1

EARLY PSYCHOLOGICAL THEORIES OF LEARNING & THE TECHNOLOGY OF EDUCATION

Figure 1-1. Components of Educational Technology: Physical and behavioural sciences. (Based on Hilgard, 1964)

Physical sciences and technologies	
Optics:	projected pictures (still and moving) Chemistry: paper, ink, photography
Electronics:	sound recording, television, complex teaching machines
Mechanical Engineering:	printing press, movable type, movies, sound recording
Electrical Engineering:	sound films, sound recording, television
Mathematics	
Probability & statistics:	experimental design
Behavioural sciences	
Psychology:	Individual differences, psychometrics, learning theory, task analysis, instructional media research, teaching machines

Educational technology is composed of at least two over-lapping subsets: technology in education and technology of education. The tools-technology, sometimes known as the hardware approach to educational technology, but more commonly known under the title audiovisual aids or instructional media, may be thought of as technology in education. Whereas, the educational application of knowledge from the behavioural sciences, such as psychology, forms the basis of a technology of education.

Educational technology can be seen as an umbrella term for the application of scientific knowledge in the field of education. This covers considerable ground, as can be seen in Figure 1-1, which lists some of the areas for inclusion in Hilgard's (1964) instructional technology and in Figure 1-2, which identifies crucial disciplines which impinge on Hawkridge's (1981) concept of educational technology.

Jonassen (1985) has discussed the psycho-philosophical perspective of educational technology in this century, showing the various shifts in theoretical foundations and practices associated with four distinct phases: the physical science or instructional media movement, the behaviourist and neo-behaviourist movements, and finally the constructivist or cognitive science approach.

The physical science approach gained momentum early in the century as the audiovisual movement, focusing on the machines and materials, rather than the learner

Figure 1-2. Components of Educational Technology: Elements of a concept map. (Based on Hawkridge, 1981)

Methods of learning:
cognitive psychology, learning styles, interaction analysis, gaming/simulation, communication theory, linguistics, textual communications, artificial intelligence, information processing

Objectives for learners:
systems theory, epistemology, politics, philosophy, sociology

Evaluation of teaching and learning:
cost-benefit/effectiveness analysis, economics, attitude and opinion research, social psychology, teacher evaluation, content analysis, measurement of learning, psychological measurement, psychology, mathematics and statistics, computing

Environments:
group dynamics, logistics, individualised learning, anthropology

Media for learning:
design, graphics, electronics, engineering, production techniques

(Saettler, 1968). This approach was concerned with the effects of devices and procedures, which were seen as acting as an antidote to the excessive verbalism of traditional teaching methods (Wittich and Schuller, 1953). The new media were to supply a concrete basis for conceptual thinking, make learning more permanent, develop continuity of thought, the growth of meaning and efficiency, depth, and variety of learning (Dale, 1954). It yielded to the behaviourist approach following the training effort of World War 2, culminating in the 'systems approach' to course design in the 1960s. In many ways this remains the corner-stone of educational technology. It was grounded historically in behaviourism and later developed by behavioural psychologists who explicitly excluded the study of mental processes, placing emphasis only on observable changes in behaviour. This aspect of educational technology is most obvious in the linear teaching machines devised by B.F. Skinner.

There has been a gradual reaction to this radical behaviourism resulting in what has been termed neo-behaviourism, which acknowledges that behaviour is all we can observe, but claims that the observed behaviour depends on mental processes. It is at this stage of evolution that educational technology is to be found in its present form, according to Jonassen.

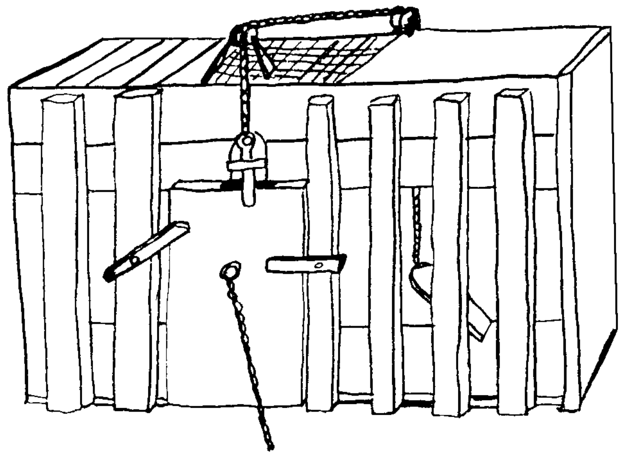
However, there has been a major revolution going on in psychology for several decades, which has replaced the mechanistic behaviourist model of human behaviour with the constructivist model. Here the individual is seen to select and interpret the raw materials of experience, which are ultimately transformed into different realities for different people. Piaget (1970) says that knowing reality is a process of constructing systems of transformations that model reality. This cognitive model of learning has largely replaced behaviourism and is now in the process of being assimilated into the technology of education. If this occurs to any great extent the goal of replication of behavioural responses will be replaced by the activation of covert mental processes required to build an appropriate cognitive model of reality within the learner.

