Module:
Psychological Foundations of Mental Health

Week 1
Introduction to cognitive psychology

Topic 1
Foundations of cognitive psychology from Plato to Pavlov – Part 3 of 3

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Lecture transcript

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Until the late 19th to early 20th century, all psychology was effectively cognitive psychology, an attempt to understand the processes and structures that constituted the mind and that permitted the mind to control a range of adaptive functions. However, in the early 20th century, dissatisfaction was growing with the existing approaches, particularly those based on introspection.

The reaction against introspection, specifically, and the definition of the psychology of the mind in general finds its voice in the growth of behaviourism. Many of the criticisms of introspection were actually raised by proponents of the method, including Wundt himself.

First, it could be unreliable, in that one person's introspection might be very different from another's, or even their own introspection on a different occasion.

Second, it was unrepresentative. Those doing the introspection were highly trained and therefore their experiences may not be representative of people in general.

Third, it was limited in its use. It could not be used with children or those with low intellectual ability or limited language skills.

Finally, it was limited in the areas of psychology to which it could be applied. More specifically, by definition, it could not be used to examine structures and processes that were unconscious or happened so rapidly that they were not accessible to the observer to describe. It could also not be applied easily to areas such as language and memory. And for that reason, they were explicitly ignored.

This latter criticism also pinpointed a wider issue. Until the late 19th century, psychology was human psychology. The idea of animal psychology did not exist, and indeed, made little sense.

While it could be argued that humans have unique faculties and abilities, it is also clear that much of our important behaviour is governed by mental properties that we share with animals, such as the ability to perceive and to react, to learn and remember, to find and approach food, and avoid danger.

When the study of animal or comparative psychology started to emerge, there was an obvious

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danger that people would start to apply human constructs related to the human mind to other animal species, without the ability to confirm their existence empirically. In response to this danger, the English psychologist C. Lloyd Morgan proposed what has come to be known as Morgan's Canon.

This bears reading to understand how important and influential it became. "In no case is an animal activity to be interpreted in terms of higher psychological processes if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development."

This set an important constraint on our theories of animal behaviour. We need the simplest possible explanation that explains what can be observed without invoking higher, that is, human, psychological processes. This makes good scientific sense and is consistent with the general scientific principle of parsimony or Occam's razor. Namely, that when you have two alternative explanations for the same observation or fact, the simplest or one with the fewest assumptions should be selected. While not inevitably correct, it's a pretty good guiding principle.

In relation to animal behaviour, it suggests that we should be looking for psychological explanations that avoid the need to infer human or human-like faculties, such as consciousness or volition or even thought.

While obviously important for the study of animal behaviour, Morgan's Canon also has an important implication for human psychology. If we don't need human processes to explain behaviour in animals, why do we need such unobservable and hard to study processes to explain our own behaviour? In other words, do we need cognition at all?

However, it's important to note-- Morgan did not deny the idea that internal or cognitive events existed in animals. Instead, he was cautioning against invoking or inferring them as explanations for animal behaviour when simpler explanations existed and that did not require them.

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Such thinking, and other similar, combined with dissatisfaction with much of 19th century psychological methods and theory, and was instrumental in the rise of a whole new approach to psychology behaviourism-- in American spelling, spelled without the u.

Although early influences of behaviourism can be found dating back before the 20th century, including Morgan, the school of psychological theory and practice was officially founded in its modern form by the American Psychologist JB Watson. At a lecture given by him at Columbia University in New York in 1913 called "Psychology as the Behaviourist Views It", that can be considered the behaviourist manifesto.

In his work, he rounded on both the structuralist and the functionalists, rejects out-of-hand the method of introspection, and denies the need to invoke faculties such as consciousness, volition, imagery, and perception. Essentially, he stated that the study of mental states is fundamentally unscientific and needs to be abandoned. We see here just a couple of the uncompromising criticisms that Watson made on the psychology of the day in 1913.

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He felt it had completely failed in its efforts to be recognised as a natural science and advocated the abandonment of its underpinning principles and methods. For behaviourists, the most fundamental unit was that of association, how the animal or human establish links between two stimuli, or between a stimulus and a response, or between a response and an outcome or adaptive behavioural goal, in other words-- learning.

In effect, the birth of behaviourism was the start of what we now call learning theory, an area of psychology that continues to flourish, albeit in the context of a much wider cognitive framework. The radical shift in approach advocated by Watson meant that things that we consider as essentially

cognitive, such as human language, reasoning, and problem solving, would become pushed to the margins of psychological study, as proposed by Watson and other behaviourists. This was not to deny their existence. He called them private events, only to say that they must be explainable by simpler, observable processes, or public events.

