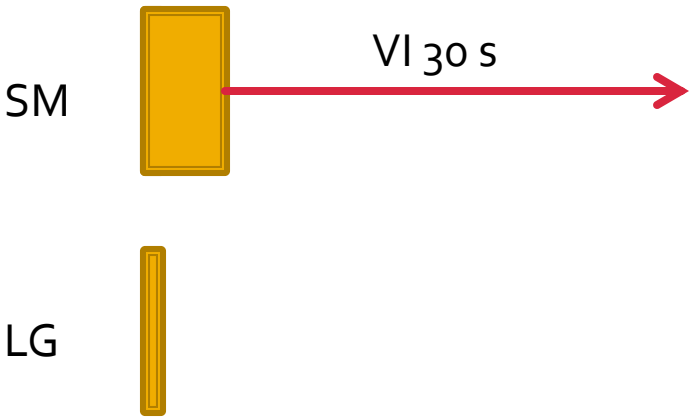

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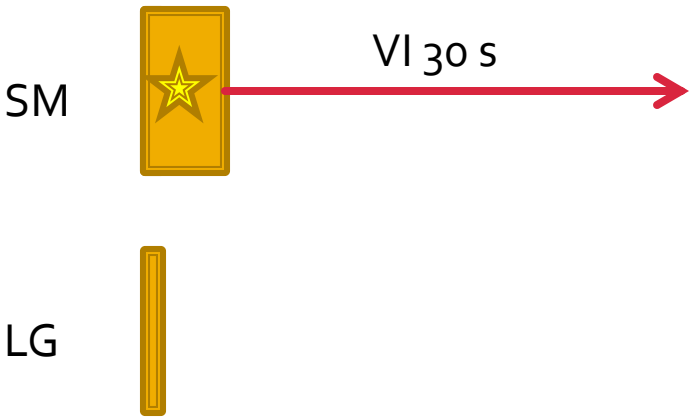

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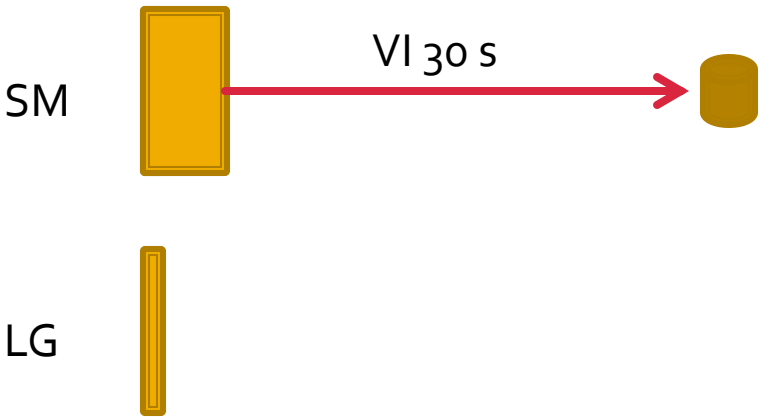

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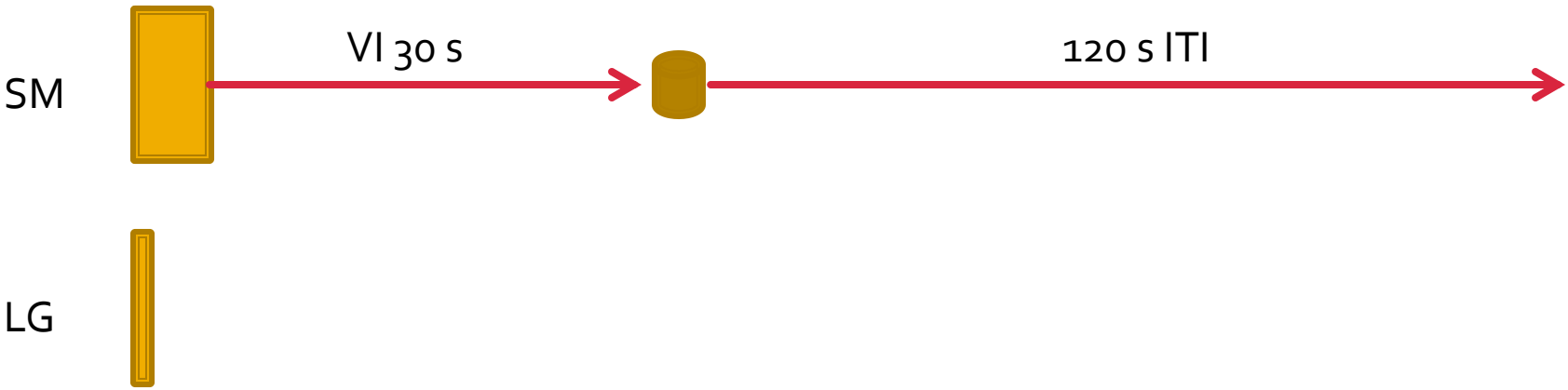

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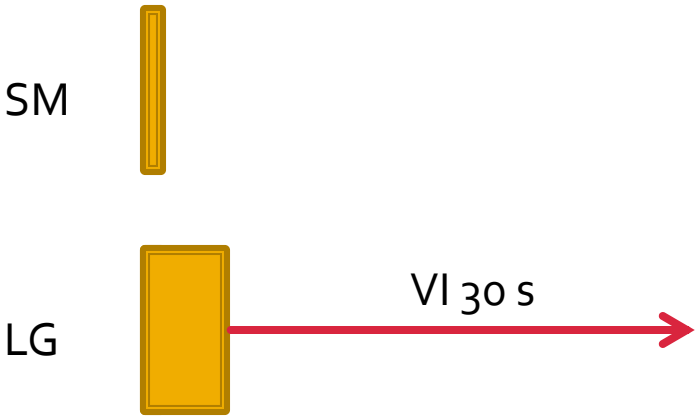

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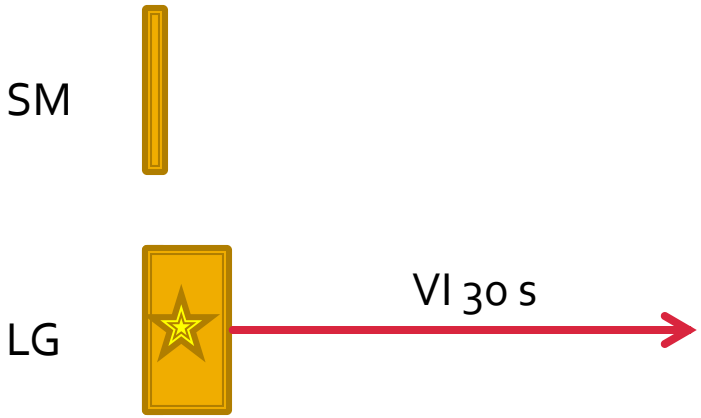

