Mechanisms of impulsive choice: reward sensitivity and devaluation

Andrew T. Marshall* & Kimberly Kirkpatrick

Kansas State University

The Reward, Timing, & Decision Laboratory

INTRODUCTION

- **Delay discounting**: reduction in subjective reward value as reward delay increases.[1]
- Lesions of brain areas in the core valuation circuit produced deficits in impulsive choice, suggesting that dysfunctional reward processing impairs choice behavior.[2]
- Previous research did not find a significant correlation between reward magnitude sensitivity and impulsive choice behavior.[3]
  - Non-significant results may be due to task structure (i.e., multiple VI-VI).
  - Effects of reward magnitude are strengthened when the individual's behavior controls the magnitude that will be experienced.[4]
- **Goals of the present study**: (1) Replicate previous effects of reward magnitude on impulsive choice behavior, and (2) determine the relationship between individual differences in impulsive choice, reward sensitivity, and reward devaluation when all tasks involve choice-based reward outcomes.

METHOD

- 24 pair-housed experimentally-naïve male Sprague-Dawley rats
- **Impulsive choice task**
  - Smaller-sooner (SS): 1 pellet in 10 s vs. larger-later (LL): 1, 2, or 4 pellets in 30 s
- **Reward magnitude sensitivity task**
  - Concurrent random-interval – random-interval (RI-RI) schedules
  - RI-30 s for 1 pellet ("small" lever) vs. RI-30 s for 1, 2, or 4 pellets ("large" lever)
- **Reward devaluation task**
  - Trained to associate levers with Bio-Serv sucrose pellets and Test Diet purified-ingredient precision pellets, and then tested on satiety-specific devaluation

DATA ANALYSIS

- **Equation 1**: Log odds of the primary behavior (N_P) of interest (e.g., LL choices) divided by the alternative (N_A) behavior (e.g., SS choices)
  - Log odds > 0: More occurrences of primary behavior
  - Log odds < 0: More occurrences of alternative behavior
- **Impulsive choice task**
  - Log odds of LL choices relative to SS choices
- **Reward magnitude sensitivity task**
  - Log odds of large-lever responses relative to small-lever responses
- **Reward devaluation task**
  - Log odds of non-devalued responses relative to devalued responses

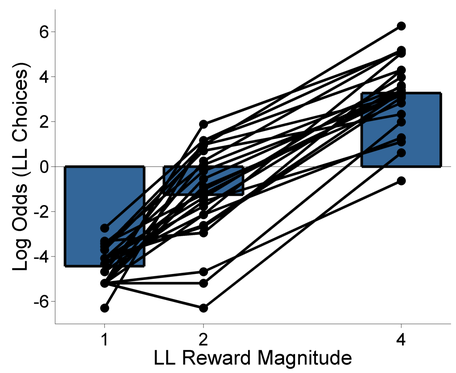
Equation 1:

$$Log\ odds = \log\frac{N_P + .5}{N_A + .5}$$

*Email: atmarsh@k-state.edu

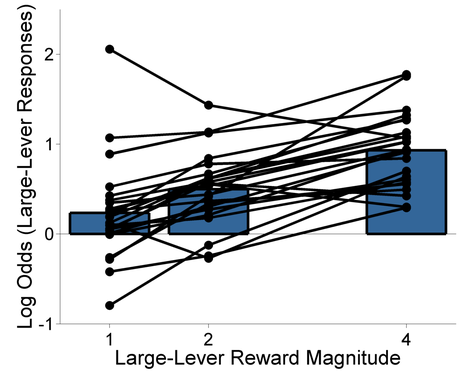
RESULTS

Impulsive Choice



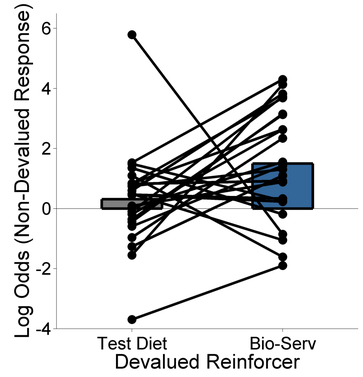
- Increase in LL choices as LL reward magnitude increased

