



Troster and Beatty (1989) carried out a study of the role of acetylcholine on memory. You can use this study for the following learning objectives:

Discuss research methods used in the study of the brain and behavior.

Effects of neurotransmission on human behavior.

Ethics in the study of the brain and behavior.

Background information

In the hippocampus, there is a high concentration of acetylcholine receptor sites. Researchers have therefore questioned the role of this neurotransmitter in the consolidation of memories.

There are many ways to study neurotransmission in the brain - but these methods are all indirect. These methods include using animal models (as seen in the study by [Rogers & Kesner \(2003\)](#)), the use of fMRIs to observe which parts of the brain are active during certain behaviors (for example, [Antonova \(2011\)](#)), or by using **antagonists**. Antagonists are drugs that block the receptor site of a neurotransmitter to see what happens with regard to behavior.

The following study uses the acetylcholine antagonist *scopolamine*. The original study may be accessed [here](#).

Procedure and results

The aim of the study was to determine the role of acetylcholine in the formation and retrieval of memory. There were several tests done in this study. To simplify the study, we are going to look at only three of the tests that were given.

The sample was made up of 13 men aged 31 to 59, with a mean age of 39.2. All participants were tested for physical and mental health before undergoing the procedure. Participants were briefed on the potential side effects of scopolamine (dry mouth, forgetfulness, sedation, and hallucinations) and were reminded throughout that they had the right to withdraw from the study.

Each participant underwent all three conditions. There was a placebo group in which they were injected with a saline solution. Then there was an injection of either 0.5 mg or 0.8 mg of scopolamine. There was a 48-hour pause between each condition and the conditions were counter-balanced. Although a placebo was given, the participants and the researcher immediately knew if it was the saline solution as there were no side effects.

The three tests were as follows:

1. **The Free Recall Test:** After the injection, participants were read a list of 14 words - 7 were high imagery and 7 were low imagery. The participants were asked to recall the list immediately. The list was reread (in a different order) five times for a final potential score of 70. Then the participants were asked to recall the list again after a 40-minute delay.
2. **The New Map Test:** Participants were given a map of a fictitious state and asked to memorize the locations of the cities. After 60 seconds they were given a blank map and a list of the cities. They were

asked to put the cities on the map. This was repeated four times.

3. **The Remote Memory Battery:** The participants were shown 150 images of famous faces and events to see if they could recognize them. Unlike the other tasks, this is based on LTM retrieval, not the transfer of memory from STM to LTM.

The findings showed that scopolamine inhibited the encoding of new memories, but did not have a significant effect on the recall of long-term memories. It appears that acetylcholine plays a role in the encoding of both semantic and spatial memories. You can see the exact results below.

Test 1: Number of words recalled - immediate or delayed conditions

Task	The placebo condition	0.5 mg of scopolamine	0.8 mg of scopolamine
Immediate recall (out of 70)	44.2	40.2	32.6
Delayed recall (out of 14)	7.5	5.8	3.1

Test 2: Percent of locations correct on the map test

Trial	The placebo condition	0.5 mg of scopolamine	0.8 mg of scopolamine
1	35.6	31.1	21.9
2	67.0	57.0	37.2
3	80.3	68.6	49.2
4	88.9	76.4	56.4

Test 3: Average percent of correct responses

The placebo condition	0.5 mg of scopolamine	0.8 mg of scopolamine
66.3	70.2	64.8

Evaluation

- The researchers used a rigorously controlled experiment with a **placebo condition** to avoid the effect of confounding (extraneous) variables. However, because of the side effects caused by the scopolamine, the participants were aware of which condition they were in.
- The study can establish a cause-and-effect relationship.
- The tasks were rather artificial and may not reflect how memories are created daily in an uncontrolled environment.
- Although ethical requirements were met, there is still a concern about the use of such drugs in human experimentation. One of the participants became delirious after taking scopolamine; he demonstrated incoherent speech, hallucinations, and the inability to focus attention. His data were eliminated from the study.
- The study uses a reductionist approach to better understand the role of a single neurotransmitter in memory. This is important because it could lead to treatment for those with dementia or Alzheimer's disease. Remember, reductionist approaches are not always a bad thing!