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

“Impulsive”
Smaller-Sooner (SS)

“Self-controlled”
Larger-Later (LL)
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)
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)
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
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
- OR
Experiment 1 Results

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

- **Fixed effects:**
  - LL Magnitude

![Graph showing impulsive choice vs LL magnitude]
Experiment 1 Results

- Random effects (individual differences):
  - Intercept
  - Large Magnitude
- Fixed effects:
  - Large Magnitude
Experiment 1 Results

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

- **Fixed effects**:
  - Devalued Food
Inter-task Correlations

Better reward discrimination was associated with better self control.

Reward devaluation did not predict impulsive choice.
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
Experiment 2 Results

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

- Fixed effects:
  - Group * Pre/Post * LL Magnitude * Session
Experiment 2 Results

Transfer back to 2 p was faster for Intervention group
Choose LL more at 4 p
Did the intervention improve reward discrimination?

- Switched the levers to remove biases
- Each pair of magnitudes delivered for 3 sessions
- $2v1 \rightarrow 2v3 \rightarrow 4v3 \rightarrow 4v5$
- Large magnitude switched sides for each phase
Did the intervention improve reward discrimination?

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

- Fixed effects:
  - Group
  - Large : small magnitude ratio
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

\[ r = .60 \]
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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Questions???

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