Changes in Thinking About How to Do Psychology

A Brief Overview for 501. (John Bransford & Nancy Vye)

In *The Cognitive Revolution* in (1986), Baars argues that have been three general "metatheories" that have guided psychological thinking. Baar defines a metatheory as "...a viewpoint about how one goes about doing the science..." (p. 4). Baar notes that, since psychology is such a young science, its theories are often quite limited in scope (e.g., a particular theory may only apply to color perception or rote memory, etc.). However, the predominant metatheory in the field defines the field itself. Baar states:

"Psychologists may disagree about any particular topic, but if they share the same metatheory, they will be able to agree on what constitutes evidence for or against their claims. On the other hand, if they cannot define their standard of evidence or their views about the proper domain for psychology, scientific work and communication become nearly impossible." (pp. 4-5).

The three metatheories discussed by Baar are: (1) Introspectionism; (2) Behaviorism and (3) Cognitive Psychology. He argues that these represent three fundamentally different ways of approaching the study of human beings.

Introspectionism

For centuries, attempts to understand human beings were usually relegated to the field of philosophy. It was only at the turn of the Century that a separate discipline called "psychology" emerged. The beginnings of psychology as a discipline are usually associated with Wilhelm Wundt (1832 - 1920), a German psychologist who established the first psychological laboratory in 1879. One of his goals was to study through experimentation of the mental processes of human beings.

A major emphasis of Wundt, and especially of his student, Edward Titchener (1867 - 1927) was on the nature of human consciousness. What were the basic elements of human consciousness, and how were they combined? One analogy was to chemistry--scientists had discovered basic elements that were the building block of all materials (e.g., water is made of hydrogen and oxygen, etc.). Perhaps there were basic sensations that could be developed that were the building block of all possible conscious ideas.

Baars (1986) provides a quotation from Wundt's introduction to psychology that was published in 1912 (Baars, p. 31). The quotation involves an analysis of the experiences produced by a series of clicks from a metronome: "...we have at the end of the row of beats the impression of an agreeable whole. If we wish to define this concept of 'agreeable' more accurately, we may describe it as a subjective feeling of pleasure.... But feelings of pleasure are not the only ones that we observe in our experiments.... At the moment immediately following one beat, expectation strains itself to catch the next one, and this straining increases until this beat really occurs....” (p. 50).

Wundt concludes by noting that "...our metronome experiments have brought to light three pairs of feelings- pleasure and pain, strain and relaxation, excitation and quiescence." (p. 51). Later in his book, he argues that these three dimensions of experience also appear in our experiences of music, color and emotion. These, then, are assumed to be some of the basics from which conscious experiences arise.

Wundt's approach to psychology was actually quite broad and included the study of people in their everyday environments (e.g., Baar, 1986). In contrast, Wundt's student, Titchner, focuses much more exclusively on the contents of consciousness. Since he was the one who brought Wundtian psychology to the United States, his ideas had a profound impact on the field (part of their impact was that people argued against them and eventually began the Behaviorist tradition).

Titchner and his students developed techniques of "analytic self-observation" to attempt to find the elements of consciousness. In essence, they introspected on their own experiences and tried to draw conclusions from these introspections. As an example, what comes to mind when you think of "triangle". Do you see a brief image, do you get a vague feeling of familiarity? Do you conjure up a verbal definition? Observations such as these provided the data for theories of the conscious mind.

Reactions Against Wundt and Titchner: Imageless Thought

Many different groups found problems with the "mentalism" inherent in the introspectionist approach to psychology. One of these groups was the Wurtzburg group who found that, for many tasks, there were no clear mental elements that came to consciousness. Instead, in many instances there seemed to be "imageless thought". If this were true, it meant that one could not have a comprehensive theory of human beings that was based solely on a theory of consciousness. It also meant that methodologies other than introspection had to be devised.

Of course, a critic of claims for "imageless thought" could argue that the people doing the introspection were simply not well-enough trained. But this highlights the limitations of introspection as a technique for scientific inquiry. As Woodworth and Schlosberg note in their discussion of the history of psychology (1954):

"Some (observers) reported visual images, some auditory, some kinesthetic, some verbal. Some reported vivid images, some mostly vague and scrappy ones. Some insisted that at the moment of a clear flash of thought they had no true images at all but only an awareness of some relationship.... Many psychologists would not accept testimony of this kind which they same must be due to imperfect introspection."