The study of basic associative processes is also central to the neural scientific study of learning and the mechanisms by which neurons alter their patterns of firing based on the relationship between a stimulus and its outcome, such as reward. That's covered in the Fundamentals of Neural Science module.

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Let's try to define behaviourism. It's an approach to psychology which limits itself to the description of relationships between observable environmental events and ensuing observable behaviour of organisms in the environment. Typically, behaviourism rejects subjective experience as a proper topic of study and resists explanations of observable acts in terms of inferred but unobservable mental processes.

The first part is a clear statement of the beliefs that we need to avoid psychological explanations that go beyond the inputs, what can be directly observed, both in terms of the environmental event that surrounds the animal or human immediately before or during the thing that we want to explain, and the outputs, the observable behaviour or response.

The second part of the definition here reflects Morgan's Canon, that we should resist using unobservable or subjective experience in our explanations. In effect, behaviourism stated that the study of unobservable mental processes, Watson's private events, is fundamentally unscientific and not valid targets for study. If the brain and the mind is a black box, it can and should remain on. The private events should remain private.

However, rather than simply limiting study to that which could be observed and ignoring mental processes, later behaviourists sought to apply the principles to explain even the most complex of behaviours, behaviours such as language and social behaviour that would seem to require acceptance of an inner state.

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A note on behaviourist terminology before we go further. Varied terms are used in behaviourists' research and explanation. In controlled experiments, the first link or input is often called the stimulus, such as a buzzer or a light. While the term antecedent is used to describe a natural, less-controlled situation, event, or circumstance that precedes a subsequent output. And so it could be deemed to have influenced it. This is the term used in what behaviourists call functional analysis, which we return to later.

In terms of the third link or output, the term response is used in controlled experiments, particularly where there is a single simple output, such as a lever press. When the output is more complex and where functional analysis is required, the term behaviour is typically used. Although the language is different, the basic input/output model remains the same.

Finally, just to note the term used for the contents and what we have called the black box-- the inner state. This is not a term that behaviourists use, except dismissively. Instead, these unobservable processes are typically referred to as intervening variables, Watson's private events. They merely provide a link in the chain between the input and the output. Pull the chain and things move at the other end, regardless of the number or nature of the hidden links. We do not need to know in detail what they are or what functions they solve, just that they provide a link between the input and the output.

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As with all new scientific approaches, they rarely emerge fully formed in the mind of the pioneers, but build on work conducted by others and then brought together in a novel way. For Watson, two key influences that shaped his thinking amongst many were the work of the Russian physiologist, Pavlov, and the American psychologist Edward Thorndike.

First, let's consider the pioneering work of Pavlov. One of his many interests was the physiological reflex. These were behaviours or reactions which did not seem to be learned, but which could be explained by built-in or innate properties of the nervous system.

For example, we blink quickly and automatically to protect our eyes if an object comes too close. And we produce saliva in our mouths when appetising food is put on a plate in front of us, helping to prepare our digestion.

The eye blink and the salivation reflex are automatic physiological responses to a specific type of stimulus. It was shown by all people and across animal species, typically from birth, and are likely to be unlearnt. They are also extremely difficult to prevent voluntarily. When putting drops in your eye, try not to blink when a drop hits your eyeball. Such reflexes are also preserved in animals and humans with major damage to the central nervous system, something that can be explained by the neuronal pathways required for their control.

Pavlov studied various reflex digestive reactions in dogs that had been prepared surgically so that their saliva or gastric enzyme secretions could be collected and measured, work that eventually led to him being awarded the Nobel Prize of Medicine in 1904.

Like most people, Pavlov was aware that a dog will start to produce saliva, not just when food was presented when it started to eat, but when it first sees the food, or even hears the cupboard containing the food being opened. For his experiments, Pavlov wanted to measure digestive fluids without getting food in the way of accurate measurement.

We only salivate to food when we are hungry. So once the dog had eaten, it could not be studied again for several hours. For these reasons, he systematically trained the dogs to make their reflex digestive secretions without the need for food at all.

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He did this by a systematic and gradual process of pairing the natural food stimulus, food in the mouth, with a neutral stimulus that would not normally produce salivation, for example, the ticking of a metronome or the ringing of a bell.

By repeatedly pairing the food and the bell, an association was formed with the result that the dog produced saliva to the sound of the bell alone without the need to present food. Pavlov called the salivation a psychic secretion.

This form of learning has come to be known as classical conditioning and relies on a temporal pairing of two stimuli so that the natural properties of one transfer to the second. It is a form of Stimulus-Stimulus, - or SS associative learning. The terminology of classical conditioning is as follows.

