

## **Clark L. Hull, 1884-1952**

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Clark L. Hull was born in Akron, New York, on May 24, 1884, and died in New Haven, Connecticut, on May 10, 1952. After early experience as a teacher in a one-room schoolhouse, and later as a school principal and apprentice mining engineer, he received his AB, with a major in psychology, from the University of Michigan in 1913. He then moved to the University of Wisconsin for graduate study, working with Joseph Jastrow (Blumenthal, 1990; Jastrow, 1930) and others, and taking his PhD in 1918. He then joined the faculty at Wisconsin before moving to Yale in 1929 as a Research Professor in the Institute of Psychology, which was later folded into the Institute of Human Relations (IHR), an interdisciplinary group of social scientists and psychiatrists whose members included John Dollard, Neal Miller, and O.H. Mowrer. At IHR, his Monday-evening seminars drew dozens of participants. He later was appointed Sterling Professor in the Department of Psychology (Beach, 1959; Hovland, 1952; Hull, 1952b).

Best known for his theory of learning, Hull's career actually went through a number of phases. His doctoral dissertation on concept formation was a milestone in the evolution of scientific psychology. Immanuel Kant had argued that psychology could never be a science, because the mind, being immaterial, could not be observed and measured. The 19<sup>th</sup>-century psychophysicists and physiological psychologists – Weber, Fechner, Helmholtz, and Donders -- quickly proved Kant wrong. Even so, Wilhelm Wundt argued that scientific psychology, as a natural science (*Naturwissenschaft*), was

limited to the study of immediate experience -- that is, to sensation and perception. The so-called "higher" mental processes, such as memory and thought, were too far away, as it were, from the instigating physical stimulus, and the underlying physiology was deemed too complex, so they were relegated to *Geisteswissenschaft*. By the end of the 19<sup>th</sup> century, however, Hermann von Ebbinghaus (1885/1964) and Mary Whiton Calkins (1896) had proved Wundt wrong with respect to memory. Hull, adapting Ebbinghaus's methods with Chinese characters as the stimulus materials, did the same for concept-formation, a function central to thinking. In the process, Hull invented the memory drum, which was to serve as an essential instrument for the study of verbal learning up until the introduction of the computer.

Hull's involvement with the study of individual differences had two quite different sources. At Wisconsin, he had been assigned to teach a course on aptitude testing. This led him to publish an early and influential textbook on the subject, advocating objective tests for use in vocational counseling (Hull, 1928). Aggravated by the tedium of computing masses of interitem correlations, he invented a "correlation machine" which took raw data on paper tape and generated squares and cross-products. The device served psychometricians well into the 1950s, when high-speed digital computers rendered it obsolete. A copy is now in the collection of the Smithsonian Institution.

The second source was hypnosis. How Hull became interested in hypnosis is not clear (Kihlstrom, 2004), but one of his teaching assignments at Wisconsin had been a course on psychology for premedical students previously taught by Jastrow, who had an interest in the subject. In any event, he and his students produced an extraordinary corpus of experimental work on the subject, culminating in his monograph on *Hypnosis*

*and Suggestibility* (Hull, 1933). Although there had been experimental work on hypnosis before, mostly at Harvard, Hull's programmatic efforts – including investigations of “waking” suggestibility as well as phenomena such as amnesia, hypermnesia, and the transcendence of normal voluntary capacities -- marked the first “golden age” of hypnosis research (the second began in the 1960s).

As its title suggests, Hull believed that hypnosis was a special case of suggestibility, and he invented a mechanical device to quantify responses to the postural sway test. Using this and similar devices, Hull explored the correlations between various forms of suggestibility, and between suggestibility and intelligence and other personality characteristics. Hull was less interested in individual differences in suggestibility, however, and more interested in hypnosis as a habit phenomenon, acquired through learning, showing the typical negatively accelerated learning curve. Nervous administrators at Yale brought an end to Hull's program of hypnosis research, although he did publish outlines of 40 experiments on suggestibility and 102 on hypnosis, many of which would be worth doing even today.

Also while at Wisconsin, Hull did pioneering research on the effects of smoking on various aspects of human performance (Hull, 1924). Smokers and nonsmokers completed a battery of tests of physiological functions, sensory-motor, and “higher” mental processes. The study yielded few significant effects on psychological functions, but more important than the results obtained were the experimental controls employed. Long before Beecher (1955) introduced the concept of the placebo to medical research, Hull understood that the results of drug studies might be artifacts of suggestion and expectation on the part of both experimenters and subjects. In an attempt to control for

such effects, Hull invented an “experimental pipe” which used an electric element to allow subjects to inhale heated air instead of tobacco smoke, through asbestos fibers (!) to simulate the effects of drawing on a pipe; the subjects were blindfolded while the experimenter smoked his own pipe to simulate the odor of tobacco. The “bite” of tobacco smoke on the tongue was simulated by increasing the temperature of the inhaled air. Subjects were literally blindfolded subjects so they could not tell the difference between experimental and control trials. All Hull neglected to do was to blind the experimenter as well.