Behaviorism

A major movement that evolved in reaction to introspectionism was Behaviorism. John D. Watson (1978-1958) was an early Behaviorist in America, and his writings were extremely influential. In fact, from 1913 on, Behaviorism dominated American

psychology. Furthermore, American psychologists began to outnumber all other psychologists throughout the world, so Behaviorism came to dominate all of psychology.

In 1913, Watson published his now- classic paper "Psychology as the Behaviorist Views it". It was extremely well received, and Watson was elected president of the American Psychological Association two years later. Watson argued that, in order to be scientific, psychology needed to be about behavior--about observable, physical movements that organisms actually make. This was very different from a psychology that attempted to analyze the contents of consciousness. Watson and his colleagues argued that introspection was subjective rather than objective--how do we know that people are accurate when they report on the seeming contents of their own consciousness. By measuring actual behavior, the data of psychology become public rather than private. With public data, different people can all observe the same thing.

In his book Behaviorism, published in 1925, Watson includes the following on the first page:

"...all schools of psychology except that of behaviorism claim that 'consciousness' is the subject-matter of psychology. Behaviorism, on the contrary, holds that the subject matter of human psychology is the behavior or activities of the human being. Behaviorism claims that 'consciousness' is neither a definable nor a usable concept; that it is merely another word for the 'soul' of more ancient times. The old psychology is thus dominated by a kind of subtle religious philosophy." (p. 1)

Pavlov and Conditioned Reflexes

The vision of a scientific psychology founded on principles of objective data rather than subjective experiences was bolstered by Pavlov's discoveries involving the conditioned reflex. Ivan P. Pavlov (18 - 19) was a Russian physiologist who was world-famous for his work on the digestive system of dogs. In one of his experiments he implanted tubes in the mouths of dogs in order to measure their salivation.

Salivation was a reflex that automatically occurred when food was presented. Pavlov noted that, eventually, the animals learned to anticipate food and hence began to salivate before it appeared. This was a future oriented behavior that appeared to be adaptive. He became interested in studying these "psychic reflexes".

In essence, Pavlov learned that any stimulus (e.g., a bell, the sight of a person, etc.) could serve as a signal for food as long as the stimulus was paired with food and that, during learning; the interval between the stimulus and the food was kept short. The salivation reflex became conditional on the stimulus. Today, this form of learning is referred to as the acquisition of "conditioned reflexes" or, more generally, as "classical conditioning".

In the U.S., Watson was excited about the discovery of conditioning and saw it as a breakthrough. A theory of learning became possible, where learning involved the conditioning of inborn reflexes to new stimuli. The idea of learning new connections

between environmental stimuli and responses provided a framework for a scientific theory of learning. The idea of understanding how learning occurred, and being able to do something do promote it, generated a great deal of optimism about people's potential--an optimism that was especially well received in the "land of opportunity". A classic quote from Watson (1930) illustrates this optimism (see also Chapter 3):

"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..." (p. 82).

The Conditioning of Emotional Reactions

Watson also felt that classical conditioning could explain a number of emotional reactions. For example, in a study published in 1920 (Watson & Rayner), he and his colleague explored emotional reactions in infants. At the time, it was commonly believed that infants were instinctively afraid of stimuli such as fire, dogs, cats and laboratory rats. Watson and Rayner tested these infants and found that, when they were young, fear of these objects did not appear to be innate.

How might fear of such stimuli develop? Through conditioning, thought Watson. To test these ideas, he and Rayner worked with Albert B., an 11- month old boy. When they began the experiment, Albert showed no fear of a white laboratory rat. However, Albert did note that he showed fear to a loud noise. By following the sight of the white rat with a loud noise, they soon established a fear response to the rat alone. Watson felt that emotional reactions to all kinds of stimuli are learned in this manner. One's reactions to various stimuli therefore need not be "rational". Through conditioning, the assumption is stimulus - response pairings are formed without conscious intent.