The food is known as the natural or Unconditioned Stimulus, or US. And the salivation to food, the natural or Unconditioned Response, or UR. Salivation to food is an unconditional reflex. The bell, on its own to begin with before it is paired with the US, is neutral and produces no response.

During the process of pairing of food in the mouth, the US and the bell, the learning or conditioning stage, the dog continues to respond in the presence of food. And so the salivation is still considered a UR.

Finally, after repeated pairings, the bell provokes salivation when presented in the absence of food. In other words, the bell has acquired properties of the US and is now a Conditioned Stimulus, or CS. The salivation, because it responds in this context to the bell and not the food, is now called a Conditioned Response, or CR, and represents a new conditional reflex.

Interestingly, once the bell has acquired the ability to elicit salivation, the bell can be paired with another neutral stimulus, such as a light, until it too becomes a conditioned stimulus, so-called secondary conditioning.

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While a useful way to measure physiological reaction in digestion without contamination by food, classical conditioning became a crucial method to study the mechanisms of associative learning, including how learning developed over time or declined. The schematic graph on the left shows the amount of saliva produced as a CR to the bell alone, before conditioning, after five, 10 or 15 pairings.

The amount of saliva produced increases with the number of pairings, up to a physiological limit, reflecting the bell acquiring strength as a CS to produce a CR. The conditioned response does not last forever. If the bell no longer serves as a signal for the imminent arrival of food, the CR eventually stops, a phenomenon known as extinction. Once again, the bell becomes a neutral stimulus.

However, not all of the learning has gone. It's simply no longer serves a useful function. If the dog is exposed to the bell, a few hours after extinction, the animal may show a reemergence of the salivation response, although this will be short lived. This is called, spontaneous recovery. This is best explained by the re-activation of a dormant learned association, rather than new learning.

The classical conditioning paradigm can be a useful tool to study things other than learning. For example, it can be used to infer the ability of the animal or the human to discriminate between difference stimuli.

Animals conditioned to produce a CR to a specific CS will produce the same CR to a similar CS. The strength of the CR will be related to how similar the new CS is to the original. For example, an animal trained to a tuning fork at a specific frequency will show a systematic reduction in saliva production for higher or lower frequencies, the so-called generalisation gradient, as shown in the figure.

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It is tempting to consider that through the process of classical conditioning, the dog comes to know, to become consciously aware, that the bell signals the imminent arrival of food. However, this was not Pavlov's contention. As this cartoon suggests, the simple ability of a stimulus to produce a response, however complex, does not necessarily imply that there is a cognitive mediational process, or conscious knowing.

Remember Morgan's Canon? We should avoid invoking cognitions if there are simpler explanations. Similarly, a change in the strength of the CR to a similar CS indicates that the animal has discriminated between the original and the new CS, but does not necessarily imply that discrimination was a conscious one.

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Perhaps the clearest demonstration that classical conditioning does not require cognitive explanations comes from the observation that even the simplest of animals can be conditioned and learn new stimulus-stimulus pairings.

The cute creature shown here is the California sea hare, or sea slug, Aplysia californica, which can grow up to 75 centimetres long and weigh in at up to seven kilogrammes. While cute, it has a very simple central nervous system, made up of only about 10,000 neurons, compare to 100 billion in the human brain. Yet, it still shows the ability to learn through classical conditioning.

This is shown in these acquisition and extinction graphs from an experiment that measures the conditioning of the natural reflex, the traction, of the animal's delicate syphoning gills to touch, much the same as a land snail retracts its eye stalks when touched. The top line shows the animal that received the paired neutral US pairing, showing the growing strength of the neutral stimulus to evoke the response, as it becomes a conditioned stimulus.

The other groups had similar stimuli or random pairings of stimuli. Reliable conditioning in the paired group happens within as a few as 15 pairings, and was retained for several days. We then see the identical extinction of the conditioned reflex when exposed to random pairings, exactly as shown by rats, dogs, and humans.

As a side note, in demonstrating that we do not need to invoke cognitions in the presence of classical conditioning in such simple animals, neuroscientists have a means or model to examine the exact processes within and between cells that allow learning through classical conditioning to take place, processes that are almost certainly going to apply in all animal species, including humans.

For example, in Aplysia, it is possible to study which part of its nervous system might be involved in the learning. The investigators found that the removal of one particular group of neurons abolishes the ability to learn through classical conditioning.

