

Procedural-Based Category Learning in Patients with Parkinson's disease

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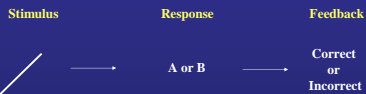
BACKGROUND

- Previous research suggests the involvement of various basal ganglia structures in implicit category learning, including the caudate, putamen, and dopamine systems⁽¹⁻⁴⁾
- These structures are known to be impacted in patients with Parkinson's Disease (PD)
- Thus, it is not surprising that PD patients are impaired on a variety of implicit category learning tasks, including those that emphasize procedural-based learning processes⁽⁵⁻⁷⁾
- The purpose of the present work was to examine under what conditions PD patients are impaired in procedural-based category learning
- To this end, we investigated the impact of (1) discontinuous category structures, (2) increases in the number of categories, and (3) delayed feedback on nondemented PD patients' ability to learn a procedural-based categorization task

GENERAL METHODS

- Participants: 10-11 nondemented PD patients and normal controls (NC) participated in each condition.
- PD patients and NC participants were matched for age, education, gender, and overall scores on the Mattis Dementia Rating Scale.
- PD patients were tested while 'on' their anti-parkinsonian medications.
- Stimuli consisted of a single line that varied in length and orientation (Experiments 1 and 2) or a Gabor patch that varied in spatial frequency and orientation (Experiment 3).

Trial Sequence



CATEGORY DISTRIBUTIONS: EXPERIMENT 1

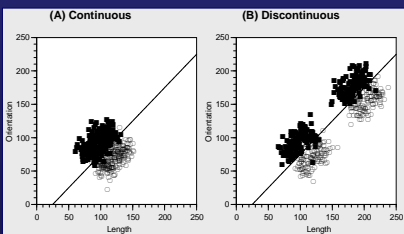


Figure 1. Stimulus distributions for (A) the continuous condition, and (B) the discontinuous condition.

RESULTS: EXPERIMENT 1

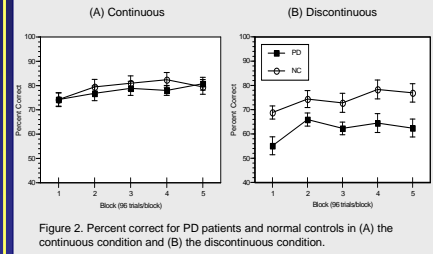


Figure 2. Percent correct for PD patients and normal controls in (A) the continuous condition and (B) the discontinuous condition.

COMMENT: EXPERIMENT 1

- PD patients are impaired in the discontinuous condition but not the continuous condition.
- Deficits are consistent with our previous work suggesting that PD patients are impaired in nonlinear procedural-based category learning^(5,7)
- PD patients' impairment on both discontinuous and nonlinear tasks may be due to a deficit in the number of "striatal units" needed to represent the categories.

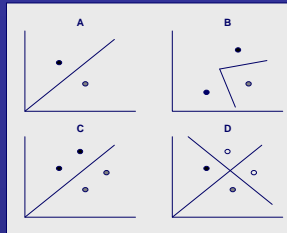


Figure 3. Theoretical examples in which (A) a linear rule is represented by 2 striatal units (one for each category), (B) a nonlinear rule is represented by 3 striatal units (two for one category, and one for the other category), (C) a linear discontinuous rule represented by 4 units (2 for each category), and (D) a 4-category rule represented by 4 units (1 for each category). In all cases, black dots represent Category A and grey dots represent Category B, whereas in (D) the clear dot represent Category C and the light grey dot represents category D.

- To explore this issue, Experiment 2 examined PD patients' ability to learn 2- vs. 4-categories

CATEGORY DISTRIBUTIONS: EXPERIMENT 2

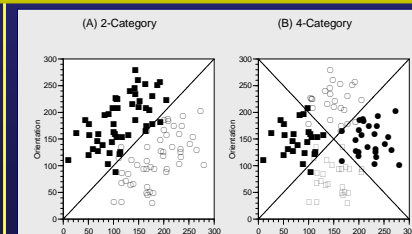


Figure 4. Stimulus distributions for (A) 2-category information-integration condition, and (B) 4-category information-integration condition.

RESULTS: EXPERIMENT 2

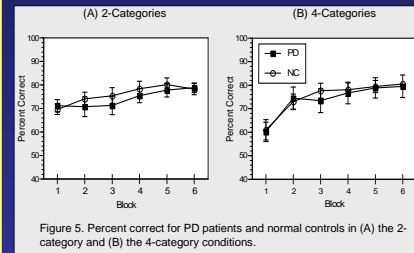


Figure 5. Percent correct for PD patients and normal controls in (A) the 2-category and (B) the 4-category conditions.

COMMENT: EXPERIMENT 2

- PD patients are not impaired in learning 4-categories relative to NC participants
- Lack of impairment suggests that the Exp. 1 deficit is not due to the number of striatal units needed to represent individual categories, but rather the number of units needed for within-category representations
- That is, PD patients are impaired in procedural-based category learning whenever multiple striatal units are needed to optimally represent individual categories (e.g., Figures 4B and 4C).

EXPERIMENT 3: IMPACT OF DELAYED FEEDBACK

- Previous studies have suggested that feedback-based learning can impact whether PD patients are impaired in category learning^(8,9)
- Such a deficit may be related to decreased levels of dopamine within those brain systems involved in feedback-based learning⁽¹⁰⁾
- To further test this idea, we examined whether PD patients' ability to learn procedural-based tasks is impacted by delayed feedback, a manipulation that has been shown to impact learning in normals^(11,12)
- Category distributions were the same as those in Figure 1A.

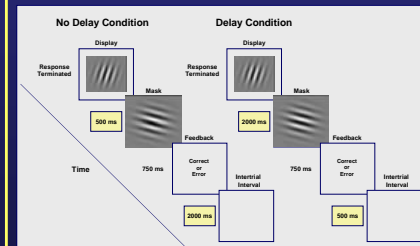


Figure 6. Trial sequences for delay and no delay conditions. Critical timing differences between the two conditions are highlighted in yellow.

RESULTS: EXPERIMENT 3

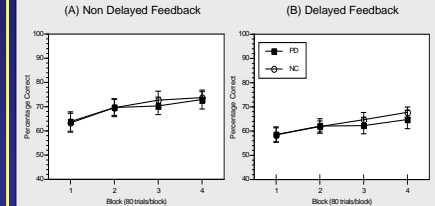


Figure 7. Percent correct for PD patients and normal controls in (A) the no-delay and (B) the delay conditions.

COMMENT: EXPERIMENT 3

- Although the delay in feedback impacted both PD patients and NC participants' ability to learn the categories, PD patients were not impaired relative to controls.
- Lack of impairment in PD may be due to patients having been medicated at the time of testing.

GENERAL CONCLUSIONS

- PD patients appear to be most impaired in procedural-based category learning with discontinuous or nonlinear categories
- This deficit may be related to an impairment in the communication among multiple striatal units that are needed to represent discontinuous or nonlinear categories
- Such a deficit does not appear to be related to the absolute number of striatal units needed to represent separate categories
- Delayed feedback does not appear to impair medicated PD patients' procedural-based category learning abilities

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