

# Central Cholinergic Systems are Necessary for Learning and Retaining “Exceptions-to-the-Rule” in Rat Serial Pattern Learning

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## Introduction

When rats learn highly organized serial patterns, they appear sensitive to pattern structure. During acquisition, rats typically make more errors on the first elements of chunks (chunk boundary elements) than on within-chunk elements. Rats also take longer to learn to anticipate violation elements that are, by definition, “exceptions to the rule.” Previous research suggests there may be dissociable cognitive systems that are employed concurrently to perform sequential tasks. Further, drugs that affect cholinergic systems impair some kinds of learning but not others in sequential learning tasks. Atropine sulfate is a muscarinic cholinergic antagonist which impairs acquisition and retention performance on a variety of cognitive tasks. We examined the effects of atropine sulfate on acquisition and retention of serial patterns.

## Method

**Subjects.** 11 male hooded rats implanted with bipolar electrodes for hypothalamic brain-stimulation reward (BSR) served as subjects.

**Atropine Effects on Acquisition.** Rats were given daily i.p. injections of either saline or atropine sulfate (50 mg/kg) and trained to press levers in a particular order (the serial pattern) for BSR in a discrete-trial procedure with correction. The two groups learned a pattern composed of eight 3-element chunks ending with a violation element:

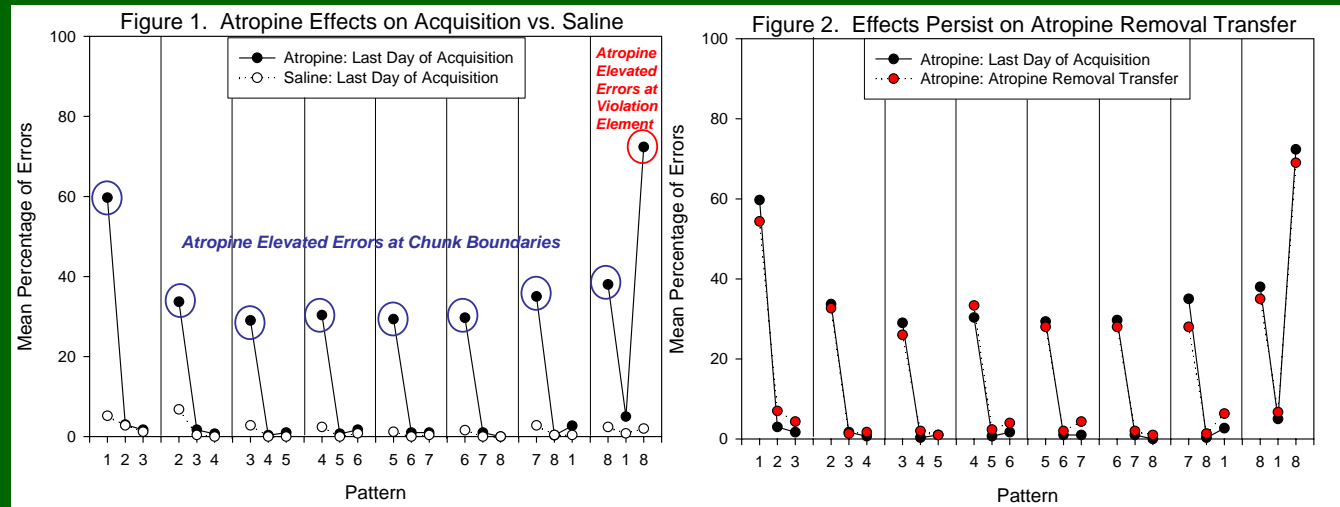
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where the digits represent the clockwise positions of levers in the chamber, dashes indicate 3-s pauses, and other intertrial intervals were 1 s. Rats were trained on 50 patterns per day.

**Atropine Removal Transfer.** To test whether atropine masked learning in acquisition, all rats were given saline and tested on the training task.

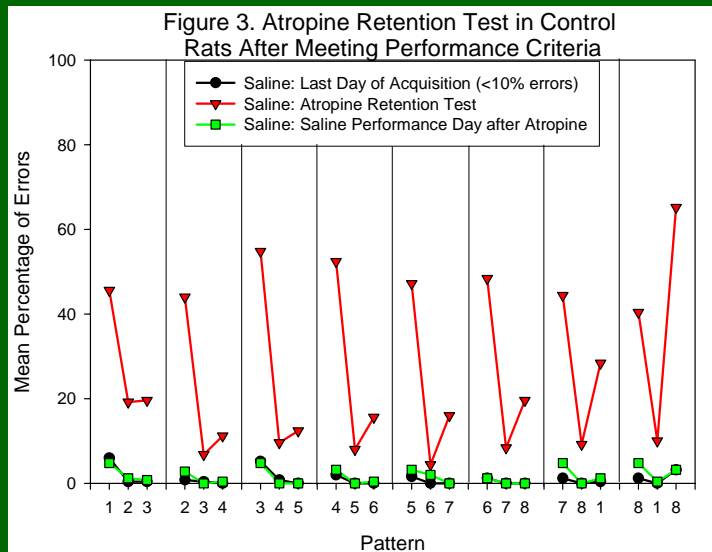


**Atropine Effects on Retention.** Once control rats reached a criterion of less than 10% errors throughout the pattern, they were given 50 mg/kg atropine and tested on the training task, followed by an additional day of saline.



## Results: Atropine Effects on Acquisition & Atropine Removal Transfer

- Atropine interfered with acquisition for chunk boundary and violation elements. These effects persisted when rats were tested without atropine. Within-chunk elements were learned equally well in both groups, indicating that atropine impaired learning and the deficit wasn't due to an inability to perform the task.
- Error types at chunk boundaries were primarily perseverations or rats chose 1 lever too far left, while error types at violation elements were primarily over-extensions of the within-chunk rule, that is, 812 instead of 818.



## Results: Atropine Effects on Retention

Atropine interfered with retention, with similar deficits to those observed in acquisition. Chunk boundary errors were mainly perseverations, while errors at the violation element were primarily overextensions.

## Discussion

These results indicate that rats learn about “exceptions-to-the-rule” differently than within-chunk elements, further supporting the literature on multiple-item memory, multiple associative processes, and our previous research suggesting that occasion setting may be employed to cue correct responses where pattern structure changes. Moreover, these results add to the growing evidence indicating that multiple concurrent cognitive systems underlie rat sequential learning and performance.