

# A reinvestigation of cognitive maps<sup>1</sup>

HAROLD F. YOUNG, E. ROBERT GREENBERG<sup>2</sup>, WILLIAM PATON<sup>2</sup>, JOHN A. JANE  
CASE WESTERN RESERVE UNIVERSITY SCHOOL OF MEDICINE, CLEVELAND<sup>3</sup>

Rats were trained in Tolman's "sunburst" apparatus modified to eliminate visual cues. Results consistent with his hypothesis of "cognitive maps" were obtained. There was a tendency to take the right sided test pathways pointing in the general direction of the food box. When the number of left and right turns in the training procedure were made equal and the ultimate turn was to the left, no tendency to turn right was found during testing.

Twenty years ago Tolman and his co-workers (Tolman, 1948; Tolman, Ritchie, & Kalish, 1946) suggested that "place" learning might be more important than "response" learning, and that animals built what they called "cognitive maps" of their environment. Although at the time other investigators criticized these and other experiments of Tolman (see Hilgard, 1956, for summary), these studies were in themselves not definitive, and Tolman's concepts have continued to occupy an important position in contemporary psychological theory (e.g., Altman, 1966, p. 390). We wished to repeat one of his original experiments with three major modifications: First, by using blind rats as well as normal rats to eliminate all visual cues; second, by using primates so that if cognitive maps were a "higher" function they might be more readily demonstrated in a higher

order; and third, by modifying the apparatus to eliminate the unequal number of left and right turns in Tolman's original apparatus.

## Apparatus

Apparatus 1 (Fig. 1) consisted of a central amphitheater of 46 in. diameter with a central training runway and 12 collateral runways of 46 in. length which were closed during training and open during the testing, at which time the central pathway was closed. This is similar to Tolman's original design.

The second apparatus was identical to the first except that at the end of the training runway a final left turn was added, thus equalizing the number of left and right turns.

In addition, the apparatus was illuminated from within, sealed to prevent visual access to the outside, and installed with automatic trap doors on the food box and collaterals. A one-way mirror was installed over the amphitheater to permit easy observation of the test animals. Sealed transport boxes were constructed to ensure no visual contact with the outside of the maze.

## Experimental Groups

The following experimental groups were utilized in Apparatus 1: GROUP 1—five normal albino rats,

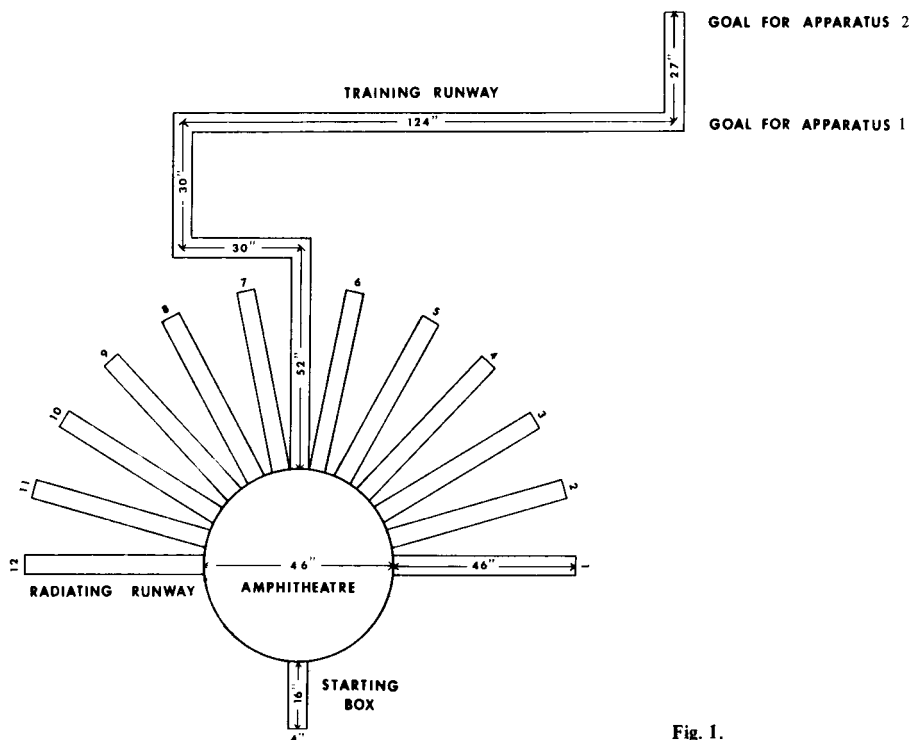


Fig. 1.