Thorndike's Connectionism

The idea of viewing learning as the formation of connections or associations between stimuli and responses was appealing to many different psychologists. A very prominent one was Edward L. Thorndike (18 - 19) who stated: "Learning is connecting. The mind is man's connection-system." (1931, p. 122). *As* Baars notes, the idea of connectionism or associationism has a long history that dates back at least to Aristotle. However, earlier associationists talked about connections among ideas. Behaviorists such as Thorndike talked about connections between physical stimuli and physic responses.

A classic set of investigations conducted by Thorndike involved a connectionist account of problem solving. Chance (1988) notes that Thorndike became interested in exploring animal intelligence. In the early 1900's, many people believed that their cats and dogs reasoned about situations. There were strong tendencies to attribute humanlike, mental qualities to animals (e.g., they have thoughts and feelings and ideas and desires). This went against the Behaviorist's beliefs.

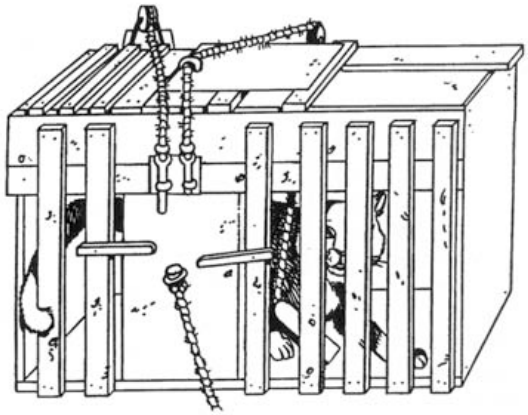

FIGURE 1 Thorndike's puzzle box. To get out of the box, the cat had to pull a string to release one of the door locks, step on the lever to release the second, and then flick one of the door latches down. From E. L. Thorndike (1898). Animal intelligence: An experimental study of the associative processes in animals. *Psychological Review Monograph Supplement*, 2(8).

In a set of famous experiments, Thorndike studied the problem solving behavior of cats. He first constructed a puzzle box that had a door (see Figure). The door could be opened by activities such as pulling a wire loop or stepping on a treadle. Food was placed outside the box and a hungry cat was placed inside. Could the cat solve the problem of getting out of the box?

Thorndike noted that the cat typically exhibited "trial and error" behavior. It would try some behaviors and, when they did not work, try something else. He wrote that the cat often "tries to squeeze through any opening; it claws and bites at everything it reaches; it continues its efforts when it strikes anything loose and shaky; it may claw at things within the box" (p. 13).

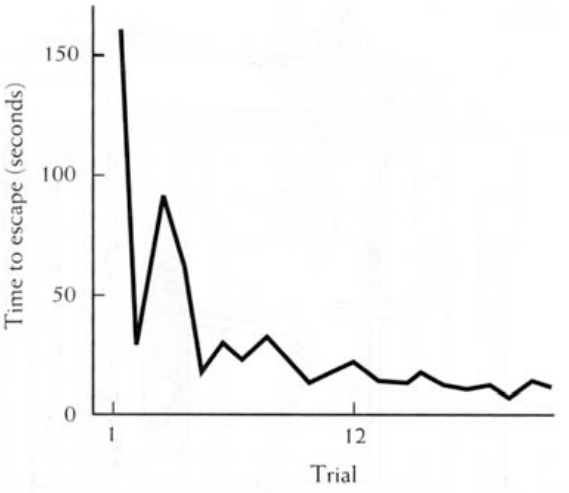

FIGURE 2 The behavior of one cat in Thorndike's puzzle box. The cat took almost 3 minutes to escape the first time, but almost always less than 1 minute after the first successful escape. From E. L. Thorndike (1898). Animal intelligence: An experimental study of the associative processes in animals. *Psychological Review Monograph Supplement*, 2(8).

Eventually, by chance, the cat would happen to pull the loop or step on the treadle and the door would open. The cat would escape and eat the food. On each successive occasion, the cat would show fewer and fewer behaviors that were irrelevant to opening the door. Eventually it would immediately pull the loop or walk on the treadle to escape (see Figure).