Hilgard's early formulation is mainly composed of those physical sciences which contribute to the production of educational hardware or machines, and those behavioural aspects which are associated with the first three stages in the evolution of educational technology: from the physical science approach to the neo-behaviourist approach.

Hawkridge's later drawing of the educational technology map is much more comprehensive, covering most of Hilgard's earlier formulation and extending it to include anthropology, sociology, philosophy and politics. Psychology is particularly well-represented, including cognitive psychology in addition to those aspects traditionally associated with educational technology.

In the following chapters the evolution of educational technology in its various guises will be considered from the psychologist's point of view, but first it is necessary to introduce the three major psychological theorists whose early work profoundly affected the development of educational technology throughout most of this century.

Figure 1-3. Thorndike's puzzle box. (Based on Thorndike, 1898)



Thorndike, Edward Lee (1874-1949)

Although later known for his pedagogical teachings, Thorndike was initially concerned, not with human learning and its educational implications, but with animal learning and intelligence. His learning theory, one which was to dominate all others in America for a quarter of a century, was first announced in his doctoral dissertation 'Animal Intelligence' (1898). This was profoundly affected by Darwinian theory, which, according to Thorndike, provided psychology with the evolutionary point of view.

> .... the mind's present can be fully understood only in the light of its total past. Psychology has by no means fully mastered this lesson. Human learning is still too often described with total neglect of animal learning. But each decade since The Origin Of The Species appeared has shown a well marked increase in comparative and genetic psychology. (Thorndike, 1909, p.65-80)

He began his work in order to provide a mechanistic account of animal learning, which could be stated in terms of elementary operations and events, and was concerned to dispel the myth of animal ratiocinative intelligence. This led to his detailed study of what was later called trial-and-error learning.

In a typical experiment a hungry cat or dog was placed in a box similar to that shown in Figure 1-3. The door was pulled open by a weight attached to a string as soon as the animal loosened the bolt or bar which held it shut. A dozen or so variations of the box were used, some having loops of wire, in various positions in the cage, attached by string to latches, others having wooden buttons or catches close to the door, and others with levers or platforms inside the box operating release mechanisms. A final version had the experimenter release the door when the animals engaged in a specific activity, such as licking or scratching themselves.

Initially the animals engaged in much unsuccessful and irrelevant behaviour before the door latch was tripped in an almost accidental manner, and Thorndike provides a vivid account of that behaviour:

> When put into the box the cat would show signs of discomfort and of an impulse to escape from confinement. It tries to squeeze through any opening; it claws and bites at the bars or wire; it thrusts its paws out through any opening and claws at everything it reaches; it continues its efforts when it strikes anything loose and shaky; it may claw at things in the box. It does not pay very much attention to the food outside, but seems simply to strive instinctively to escape from confinement. The vigour with which it struggles is extraordinary. For eight or ten minutes it will claw and bite and squeeze incessantly.... The cat that is clawing all over the box in her impulsive struggle will probably claw the string or loop or button so as to open the door. And gradually all the other non-successful impulses will be stamped out and the particular impulse leading to the successful act will be stamped in by the resulting pleasure, until, after many trials, the cat will, when put in the box, immediately claw the button or loop in a definite way.
>
> The starting point for the formation of any association in these cases, then, is the set of instinctive activities which are aroused when a cat feels discomfort in the box

either because of confinement or a desire for food. (Thorndike, 1898, p.13)

