1. Introduction

- Patients with medial temporal lobe (MTL) lesions and patients with Alzheimer's Disease (AD) have been shown to have intact implicit learning in a number of paradigms, despite considerable impairments in explicit forms of learning.

- In general, this is interpreted as reflecting a crucial role for the MTL in mediating explicit, but not implicit, forms of learning.

- Some evidence suggests that 'explicitness' per se is not the critical determinant of whether learning is mediated by the MTL (e.g., Chun & Phelps, 1999).

- An alternative view is that the MTL performs a binding function in memory (Eichenbaum, 1997), regardless of whether learning is implicit or explicit.

- Category learning tasks that have been used to study implicit learning in MTL and AD patients, such as the prototype-distortion task (Knowlton & Squire, 1993), do not require binding (they can be solved using feature familiarity alone).

- We designed an implicit two-category learning task that requires binding between features to perform successfully, using stimuli that have been used in prototype-distortion tasks that AD patients are able to learn normally (Koenig et al., 2007, in press).

- We predict that patients with AD will fail to learn the task, while control participants will learn the task successfully.

2. Participants

- Participants Demographics

<table>
<thead>
<tr>
<th>Category</th>
<th>n</th>
<th>% Female</th>
<th>Age (SD)</th>
<th>MMSE (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>11</td>
<td>90.9%</td>
<td>69.4 (8.7)</td>
<td>27.3 (2.5)</td>
</tr>
<tr>
<td>Patients</td>
<td>10</td>
<td>60.0%</td>
<td>77.5 (7.5)</td>
<td>21.7 (4.4)</td>
</tr>
</tbody>
</table>

- MTL = Mini Mental State Exam; SD = Standard Deviation

3. Example Training Items

<table>
<thead>
<tr>
<th>Category A</th>
<th>Category B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension Values: Stimulus:</td>
<td>Dimension Values: Stimulus:</td>
</tr>
<tr>
<td>1 1 1 1</td>
<td>2 2 2 1</td>
</tr>
<tr>
<td>1 1 2 2</td>
<td>2 2 2 1</td>
</tr>
</tbody>
</table>

- The stimulus treated as “1 1 1 1” was selected randomly for each subject, and all other stimuli were derived from it as shown above.

- Four training stimuli were presented ten times each in pseudo-random order.

- The only instructions participants received was to pay attention to the images that appeared on the screen.

4. Example Test Trials

<table>
<thead>
<tr>
<th>Dimension Values: Stimulus:</th>
<th>Dimension Values: Stimulus:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 2 2</td>
<td>2 2 2 1</td>
</tr>
<tr>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
</tbody>
</table>

- Following training, participants were informed that the training items made up two categories, one consisting entirely of red animals, and one made up of yellow animals.

- Subjects were then given eight two-alternative forced-choice trials in which both animals shown were of the same color, but one animal always had a different snout shape than the shape shown with that color during training.

- On each trial, subjects were asked which of the two animals was a better example of the red (or yellow) animal category.

- Half of the trials used stimuli not seen during training.

- Half of the patients and all of the controls performed an additional eight trials with the same stimuli (different pairings).

5. Results

- Control participants performed significantly better than chance (t = 3.97, p = 0.003).

- AD patients did not perform significantly above chance levels (t = 0.88, p = 0.404).

- Control participants performed significantly better than patients (t = 2.19, p = 0.041).

- Error bars are +/- one standard error.

6. Participants do not perform better on category members seen during training

- Performance on trials in which the category member was seen during training was not better than trials with novel members.

- For controls, t = 1.10 and p = 0.296. For patients, t = 0.17 and p = 0.868. For both combined, t = 0.83 and p = 0.419.

7. Controls who could not identify the categorization rule still outperformed patients

- Nine of the eleven control participants and all of the patients failed to identify the correct categorization rule during post-experimental interview.

- Control participants who did not identify the categorization rule still performed better than chance (t = 3.21, p = 0.012) and marginally better than patients (t = 1.85, p = 0.082).

8. Discussion

- These data demonstrate a failure by patients with AD to learn during an implicit category learning paradigm that requires binding.

- An account of MTL function that predicts that an intact MTL is required for explicit, but not implicit, tasks is incompatible with these data.

- The data are consistent with the view that the MTL is required for explicit, irrespective of whether materials are learned implicitly or explicitly.

- Critically, task performance was not predicted by reading span or mini-mental state exam scores in the patient group. Reading span also failed to predict task performance in a sample of 73 undergraduates and other Columbia University affiliates who were tested on two versions of this task.

- Finally, the failure to learn by patients cannot be attributed to the stimuli used, as these patients learn normally in prototype-distortion tasks with these stimuli (Koenig et al., 2007, in press).