Generalization in a pattern separation task implicates hippocampal processes in anxiety vulnerability.

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Abstract

Using a hippocampal learning & memory task, the influence of risk for anxiety on encoding and retrieval processes was explored. Overall and contrary to our expectations, high-risk participants made less generalization errors than the low-risk participants did, suggesting that enhanced memory processes either at encoding or retrieval may underlie the development and maintenance of avoidance behaviors in clinical anxiety.

Introduction

• Pattern separation is the ability to discriminate among similar experiences. This process is a crucial feature of episodic memory and is believed to require the hippocampus [1–3].
• Generalization takes place when similar inputs cause interference and are unable to be distinguished from each other [4].
• Overgeneralization occurs when pattern separation processes fail; this type of generalization may play a key role in re-experiencing symptoms observed in post-traumatic stress disorder or PTSD (“flashbacks”).
• Recent research indicates that behavioral inhibition, (the tendency to avoid novel things, places or people) is related to enhanced associative learning and avoidance behaviors [5].
• While there are clear connections between the hippocampus, learning/memory, and anxiety vulnerability, no one has examined role of pattern separation as a risk factor for anxiety. We hypothesized that behaviorally inhibited participants would show memory differences in a pattern separation task. Furthermore, we expected behaviorally inhibited participants to show increased generalization in the pattern separation task.

Measures

Participants

46 Lafayette College Psychology students (65.4% female, M = 19.3 years) participated for extra credit.

Measuring risk for anxiety

Participants completed a self-report measures related to likelihood to develop anxiety disorders in nonclinical populations

Adult Measure of Behavioral Inhibition (AMBI)

A 16-item self-report measure that assesses the presence of inhibition or avoidance in response to new stimuli or social situations. Participants are asked to respond to questions on a three-point scale and indicate no/hardly ever (“1”), of the time (“2”), or yes/most of the time (“3”). Total scores range from 0 to 32.

Behavioral Inhibition groups

Based on previous research, a score of 15.5 was used to separate participants into High AMBI and low AMBI groups.

Methods

Pattern separation task: The task was modeled on the one used by Lacy et al., 2011 and had two phases: learning and testing.
• Learning consisted of an incidental encoding task which presented 60 color images centered on a computer monitor for 2 s (0.5 s ITI)
• Testing consisted of 90 trials of images randomly presented from three categories:
  • 30 images were repeated from the learning phase (“old”)
  • 30 images were similar, but slightly different from those presented in the learning phase (“similar”)
  • 30 completely novel images (“new”)

Figure 1. Example of timing and images shown to participants in incidental encoding (learning) phase. Participants indicated by keypress if image was “likely to be found in a kitchen”.

Figure 2. Example of learning phase stimulus and three testing phase stimuli from each category. Participants indicated by keypress if image was “old”, “similar”, or “new”.

Figure 3. An independent samples t-test showed a significant difference in the number of overgeneralizations (responding “old” when a lure was similar to the studied item) between high and low AMBI groups, (n = 44), t (44) = 2.137, p = .038.

Results

Responses were coded for correctness ("old" response for old stimulus) and for which response was given in incorrect trials ("old" response for similar stimulus).

Overgeneralizations are defined as an “old” response to a similar stimulus. Reaction time (ms) for correct and incorrect responses were averaged across all trials.

Table 1. Descriptive statistics for high and low AMBI groups.

<table>
<thead>
<tr>
<th></th>
<th>High AMBI</th>
<th>Low AMBI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females/Males</td>
<td>14/8</td>
<td>19/5</td>
<td>.595</td>
</tr>
<tr>
<td>Mean Age (SD)</td>
<td>19.3 (0.99)</td>
<td>19.37 (0.97)</td>
<td>.845</td>
</tr>
<tr>
<td>Mean RT correct trials (SD)</td>
<td>1.16 (0.10)</td>
<td>1.14 (0.10)</td>
<td>.505</td>
</tr>
<tr>
<td>Mean RT incorrect trials (SD)</td>
<td>1.23 (0.12)</td>
<td>1.17 (0.12)</td>
<td>.101</td>
</tr>
<tr>
<td>Mean Overgeneralizations (SD)</td>
<td>8.04 (3.96)</td>
<td>10.3 (3.16)</td>
<td>.038</td>
</tr>
</tbody>
</table>

Conclusions

• Contrary to our expectations, high-risk participants made less generalization errors than low-risk participants did, which suggests that it may actually be enhanced memory processes either at encoding or retrieval which underlie the development and maintenance of avoidance behaviors in clinical anxiety.
• This result is in line with recent research which found that Veterans with PTSD perform better on a spatial pattern separation task than Veterans without PTSD [6].
• These results suggest that the hippocampus may play a key role in the development and maintenance of anxiety disorders, and that differences in learning and memory processes may be present in those at risk for anxiety.
• Future studies examining under what circumstances participants make pattern separation errors is important for understanding basic learning and memory processes as well as how discrimination and generalization play a role in anxiety disorders.
• Studying pattern separation and individual differences underlying generalization and discrimination will add to the understanding of the processes of learning and memory in the development and maintenance of anxiety disorders, particularly PTSD.

References