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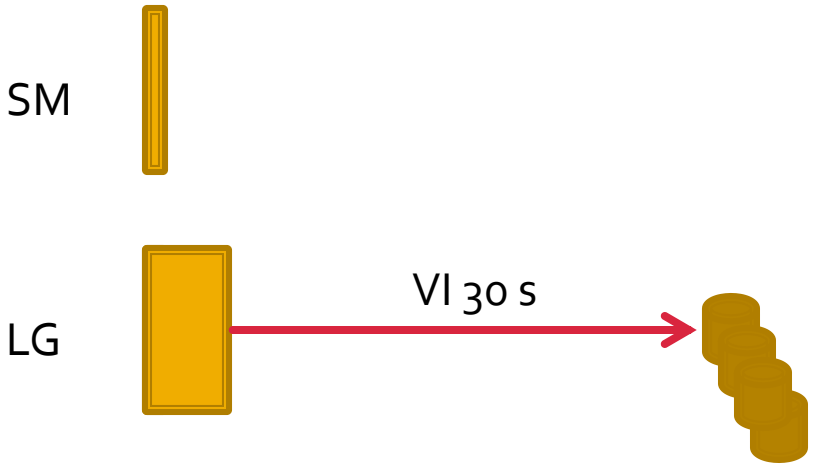

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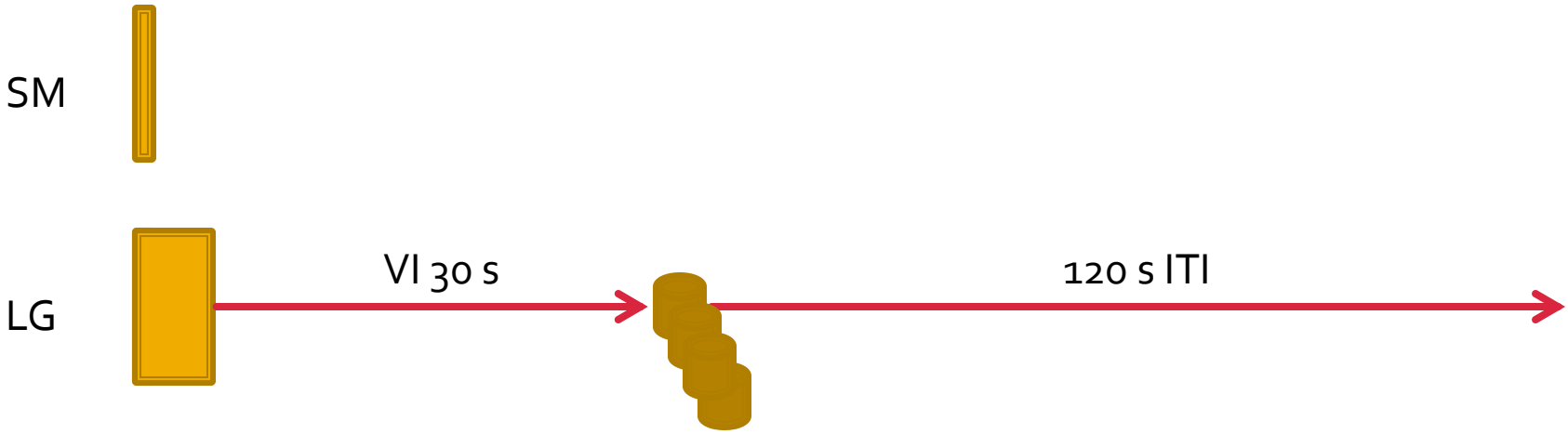

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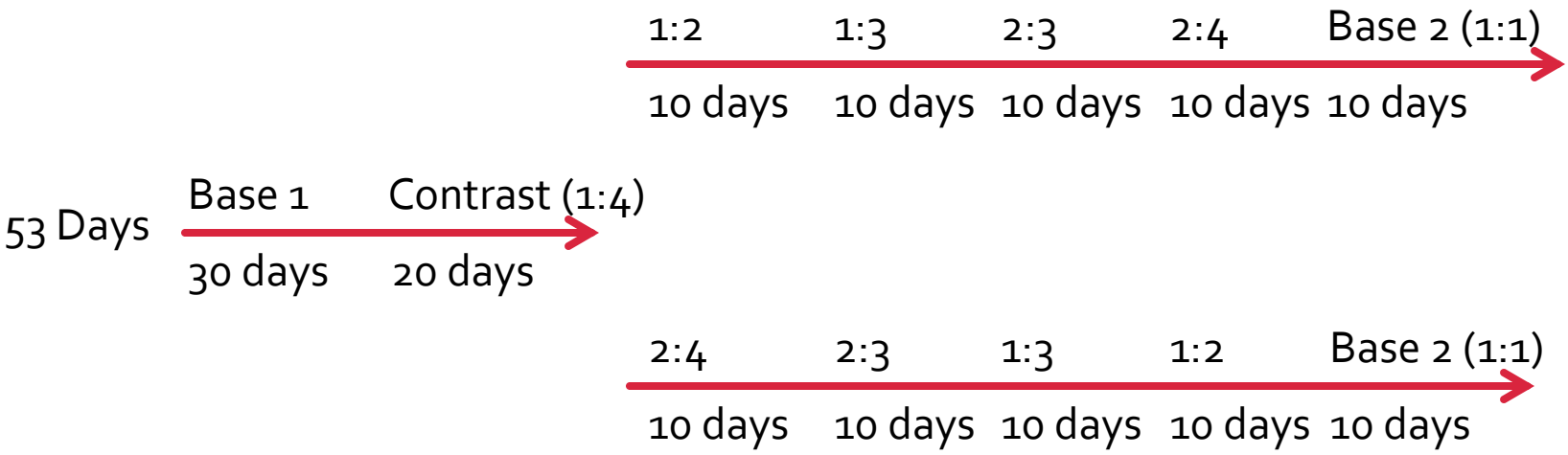