The times taken for the animal to escape were high at first but on succeeding trials times for escape decreased, remaining relatively stable after 10-20 trials. The associative processes, which Thorndike was concerned to study, showed a gradual stamping in of correct responses and stamping out of incorrect responses, according to the commensurate pleasure (or lack of it) resulting from the response. It was from these studies with animals that the first scientific theory of learning emerged, Thorndike's theory of connectionism:

> I have spoken all along of the connection between the situation and a certain impulse and act being stamped in when pleasure results from the act and stamped out when it doesn't. (Thorndike, 1898, p.103)

This 'law of effect', as it was to be called, brought motivation and reward to the foreground of experimental psychology. Rewards, or successes and failures, provided a mechanism for the selection of the more adaptive responses, and this bears much resemblance to the mechanism of 'natural selection by successful adaptation', which was the basis for Darwin's theory of evolution. This law augmented the familiar law of habit formation through repetition, for Thorndike, and the two became central to his theories of learning and instruction, when he joined the faculty of Teachers College, Columbia University, in 1899, where he shifted his emphasis from animal to human learning.

> The Law of Effect: The Law of Effect is that, other things being equal, the greater the satisfyingness of the state of affairs which accompanies or follows a given response to a certain situation, the more likely that response is to be made to that situation in the future.
> The Law of Exercise: All changes that are produced in human intellect, character and skill happen in accord with and as a result of, certain fundamental laws of change. The first is the Law of Exercise, that, other things being equal, the oftener or more emphatically a given response is connected with a certain situation, the more likely it is to be made to that situation in the future.... This law may be more briefly stated as: 'Other things being equal, exercise strengthens the bond between situation and response.' (Thorndike, 1912, pp.95-96)

The kinds of phenomena coming under the law of exercise are those repetitive habits such as rote memorization or the acquisition of muscular skills. The belief being simply that, as the old saying has it, 'Practice makes perfect.' From this it is predicted that learning curves plotting performance against practice trials should increase in accord with the law. Forgetting curves will show the opposite tendency with a loss of skill over various intervals. A third law, the law of readiness, was an accessory principle which characterizes the conditions under which there is satisfaction or annoyance. It was couched in rather dubious neuro-physiological terms which can be paraphrased as follows:

1. Given the arousal of an impulse to a particular sequence of actions, the smooth carrying out of the sequence is satisfying.
2. If the sequence is blocked, that is annoying.
3. If the action is fatigued or satiated, then forced repetition is annoying.

Here, Thorndike was suggesting that satisfaction and frustration or annoyance depend on the state of readiness of the organism when a particular response occurs.

These laws of connection forming or association or habit furnished education with two obvious general rules, according to Thorndike: (1) put together what should go together and keep apart what should not go together, (2) reward desirable connections and make undesirable connections produce discomfort. In other words, exercise and reward desirable connections and prevent or punish undesirable connections. He felt that although such rules or principles may seem obvious the fact was that an examination of the literature of educational theory, at that time, would prove that they were neglected and misunderstood, and that practical use of them was never made.

However, these simple laws, derived from his early research in the animal laboratory, were placed in the context of the complexities of human learning, where four varieties of learning could be distinguished: (1) connection-forming of the common animal type, as is found when the ten-month- old baby learns to beat a drum, (2) connection-forming of ideas, as when a two-year-old learns to think of its mother upon hearing the word 'mother', (3) analysis or abstraction, as when a student of music learns to respond to an overtone in a given sound, and (4) selective thinking or reasoning, as when a language student learns the meaning of a sentence by using his knowledge of the rules of syntax.

His advice to the teacher was not limited to the application of his major laws. The active role of the learner, who comes to the learning situation with a constellation of motivational variables was also recognized by Thorndike and he listed five aids to improvement in learning, which he believed were accepted by educators, and which will surely stand scrutiny today (1913, pp.217-226):

1. Interest in the work

2. Interest in improvement in performance
3. Significance of the lesson for some goal of the student
4. Problem attitude in which the student is made aware of a need which will be satisfied by learning the lesson
5. Attentiveness to the work

Unfortunately, his laws of learning did not stand the test of time. To Thorndike's credit, he was prepared to acknowledge his errors and, in 1929, before the International Congress of Psychology in New Haven, he admitted that he was wrong and introduced two fundamental revisions of his laws of exercise and effect.

