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Mechanisms of impulsive choice: III. The role of reward processes

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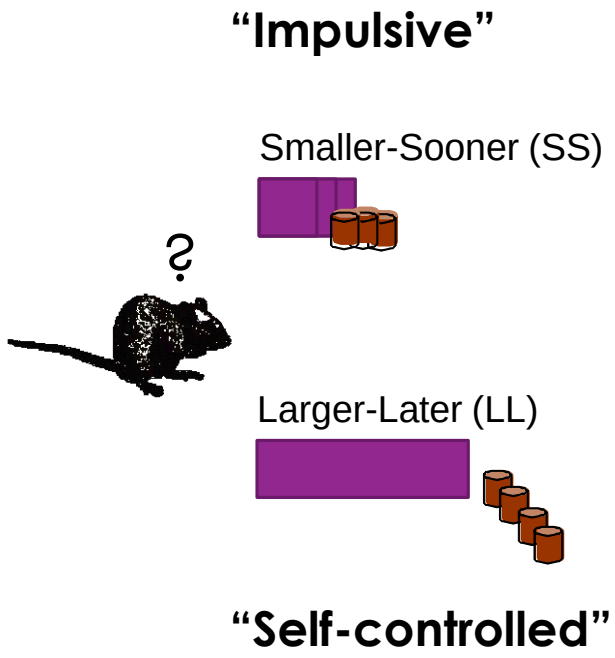
Impulsive Choice in Rats

- Offer rats choices between smaller-sooner (SS) and larger-later (LL) rewards (based on Green & Estle, 2003)
  - SS = 1 pellet in 10 s
  - LL = 2 pellets in 30 s
- Can manipulate **delay** to and/or **magnitude** of reward
- Choices of SS in most cases indicate impulsive choice



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Individual Differences in Impulsive Choice

- Impulsive choice is a stable trait in humans (e.g., Odum, 2011) and rats (Peterson, Hill & Kirkpatrick, 2015)
- Individual differences in impulsive choice are related to:
  - Substance abuse (e.g., Bickel & Marsch, 2001; Carroll et al., 2009; deWit, 2008)
  - Pathological gambling (e.g., Alessi & Petry, 2003; MacKillop et al., 2011; Reynolds et al., 2006)
  - Obesity (e.g., Davis et al., 2010)
  - ADHD (e. g., Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001; Solanto et al., 2001; Sonuga-Barke, 2002; Sonuga-Barke, Taylor, Sembi, & Smith, 1992)
- Impulsive choice is a trans-disease process (Bickel & Mueller, 2009)

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Timing Processes and Impulsive Choice

- Recent research in our laboratory has indicated an important role for timing processes in individual differences in impulsive choice (Marshall, Smith, & Kirkpatrick, 2014; see also McClure, Podos & Richardson, 2014)
  - More impulsive rats showed poor temporal discrimination ability
- Moreover, substantial exposure to time-based schedules of reinforcement resulted in:
  - Improvements in temporal discrimination ability
  - Decreases in impulsive choice / Increases in self-control
  - Smith, Marshall & Kirkpatrick (2015)

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Reward Processes and Impulsive Choice

- Are reward processes related to impulsive choice?
  - Experiment 1
- Can we improve reward processing capabilities? Does that then improve self-control?
  - Experiment 2

