Differential Effects of Nicotine, Mecamylamine, and Scopolamine on Rat Serial Pattern Retention

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INTRODUCTION

Previous work in our lab with an ACh muscarinic receptor antagonist has shown severe impairments in acquisition and retention performance in sequential learning. Rats are sensitive to the structural organization of serial patterns in sequential learning, often making more errors where structure changes (e.g., chunk boundary and violation elements) than on within-chunk elements in acquisition. ACh muscarinic receptor antagonists impair learning at these structural changes in patterns, suggesting that central cholinergic systems are necessary for making correct responses at these points in the pattern. Based on these results, we examined the differential effects of nicotine, mecamylamine, and scopolamine on serial pattern retention performance.

METHOD

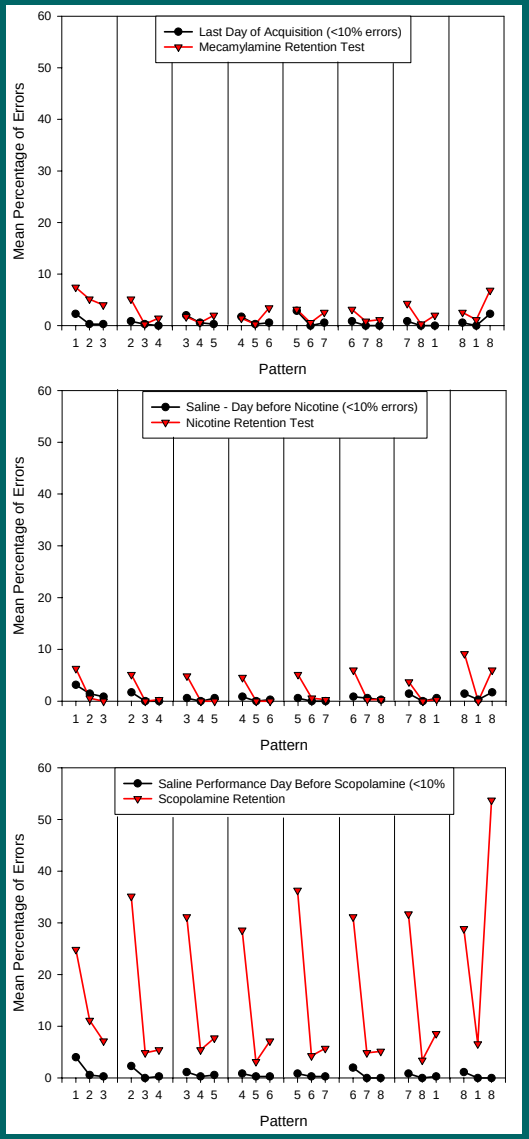
Subjects. 7 male hooded rats implanted with bipolar electrodes for hypothalamic brain-stimulation reward (BSR) served as subjects.

Training. Rats were trained in an octagonal operant chamber equipped with a lever on each wall. They learned to press the levers in a particular order (the serial pattern) for BSR in a discrete-trial procedure with correction. All rats learned the same pattern composed of eight 3-element chunks ending with a violation element (8):

123-234-345-456-567-678-781-818

where the digits represent the clockwise positions of levers in the chamber, dashes indicate 3-s pauses, and other intertrial intervals were 1 s. Rats were trained on 50 patterns per day.

Retention. Rats were given i.p. injections of mecamylamine (10 mg/kg), nicotine (0.4 mg/kg), & scopolamine (0.6 mg/kg) in that order with at least one day of criterion performance on saline injection days between drug injection days.



RESULTS

Figure 1: Mecamylamine Effects on Retention

- Mecamylamine, an ACh nicotinic receptor antagonist, caused slight but nonsignificant impairments at chunk boundary elements and the violation element.
- Within-chunk element performance was also slightly, but not significantly, affected by the drug treatment.

Figure 2: Nicotine Effects on Retention

- Nicotine, an ACh nicotinic receptor agonist, caused slight but nonsignificant impairments at chunk boundary elements and the violation element; however, the effect was due to only 1 subject.
- Within-chunk elements were not affected by the drug treatment.

Figure 3: Scopolamine Effects on Retention

- Scopolamine, an ACh muscarinic receptor antagonist, caused severe significant impairments in performance at chunk boundary elements and the violation element. Specifically, there was a significant increase in the number of perseveration errors (e.g., 123-3… instead of 123-2…) when the rats were exposed to scopolamine compared to saline.
- Within-chunk elements did not significantly differ from saline performance.

DISCUSSION

These results indicate that multiple memory processes may be involved in the retention of sequential tasks. More specifically, the processes required for retaining higher order rules (i.e., at chunk boundaries) are more sensitive to central cholinergic manipulations than those necessary for retaining lower order rules (i.e., within-chunk elements). Further, it appears that muscarinic receptors specifically are necessary to produce correct responses at structural changes in a sequential pattern, whereas the activation and deactivation of nicotinic receptors may play a smaller, supportive role in the maintenance of sequential responses.