

PROBABILISTIC CHOICE IN RATS: THE EFFECTS OF DIFFERENTIAL LOSSES AND ALTERNATIVE OUTCOMES

Andrew T. Marshall, Jeffrey Hyder, & Kimberly Kirkpatrick
Kansas State University



KANSAS STATE UNIVERSITY
DEPARTMENT OF PSYCHOLOGICAL SCIENCES
REWARD, TIMING, & DECISION LABORATORY



Probabilistic Gains and Losses

- Probabilistic outcomes are partitioned as gains and losses relative to a *subjective reference point*
 - Gains: Outcomes $>$ reference point
 - Losses: Outcomes $<$ reference point
- In humans, the reference point may potentially reflect...
 - What an individual aspires or expects to have
 - Kahneman and Tversky (1979); Wang and Johnson (2012)
 - What an individual currently has
 - Kahneman and Tversky (1979)
 - What an individual minimally requires to have
 - Stephens and Krebs (1986); Wang and Johnson (2012)
 - Or, what an individual could have had for making a different choice
 - Boles and Messick (1995)
- Due primarily to the procedures in use, it has been difficult to determine what such a reference point may be in animals

Identifying a Reference Point

- Choice between a certain smaller outcome and a larger uncertain outcome

Certain
1 pellet, $p = 1.00$

Uncertain
4 pellets, $p = .50$
0 pellets, $p = .50$