Thorndike attributed the cat's eventual problem solving to trial and error behavior. Eventually, a response was rewarded by food and hence would be strengthened so that it was more likely to be elicited the next time. Thorndike referred to the effects of rewards as the Law of Effect. They probability of a response depends on the effect it has on the environment (e.g., getting out of the cage versus not). The law of effect assumes that responses that do not help solve a problem lose strength whereas those that do help solve one gain in strength.

The Importance of Feedback: Thorndike believed that reinforcement could involve information rather than always be tied to food. In one study (1931/1968) he tried to draw lines that were exactly 4 inches long with his eyes closed. He practiced for 3,000 trials but he never received any feedback about how close each attempt was. Without feedback he made no progress. On the first day of practice, his lines varied from 4.5 to 6.2 inches. On the last day they varied from 4.1 to 5.7 inches. Thorndike concluded that practice does not make perfect unless it provides the opportunity for reinforcement.

Observational Learning: In his 1898 studies, Thorndike also explored the degree to which a cat could learn to escape from a puzzle box by being placed in one and then watching another cat escape. No matter how many times Thorndike explored cats to the right of another one escape, the cats who merely observed showed no evidence of learning (see Chance, 1988, p. 131). Similar attempts were made later with monkeys; again with no success. In 1908, John B. Watson performed a similar series of experiments using monkeys and found the same negative results that Thorndike found.

It was not until the 1930s that researchers found evidence that monkeys could learn from observing. Carl Warden and coworkers at Columbia had monkeys observe as a trained one pulled a chain that opened a door and revealed a raisin that was then eaten. The observer monkeys provided evidence that, after *5* chances to observe, they had learned. Perhaps Warden's situation was simpler and hence there was a greater chance that the observer monkeys would attend to the correct dimension. Perhaps the response was more natural (pulling on a chain versus stepping on a treadle). At any rate, it became clear that, under the right conditions, observational learning could occur.

Skinner's Operant Conditioning

The heir apparent to John B. Watson is B. F. Skinner. Born in 1904, Skinner has had a profound influence on twentieth century psychological thought. Skinner's work builds upon and extends Thorndike's. Skinner's primary focus is on instrumental conditioning, which can be contrasted to Pavlov's classical conditioning. In general, in classical conditioning the responses to be connected to new stimuli are all "old, they began as inborn reflexes. In Instrumental conditioning, new responses are shaped by contingencies between the response and a reinforcement. This distinction is somewhat oversimplified,

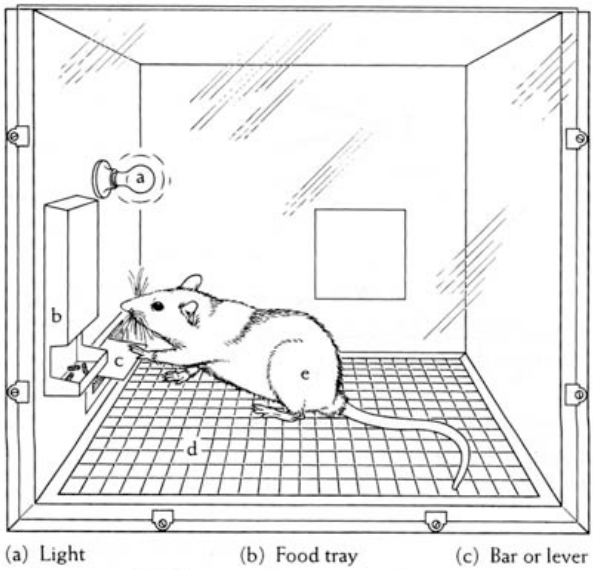

FIGURE 3 A Skinner box. Skinner called it an "experimental space."

however. Even in classical conditioning, the conditioned response is somewhat different from the original reflex. In salivation in dogs, for example, the among of salivation may be less for the conditioned salivation response (see Chance, 1988, for a discussion of classical conditioning).

As an illustration of instrumental conditioning, imagine placing a laboratory rat in a "Skinner box" such as the one illustrated in Figure . Is it possible to teach a rat to press the lever? How about teaching it to press the lever only when a red light appears?