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Experiment 1 Method

Impulsive Choice

SS = 10 s, 1 p

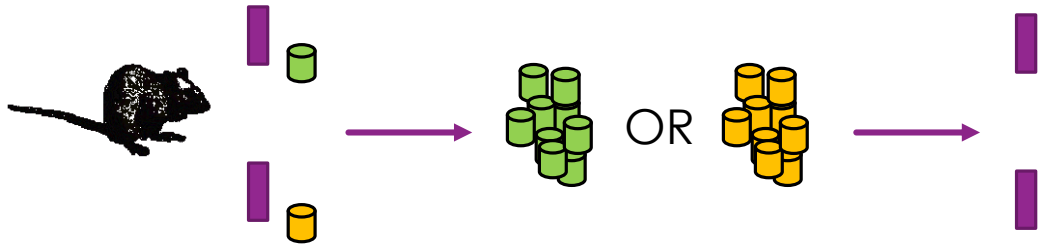
LL = 30 s, 1→2→4 p

Reward Magnitude Sensitivity

Small: RI 30 s, 1 p

Large: RI 30 s, 1→2→4 p

Reward Devaluation



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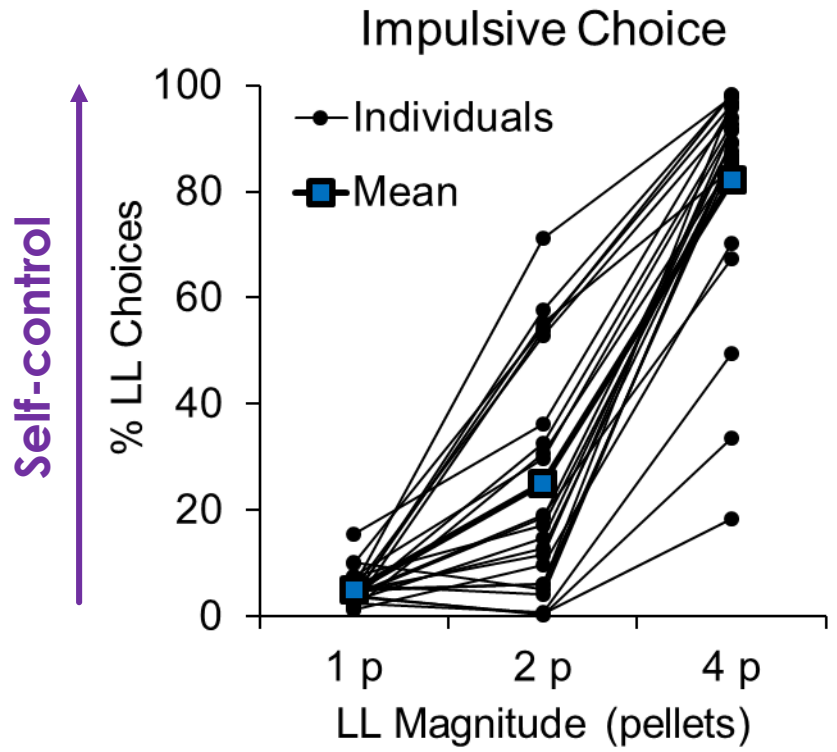
Experiment 1 Results

- Random effects (individual differences):
  - Intercept
  - LL Magnitude
- Fixed effects:
  - LL Magnitude



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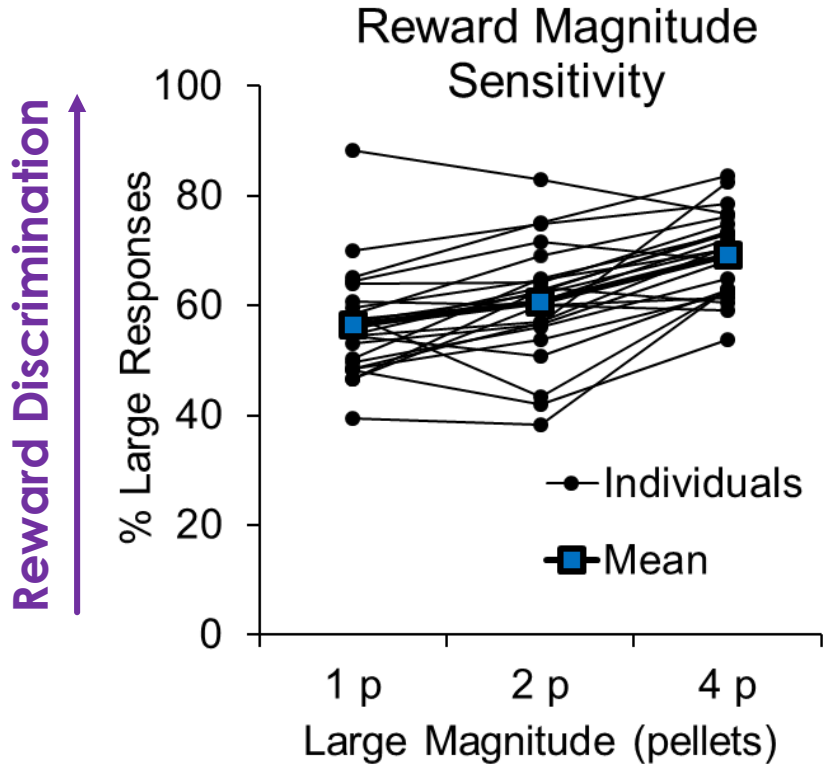
Experiment 1 Results