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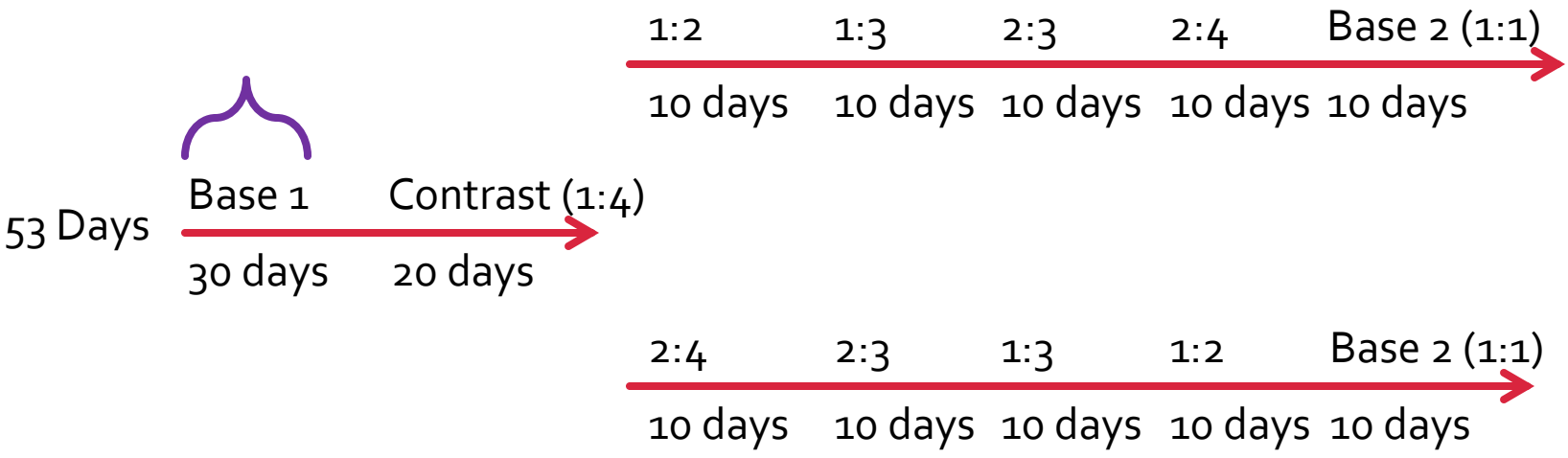

Isolated condition showed greater responding during baseline

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- No difference between EC and SC
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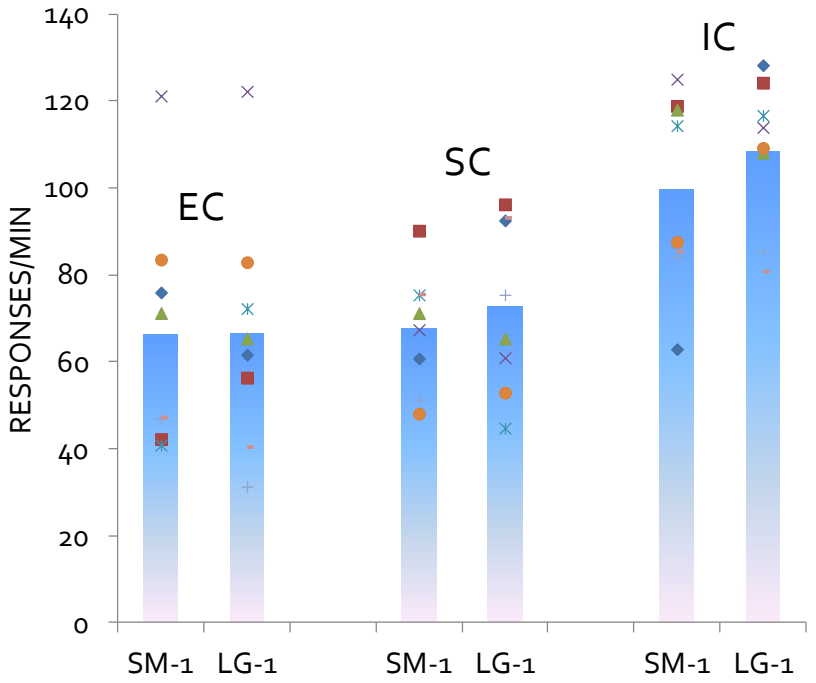

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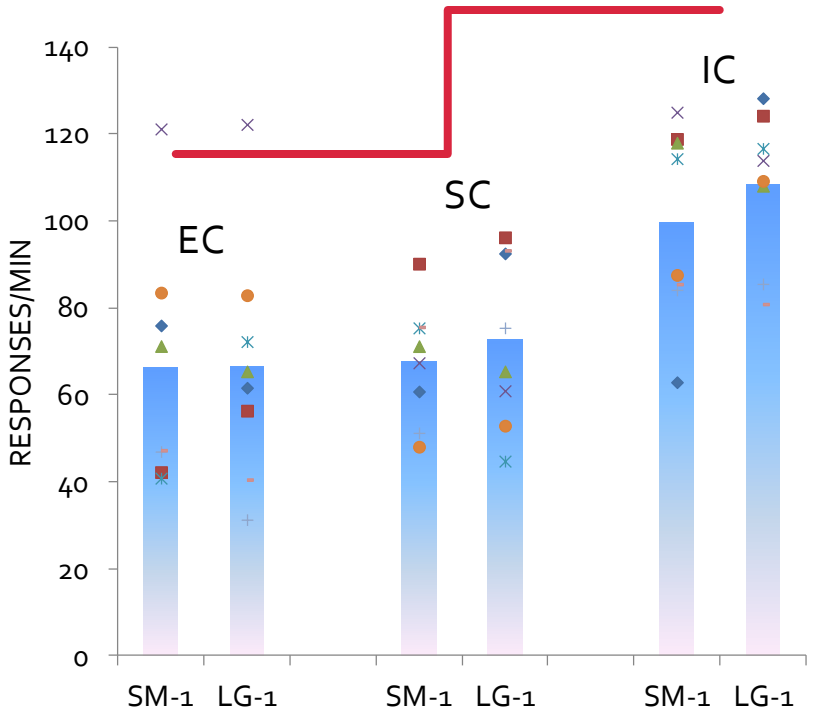

