Feedback and block length facilitate adoption of a more optimal speed-accuracy tradeoff policy

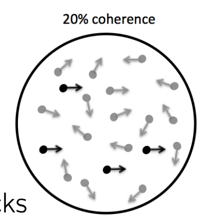
Jeffrey C. Zemla[1] and Michael D. Byrne[1,2]

[1]Department of Psychology [2]Department of Computer Science, Rice University, Houston, TX

Abstract

Many simple decisions allow decision-makers to trade off speed and accuracy. Often, the optimal strategy is to choose a tradeoff that maximizes reward rate (Bogacz et al., 2006). However, recent evidence suggests that we may choose a tradeoff that is suboptimal (Holmes & Cohen, 2014). We modeled performance in a random dot motion task using the drift diffusion model, and found that both feedback and short block lengths facilitate adoption of a more optimal speed-accuracy tradeoff policy.

Methods



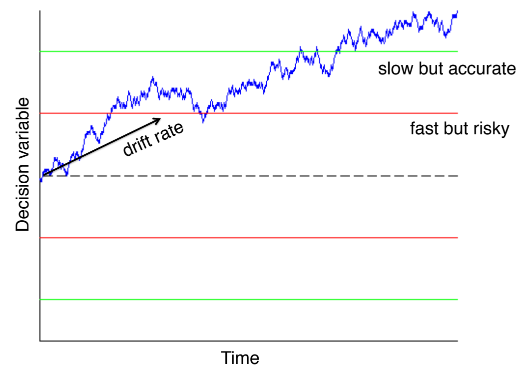
- 40 subjects participated in a random dot motion task
- Decide if dots are moving left or right
- **1-minute** and **5-minute** blocks
  - Pseudo-randomized
- **Feedback** and **no-feedback** blocks
  - Order counterbalanced across participants
- Goal: Get as many "points" (correct trials) as possible in each block

Behavioral Results

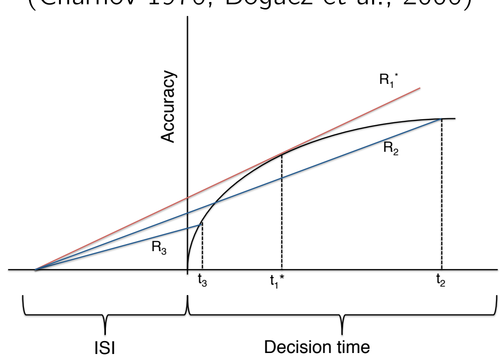
- **Feedback:**
  - Faster response times ($p < .01$)
  - Increased accuracy ($p = .06$)
- **Block length:**
  - Faster response times in shorter block ($p < .001$)
  - Accuracy remained the same ($p = .48$)

Modeling Results

- Behavior modeled using the drift diffusion model (Ratcliff, 1978)

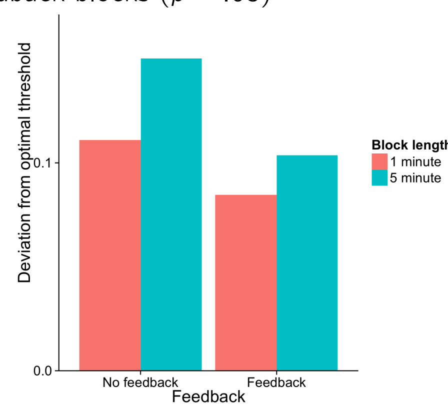


- **Feedback:**
  - Higher drift rate ($p < .01$)
  - Lower decision threshold ($p < .05$)
- **Block length:**
  - Higher drift rate in shorter block ($p = .07$)
  - Lower decision threshold ($p = .01$)
- Optimal decision thresholds were calculated using achieved drift rate (Charnov 1976; Bogacz et al., 2006)



Modeling Results (cont.)

- Optimal threshold is one that maximizes reward rate (as in t_1/R_1^*)
- Participants chose a threshold closer to optimal in shorter blocks ($p < .01$) and in feedback blocks ($p = .03$)



Discussion

- Feedback improved perceptual ability (higher drift rate), leading to lower response times and higher accuracy
- Feedback helped participants better calibrate threshold
- Longer blocks revealed lower drift rates (vigilance decrement)
- In order to preserve accuracy, participants raised threshold in longer blocks
- Feedback and short block lengths resulted in more optimal thresholds and higher reward rate (points per minute)

References

Bogacz, R., Brown, E., Moehlis, J., Holmes, P., & Cohen, J.D. (2006). The physics of optimal decision making. *Psychological Review*, *113*, 700-765.

Charnov, E. (1976). Optimal foraging, the marginal value theorem. *Theoretical Population Biology*, *9*, 129-136.

Holmes, P., & Cohen, J. D. (2014). Optimality and some of its discontents: Successes and shortcomings of existing models for binary decisions. *Topics in Cognitive Science*, *6*, 258–278.

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review*, *85*, 59-108.