

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

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Introduction

Rats are sensitive to the structural organization of patterned sequences of responses (i.e., of “serial patterns”). For example, during acquisition rats make more errors at places where the structure changes, namely, on the first elements of chunks (chunk boundary elements), than on within-chunk elements. Rats also have difficulty learning to anticipate violation elements that are, by definition, “exceptions-to-the-rule.” Atropine 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 of serial patterns.

Method

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

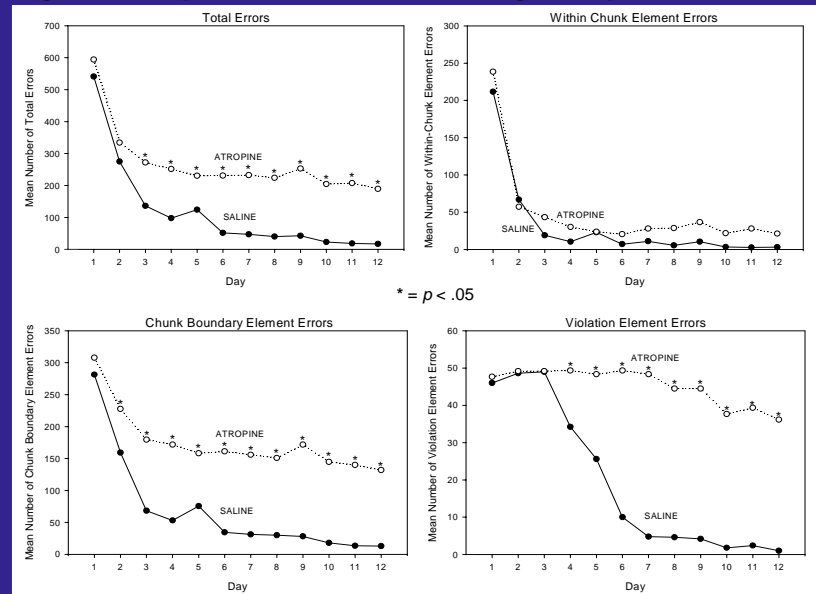
Acquisition Training. Rats were given daily i.p. injections of either saline or atropine sulfate (50 mg/kg) and trained in an octagonal operant chamber equipped with a lever on each wall. They learned to press the levers in a particular order (the serial pattern) for BSR in a discrete-trial procedure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

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

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.

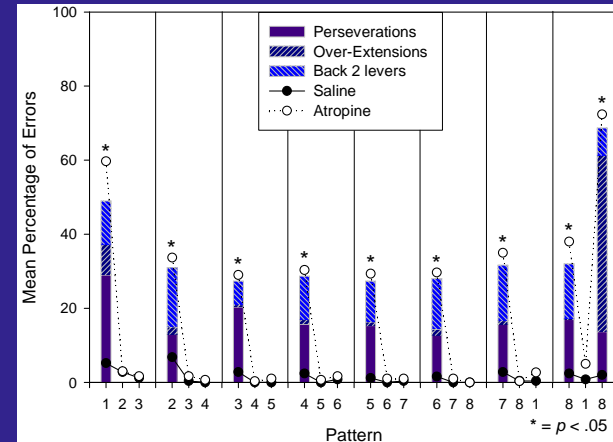


Figure 1: Atropine Interfered with Learning “Exceptions-to-the-Rule”



* = p < .05

Figure 2: Trial-by-Trial Errors for Last Day of Acquisition



* = p < .05

Results

Figure 1: Acquisition

- Atropine interfered with acquisition, most notably for chunk boundary and violation elements – the “exceptions-to-the-rule.”
- Within chunk elements were learned at the same rate in both groups, indicating that atropine impaired learning and the deficit was not due to an inability to perform the task.

Figure 2: Error Rates by Pattern Element

- Atropine caused the highest number of errors on the violation element that ended the pattern.
- Atropine also caused high error rates on chunk boundary elements. Especially high error rates were observed on the first element of the pattern, which was immediately after the violation element at the end of the preceding pattern.
- The most common types of errors committed at chunk boundaries were perseverations and turning left 2 levers instead of 1, while rats over-extended the pattern at the violation element.

Discussion

These results indicate that intact central cholinergic systems are necessary for learning appropriate responses at places in sequences where pattern structure changes, but may not be necessary for learning about pattern structure. The results also fit well with other data indicating that dissociable brain systems underlie learning about different aspects of serial patterns.