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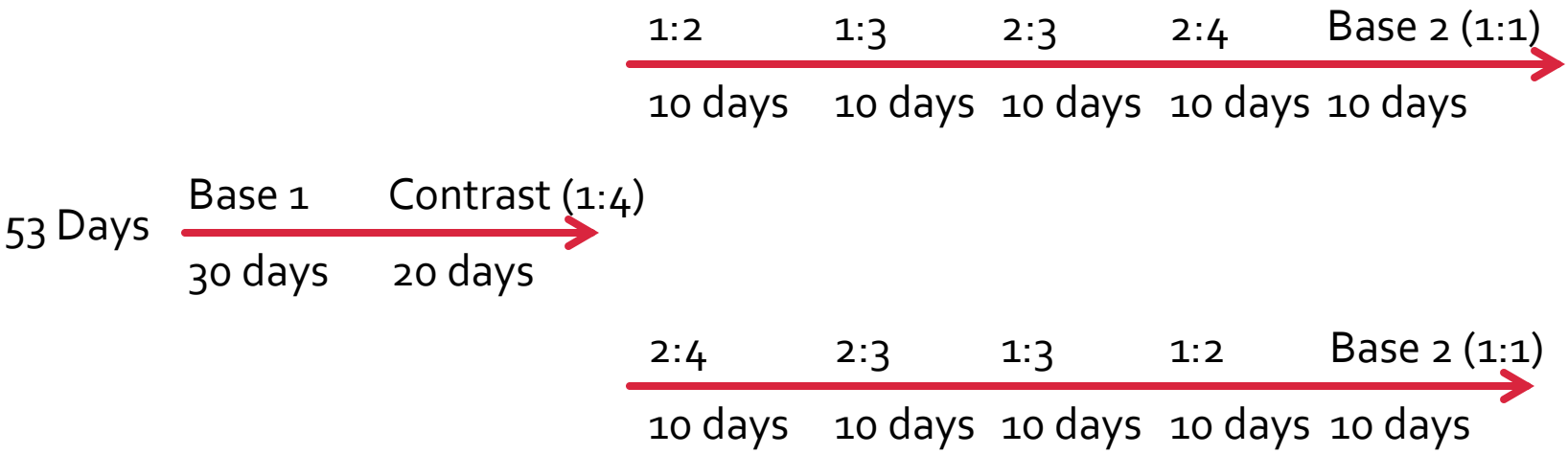
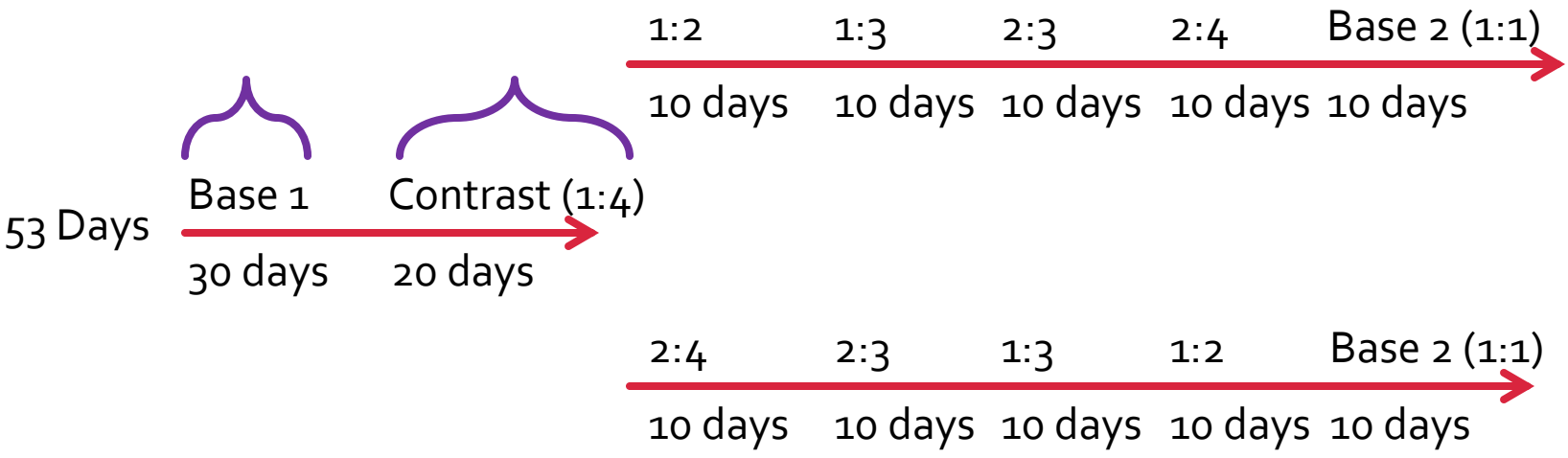
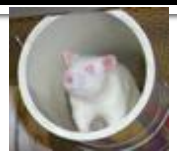


Contrast Sensitivity Test



Enrichment did not affect contrast sensitivity



- All enrichment conditions showed an induction response on the LG lever
  - Sensitivity to increase in reward
- No significant negative contrast in any condition
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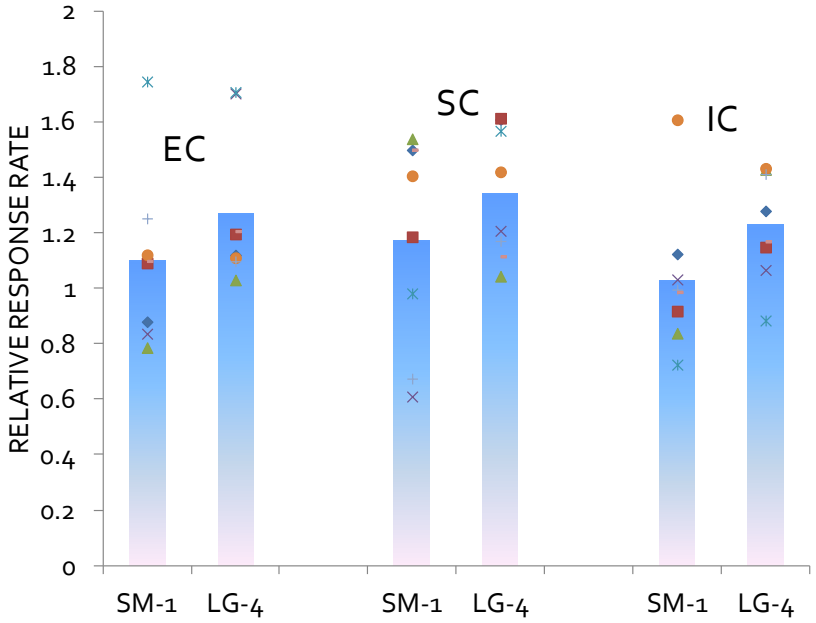