Reward Sensitivity



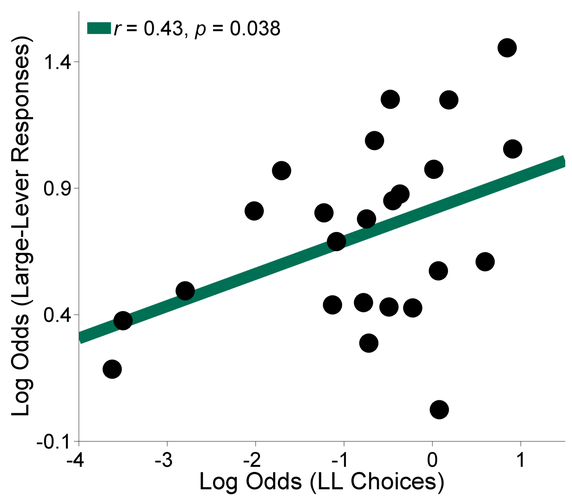
- Responded more on large lever as reward magnitude increased

Reward Devaluation



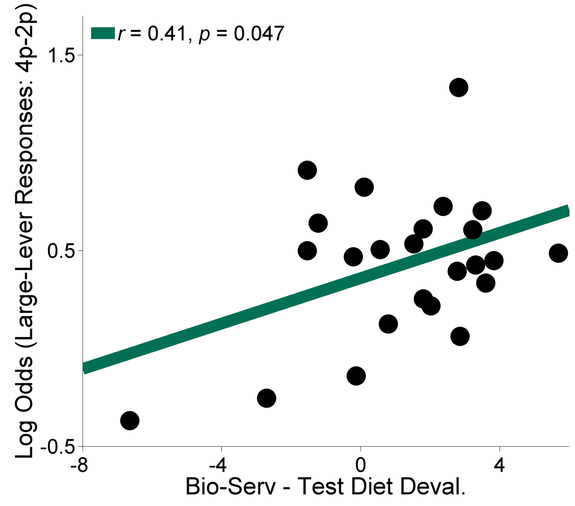
- Responded more for non-devalued reinforcer

Impulsive Choice × Reward Sensitivity



- The better the rats discriminated 1 vs. 2 pellets and 1 vs. 4 pellets in the reward magnitude sensitivity task, the more frequently they chose the LL outcome.

Reward Devaluation × Reward Sensitivity



- The greater that the Bio-Serv pellets were devalued relative to the Test Diet pellets, the greater increase (i.e., difference score) in large-lever responses with larger reward magnitudes.

DISCUSSION

- Greater sensitivity to differences in reward magnitude was associated with greater self-control.
  - Discrepancies from past results are likely due to differences in task structure (i.e., concurrent vs. multiple schedules).
- Lack of an impulsive choice × devaluation relationship may be driven by reward quality differences.
- Neurocognitive/pharmacological interventions should focus on reward discrimination to alleviate impulsive choice deficits.

REFERENCES

1. Myerson, J., & Green, L. (1995). Discounting of delayed rewards: models of individual choice. *Journal of the Experimental Analysis of Behavior, 64*, 263-276.
2. Galtress, T., & Kirkpatrick, K. (2010). The role of the nucleus accumbens core in impulsive choice, timing, and reward processing. *Behavioral Neuroscience, 124*, 26-43.
3. Marshall, A. T., Smith, A. P., & Kirkpatrick, K. (in press). Mechanisms of impulsive choice: I. Individual differences in interval timing and reward processing. *Journal of the Experimental Analysis of Behavior.*
4. Bonem, M., & Crossman, E. K. (1988). Elucidating the effects of reinforcement magnitude. *Psychological Bulletin, 104*, 348-362.

ACKNOWLEDGMENTS

The research was supported by the National Institute of Mental Health (NIMH) via award MH 085739. We would like to thank Charles Pickens, Jennifer Peterson, James Provost, and Maya Wang for their contributions.