- Random effects (individual differences):
  - Intercept
  - Large Magnitude
- Fixed effects:
  - Large Magnitude



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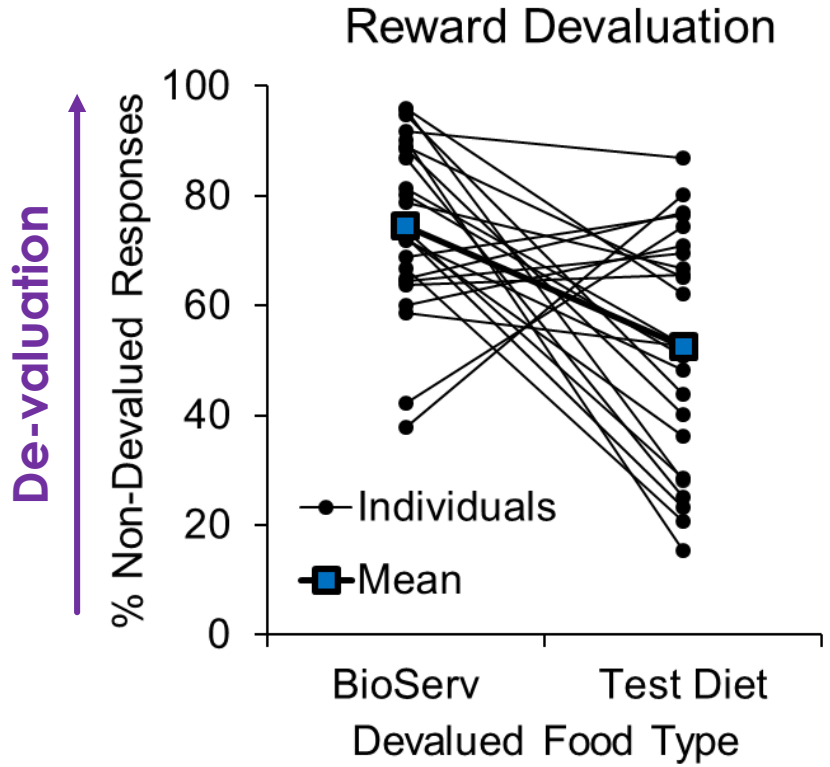
Experiment 1 Results

- Random effects (individual differences):
  - Intercept
  - Devalued Food
- Fixed effects:
  - Devalued Food



