

The Effects of Scopolamine on Rat Serial Pattern Learning with Water Reward

Amber M. Chenoweth & Stephen B. Fountain, Kent State University, Kent, OH 44242

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, than on within-chunk elements. Rats also have difficulty learning to anticipate violation elements that violate the rules set forth in a structured serial pattern. Prior research in our lab using atropine, a muscarinic cholinergic antagonist, produced evidence for the role of central cholinergic systems in the acquisition of a serial pattern containing a violation element using brain stimulation reward (BSR). While much has been done using BSR, other manipulations can be assessed by using water reinforcement (WR), such as brain lesions and pre-exposure to drugs during adolescence. The present study examined the effects of scopolamine on acquisition of serial patterns using WR, in part to replicate the earlier findings with atropine and BSR, and also to explore WR as a reliable method for investigating the role of the cholinergic system in sequential learning.

METHOD

Subjects. 24 male Long-Evans hooded rats served as subjects. Rats were water deprived, but allowed free access to food in their home cages.

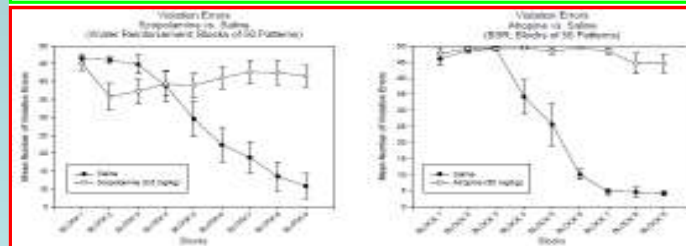
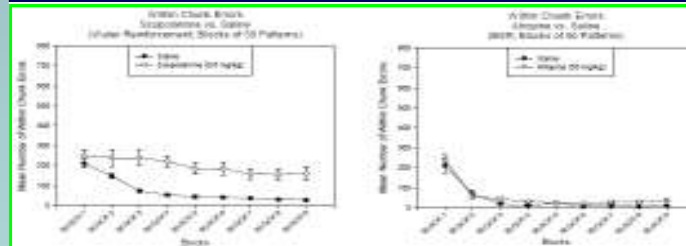
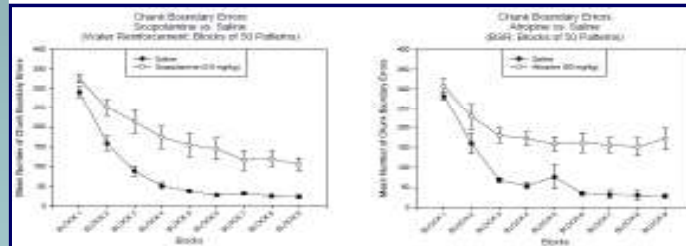
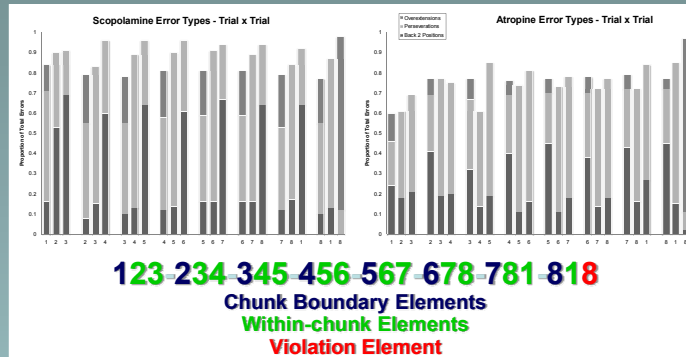
Training. Rats were given daily i.p. injections of scopolamine (0.6 mg/kg) or an equivalent volume of saline 30 min prior to training in an octagonal operant chamber equipped with a nose poke receptacle on each wall. Rats learned to nose poke for water reinforcement in a particular order (the serial pattern) in a discrete-trial procedure with correction. The rats learned the pattern:

123 234 345 456 567 678 781 818

where the digits represent the clock-wise positions of receptacles in the chamber, spaces indicate 3-s pauses, other intertrial intervals were 1 s, and the last pattern element violated pattern structure. Rats received 10 patterns a day throughout acquisition.

Acknowledgements

Thank you to Undergraduate Assistants Owen McCabe and Emily Durr for their assistance in data collection.



RESULTS

Error profiles were collapsed across the first 45 days of acquisition and compared to the first 9 days of acquisition of the prior atropine study to equate for pattern experience. Errors were defined as:

- **Overextensions** – overextending the pattern (e.g., 123-4 or 812)
 - **Perseverations** – previously reinforced position (e.g., 123-3 or 122)
 - **Back 2 positions** – 1 position to the left of the correct position (e.g., 123-1 or 121)
- (Note "WR" = water reinforcement, "BSR" = brain stimulation reward)

Chunk Boundary Errors:

- **Overall acquisition:** WR-scopolamine and BSR-atropine both made significantly more errors than saline controls, with rats in both studies showing an approximate 50% error rate.
- **Error profile analyses:** WR-scopolamine rats committed a higher proportion of perseveration errors while BSR-atropine rats committed more back 2 positions errors. Errors were consistent across all chunk boundary elements of the pattern in both studies.

Within Chunk Errors:

- **Overall acquisition:** WR-scopolamine rats showed significantly elevated errors relative to saline controls (approx. 25% error rate), while BSR-atropine rats showed no differences in acquisition relative to saline.
- **Error profile analyses:** Rats behaved similarly in both studies for the 2nd element of chunks, committing primarily perseveration errors. Rats differed in types of errors made at the 3rd element of chunks, with WR-scopolamine rats making more back 2 positions errors while BSR-atropine rats making more perseveration errors. These errors were consistent across the first 7 chunks of the pattern.

Violation Errors

- **Overall acquisition:** Rats in both drug/reinforcement conditions made significantly more errors than saline controls; however, while WR-scopolamine rats showed an 80% error rate, BSR-atropine rats showed a near 100% error rate.
- **Error profile analyses:** Rats in both drug/reinforcement conditions committed primarily overextension errors.

DISCUSSION

The results of the present study, when compared to the prior investigation with atropine and BSR, revealed some different behavioral effects under scopolamine and WR. Although the differences in error rates and types of errors made at the within chunk elements suggest that rats in the BSR-atropine study may have learned more about the pattern than the WR-scopolamine rats, the error profile analysis suggests the opposite is true. If so, the results would indicate that the differences between experiments were due to differences in drug dose, not in qualitatively different effects of drugs or reinforcers. However, what is clear is that in both cases intact central cholinergic systems are necessary for learning appropriate responses at places in sequences where pattern structure changes, as evidenced in the impaired acquisition of chunk boundary and violation elements in both studies.