- General assumption: the 4-pellet outcome is a **gain**
 - Greater than the expected value of the uncertain choice (2)?
 - *What an individual expects or aspires to have*
 - Greater than the zero-pellet outcome (0)?
 - *What an individual currently has or minimally requires to have*
 - Greater than the certain smaller outcome (1)?
 - *What an individual could have had for making a different choice*

Identifying a Reference Point

- Previous research (Marshall, 2013)
 - Manipulated uncertain food amounts in a probabilistic choice task
 - Measured win-stay / lose-shift behavior
 - More uncertain choices following gains than following losses
 - Evenden and Robbins (1984); Marshall and Kirkpatrick (2013); Stopper and Floresco (2011)
- Possible reference point: Expected value of the certain choice

Goals of the Current Experiment

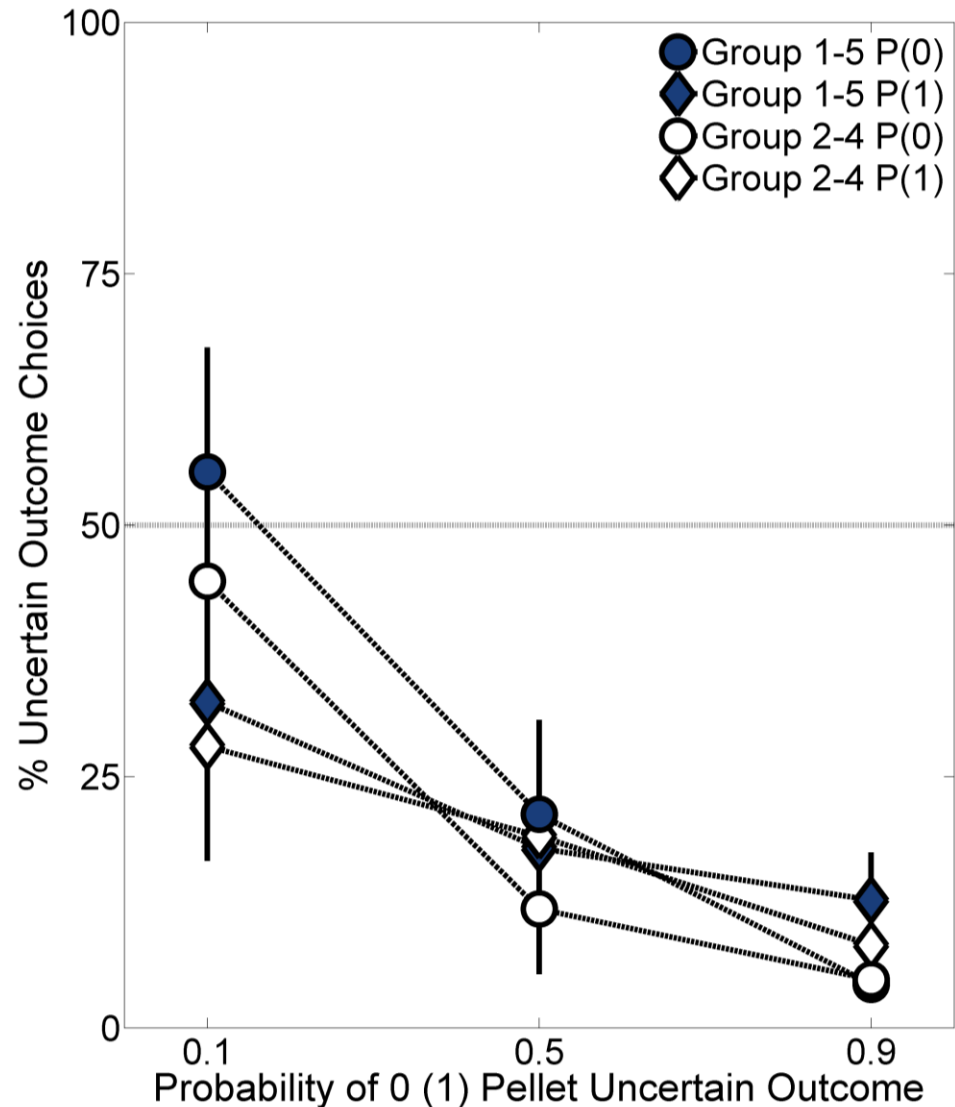
- (1) Determine if the expected value of the certain choice outcome or its individual outcome values comprise the reference point
 - Previous research in our laboratory has maintained the same parameters of the certain choice
- (2) Determine if the effects of the previous outcome will differ if the probability of a non-zero loss and the probability of a zero-magnitude loss is manipulated