It became apparent that exercise alone will not necessarily produce improved performance. For example, if a blindfolded subject is asked to attempt to draw a line of a given length, and to do so hundreds of times, over many days, but without information concerning the accuracy of his performance, there is no improvement in the ability to draw the line of correct length during the experiment. Feedback is clearly an essential component. Thorndike (1931) quotes an experiment in which a long series of word-number pairs was presented to the subjects. If repetition alone produced the stamping in of associations then each of the pairs (number-word, word-number) should have been recalled with equal strength. They were not, and it was clear that the subject's mental set and expectations guided the associations formed.

A number of experiments also demonstrated that the effects of reward and punishment are not equal and opposite. Instead, under several conditions, reward was found to be much more powerful than punishment. One such experiment (1932) used a simple maze which gave chicks a choice of three pathways, one of which led to 'freedom, food and company.' The wrong choices led to confinement for thirty seconds. Thorndike concluded that:

> The results of all comparisons by all methods tell the same story. Rewarding a connection always strengthened it substantially; punishing it weakened it little or not at all. (Thorndike, 1932, p.58)

Similar effects were found with human subjects learning word translations, the rewarded responses (experimenter saying 'Right') led to repetition of the rewarded condition, but the punished condition ('Wrong') did not weaken the connections.

Thorndike went on to collect a series of testimonials about the relative effects of rewards and punishments from published biographies and other sources and found almost universal evidence of the greater beneficial effect of reward than punishment (1935, pp.135-144, 248-255).

These changes in the laws of learning occurred at a time when Thorndike's proposals for the development of a science and technology of instruction were being eclipsed by the rise of the new school of psychology, J. B. Watson's 'Behaviourism.'

His contribution to modern instructional technology, however, cannot be overestimated. He was the undisputed originator of the first scientific theory of learning and, as such, his influence has been profound and long-lasting, not least because of his prescience concerning the potential of technology in the pedagogical process. As early as 1912 he suggested that:

> Great economies are possible by printing aids, and personal comment and question should be saved to do what only it can do. A human being should not be wasted in doing what forty sheets of paper or two phonographs can do. Just because personal teaching is precious and can do what books and apparatus cannot, it should be saved for its peculiar work. The best teacher uses books and appliances as well as his own insight, sympathy, and magnetism. (Thorndike, 1912, p.167)

Saettler (1968) claims that in his three-volumed work, 'Educational Psychology' (1913), Thorndike formulated the basic principles underlying a technology of instruction. In implementing these principles Thorndike suggested that control of the learning may not be the sole responsibility of the teacher and that machines could play a part. He proposed what may be considered the earliest example of programmed learning in his influential text 'Education' (1912):

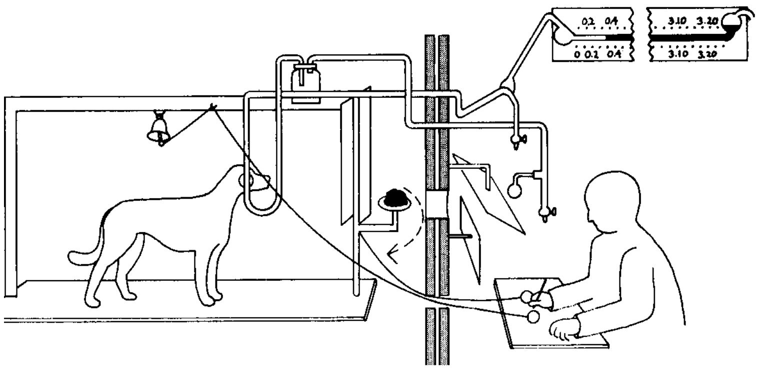
> If, by a miracle of mechanical ingenuity, a book could be arranged that only to him who had done what was directed on page one would page two become visible, and so on, much that now requires personal instruction could be managed by print. (Thorndike, 1912, p.165)

He was also an advocate of the laboratory method where students examined real things and observed them working rather than merely speculating or arguing about them. He suggested that there are certain elements of knowledge, certain tendencies to respond, which can only be got by direct experience of real things.