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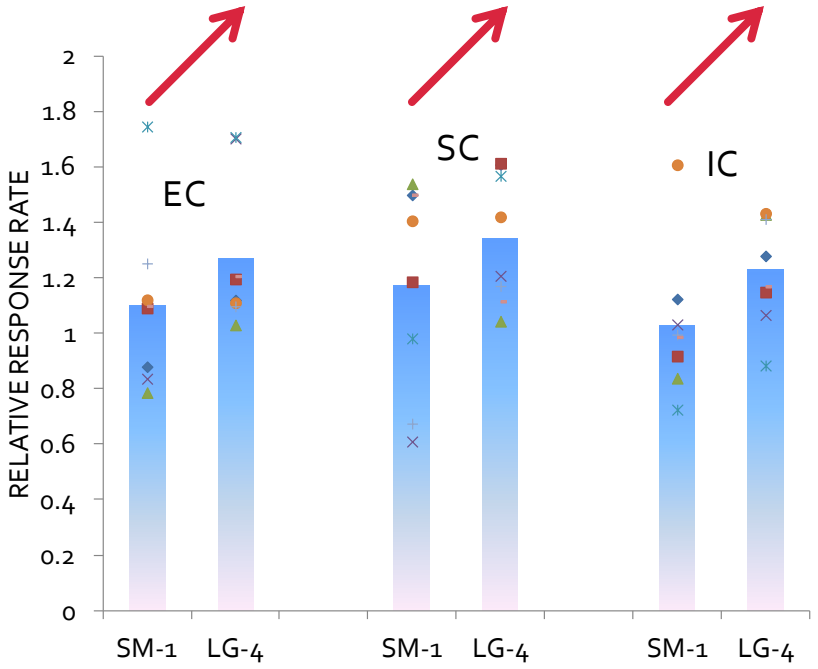

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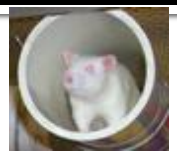

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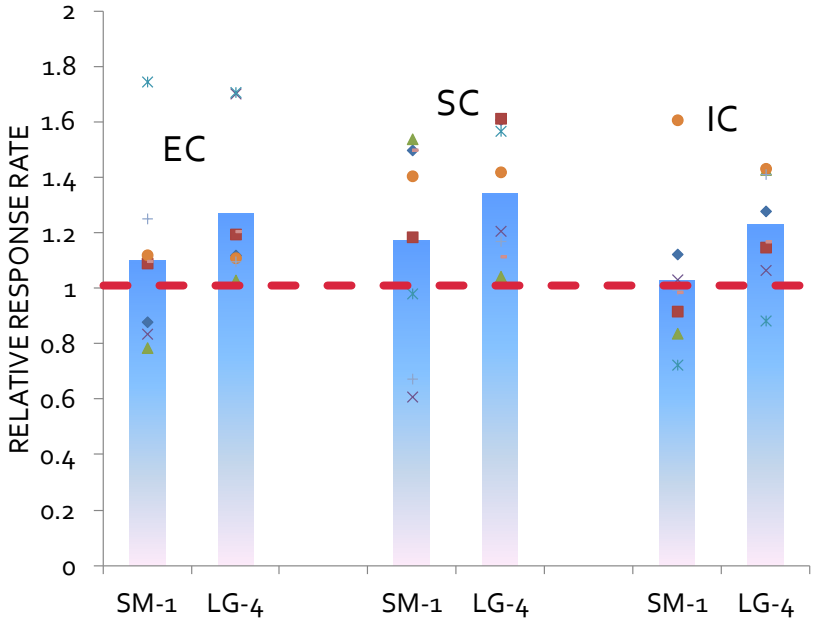

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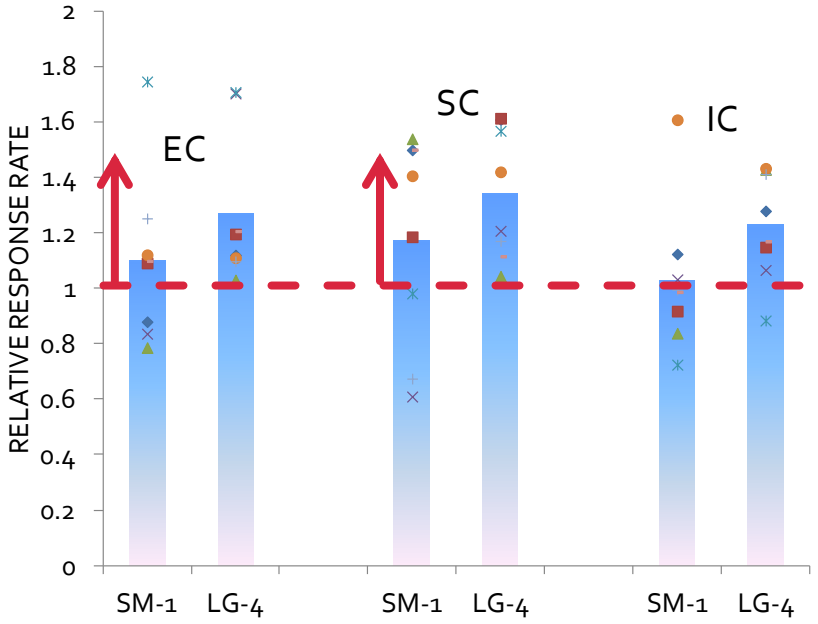
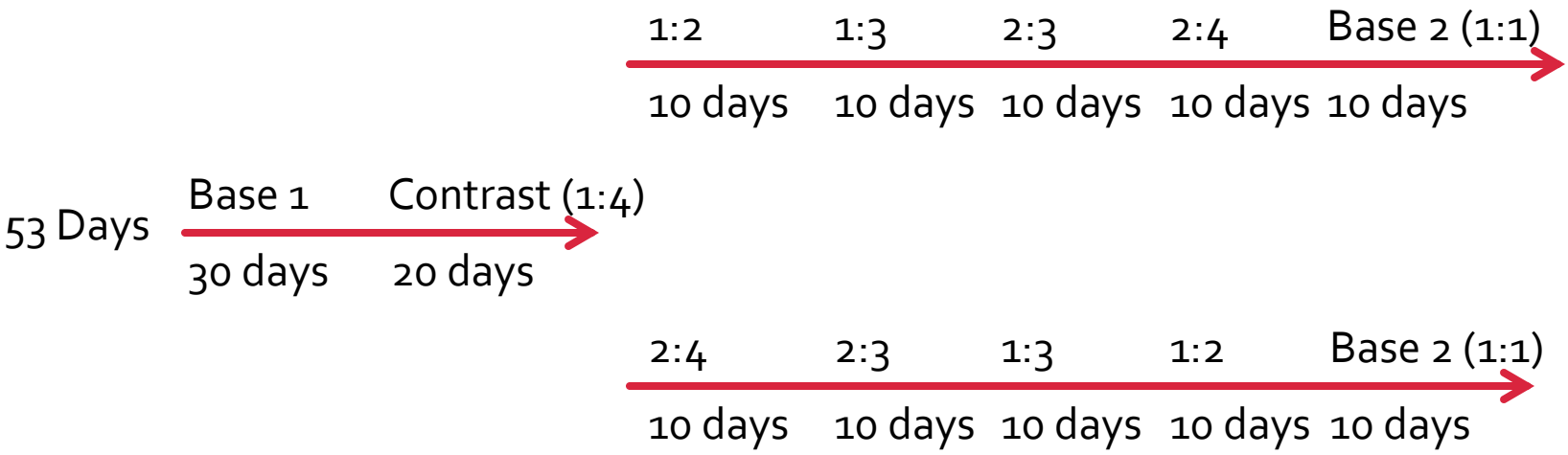