Current Procedure

- 24 male experimentally-naïve Sprague Dawley rats
- Choice between a certain and an uncertain outcome
 - Certain outcome
 - Group 2-4: **2** or **4** pellets ($\mu = 3$ pellets)
 - Group 1-5: **1** or **5** pellets ($\mu = 3$ pellets)
 - Uncertain outcome: **0**, **1**, or **11** pellets
 - Zero- and non-zero loss (i.e., $<$ Certain outcome expected value)
- Probabilities of uncertain outcomes
 - Manipulated the probability of zero pellets across phases
 - $P(0) = .1, .5, .9$
 - Manipulated the probability of one pellet across phases
 - $P(1) = .1, .5, .9$

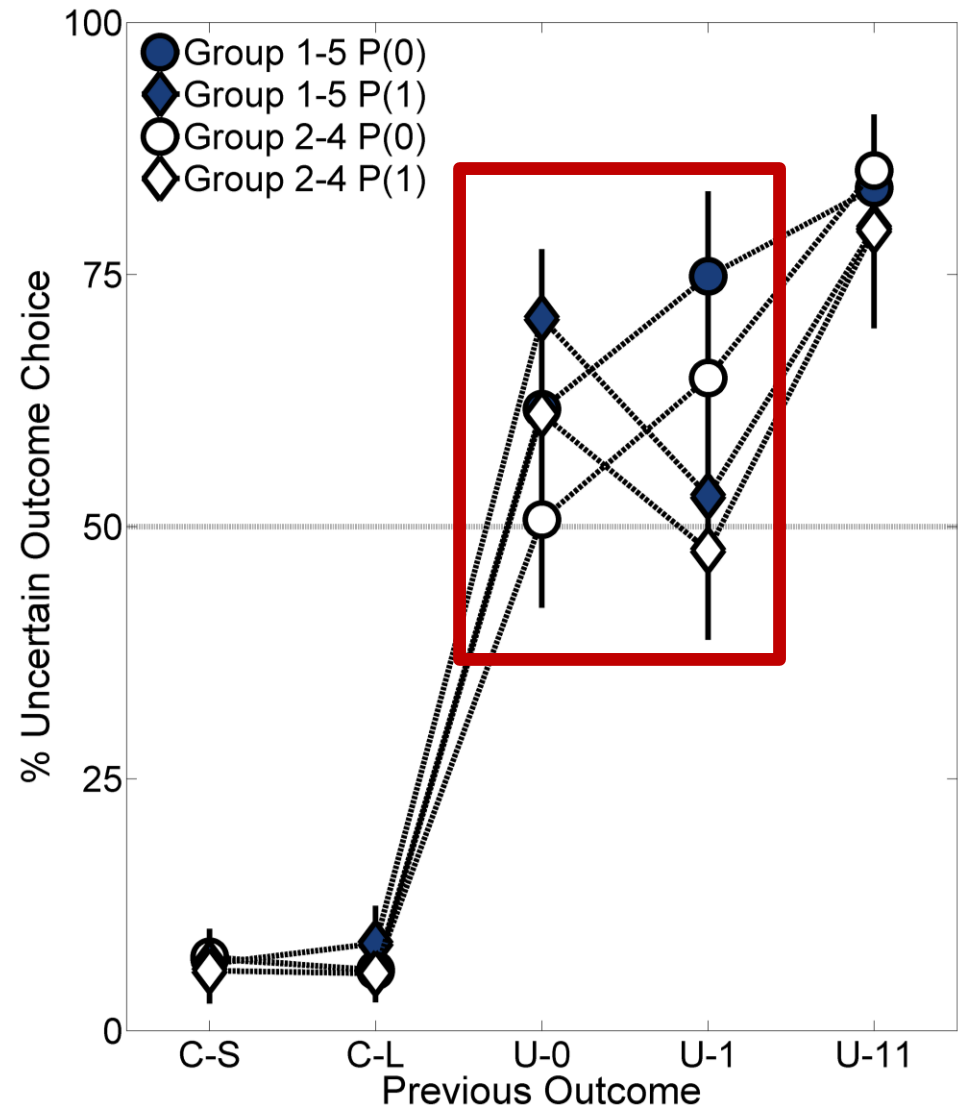
Probability of the 11-Pellet Reward

- Decrease in % uncertain outcome choice with increases in $P(0)$ and $P(1)$
- Group 1-5 \approx Group 2-4
 - Expected value of certain choice was more important than the individual values
- Steeper functions within $P(0)$ manipulation
 - Differences in global behavior depending on if zero- or non-zero loss probability is manipulated



