Effect of level of structure on acquisition of cue-target relationships in a four-choice prediction task

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Background

- People become sensitive to sequential regularities in their environments[1], even when there are random intervening events[2].
- People can use this knowledge to make predictions[3,4].
- Learning is better for adjacent relationships (1st order structure) than non-adjacent relationships (2nd order)[5].

Aim

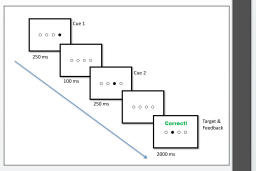
We sought to investigate the effect of structure on learning and transfer of learning in a cued prediction task.

Methods

Participants

Measure	First Order	Second Order
N	12	12
Gender*	7 females, 5 males	9 females, 3 males
Age (in years)*	19.42 (1.68)	19.25 (1.06)
Self-rated Health*	4.58 (0.52)	4.67 (0.49)
WAIS digit coding*	81.42 (18.75)	82.58 (16.70)
NAART vocabulary*	19.67 (5.87)	17.58 (5.89)
WMS-III digit span forward*	10.50 (2.71)	10.33 (1.37)
WMS-III digit span backward*	7.25 (1.55)	7.33 (2.61)

* No significant group difference



Triplets Prediction Task[3,4]

- Participants saw two successive visual cues and predicted the location of a target by key press.
- Feedback included prediction accuracy as well as the correct target location.
- One of the cues predicted the target 80% of the time and the other cue was random.
- There were 6 sessions, with 4 blocks per session and 70 trials per block, for a total of 1680 trials.

Groups

- **First Order** structure: Cue 2 predicted the target.
- **Second Order** structure: Cue 1 predicted the target.

Accuracy

- **Optimal predictions (OP)** occurred when participants chose the high probability target for the predictive cue.
- Other choices (low probability targets) were coded as **non-optimal predictions (NP)**.
- Higher proportion of OP reflects better learning of cue-target relationships.

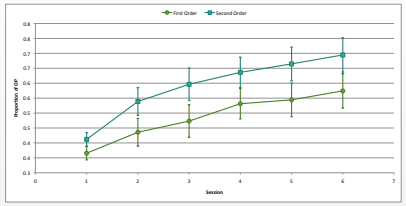
Win-Stay Lose-Shift (WSLS)[6,7]

- **Win-Stay** is the proportion of trials following *positive feedback* where the same prediction is repeated in response to the same cue.
- **Lose-Shift** is the proportion of trials following *negative feedback* where the prediction is changed in response to the same cue.

Results

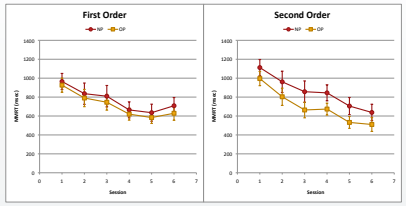
Learning

Accuracy



- There was increase in OP with practice.
  - Session: $F(2.70, 59.40) = 24.29$, $p < .001$
- The Second Order group showed a trend toward more optimal predictions.
  - Group: $F(1,22) = 2.80$, $p = .108$

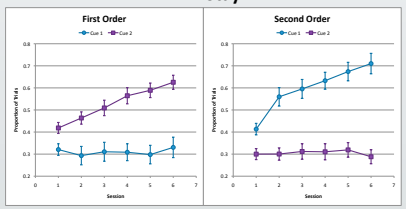
Reaction Time



- The Second Order group was significantly faster on OP than NP while there was no difference for the First Order group.
  - Prediction Type x Group: $F(1,22) = 6.01$, $p = .023$

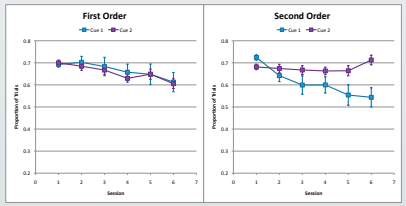
Feedback Processing

Win-Stay



- Both groups were more likely to Win-Stay for the cue that was predictive in their structure.
  - Cue x Group: $F(1,22) = 67.20$, $p < .001$
- Both groups increased their Win-Stay behavior for the predictive cue with practice.
  - Cue x Session x Group: $F(3.07, 67.59) = 16.17$, $p < .001$

Lose-Shift

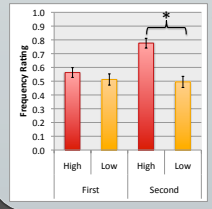


- Both groups showed a decrease in Lose-Shift behavior with practice.
  - Session: $F(3.29, 72.32) = 11.94$, $p < .001$
- The Second Order group showed differential Lose-Shift behavior for Cue 1 and Cue 2 while the First Order group did not.
  - Cue x Session x Group: $F(3.25, 71.53) = 4.11$, $p < .008$

Transfer of Learning

Recognition

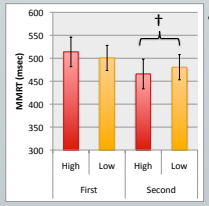
- Participants were asked to rate how frequently (0 infrequent, 1 frequent) each three-event sequence (triplet) occurred during the task.
- All 64 possible triplets were presented.



- Second Order group differentiated High Frequency Triplets (HFT) from Low Frequency Triplets (LFT) while First Order group did not.
  - TT x Group: $F(1,22) = 10.38$, $p = .004$

Response Learning Probe

- As in the Triplets Learning Task[2], participants were asked to respond to (instead of predict) the target.
- All 64 possible triplets were presented.



- There was a non-significant trend for Second Order group to respond faster to HFT than LFT while First Order group did not.
  - TT x Group: $F(1,22) = 3.28$, $p = .084$

Discussion

- We found evidence of marginally better learning for higher-order sequences in this study.
  - Previous studies of sequence learning have found better learning for First Order structure compared to those those with Second Order structure[2,5].
  - These results could be due to task demands; the nature of prediction changes the strategy the learner employs during the task to a more explicit strategy, leading to different cognitive biases (i.e. primacy).
- Both groups showed evidence of learning the predictive cues for their structure. With experience:
  - The First Order group showed more Win-Stay behavior in response to Cue 2.
  - The Second Order group showed more Win-Stay behavior and less Lose-Shift behavior in response to Cue 1.
- The Second Order group demonstrated more flexibility in applying the knowledge gained during the TPT to new tasks by:
  - Rating HFT higher than LFT in Recognition Task.
  - Responding marginally faster to HFT than LFT on the Response Learning Probe.
- This flexibility could be due to the explicit/declarative nature of the learning, particularly for those exposed to the Second Order structure.

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