Supplementary reading in the Companion Website accompanying HUMAN LEARNING 5/E by J. E. Ormrod, 2008, Upper Saddle River, NJ: Merrill/Prentice Hall.

STUDYING COGNITIVE PHENOMENA WITH BEHAVIORIST TECHNIQUES: TOLMAN'S WORK

Note: In the fifth edition of Human Learning, *I condensed my discussion of Edward Tolman's early cognitive theory in order to make additional room for more contemporary perspectives. The lengthier discussion of Tolman's work that appeared in the fourth edition of the book is presented here.*

Edward Chace Tolman (1932, 1938, 1942, 1959) was a prominent learning theorist during the heyday of behaviorism, yet his work had a distinctly cognitive flair. Like his behaviorist contemporaries, Tolman valued the importance of objectivity in conducting research and used nonhuman species (especially rats) as the subjects of his research. Unlike his contemporaries, however, Tolman included internal mental phenomena in his explanations of how learning occurs and adopted a more holistic view of learning than was true of S-R theorists.

Tolman developed his mentalistic view of learning by using some rather ingenious adaptations of traditional behaviorist research methods. We will see examples of his approach as we consider the central ideas of his theory:

• ***Behavior should be studied at a molar level.*** Early theorists in the behaviorist tradition, such as Ivan Pavlov, John Watson, and Edward Thorndike, attempted to reduce behavior to simple stimulus-response connections. In contrast, Tolman was adamant in his position that more global (molar) behaviors are the appropriate objects of study. Tolman argued that breaking behavior down into isolated S-R reflexes, rather than looking at it in its totality, obscures the meaning and purpose of that behavior.

• ***Learning can occur without reinforcement.*** Tolman opposed the behaviorist idea that reinforcement is necessary for learning to occur, and he conducted several experiments to support his contention. As an example, let's look at a study by Tolman and Honzik (1930) in which three groups of rats ran a difficult maze under different reinforcement conditions. Group 1 rats were reinforced with food each time they successfully completed the maze. Group 2 rats received no reinforcement for successful performance. Group 3 rats were not reinforced during the first 10 days in the maze but began receiving reinforcement on the eleventh day.

Before we examine the results of this experiment, let's predict what should have happened in this situation *if* reinforcement were an essential condition for learning to occur. Because Group 1 rats were continuously reinforced, we would expect their performance to improve over time. Because Group 2 rats were *not* reinforced, we would expect their performance to stay at a constant low level. And we would expect the rats in Group 3 to show no improvement in performance until after Day 11, at which point they should show a pattern of behavior similar to the Group 1 rats' first few days of performance.

The actual results of the Tolman and Honzik experiment appear in Figure 1; the data points indicate the average number of wrong turns (errors) each group made while traveling the maze every day. Notice that the performance of Groups 2 and 3 improved somewhat even when they were not receiving reinforcement. Notice also that once the rats in Group 3 began receiving reinforcement, their performance in the maze equaled (in fact, it surpassed!) Group 1's performance. Apparently, Group 3 rats had learned as much as Group 1 rats despite their lack of reinforcement during the first 10 days. Such results cast doubt on Thorndike's law of effect: Perhaps reinforcement is not as critical a factor in learning as behaviorists have suggested.

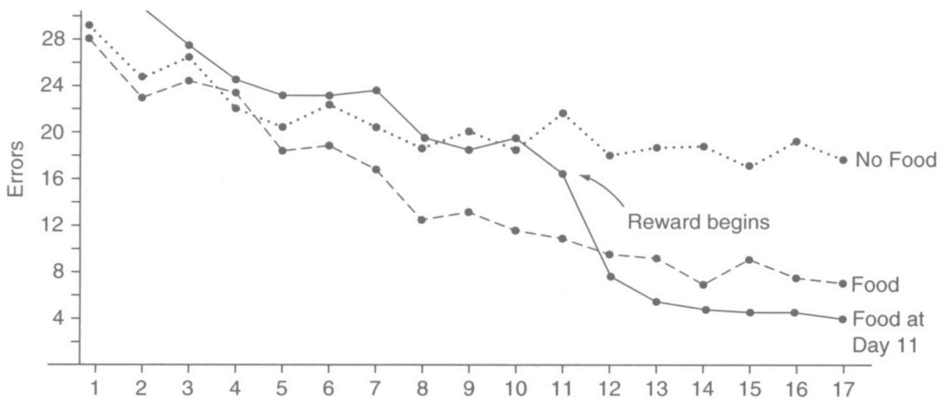

Figure 1. Maze performance of rats receiving food, no food, or food beginning on Day 11. Adapted from "Introduction and Removal of Reward, and Maze Performance in Rats" by E. C. Tolman and C. H. Honzik, 1930, *University of California Publications in Psychology, 4,* p. 267.

• ***Learning can occur without a change in behavior.*** Although early behaviorists equated learning with behavior changes, Tolman argued that learning can occur *without* being reflected in a change in behavior, using the term **latent learning** for such unobservable learning. The Tolman and Honzik study just described provides an example of latent learning: Group 3 rats must have been learning just as much as Group 1 rats during the first 10 days, even though their behavior did not reflect such learning. (Presumably, Group 2 rats were also learning more than they let on.) Tolman proposed that reinforcement influences *performance* rather than learning, in that it increases the likelihood that a learned behavior will be exhibited. (As noted in Chapter 6 of *Human Learning,* social cognitive theorists came to conclusions similar to those of Tolman, proposing that learning can occur without a change in behavior and that reinforcement simply increases the likelihood that people will *demonstrate* what they have learned.)