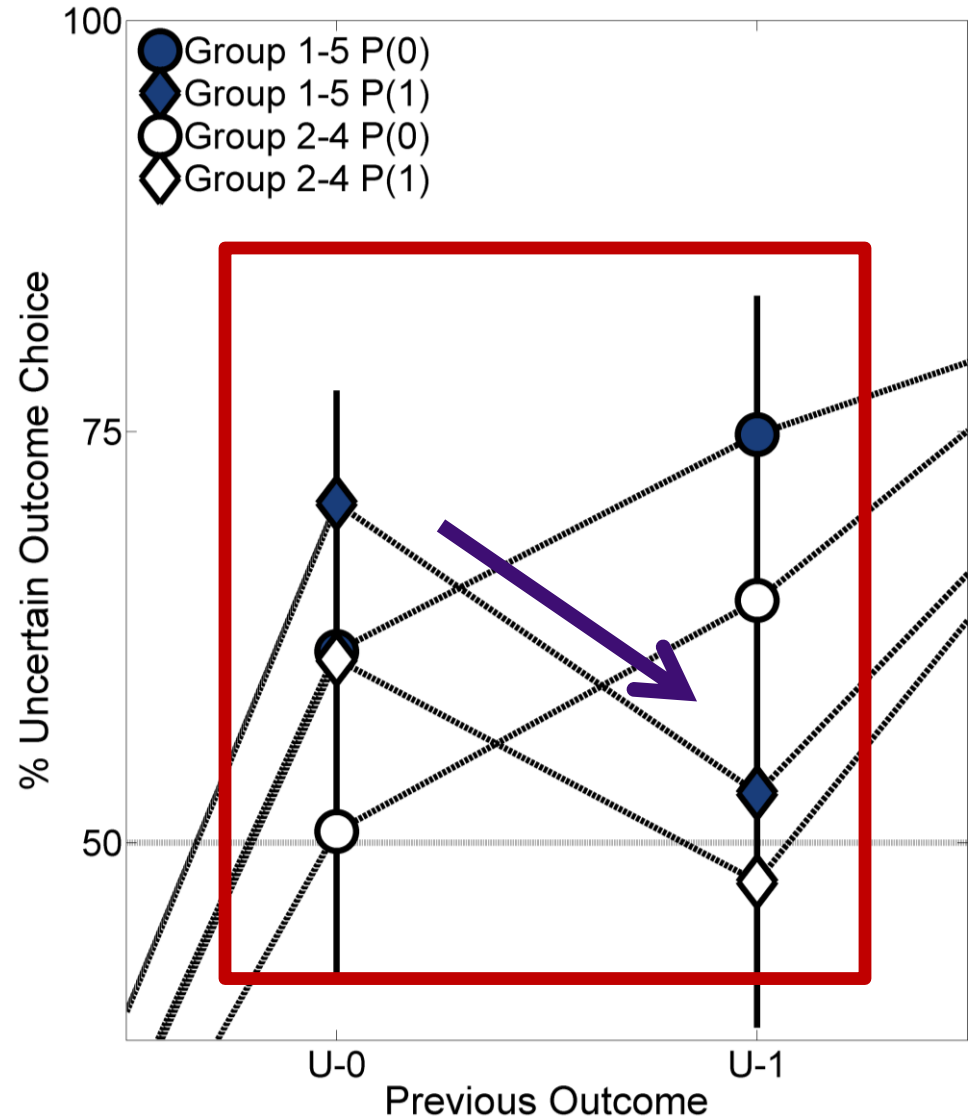
Effect of the Previous Outcome

- More uncertain choices following U-11 outcome than U-1 and U-0 outcomes
 - Win-stay / lose-shift behavior
- Group 1-5 \approx Group 2-4
 - Expected value exhibits a greater influence than individual values
- $P(0) \neq P(1)$
 - In P(1) manipulation, there were more uncertain choices following U-0 than following U-1 outcomes
 - 0 is less of a loss than 1?