> This fact may, and should, now seem axiomatic, but many teachers in practice forget it, and teachers a few centuries ago rarely thought about it. The increased use of methods whereby the realities are examined and experimented with as well as talked about, enormously improved the teaching of mathematics, science, history and even language. (Thorndike, 1912, p.176)

However, he also advised that verbal methods were

Figure 1-4. Pavlov's Experimental Apparatus.



not always wrong, nor that a pupil should always be provided with the direct experience itself. He anticipated the later audiovisual movement with his claim that different degrees of reality may be desirable - the actual thing or a model of it, a photograph or a rough sketch or even a map of it (1912, p.177). He also cautioned against the unbridled use of the popular discovery methods and suggested that if the doctrine is taken literally ‘it becomes absurd’, and that:

> It would be enormously costly thus to deprive children of the advantages of civilization, and would be the height of folly, even if it could be done at no cost. (Thorndike, 1912, p.194)

In fact, in his early work, Thorndike sees much to commend those methods embodying ‘telling and showing’, such as lectures and demonstrations but also including the use of printed text-books, object lessons, maps, dictionaries and tables of logarithms, all of which are ‘clear cases of the lecture-demonstration or telling-showing method’ (1912, p.189). He acknowledged the criticisms that the student may see or hear but not understand and that he does not learn to think but concluded that ‘the chief excellence of this method is economy.... in some cases this advantage alone justifies its use’ (1912, p.189).

Pavlov, Ivan Petrovich (1849-1936)

Pavlov, the father of Russian psychology, initially trained and worked as a physiologist. He gradually changed his interest in favour of psychology following the incidental observation of the phenomena we now know as the conditioned reflex. His influence on psychology has been profound and long-lasting. In fact, Kimble (1961) found that 31 terms relevant to conditioning and learning are directly attributable to Pavlov, and only 21 terms to all American and Western psychologists combined. He was awarded the Nobel Prize in 1904 for ‘The Work of the Digestive Glands’ (1897), the first Russian scientist, and the first physiologist in the world, to receive the award.

In his student years Pavlov was attracted to the philosophy of materialism, particularly as embodied in the work of Claude Bernard, which suggested that the science of living phenomena must have the same foundations as the science of inorganic bodies and that there is no difference between the principles of biological science and those of physico-chemical science.

A particularly strong influence on Pavlov was the physiologist I.M. Sechenov, who conducted a series of experimental investigations of the nervous system and its reflexes in Bernard’s laboratory in 1862. He tried to publish the results of this work in a widely read Moscow review under the title ‘An Attempt to Establish the Physiological Basis of Psychical Processes.’ However, the tsarist censor realized that Sechenov’s intention was to spread materialistic ideas concerning the relationship between physiology and psychic activity, and would only permit publication in a specialist medical journal under the title ‘Reflexes of the Brain.’ The article represented a daring challenge to the deeply entrenched Cartesian doctrine of psycho-physiological parallelism, that body and mind comprise two completely separate and materially unrelated systems, which somehow run on parallel tracks and, when it eventually appeared in book form, it again produced a reactionary outcry from the Petersburgh Censorial Committee, on the grounds that it destroyed the religious doctrine of eternal life. This was just four years after Darwin’s ‘Origin of the Species’ (1859), which taught that all phenomena have a history including origin and development from lower forms, had shaken the foundation of the creationist religious dogma. Sechenov’s book, which supported Darwin’s ideas, eventually became a popular classic of the time and Sechenov

Figure 1-5. Pavlov's Conditioning Procedure.

Meat Powder (unconditioned stimulus)	→	Salivation (unconditioned response)
Meat Powder	→	Salivation + Sound of bell (neutral stimulus)
Sound of bell (conditioned stimulus)	→	Salivation, after repeated pairings (conditioned response)

passed the remaining years of his academic life as Professor of Physiology at Moscow University.

Sechenov proposed that all the immense diversity of psychical phenomena can and must be explained on the basis of the nervous system and the brain, through the mechanism of reflex arcs. He suggested that thought and emotion can be accounted for in terms of the reflex, by analogy with lower forms, but it was Pavlov who provided experimental proof of this with the discovery of the conditioned reflex.

