Gains and Losses in Reflective Exploratory Decision-making in Depression

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Introduction

Exploratory decision-making

- Effective decision-making requires balancing competing demands of exploiting and exploring\(^\text{1}\).
- A reflective decision maker builds a mental representation of the environment, which is dependent on frontal cortex, effortful, and resource intensive. Exploratory choices are directed toward uncertainty in the environment.

- A reflexive decision maker has a limited representation of the environment. Exploratory choices are undirected, arising from a stochastic decision process. Reflective decision making is largely striatally based.

Depressive symptoms and decision-making

- Individuals with elevated depressive symptoms tend to perform worse at decision-making tasks.
- But, some studies have found that they perform better when the task goal is to minimize losses, rather than to maximize gains\(^2,3\).
- Previously we found individuals with elevated depressive symptoms performed worse and less often used reflective strategies during an exploratory decision-making task\(^4\).

Participants

- Participants were classified as having Elevated Symptoms or Lower Symptoms based on their score on the CES-D\(^5\).

Participant Counts:

<table>
<thead>
<tr>
<th></th>
<th>Gains</th>
<th>Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated Symptoms</td>
<td>44</td>
<td>37</td>
</tr>
<tr>
<td>Lower Symptoms</td>
<td>30</td>
<td>29</td>
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Special thanks to Seth Koslov, and the rest of the Maddox Lab for their help with this project.

This research was supported by the NIA grant AG043425 to W. Todd Maddox and NIH Diversity Supplement Award R01DA032457-01A1S1 to NJB.

Leapfrog Task

- On any trial, with probability = 0.075, the lower valued option can “leapfrog” over the other option becoming the better option.
- The best option alternates over time.
- Exploration is necessary to determine whether a jump has occurred.

- In the Losses condition point values began at -300 and -290. In Gains they started at 10 and 20 points.

How does valence (reward vs. punishment) influence the effect of depressive symptoms on exploratory decision-making strategies?

Models

Ideal Actor Model

- Reflectively updates (Bayesian) beliefs about the environment
- Optimally converts those beliefs into action-values
- Action-values are a product of expected rewards and the potential to reduce uncertainty about the environment
- Maximizes long-term payoffs
- Exploration becomes more likely as state uncertainty increases
- It is instantiated by specifying the task as a Partially Observable Markov Decision Process (POMDP)\(^1\)

RL Model

- Represents the reflexive account of choice
- Expects rewards to be as they were last observed
- Does not utilize uncertainty to guide exploratory choices
- Explores with equal probability on every trial

\[ P(a_t|s_t) = \frac{\exp[\gamma \cdot Q(a_t,s_t)]}{\sum_a \exp[\gamma \cdot Q(a_t,s_t)]} \]

Results

- Individuals with Lower Symptoms were more reflective in Gains, while those with Elevated Depressive Symptoms were more reflective in Losses, \(F(1,136) = 4.67, p = 0.0325\).

Conclusions

- Previous research suggested the individuals with Elevated Depressive Symptoms may have a deficit in reflective exploratory decision-making, but our results indicate that they are more reflective than those with Lower Symptoms in Loss-minimization conditions. Valence framing is a crucial factor in understanding the effect of depressive symptoms on decision-making.

References