One of the co-authors of this classic study, Eric Kandel, won the Nobel Prize for physiology in medicine in 2000 for his work on the physiological basis of memory, much of it using Aplysia. Kandel started out as a psychiatrist and studied psychoanalysis, making him want to understand how memory worked. He was at Harvard University at the same time as Skinner and was undeniably influenced by his work.

However, while Skinner remained firmly within the psychological domain, Kandel's work forged links between psychology and brain science that we recognise today, a long way from his roots in Freudian psychoanalysis.

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Before leaving classical conditioning for now, we need to note an influential, if highly questionable, study conducted by JB Watson and colleague Rosalie Rayner and published in 1920 in one of the earliest volumes of the new Journal of Experimental Psychology.

The study was intended as a demonstration of how basic principles of classical conditioning can explain the development of neurosis and specifically phobias. Fear is a natural reflexive response to naturally occurring stimuli in our environment, something that has developed through evolution as a critical survival tool. As well as the emotional reaction, it has physiological components such as an increased heart rate and breathing, and behavioural components such as avoidance or escape. The phobia-- these natural fear responses occur in the context of environmental stimulus that's typically perceived as safe and unthreatening to most people.

A prevailing psychological explanation at the time came from Sigmund Freud and his psychoanalytic concepts. Famously, he wrote a case study of a young boy called Little Hans who had developed a fear of horses falling over and of being bitten by them. Freud's analysis, published in 1909, had concluded in essence that the fear was actually related to the Oedipal complex, that Little Hans unconsciously wanted to have sex with his mother and that he was afraid that his father, symbolised by the horse, would cut off his penis. Poor Little Hans had clearly seen horses in the street. And these, for some reason, had caused him to develop a fear of them.

For Freud, to use the behaviourist terminology, the first link, the actual experience or stimulus, was less important than the second link, the internal, unobservable, unconscious or private event.

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Not surprisingly, this gave a perfect opportunity for Watson to show that there was no need to infer these private or internal events, that phobias could develop by the process of conditioning.

With that in mind, he set about demonstrating that it was possible to simply and quickly condition fear in a baby using Pavlov's principles. This was a practical test of a theory which he had published a couple of years before by Watson and a different Morgan, that infancy was the time when patterns of emotional reaction were shaped by experience and associations made to stimuli, which could evoke them.

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Watson and Rayner reasoned that they could take a neutral object and condition a fear response by pairing it to the stimulus that evoked fear. They chose a white rat as the neutral stimulus. Albert, then about nine months old, showed no evidence of fear when presented with the rat. Indeed, he was curious and touched it as it ran around him. He was also untroubled by a large white dog brought up to him, or a wide range of other stimuli, such as a rabbit or a monkey and various masks. Watson described Albert as generally stolid and unemotional.

The next stage involved testing Albert's response to another stimulus that might provoke an emotional reaction. After trying various things with no obvious effect on Albert, they found that striking a steel bar with a hammer unexpectedly from behind evoked the expected and, for Watson, hoped for response of crying and distress or fear.

This was the first observation of emotion that Watson had observed in Albert. Watson has his unconditioned stimulus, or US, and could provoke crying, a sign of fear or distress, as the natural or unconditioned response, the UR.

The next stage involved re-presenting the rat to Albert, but this time, at each presentation, pairing it with a distressing sound of the hammer hitting the bar. As before, Albert exhibited signs of distress. This pairing was repeated seven times over a period of a week.

Eventually, Watson recorded the following in his notes. "The instant the rat was shown, the baby began to cry. Almost instantly, he turned sharply to the left, fell over on his left side, raised himself on all fours, and began to crawl away so rapidly that he was caught with difficulty before reaching the edge of the table."

These were classical signs of fear. The rat was now a conditioned stimulus. And poor Little Albert developed a conditioned fear response to a previously neutral object.

Watson went on to show five days later that this conditioned fear also extended or generalised to other white furry objects, such as a rabbit. When Albert tried to escape, Watson noted this was a most satisfactory test.

Other generalisations of the fear response, although less pronounced, were observed with a dog, a pile of white cotton wool, and Watson himself wearing a large fake white beard. The study ended soon after. And it was noted by Watson that contact with Little Albert was lost at that point before they could seek to undo the learned fear by a process of deconditioning.

Watson expressed concern that the learned fear would persist indefinitely. Much has been written about the study and little Albert, whose identity and fate remain a mystery. Considerable effort has gone into tracking him down later in life, but none of them conclusive.

The study is unquestionably unethical by today's standards, but it is informative of the thinking of the early behaviourists as it is about the origins of neurosis. However, it also triggered subsequent work in the development of positive therapeutic uses of conditioning principles and was a key step in the

evolution of what came to be called behaviour therapy, that we will come back to later in the week.