Through Skinnerian principles of instrumental conditioning, it is quite easy to get a laboratory rat, a pigeon, a cat, dog and so forth to learn the preceding responses. One approach is to give the animal food immediately after it presses the level. Or alternatively, to give it food after pressing the lever but only when a red light appears.

Shaping: How does one get the organism to push a lever in the first place. Unlike the procedure used by Pavlov, there is no "push the lever reflex" with which to work. Skinner devised the method of "shaping". At first, the animal might receive food when it looks at the bar. Next when it barely touches the bar. Later it has to press the bar with enough strength to depress the lever in order to get food. Finally, only presses that occur when a red light appears are rewarded for food.

Chaining: Skinner and his colleagues have demonstrated the power of instrumental conditioning by getting animals to do perform some impressive, complex feats. For example, Skinner (1938) taught a rat to pull a string that released a marble from a rack, pick up the marble with its pays, carry the marble to the top of a tube, and drop it inside.

Cheney (1978) created a demonstration involving the apparatus in Figure . Imagine that a rat starts at A and climbs the ramp to B, crosses the drawbridge to C, climbs the latter to D, crosses the tightrope to E, climbs the ladder to F, crawls through the tunnel to G, enters the elevator and N, descends to I, presses the lever a J and receives food.

Clearly, it would be difficult to teach the preceding complex behaviors all at once (e.g., to wait until the rat does them and then provide food). Skinner's technique, and the technique used by Cheney, is to shape the behavior bit by bit and eventually chain them together.

Chance (1988) argues that the concept of chaining is highly relevant to human behavior.

"Students learn to do long division, which consists of a varies of multiplication and subtraction operations performed in a particular order. And when the students fix themselves a snack, they perform a sequence of acts: going to the refrigerator, taking out the milk, getting a glass from the cupboard, and so on. In these and other instances, reinforcement is normally available only upon completion of the last response in the chain." (p.106)

Cognitive Psychology and Cognitive Science

Baars (1986) argues that the cognitive revolution was a quiet one that occurred between 1955 and 1965:

"The cognitive revolution was not *a* spectacular one--no one stormed the Winter Palace, not even metaphorically. Public fireworks were rare. Furthermore, unlike Watson's revolution, the cognitive shift was not self-conscious. No one announced its existence until well after the fact" (p. 141).

Some cognitive psychologists disagree with this description of a quiet revolution. For them, personally, there was a considerable amount of intellectual turmoil. For example, we noted earlier the videotaped interview with Jim Jenkins who was prompted to rethink 10 years of his work on language. Furthermore, in many graduate schools in the mid 1960s there were fierce debates between behaviorists and cognitive psychologists. And there were conferences that explicitly explored the changes in points of view (e.g., see 8 Weimer & Palermo, 1974).

George Mandler, a leading psychologist, makes the following observations:

"For reasons that are obscure at present, the various tensions and inadequacies of the first half of the twentieth century cooperated to produce a new movement in psychology that first adopted the label of information processing and after became known as modern cognitive psychology. And it all happened in the five year period between 1955 and 1960. Cognitive science started during that five year period, a happening that is just beginning to become obvious to its practitioners" (1981, p. 9).

In general, cognitive psychologists began to give serious consideration to the role of "mental phenomena" such as images, concepts and general knowledge structures ("schemas"). They argued that human behavior could not be explained without recourse to these mentalistic events. Several factors contributed to these ideas.

Chomsky's Work in Linguistics: *An* important impetus to the cognitive revolution was Noam Chomsky's work in linguistics (1959). He analyzed the nature of human language and showed that it was a very complex system that could not be acquired by simply laws of conditioning (Chomsky, 1957, 1965). His critical review of Skinner's Verbal Behavior (Skinner, 1957; Chomsky, 1959) prompted a great deal of interest.