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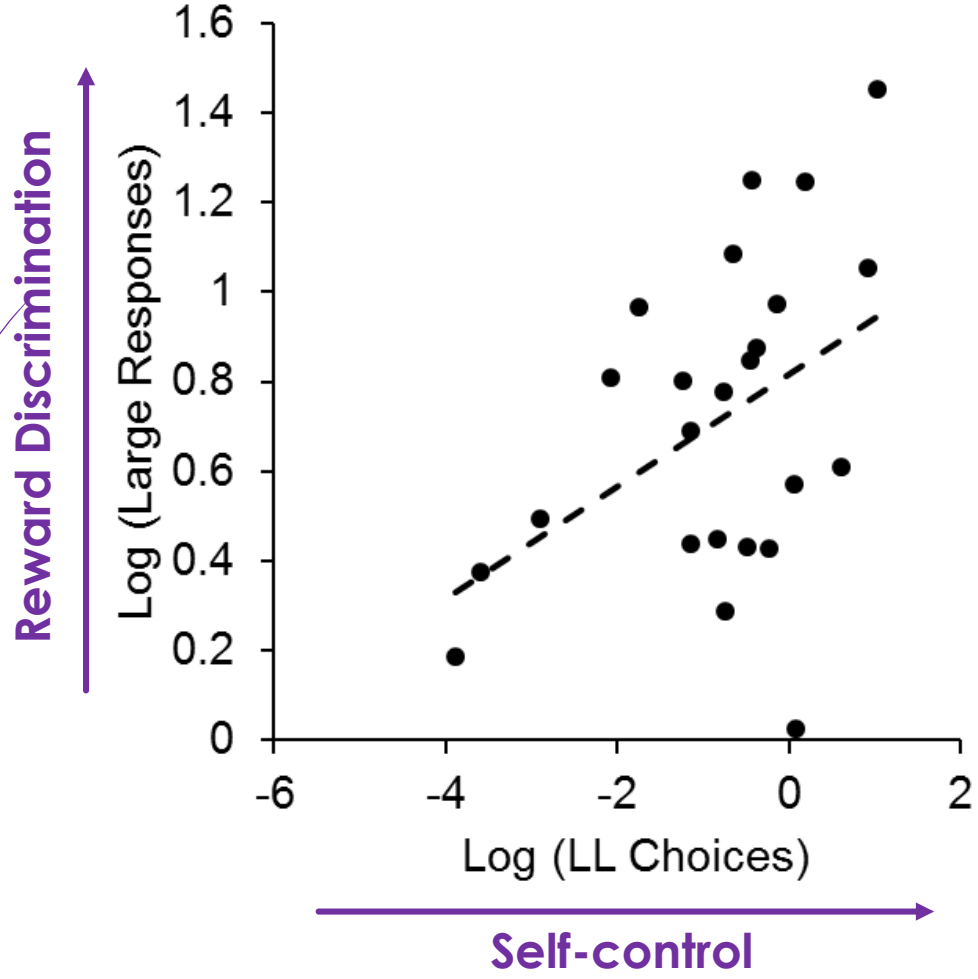
Inter-task Correlations



- Better reward discrimination was associated with better self control
- Reward devaluation did not predict impulsive choice

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Experiment 2 Method

Impulsive Choice

SS = 10 s, 1 p

LL = 30 s, 2→4 p

Intervention

Small = 1 p

Large = 2, 4 p

Control

"Small" = 2 p

"Large" = 2 p

Impulsive Choice

SS = 10 s, 1 p

LL = 30 s, 2→4 p

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Experiment 2 Results

- Random effects (individual differences):
  - Intercept
  - Pre/Post * LL Magnitude
- Fixed effects:
  - Group * Pre/Post * LL Magnitude * Session