• ***Intervening variables must be considered.*** If you have already read the supplementary reading "Beyond Pavlov, Thorndike, and Skinner" on this Companion Website, you may recall that Clark Hull incorporated **intervening variables** into his theory of learning, arguing that variables such as drive, habit strength, and incentive play critical roles. The concept of intervening variables did not originate with Hull, however; as early as 1932, Tolman proposed that variables within the organism (e.g., cognitions and physiological states) affect the behaviors observed. Thus, with Tolman's work, we have an early concern for *individual differences* in the learning process, a concern that continues in contemporary cognitivism.

• ***Behavior is purposive.*** Tolman believed that learning should be viewed not as the formation of S-R connections but as a process of learning that certain events lead to other events (e.g., that following a particular path through a maze leads to reinforcement). He proposed that once an organism has learned that a behavior leads to a certain end result, the organism behaves in order to achieve that end. In other words, behavior has a *purpose*, that of goal attainment. Because Tolman stressed the goal-directed nature of behavior, his theory of learning is sometimes referred to as **purposive behaviorism**.

• ***Expectations affect behavior.*** According to Tolman, once an organism learns that certain behaviors produce certain kinds of results, it begins to form expectations about the outcomes of its behaviors. Rather than reinforcement affecting the response that it follows, the organism's *expectation* of reinforcement affects the response that it *precedes*. (Once again we see a similarity with social cognitive theory.)

When an organism's expectations are not met, its behavior may be adversely affected. For example, in an experiment by Elliott (cited in Tolman, 1932), rats received one of two different reinforcers for running a maze: An experimental group received a favorite rat delicacy—bran mash—whereas a control group received relatively unenticing sunflower seeds. The experimental group ran the maze faster than the control group, apparently because they were expecting a yummier treat at the end of the maze. On the tenth day, the experimental group rats were switched to the sunflower seed reinforcement that the control group rats had been getting all along. After discovering the change in reinforcement, these rats began to move through the maze more slowly than they had previously, and even more slowly than the control rats. Because both groups were being reinforced identically at this point (i.e., with boring sunflower seeds), the inferior performance of the rats in the experimental group was apparently due to the change in reinforcement, resulting in a *depression effect* similar to what I describe in Chapter 4 of *Human Learning*. As Tolman might put it, the rats' expectation of reinforcement was no longer being confirmed. As you or I might say, the rats were very disappointed with the treat awaiting them.

• ***Learning results in an organized body of information.*** Through a series of studies, Tolman demonstrated that rats who run a maze learn more than just a set of independent responses. It appears that they also learn how the maze is arranged—the lay of the land, so to speak. For example, in a classic study by Tolman, Ritchie, and Kalish (1946), rats ran numerous times through a maze that looked like Maze 1 in Figure 2. They were then put in a situation similar to Maze 2 in Figure 2. Because the alley that had previously led to food was now blocked, the rats had to choose among 18 other alleys. Using S-R theory's notion of stimulus generalization, we would expect the rats to make their running response to a stimulus very similar to the blocked alley. We would therefore predict that the rats would choose alleys near the blocked one—particularly Alley 9 or Alley 10. However, few of the rats chose either of these routes. By far the most common choice was Alley 6, the one that presumably would provide a shortcut to the location in which the rats had come to expect food.

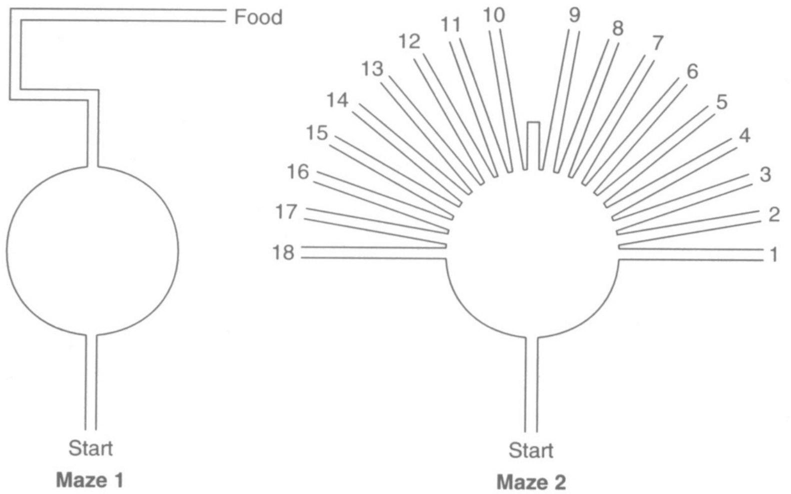

Figure 2. Mazes used by Tolman, Ritchie, and Kalish (1946).

Based on such research, Tolman proposed that rats (and presumably many other species as well) develop **cognitive maps** of their environments: They learn where different parts of the environment are situated in relation to one another. Knowing how things are organized in space enables an organism to get from one place to another quickly and easily, often by the shortest possible route. The concept of a cognitive map (sometimes called a *mental map*) has continued to be a topic of research for contemporary researchers, psychologists and geographers alike (e.g., Downs & Stea, 1977; Foo, Warren, Duchon, & Tarr, 2005; García-Mira & Real, 2005; Salomon, 1979/1994.

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