Module: Psychological Foundations of Mental Health

Week 1
Introduction to cognitive psychology

Topic 3
The cognitive (r)evolution – Part 1 of 3

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Lecture transcript

Slide 4

One of the most influential and important neo-behaviorists was the American psychologist Edward Tolman. Unlike Skinner, who used simple behaviours, such as key pecking or lever pressing to study learning, Tolman was interested in the learning of more complex or purposive behaviour. He used mazes that the animal, typically the rat, had to explore or learn to navigate to find a reward.

The slide illustrates some of the many designs of maze that Tolman used in his studies. The important thing about mazes is that the animal has choices to make, such as turning left or right or sometimes continuing straight ahead. This is somewhat different and potentially more cognitive than decisions to press a lever or press a key. However, we should take care to avoid inferring cognitions, unless the evidence strongly points us in that direction.

Perhaps Tolman's most influential work was around the concept of latent learning. This had been described by others earlier in the 20th century. But it was studied most extensively by Tolman and collaborators. Latent, here, means learning that is dormant or concealed.

Latent learning is a term applied to learning that seems to occur through exposure to environmental stimuli without any reinforcement. While there is limited change in actual behaviour during the exposure, the animal shows the ability to rapidly learn subsequent reinforced behaviour. This was taken to imply that the animal was learning without reinforcement. We will look at an example experiment in a minute.

First, though, we need to note that learning without reinforcement presented a major challenge for strict operant conditioning models. Operant theorists attempts at explanation were often rather elaborate and convoluted. This was somewhat paradoxical. In an attempt to fit the evidence to a strict operant model that avoided using cognitive constructs, they found themselves breaking the guiding rule of scientific parsimony. If there are two explanations, pick the simplest.

In the case of latent learning, the simplest solution seemed to be the one that included cognitions. We do not need to dwell on the heated debate that raged for many years between strict behaviourists and the neo-behaviorists, such as Tolman, nor need we concern ourselves with the debates within behaviourism, such as that between Tolman and a contemporary, CL Hull.

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More important to us in this context is the contribution of the neo-behavioral work of Tolman and others made in the transition from strict behaviourism to cognitivism during the early to middle parts of the 20th century.

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Probably the most cited study taken to support the idea of latent learning was one conducted by Tolman and Honzic in 1930 and summarised, along with other related work on the subject, in a later review published by Tolman in 1948. In the classic 1930 study, three groups of rats were exposed to a complex maze made up of a series of interconnected T shapes, like the one illustrated here, with a dead end at one branch of the T and access to the rest of the maze at the other branch.

A food box was located at the end of one of the final branches. The rat was introduced to the maze once a day for 17 days, with the aim of seeing how many turns it made before reaching the food box, whether or not it had food in it. We do need to understand that rats, especially hungry rats, explore their environment to find food.

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Rats in group one were rewarded every time they reached the food box. This was a standard operant learning condition and formed the control group. Because this was a study to look at early learning, it used a continuous reinforcement schedule.

Rats in group two were also rewarded, but only when they were taken from the box. Crucially, the reinforcement was not contingent on specific response. In other words, they never got rewarded at the food box. This was called the no reward condition.

Rats in group three were the main experimental group. For the first 10 days, like group two, they were rewarded when they were taken out of the maze. For days 11 to 17, however, the reward was placed in the food box for them to find. This was the delayed reward condition.

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What was the pattern of learning shown by the rats in the three groups over the 17 days? Here's a schematic diagram of what was typically seen in a latent learning experiment like this. Rats in group one, shown by the green line, learned quickly over the initial days, reducing the mean number of errors to around three per run by day 11. This is what we would expect from straightforward operant learning, a behaviour being the sequence of left and right turns needed to reach the goal and food reinforcement.

Group two, shown by the red line, rewarded non-contingently after being removed from the box, did show some learning, but it was limited. As expected, group three, the delayed reward group shown by the blue line, performed the same as group two for the first 11 days, when they were treated exactly the same.

However, when food was placed in the box for the first time at day 12, the rats' behaviour changed almost immediately. They followed an accurate path from the start to the goal, with even fewer number of wrong turns than group one. Clearly, the rats in group three had learned information about the maze while exploring over the previous 11 days, even if the information were laying dormant until the behaviour was reinforced-- hence the term latent learning.

Subsequent experiments carried out by Tolman and others suggested that the rats were learning a relative spatial location, a place, rather than a specific route. This was tested using so-called detour mazes, such as the one shown here.

In detour maze studies, a previously learned direct route to the food box is blocked. When a rat that had explored the maze is presented with this situation, they tend to adapt by taking a next short route, rather than taking a long one, even though that new route was one that had previously never led to a quick reward.

For Tolman, this implied that the rats had an internal representation or cognitive map of the maze and that this map could be used flexibly, according to the specific environmental demands.

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Plenty of later research has supported the existence of such mental maps and even pointed to the parts of the brain that may contribute to storing the information.

A famous study by Eleanor Maguire and colleagues in 2006 showed that London cab drivers, who have to learn to navigate the complex streets of London, showed brain differences compared to bus drivers, who tend to follow the same route every day. In particular, they showed enlargement of the part of the brain called the hippocampus, a region also involved in navigation in rats and other species.

A subsequent study in 2015 by Timothy Keller and Marcel Just showed that the human hippocampus goes through structural changes within 45 minutes of learning a new route. Clearly, the brain changes as we learn, so-called neuroplasticity. And the information is stored and available for later use.

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Although Tolman still considered himself to be a behaviourist and opposed the introspection-based cognitivism of Wundt and Titchener, his theory was still far more cognitive than the radical behavioural, S-R operant models of Skinner and Watson. Initially, his maze learning experiments even led him to consider them as evidence for cognitive faculties that included insight, a ratty aha moment.

That was clearly something that Morgan's Canon suggested may be a step too far. Indeed, Tolman saw the light, and his later work focused on explanations for latent learning using predominantly behaviourist principles, without invoking the notion of animal insight.

Even when using the behaviourist explanation, there were some critical differences between the operant models and Tolman's model. Latent learning was seen as the establishment of stimulus-stimulus, rather than stimulus-response associations, through a process of exploration. This is a different type of stimulus-stimulus learning than we saw in Pavlovian classical conditioning.

For Tolman, unlike Skinner, the role of reinforcement was that it drove the animal to behave in a way when it was productive for it to do so, that is, when it was motivated by the prospect of reward. Another simple and rather simplistic distinction is that operant conditioning is an example of response learning, while latent learning is an example of place learning.

However, the biggest difference between Tolman and radical behaviourism was the importance prescribed to the intervening variable or process. Remember, for radical behaviourism, their existence was not denied, simply ignored as unhelpful and unnecessary for explanation. To Tolman, however, they were seen to be essential to account for observations such as latent learning.

For Tolman, these intervening variables or mediating internal representations were more than just a number of extra links in the chain between the external stimulus and the subsequent response. Instead, they fundamentally transform the input-output relationship. As indicated by this graphic, they related to various stages, from the processing of the stimulus or environment, the transformation of that information into a stored, spatial representation or map, and, finally, to processes that permitted access to specific information within the map to plan and execute an adaptive behavioural response, motivated by reward.

The map was something new and distinctive in its own right, a novel internal representation, not just a series of associative pairs or deterministic links in a chain. This information processing and storage model is one that is readily recognised today as a basis for many cognitive models of both animal and

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human behaviour.

Although Tolman is often called a neo-behaviorist, he can also be considered a key influence in a wider cognitive behaviourist tradition that continues to this day within cognitive psychology.

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