Age-related differences in the effect of statistical structure on learning in a sequentially-cued prediction task

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Background

• Age-related deficits in risky decision-making have been linked to learning1.
• People become sensitive to sequential regularities in their environments1, even when there are random intervening events2.
• Learning is better for adjacent relationships (1st order structure) than non-adjacent relationships (2nd order)3.
• People can use this knowledge to make predictions2.
• This learning is better in young than older adults4,5.

Methods

Triplets Prediction Task

• 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.

Conditions

• First Order structure: Cue 2 predicted the target.
• Second Order structure: Cue 1 predicted the target.
• Condition was varied between-subjects.

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.

Feedback Processing (Win-Stay Lose-Shift)

• A modified Win-Stay Lose-Shift analysis was used.
• Win-Stay is the proportion of trials following positive feedback where the same prediction is made to the same cue.
• Lose-Shift is the proportion of trials following negative feedback where the prediction is changed to the same cue.

Participants

- With experience, participants were less likely to shift to a different prediction following negative feedback.
- First Order − Session: F(2, 210) = 4.06, p < .001, ηp2 = 0.088
- Second Order − Session: F(2, 210) = 7.10, p < .001, ηp2 = 0.145
- Age differences only in the second order condition.
- Older adults were more likely shift after negative feedback than young adults.
- Age: F(2, 210) = 5.26, p < .001, ηp2 = 0.09
- Older adults continued shifting after negative feedback while young adults decreased shifting with experience.
- Age: F(2, 110) = 7.10, p < .01, ηp2 = 0.258

Positive Feedback (Win-Stay)

• All groups increasingly stayed with the same prediction following positive feedback.
- First Order − Session: F(2, 210) = 13.76, p < .001, ηp2 = 0.219
- Second Order − Session: F(2, 210) = 10.84, p < .001, ηp2 = 0.208
- Age differences only in the second order condition.
- Older adults were less likely to repeat the same prediction after positive feedback than young adults.
- Age: F(2, 210) = 15.02, p < .001, ηp2 = 0.43
- This trend became more pronounced with experience.
- Age: Session: F(2, 110) = 4.47, p < .028, ηp2 = 0.148

Result

• OP increased with practice.
- Session: F(2, 210) = 18.07, p < .001, ηp2 = 0.401
• Older adults made fewer OPs than young adults.
- Age: F(1, 42) = 12.38, p < .001, ηp2 = 0.228
• Older adults showed less learning than young adults.
- Age: Session: F(2, 110) = 3.92, p = .017, ηp2 = 0.085
• Age differences occurred only in second order conditions.
- Age: Condition: F(2, 42) = 4.26, p = .045, ηp2 = 0.092

Reaction Time

Discussion

• There were significant age differences in learning.
• Older adults were less accurate and showed improvement with experience.
• Older adults showed no change in reaction time with experience while young adults showed skill learning.
• Age differences were more pronounced in the second order statistical structure.
• These age differences were consistent with results found with sequence learning (SL) tasks.
• Older adults generally demonstrate less learning on SL tasks.
• This age difference is exacerbated when the complexity of the statistical environment is increased4,6.
• Compared to young adults, older adults were less likely to win-stay and more likely to lose-shift.
• These age differences increased with experience on the task.
• This could explain the differences in learning.
• This is consistent with the dopamine hypothesis of aging7,8.
• Older adults are less sensitive to positive feedback9,10.
• Older adults are more sensitive to negative feedback11,12.
• This has implications for older adults making decisions in unfamiliar domains.

References


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