Entering the University of St. Petersburgh to study natural science, Pavlov's early interest in physiology flourished and he received a gold medal for his experimental work on the physiology of the nerves of the pancreas. In 1875 he received his degree, with an outstanding record of achievement. By 1890 Pavlov had perfected a method for studying the nervous regulation of the blood, with animals trained to undergo all the manipulations of a long and complex experiment without narcosis. From 1891 he was head of the Department of Physiology in the new Institute of Experimental Medicine, and it was here that he conducted his work on the digestive glands. Pavlov found that vivisectional methods were unsuitable for studying the intricate workings of the digestive system and so he perfected the 'chronic' experimental method, begun in his work on the circulatory system. This involved the creation, through highly skilled surgery, of a fistula, an opening or a window which allowed the experimenter to observe the functioning of the gland under controlled conditions, but in a normal healthy animal.

By 1901 Pavlov became engrossed in a problem which he had deferred investigating, but which was to lead to the discovery of the conditioned reflex, to which he devoted the remaining 35 years of his life.

During his experimental work Pavlov had found that gastric juice was secreted by experimental dogs not only when food was introduced into the mouth but also when they saw the food. This action at a distance, through the eyes, ears and nose was generally interpreted in terms of the so-called higher functions and was considered to be far beyond the reach of physiology.

Animal psychology was not on an objective experimental basis at this time, Thorndike's 'Animal Intelligence' had only recently been published and was not available to Pavlov. At first, Pavlov suggested that the observed anticipation and consequent salivation must be acquired with the aid of the higher functions - the animals judgement, will and desires, but he soon distanced himself from such a view:

> To understand these phenomena, are we obliged to enter into the inner state of the animal and to fancy his feelings and wishes as based on our own? For the investigator, I believe there is only one possible answer to the last question - an absolute "No." .... In our "psychical" experiments on the salivary glands (we shall provisionally use the word "psychical"), at first we honestly endeavoured to explain our results by fancying the subjective condition of the animal. But nothing came of it except unsuccessful controversies, and individual, personal, inco-ordinated opinions. We had no alternative but to place the investigation on a purely objective basis. (Pavlov, 1928, p.50)

The psychical experiments demonstrated that it was not just the appearance of the food, its odour etc. which produced salivation, but 'absolutely all the surroundings in which these objects are presented to the dog, or the circumstances with which they are connected in real life'(p.52). For example, the dish, the room, the person who usually fed the animal and the noises produced by him. Pavlov recognized the adaptive value of such reactions to 'remote signs (signals).' In fact, this adaptive reflex was originally termed conditional and not conditioned by Pavlov, in his address on the occasion of receiving the Nobel Prize. However, 'conditioned' reflex has become fixed in English usage. The conditioning procedure is shown in Figure 1-5.

> A further essential difference between the old and the new reflexes is that the former are constant and unconditional, while the latter are subject to fluctuation, and dependent upon many conditions. They, therefore, deserve the name "conditional" (ooslovny). (Pavlov, 1928, p.79)

The great discovery made by Pavlov was that any stimulus, even one not remotely connected with an inborn reflex, when paired with a stimulus inextricably linked to an inborn reflex response, could take the place of the original stimulus. In this case, the sound of the bell (originally neutral, producing no salivation) is repeatedly paired with meat powder (the unconditioned stimulus) which calls forth the salivation reflex. Following repeated pairings, the sound of the bell acquires the power to evoke the salivation reflex, even in the absence of meat powder. It is, in effect, acting as a signal for the meat powder, producing an anticipatory response.

By 1904, Pavlov was discussing the importance of the signals which stand in place of the unconditioned stimulus in the reflex. These signals can have only a conditional significance and are readily subjected to change, for example, when the sound of the bell is not accompanied by meat powder the salivation response is gradually weakened, a process termed 'extinction.' And this is precisely how adaptive advantage is conferred. In the wild a startle or fear response may be evoked in an animal by any number of stimuli presented by a predator, those which are repeatedly present are strengthened as signals, while others of an incidental nature are extinguished.