Hull’s larger reputation, of course, rests on his contributions to stimulus-response learning theory (Hull, 1943, 1952a; see also Hilgard, 1948, 1987; Hilgard & Marquis, 1940). Inspired by Newton’s *Principia* and Whitehead and Russell’s *Principia Mathematica*, and employing the hypothetical-deductive method to generate experiments, he developed a comprehensive “behavior system” consisting of definitions, postulates, corollaries, theorems, and proofs, all expressed in mathematical form such as his famous equations,  $S E_R = S H_R \times D$  and  $S H_R = 1 - 10^{-aN}$ . In Hull’s theory, the excitatory potential of a response to a stimulus is a function of habit strength and drive strength. Drive strength is a matter of deprivation, habits are acquired through learning, learning occurs by repeatedly reinforcing responses to stimuli, and reinforcement is a matter of drive reduction.

Unfortunately, the precision of Hull’s theory was also its undoing. Examined closely, for example, it appeared to predict that both acquisition and extinction were impossible (Gleitman, Nachmias, & Neisser, 1954). In addition, Tolman demonstrated “latent” learning, in the absence of reinforcement, undermining the role of drive

reduction (Tolman & Honzik, 1930), while Skinner (1938) offered a competing system based on reinforcement that did not involve hypothetical mediating variables such as drive and drive-reduction. Nevertheless, in its broad outlines Hullian learning theory influenced both Eysenck's (1952) early experimental investigations of personality and Wolpe's (1958) technique of systematic desensitization.

Although based mostly on animal research, Hull's theory was intended to encompass human behavior as well, and the behavior of groups as well as individuals. A major project at IHR was the exploration of connections between his behavior system and Freudian psychoanalytic theory. Psychoanalysis was, by any measure, the dominant theory of personality and psychotherapy at the time, and the two theories were obviously linked by their emphasis on drive-reduction. Aside from Hull himself, the leading figures in this effort were John Dollard, a sociologist who made major contributions to understanding race relations, but who had also trained as psychoanalyst in Berlin, and Neal Miller, a psychologist whose dissertation had analyzed fear as a conditioned drive, and who had himself been analyzed in Vienna by Heinz Hartmann (he couldn't afford Freud's fee).

Under Hull's auspices, the IHR group produced a huge amount of influential work, including a major treatise on *Frustration and Aggression* (Dollard, Doob, Miller, Mowrer, & Sears, 1939), which argued that aggression was a reflexive response to the frustration of goal-directed behavior. The theory has since undergone considerable revision and refinement (Berkowitz, 1989); but the connection of the original formulation to psychoanalysis is obvious.

Another product of Hull's IHR group, less obviously tied to psychoanalysis, was the first statement of social learning theory (Miller & Dollard, 1941), with its emphasis on imitation as a secondary drive acquired through reinforcement. For Miller and Dollard, imitation was not just behavior: by virtue of reinforcement, it took on the properties of an acquired or secondary drive. Thereafter, the individual is motivated to imitate the behavior of others -- to copy their behavior in order to obtain the same rewards that they receive from their actions. Imitation is widespread because the culture reinforces it strongly, as a means of maintaining social conformity and discipline.

Miller and Dollard distinguished between two forms of imitation. In *matched-dependent* behavior, only the model recognizes the cues that elicit the behavior. A good example is crowd behavior, where people engage in certain actions (like applause or yelling) simply because other people are doing so, without knowing why. *Copying* is a much more deliberate act, in which one person consciously conforms his or her behavior to that of another person. This entails awareness of the cues that elicit the behavior of the model. Imitative behavior is central to social learning, and thus to personality. It is readily observed in even the youngest children, and indeed whenever one person possesses more authority or knowledge than another. Imitation, especially matched-dependent behavior, is the chief means by which patterns of behavior are passed from one person to another.

Social learning theory subsequently shed its Hullian origins, and focused more on expectation and other cognitive processes, and observational learning in the absence of reinforcement (Bandura, 1977; Rotter, 1954). The final product of Hull's IHR group was *Personality and Psychotherapy*, a wholesale reformulation of psychoanalytic

theory in terms of Hullian learning theory, with analyses of drive and its reduction, and the resolution of various forms of conflict – approach avoidance, approach-approach, and avoidance-avoidance (Dollard & Miller, 1950).

Hull served as president of the American Psychological Association in 1936. He received many other honors in his lifetime, including election to the National Academy of Sciences and the American Academy of Arts and Sciences. In recognition of his work, in 1945 Hull received the Warren Medal of the Society of Experimental Psychologists, honoring “his careful development of a systematic theory of behavior... in a precise and quantitative form.... A truly unique achievement in the history of psychology to date”.

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