Reward Sensitivity Test



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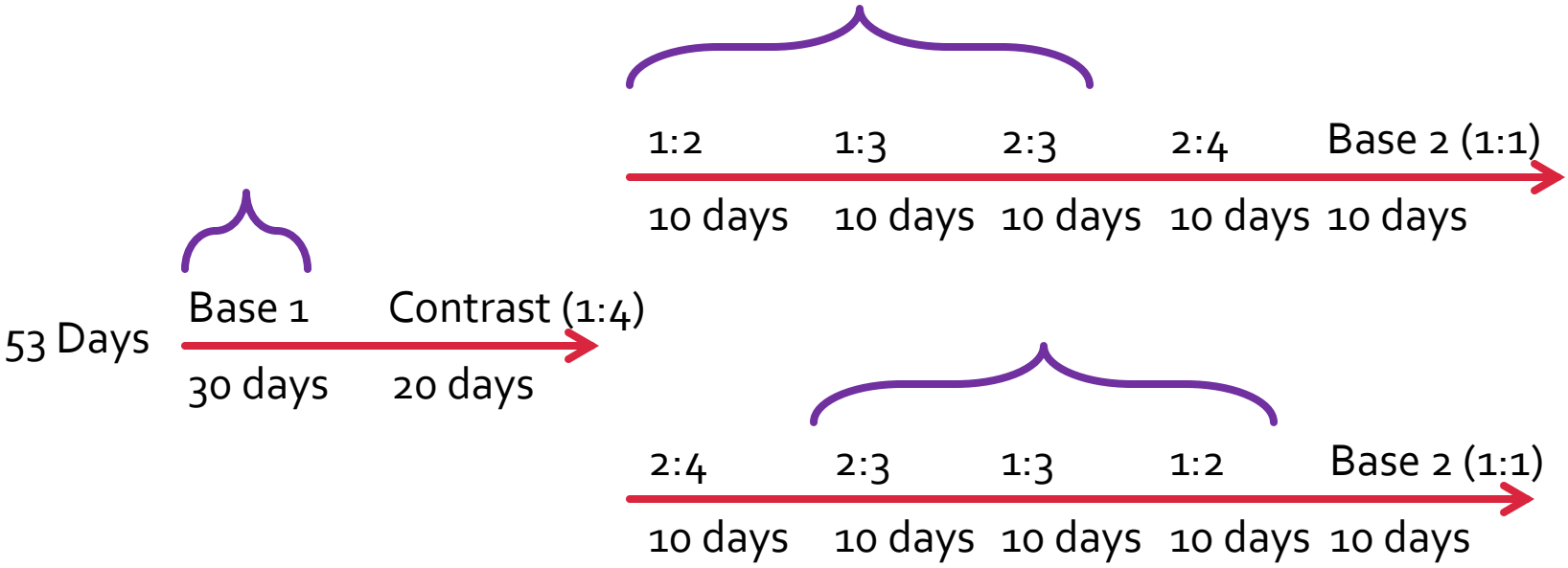
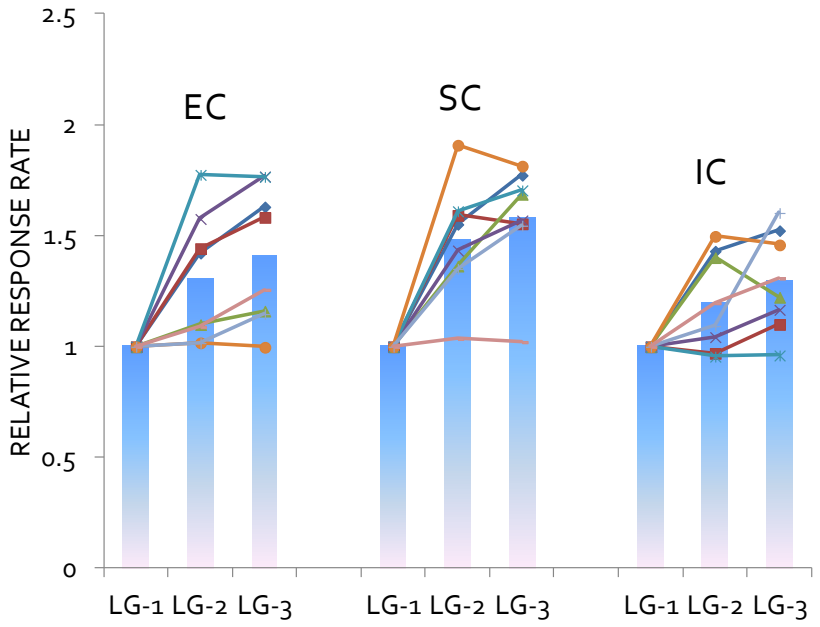


Enrichment did not affect responding for the LG reward

- All rearing conditions significantly increased their relative response rate on the large lever as a function of reward magnitude
- No effect of rearing condition on response to LG reward