Pavlov decided that organisms must possess two sets of reflexes. A fixed set of simple, inherited reflexes and a set of acquired, conditioned reflexes formed by the pairing of previously neutral stimuli with a stimulus which triggers off a simple reflex. The conditioned reflexes were found to be routed through the cerebral hemispheres, causing Pavlov to suggest that:

> The central physiological phenomenon in the normal work of the cerebral hemispheres is that which we have termed the 'conditioned reflex.' This is a temporary nervous connection between numberless agents in the animal's external environment, which are received by the receptors of the given animal, and the definite activities of the organism. This phenomenon is called by psychologists 'association'....The basic physiological function of the cerebral hemispheres throughout the.... individual's life consists in a constant addition of numberless signalling conditioned stimuli to the limited number of the initial inborn unconditioned stimuli, in other words, in constantly supplementing the unconditioned reflexes by conditioned ones. Thus, the objects of the instincts exert an influence on the organism in ever-widening regions of nature by means of more and more diverse signs or signals, both simple and complex; consequently, the instincts are more and more fully and perfectly satisfied, ie., the organism is more reliably preserved in the surrounding nature. (Pavlov, 1955, p.272-273)

The organism is sensitized to signals in the environment which help in the avoidance of pain and difficulties and lead to the things needed for the preservation of the individual and perpetuation of the species. Pavlov felt that all complex learned behaviour is composed of orchestrated simple reflexes, which are physiological, rather than mental, processes. From this it followed that objective investigations would lead, ultimately, to the prediction of all human and animal behaviour. In this, Pavlov paved the way for an objective science of behaviour which was to appeal to Watson and the behaviourists later in the century.

Watson, John B. (1878-1958)

John B. Watson is generally accorded the distinction of being the founder of 'Behaviourism.' His early work was concerned with ethological studies of the behaviour of birds in the wild, and laboratory learning experiments with white rats in mazes, which earned him his doctorate in 1903. His major impact was made with the so-called manifesto for behaviourism: Psychology as the Behaviourist Views It (1913), in which he was not proposing a new science as such, but was arguing that psychology should be redefined as the 'study of behaviour' rather than the science of the 'phenomena of consciousness.'

> Psychology as the behaviourist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behaviour. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. The behaviourist, in his efforts to get a unitary scheme of animal response, recognizes no dividing line between man and brute. The behaviour of man, with all of its refinements and complexity, forms only a part of the behaviourist's total scheme of investigation. (Watson, 1913, p.158)

Just as Thorndike had sought to rid psychology of speculations concerning animal consciousness and thought, so Watson wished to circumvent human consciousness in favour of an objective study of behaviour alone. He wished psychology to turn away from the introspectionist psychology of Wundt and Titchener. Wundt had set up the world's first formal laboratory of psychology in Leipzig and had started the first effective journal for experimental psychology, but his work and that of his followers, including Titchener at Cornell University's laboratory of experimental psychology, failed to live up to Watson's expectations:

> It was the boast of Wundt's students, in 1879, when the first psychological laboratory was established, that psychology had at last become a science without a soul. For fifty years we have kept this pseudo-science, exactly as Wundt laid it down. All that Wundt and his students really accomplished was to substitute for the word "soul" the word "consciousness." (Watson, 1925, p.5)

Watson felt that one can assume either the presence or absence of consciousness anywhere in the phylogenetic scale, without it influencing the study of behaviour or the behaviouristic experimental method. The emphasis on human consciousness as the centre of reference for all behaviour caused him to draw the analogy with the Darwinian movement and its initial concern with material which contributed to an understanding of the origin and development of the human race. However, the moment zoology undertook the experimental study of evolution and descent, the situation immediately changed and data was accumulated from the study of many species of plants and animals, with the laws of inheritance being worked out for the particular type under investigation. Such studies were of equal value when compared with those dealing with human evolution.

The new brand of psychology was also to provide an answer to the question 'What is the bearing of animal work upon human psychology?' which, Watson admitted, had caused him some embarrassment. He suggested that for a fusion of animal and human studies to occur some kind of compromise was necessary: either psychology would have to change its viewpoint so as to take into account facts of behaviour, whether or not they had bearings upon the problems of consciousness; or else behaviour would have to stand alone as a wholly separate and independent science. Watson declared that should there be a failure of 'human psychologists' to accommodate, the behaviourists would be driven to using methods of investigation comparable to those employed in animal work, with human subjects.

Watson's quarrel was not with the systematic and structural introspectionists alone. It was also with the new styled functionalist school, which was supposed to throw light on the biological significance of consciousness instead of its analysis into structural elements. Watson found, having done his best to understand the difference between structural and functional psychology, that 'instead of clarity, confusion grows in me.'