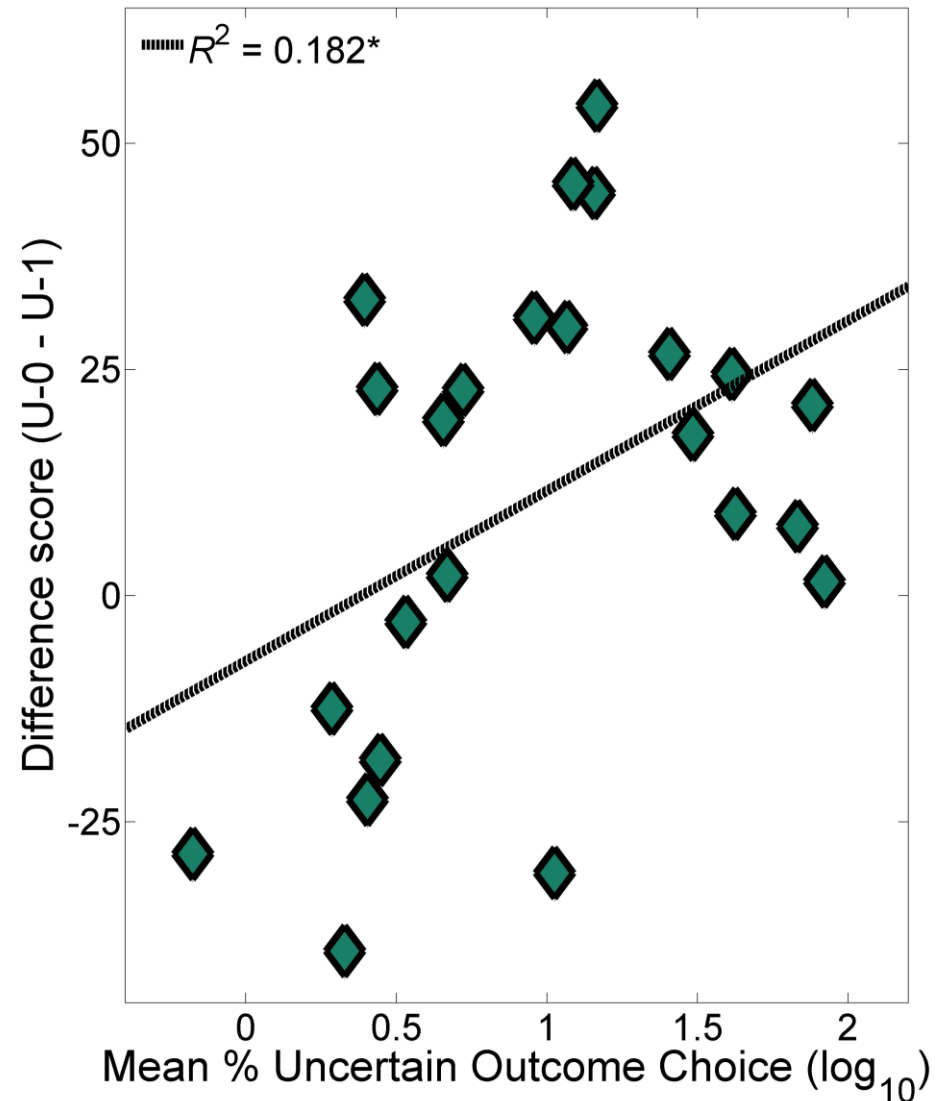
Effect of the Previous Outcome

- Investigated whether the reduction in post U-1 behavior vs. post U-0 behavior was related to the propensity to make risky choices
- Are rats that are more likely to gamble following U-0 than following U-1 more susceptible to “gambling” despite experienced losses?



Effect of the Previous Outcome

- More risky choices → greater reduction in uncertain choice behavior following U-1 outcomes
- The probabilistic presentation of *non-zero losses* may be more effective than that of reward omission to reduce problematic gambling behavior



Factors of Probabilistic Choice Behavior

- *(1) Determine if the expected value of the certain choice outcome or its individual outcome values comprise the reference point*
 - The expected value of the certain choice is a more likely candidate for a subjective reference point than the corresponding individual reward outcomes
- *(2) Determine if the effects of the previous outcome will differ if the probability of a non-zero loss and the probability of a zero-magnitude loss is manipulated*
 - Differences in behavior at the molar and molecular level
 - Differential sensitivity to differential losses

Theoretical Perspectives

- Reference points for probabilistic gains and losses
 - What an individual aspires or expects to have
 - What an individual currently has
 - What an individual minimally requires to have
 - Or, what an individual could have had for making a different choice



- Scratch tickets
 - If you win \$8 off a \$10 scratch ticket, the first thing that likely comes to mind may be...
 - “Shoot! I could have kept my \$10!”
 - Rather than...
 - “Yay! I won \$8, which is much less than the jackpot...”



Theoretical Perspectives

- If we are to understand the effects of previous and prospective **gains** and **losses**, we should be aware of the reference point that distinguishes outcomes as such
- Conclusion
 - (1) Computations of subjective valuation may be more complex than initially envisioned
 - (2) Gains or losses may be regarded as such relative to alternative outcomes in the environment
 - (3) The presentation of non-zero losses may be an effective neurocognitive intervention to reduce problematic risky decision making behaviors, and to identify those individuals susceptible to such behaviors

Thank you!

- Acknowledgements

- Current and former members of the Reward, Timing, & Decision Laboratory
 - Dr. Kimberly Kirkpatrick
 - Dr. Jennifer Peterson
 - Dr. Tiffany Galtress
 - James Provost
 - Maya Wang
 - Jon Smith
 - Paul Brungardt
 - Patricia Brady
 - Marina Vilaro
 - Aaron Smith
 - Jeffrey Hyder
 - Catherine Hill
 - Erica Fardette
- My rats



**The
Reward,
Timing, &
Decision
Laboratory**