	Left test lanes						Total Responses to left		Total Responses to right		Right test lanes					
	12	11	10	9	8	7	NO.	%	NO.	%	6	5	4	3	2	1
	Apparatus 1															
Group 1	2				1	1	4	20	80	16	4	5	3			4
Group 2	2	1		3	9	17	32	34	66	62	41	8	3	1		9
Group 3			1			///	1	5	95	19	///	13	1	3	1	1
Group 4	1				1		2	13	87	13	3	3	6	1		
Apparatus 2																
Group 5	3	3	4	4	4	8	26	59	41	18		6	6	3	1	2
Group 6	3	2	3	2	5	9	24	48	52	26	6	5	1	4	4	6

Fig. 2.

all test lanes open; GROUP 2—five normal albino rats, all test lanes open but center runway in amphitheater removed; GROUP 3—five normal albino rats, two center lanes closed (6, 7); GROUP 4—four blind albino rats (enucleation four weeks prior to experiment).

The following experimental groups were utilized in Apparatus 2: GROUP 5—nine normal albino rats, all test lanes open; GROUP 6—five squirrel monkeys, *Saimiri sciureus*, all test lanes open.

**Training Procedure**

All animals were run on the training route for a food reward with the test runways closed until they achieved consistent runs to the food box of under 1 min. The training route was then blocked and the radiating test runways opened. The animals in Group 2 were tested for an extended period to see if the preference for the right side remained. In addition, the center runway was removed in Group 2 and test doors 6 and 7 closed in Group 3.

**Results**

In Apparatus 1, minor changes in the apparatus, namely, removing the center piece (Group 2) or closing the two inner test doors (Group 3), did not change the results. On the  $\chi^2$  test there was a significant tendency to turn to the right in the test situation ( $p \leq .05$ ). This tendency became less marked with increasing number of trials, as seen in Group 2.

In Apparatus 2 both rats and squirrel monkeys no longer showed this tendency to turn right where the number of left turns in the training route equalled the number of right turns.

**Discussion**

We have found it possible to reproduce Tolman's results in an apparatus where outside visual cues have been eliminated and also in blind animals. The presence of visual cues in Tolman's design had previously been considered to be a possible factor in the "place" learning that he observed.

We interpret these results as indicating that the tendency for the animals to turn to the right in Tolman's test situation may not be due to the ability to find the "short cut" to the food because of the presence of a cognitive map, but rather to either the greater number of right turns in his original apparatus and our Apparatus 1, or to the last goal box turn being toward the right. When these factors were eliminated, no differential response could be demonstrated.

**References**

ALTMAN, J. *Organic Foundations of Animal Behavior*. New York: Holt, Rinehart & Winston, 1966.  
 HILGARD, E. R., *Theories of Learning*. New York: Appleton-Century-Crofts, 1956.  
 TOLMAN, E. C. "Cognitive Maps in Rats and Men" *Psychol. Rev.*, 1948, 55, 189-208.  
 TOLMAN, E. C., RITCHIE, B. F. & KALISH, D. "Studies in Spatial Learning: I Orientation and the Short Cut" *J. exp. Psychol.*, 1946, 36, 13-24.

**Notes**

1. Supported by NIH Grant NB-00779 and VA Grant CH1-66.
2. Submitted in partial fulfillment for requirements of Doctor of Medicine Degree, Case Western Reserve University School of Medicine.
3. Department of Surgery, Division of Neurosurgery, Case Western Reserve University School of Medicine, Cleveland Veterans Administration Hospital and University Hospitals, Cleveland, Ohio 44106.