Digital Computers: Another major influence on cognitive theory was the advent of the digital computer. Computers make it possible to construct complex, dynamic theories that allow one to follow the possible implications of basic ideas. For example, in the mid 1950s, Alan Newell and Herbert Simon created a program called **The Logic Theorist**. It was able to solve a variety of theorems in mathematics. Later they created other programs such as the **General Problem Solver** (Newell and Simon, 1972) that could solve theorems, play chess, and solve puzzles such as the missionary-cannibal problem. By

creating working computer models, Newell and Simon were able to build a much more precise theory than is possible if one only uses words.

Sophisticated Experimental Methods: A third influence on cognitive psychology involved advances in methodological tools necessary to understand complex phenomena. For example, cognitive psychologists built on the original work of Donders (19) in order to develop techniques for measuring reaction time. This allowed them to study hypothetical mental phenomena rather than merely introspect on what appeared in consciousness.

Here is an example of a use of reaction time: Imagine being in an experiment where you are asked to read a sentence and decide whether it is true or false as quickly as possible. Examples might be:

2. A dog has wings (false)
3. Aristotle was a man (true)
3. Aristotle had a liver (true)

As you can imagine, people are much faster at answering sentences like (2) than like (3). But why? One possibility is that, in order to answer sentence (3), one has to make a set of inferences: "Aristotle was a human. All humans have a liver. Therefore, Aristotle must have had a liver." It takes time to make inferences, so the reaction time is slower in cases such as these.

A number of theorists use reaction time data to make inferences about the structure of knowledge and about the processes people use to operate on that knowledge. Examples include J. Anderson (1987); Collins & Quillian (1970) and Ericson (1988). I'll say more about reaction time data later on.

Precursors to the Cognitive Revolution

It is important to note that, even during the Behaviorist era, there were schools of psychologists who were cognitive in nature. Some of them were outspoken in their opposition to behaviorist points of view.

Gestalt Psychology

A case in point is the Gestalt psychologists. These theorists argued that perception and memory were not simply composed of chains of associations. Instead, percepts and ideas involved organized structures--Gestalts. The whole of these structures was more than the sum of their parts.

One contrast between Gestalt and Behavioristic approaches to psychology involves work on problem solving. Our earlier discussion of Thorndike emphasized the importance of trial and error behavior in accounting for cats getting out of puzzle boxes. In contrast,

Gestalt psychologist emphasized the importance of reorganizing one's perception of the situation through insight

Wolfgang Kohler's work with chimpanzees is a good illustration of a Gestalt perspective (Kohler, 1925). In one of his experiments he put a chimp in a cage with a banana outside, out of reach. The chimp might have several sticks in his cage, but neither one alone was long enough to reach the banana. Kohler noted that the ape first tried to reach the banana with one stick and eventually paused and seemed reflective. The ape then seemed to get an insight--a "aha experience"--that allowed him to restructure the situation into a new Gestalt. The "aha" was to put the two sticks together *so* that they were long enough to reach the banana. In other experiments the ape might have to move a chair on top of a box to get food hung at the top of its cage.

Other psychologists in the Gestalt tradition extended this type of thinking to human problem solving. Max Wertheimer (1945) looked at ways of solving geometry problems and arithmetic puzzles that involve understanding and insight. Karl Dunker (1942) explored how restructuring occurred in the solving of engineering problems. Abraham Luchins (1942) studied how various aspects of knowledge can block insight into new solution paths.

Bartlett

Another influential non-behaviorist was Frederic Bartlett, an English Psychologist. He was interested in memory and he noted that, in most cases people provide paraphrases of the general gist of messages rather than recall word-for-word. He postulated the importance of "schemas" for memory--a theory of memory that is quite different from one which assumes that, in verbal recall for example, one is remembering connections between specific words that comprise sentences. This notion of schema theory will be discussed in more detail later on.

Piaget

Jean Piaget, a leading pioneer in developmental psychology was another influential theorist who orientation was decidedly cognitive rather than behavioristic. His work is most relevant in the context of discussions of child development (see Chapters). For present purposes, it is interesting to note that, for many years, his work was prominent in Europe but not in the United States (Piaget lived in Geneva, Switzerland). A major part of the reason was that his approach to psychology did not fit the behaviorists' framework. In 19 , John Flavell published a text that played an important role in introducing Piaget's work to American psychologists. Since that time, Piaget's ideas have had an important influence on psychological thought.