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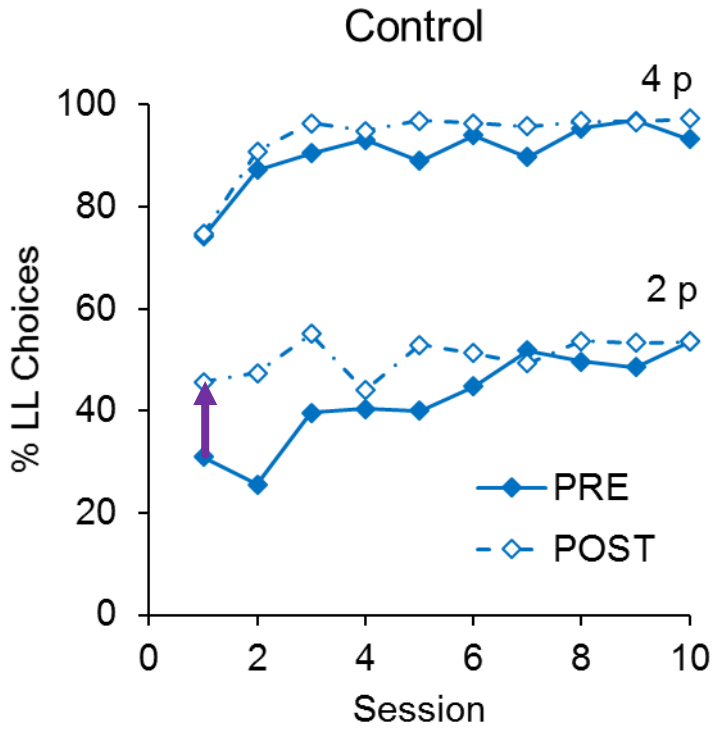
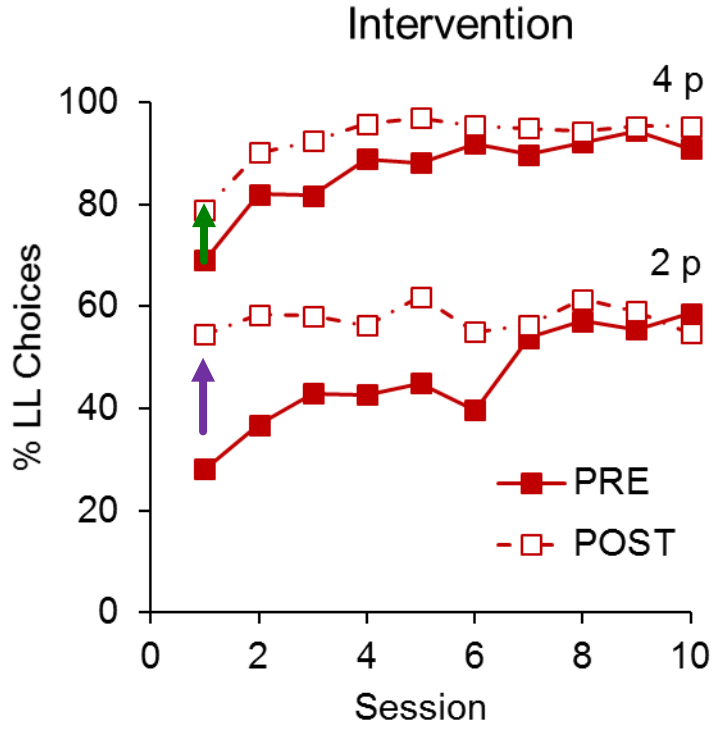
Experiment 2 Results





Transfer back to 2 p was faster for Intervention group

Choose LL more at 4 p

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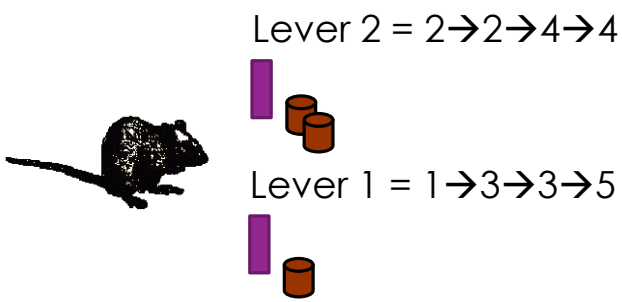
Did the intervention improve reward discrimination?

Reward Discrimination



- Switched the levers to remove biases
- Each pair of magnitudes delivered for 3 sessions
- 2v1→2v3→4v3→4v5
- Large magnitude switched sides for each phase

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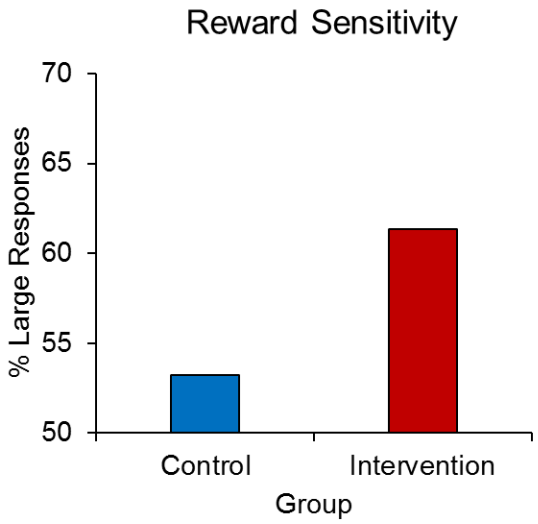
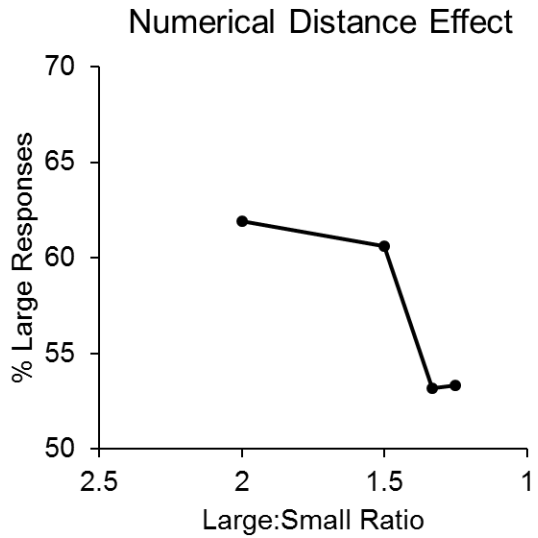
Did the intervention improve reward discrimination?