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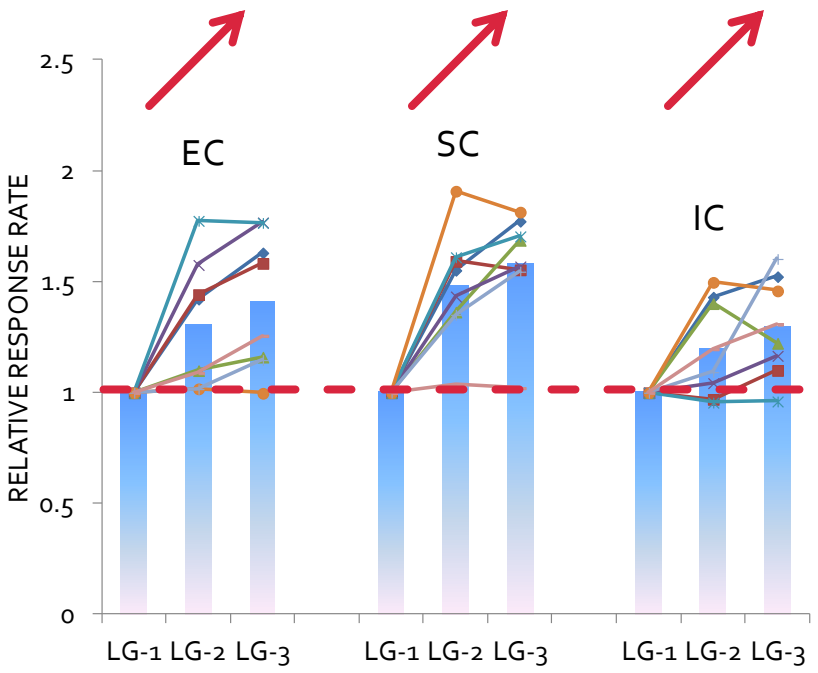
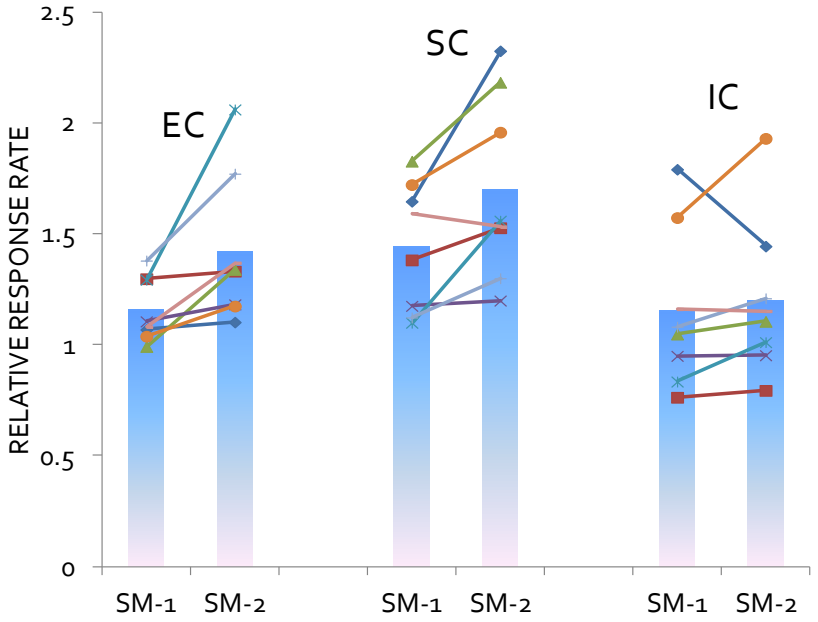


Enrichment resulted in more generalization to SM lever

- EC and SC rats generalize LG responding in SM-1 condition
- IC rats do not generalize to SM-1



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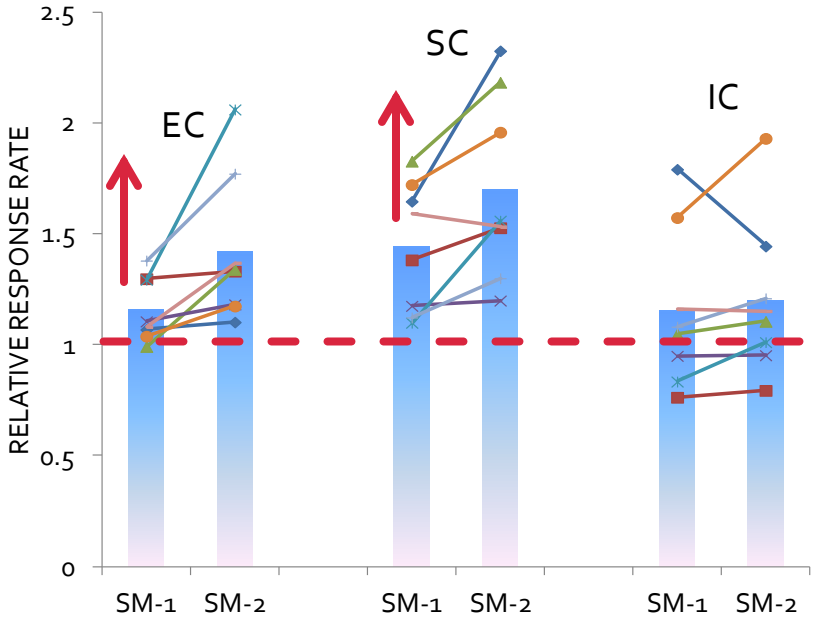
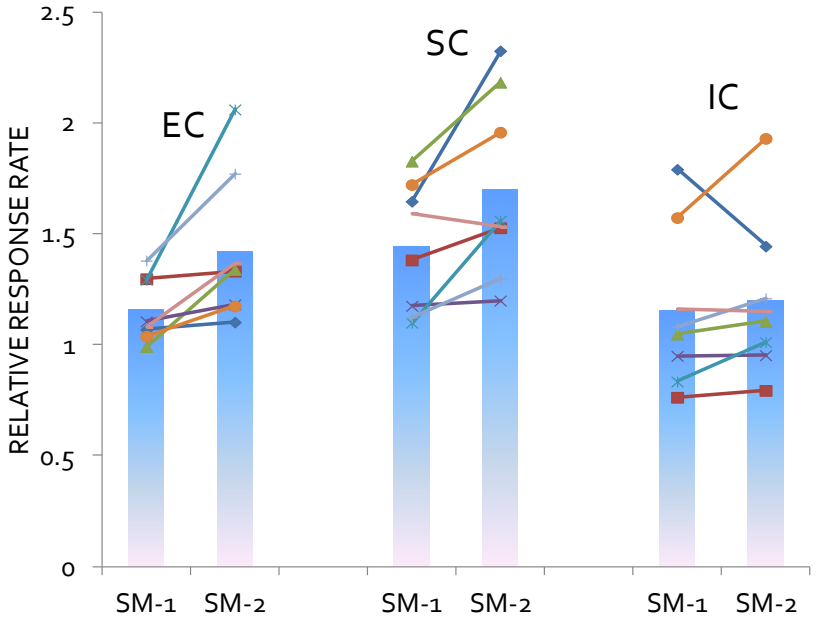