He was concerned, ultimately, to unite such diverse studies as the paramecium response to light, learning problems in rats and plateaus in human learning curves, but in each case by direct observation and under experimental conditions. This psychology would be undertaken in terms of stimulus and response, habit formation, habit integrations and the like. It would take as a starting point, first, the observable fact that organisms, man and animal alike, adjust to their environments by two means: hereditary and habit. Secondly, that certain stimuli lead organisms to make responses. Such a system of psychology, Watson believed, when completely worked out would enable the stimulus to be predicted, given the response; or, given the stimulus, the response could be predicted. Watson makes clear what it is he really requires of psychology:

> In the main, my desire in all such work is to gain an accurate knowledge of adjustments and the stimuli calling them forth. My final reason for this is to learn general and particular methods by which I may control behaviour. (Watson, 1913, p.168)

If psychology were to take such a path there would be practical benefits, which Watson put into effect in 1920, when he was forced to leave the academic life following a scandalous affair with a former pupil: he became an advertising man. He felt that, with such a psychology, the educator, the physician, the jurist and the businessman could utilize the data in a practical way. In pedagogy, for example, the psychologist may endeavour to find out 'by experimentation whether a series of stanzas may be acquired more readily if the whole is learned at once, or whether it is more advantageous to learn each stanza separately and then pass to the succeeding one' (p.169). The psychologist would not attempt to apply the findings, they would merely be made available to the teacher, application of the principle being purely voluntary.

But who would fail to apply the principles and powerful techniques which Watson had in mind for his new psychology? Conditioning was to play a significant role in this psychology as Watson made clear two years after his 'somewhat impolite papers against current methods in psychology' (1916, p.89). He felt it incumbent upon himself to suggest some method which might be used in place of introspection, following his criticisms. Conditioned reflexes were claimed to be suitable for providing the possibility of objectively approaching many problems in psychology. Using such methods Watson claimed that he gave no more instruction to the human subjects than he gave to the animal subjects; nor did he care what language the subject spoke or whether he spoke at all. The conditioned reflexes enabled Watson to 'tap certain reservoirs which have hitherto been tapped only by the introspective method.'

It was, however, Watson's conditioning of Little Albert which has attracted most attention, and has been enshrined in the history of psychology (Watson and Watson, 1921). Albert was eleven months old when he first entered Watson's laboratory. A small, white rat was shown to the boy, whose natural tendency was to stretch out his hands to touch and play with the animal. Watson documented this response, identifying it as that of a normal child, who is curious and reacts positively to the rat. A few days later the boy and the rat were brought together in the same room, but with a rather bizarre difference. Each time the child reached for the rat Watson banged a long steel bar very loudly with a carpenter's hammer, causing the infant to jump violently and fall forward 'burying his face in the mattress.' After a short interval the boy again reached out to the animal - and Watson repeated his routine with the hammer. 'Again the infant jumped violently, fell forward and began to whimper.' Little Albert was so disturbed that no further tests took place for a week.

At first, when boy and rat were reunited, Albert did not reach out for the rat. Eventually, when the rat was placed near to him, he began to reach out towards it, very gingerly, then he began playing with blocks in a normal way. Watson now showed Albert the rat three times and accompanied each presentation with the same loud noise. The child puckered his face, whimpered and withdrew his body. This procedure was repeated on a further three occasions, until as soon as the child saw the rat he began to cry and crawl away so rapidly that he was 'caught with difficulty before he reached the edge of the mattress.'

Watson claimed that this demonstrated an explanatory principle of how our emotions originate. The conditioned response generalized to other animals, including a rabbit and a dog, and even a fur coat, and survived intact for more than a week. Watson did intend de-conditioning the child, but Little Albert was adopted by a family living some distance from the laboratory, and may, even at the time of writing, survive with his fear intact!

Building on his success with Little Albert and other similar conditioning and de-conditioning experiments, and following on from the claims made by Pavlov, which suggested the powerful influences of the environment on an organism's behaviour through the agency of conditioning, Watson proposed a daring challenge, epitomizing the empiricist tradition:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select - doctor, lawyer, artist, merchant-chief and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors. (1925, p.82)

The work of Thorndike, Pavlov and Watson made psychology a respectable science in which phylogenetic continuity was an essential ingredient, permitting extrapolation from the results of animal experimentation to the complex domains of human behaviour. And nowhere was this more apparent than in the emergence of B.F. Skinner's radical behaviourism, and its educational manifestation: the linear teaching machine.

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