- Random effects (individual differences):
  - Intercept
  - Large : small magnitude ratio
- Fixed effects:
  - Group
  - Large : small magnitude ratio





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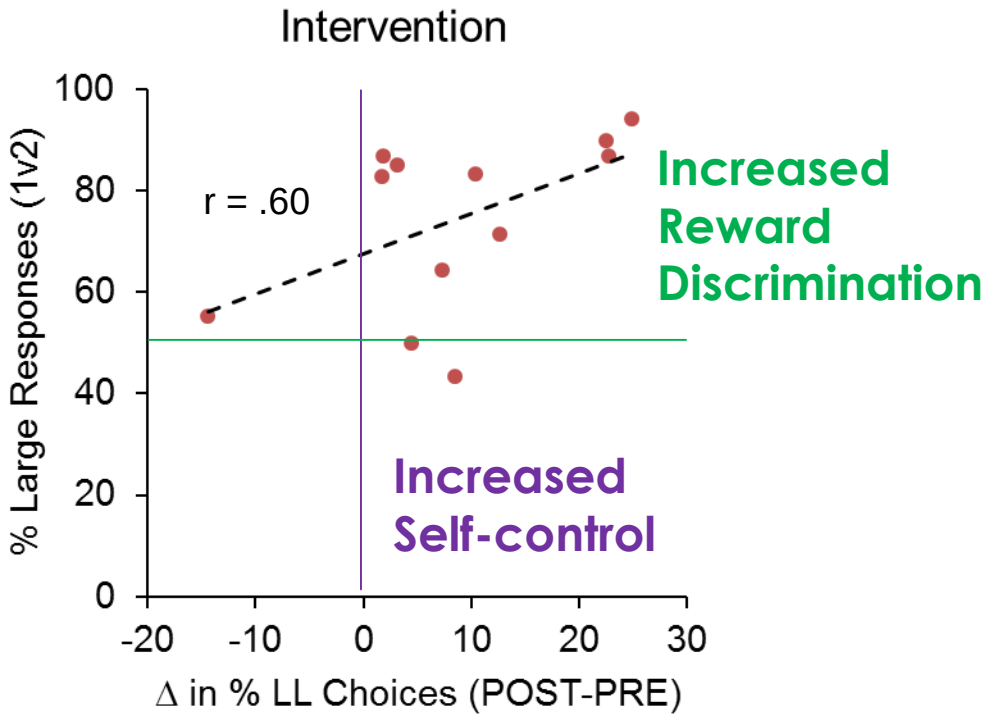
Did the improved reward discrimination predict choice behavior?

- For the intervention group
  - The rats with the highest reward discrimination also showed the greatest increases in self-control following the intervention
  - Strongest for 1v2 pellet
- For the control group
  - No significant correlation



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Overall Summary

- Reward discrimination ability may be important for making self-controlled choices
  - Well informed choice
- But, the intervention effects were weaker compared to our previous time-based interventions
- May need to give an intervention that delivers extensive experience with more difficult magnitude discriminations (e.g., 4 vs. 5 pellets)
  - Or maybe lots of experience with lots of different magnitudes

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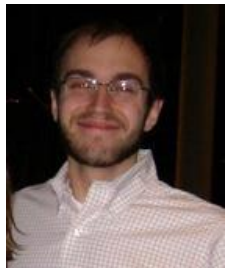
Acknowledgments



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Questions????

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