Enrichment increased sensitivity to changes in the SM reward

- EC and SC rats increase their SM response when SM reward is increased from 1 to 2 pellets
- IC rats do not increase their response when SM reward increases



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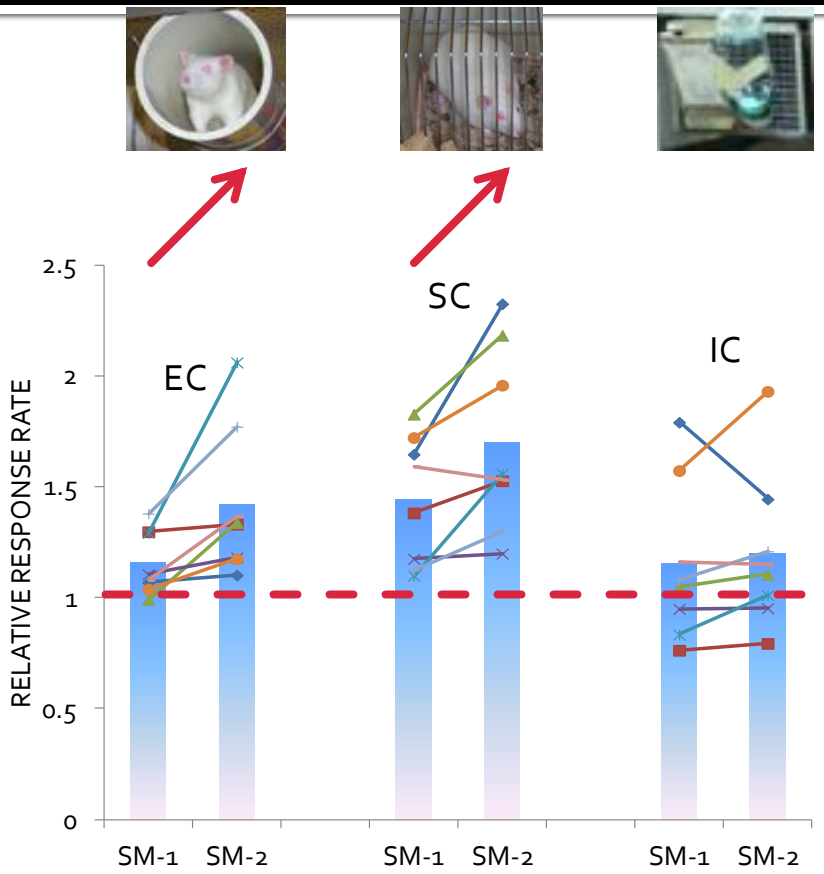

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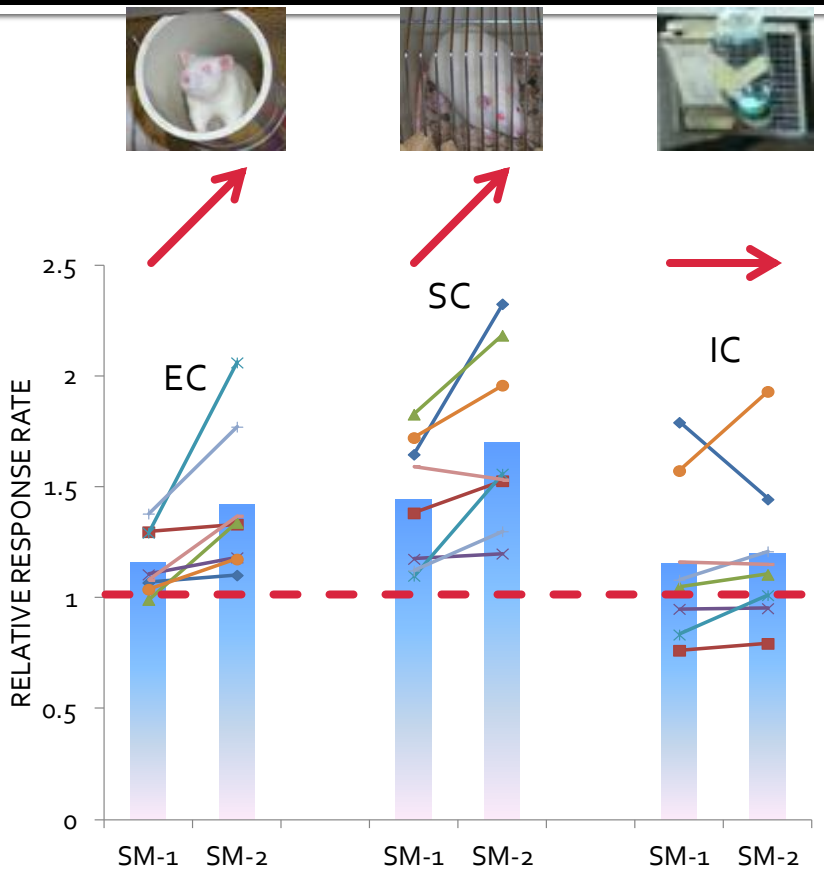

Conclusions

- Environmental enrichment produced:
  - Lower amounts of locomotor activity, both with and without AMP
  - Lower baseline response rates of lever pressing
- These two results suggest that enrichment may be reducing overall motivation/reward-seeking behavior
- Lower motivation to seek rewards could play a role in the protective effect of enrichment against drug-seeking behaviors.

Conclusions

- Environmental enrichment did not affect the response to the increase in magnitude on the large lever
  - This suggests an intact incentive motivational response to food
- But, enrichment did increase generalization to the SM lever
  - This indicates that the EC and SC rats were poorer at discriminating between the SM and LG outcomes (or in lever-outcome associations)

Conclusions

- Environmental enrichment appears to provide a "protective effect" against addictive behaviors
  - This may be due to:
    - Reduced incentive learning
    - Reduced reward sensitivity/discrimination
    - Impaired motivational processes
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Impaired response-outcome associations 

Acknowledgements

- Ana Garcia and Angela Crumer for help in running the experiment
- Andrew Marshall for help with data analysis
- Kansas State University USRG program for funding