Age Deficits in Probabilistic Category Learning

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Abstract and Background

The weather prediction task has been used to characterize probabilistic category learning in several patient populations including those diagnosed with Parkinson's disease (Sage et al. 2003), amnesia (Knowlton et al. 1994), and schizophrenia (Keri et al. 2005, Weickert et al. 2002) as compared to healthy adults. In addition, an imaging study compared healthy young and old adults (Fera et al. 2005). This study found age differences in brain activation, but no age deficits on the behavioral measure of learning. However, learning was assessed via mean percent correct, rather than the more commonly used classification accuracy measure. In addition, only 96 trials of training were given.

Knowlton et al. (1994) demonstrated that amnestic and control participants performed similarly on the initial trials in a weather prediction task, suggesting that declarative memory does not heavily contribute to learning early in the task. In a later study, individuals with Parkinson's disease demonstrated significant learning during later trials (51-100) though they had been impaired on earlier trials (Knowlton et al. 1996). Knowlton et al. (1996) attributed this performance to the use of the explicit memory system during later trials, compensating for initial, impaired striatal learning. Thus, the weather prediction task appears to be characterized by implicit learning in its early phase and explicit awareness later in the task after approximately 50 trials.

In the present study, older (aged 65-80 years) and younger (18-22 years) participants completed 180 trials on the weather prediction task first developed by Knowlton et al. (1994). In this test, four different cards serve as neutral cues probabilistically associated with one of two weather outcomes, rain or sunshine. Upon conclusion of the task, subjects completed two paper-based recognition tests. In addition to the administration of a multiple choice questionnaire described by Knowlton et al. (1994) in which subjects recalled specific details about the task itself, subjects also completed a forced choice recognition task in which they chose the outcome more highly associated with each of the 14 possible stimuli combinations. This measure was not used in previous studies. We found evidence of age-related deficits in classification accuracy, especially during later trials. This suggests that there are age-related deficits in this form of probabilistic classification learning, and that these deficits are at least partially due to differences in explicit learning.

Methods

The Weather Prediction Task

The task consisted of 180 trials total. On each trial, a combination of one, two, or three cards, resulting in 14 possible stimulus patterns, appeared for 5 sec during which a subject responded "sunshine" by pressing the leftmost response button or "rain" by pushing the rightmost response button. Feedback then appeared for 2 sec, followed by the next card combination.

There were 12 blocks of 15 trials each. During a 10 second-break between blocks, the subject received his or her cumulative correct response score.

Only 14 out of the 24 possible versions of the weather prediction test were used. The 10 eliminated versions had enhanced stimulus-response compatibility, which could have provided a greater opportunity for explicit, rather than implicit, learning to take place.
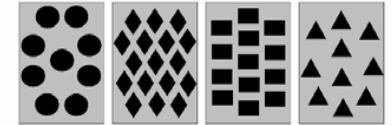
Participants

- 16 healthy older adults: 7 females, 9 males, mean age of 69.5 (range: 65-80)
- 29 younger adults: 20 females, 9 males, mean age of 19.6 (range: 18-22)

Post-Test Recognition Measures

- Paper-based multiple choice and short answer recognition test as developed by Knowlton et al. (1994)
- Paper-based forced choice recognition task in which participants chose the outcome more highly associated with each of the 14 possible stimuli combinations

Results

Box 1: Overall Classification Accuracy Across Epochs

- Each group above chance on Epoch 1 (p<.01 for each)
  - Within Epoch 1, each group at chance (.5) on Block 1, but above chance on Block 2--Data Not Shown
- Young adults improved across epochs (p <0.02), but older did not (p=0.99).
- Trend for an overall age deficit in accuracy (p=0.07).

Overall Classification Accuracy for Young and Old across Epochs

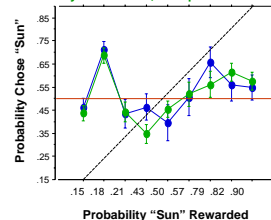(Epoch = 3 blocks of 15 trials each, or 45 trials)
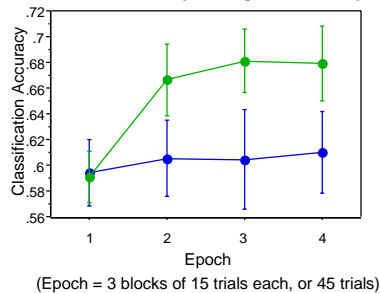
Box 2: One-Card versus Multiple-Card Learning

- Subjects mainly learned to associate responses with single card conditions.
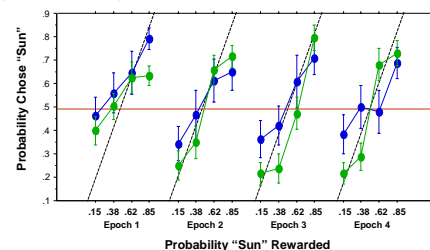

Single-Card Performance as a Function of Probability Association, Collapsed across Epochs
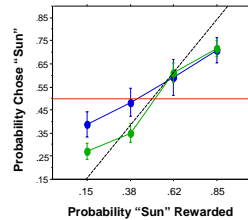
Multi-Card Performance as a Function of Probability Association, Collapsed across Epochs
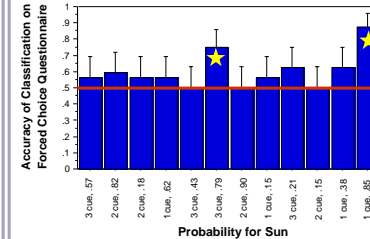

Single-Card Learning as a Function of Probability Association for Each Epoch
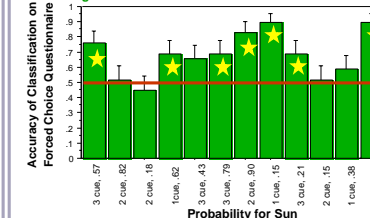
Box 3: Declarative Awareness May Contribute to Age Deficits

- Red line indicates chance (.5)
- Yellow stars indicate cue combination accuracy significantly different from chance
- 7/14 cues above chance for young, only 2/14 for old

Older Adult Performance on Forced Choice Questionnaire

Younger Adult Performance on Forced Choice Questionnaire

Conclusions

- Trend for age differences in classification accuracy, due to performance on the later epochs which are usually thought to reflect declarative learning

- Both ages showed some awareness as revealed by forced-choice questionnaire, but younger displayed awareness for more cue combinations than did older adults

- In sum, age deficits were observed for the weather prediction task, but may be due, at least in part, to deficits in explicit learning