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HARRY FREDERICK HARLOW

*1905—1981*

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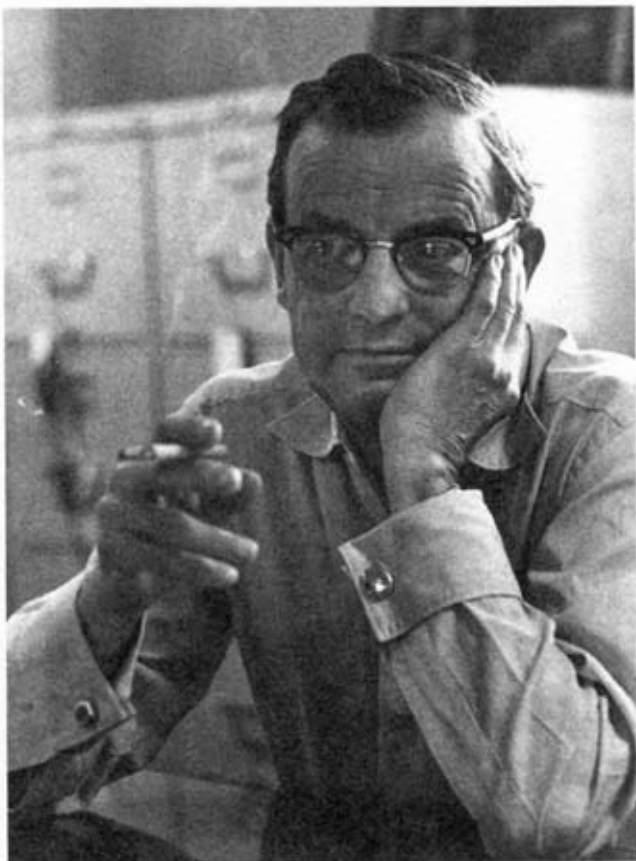
*A Biographical Memoir by*

JOSEPH B SIDOWSKI AND DONALD B. LINDSLEY

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*Biographical Memoir*

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# HARRY FREDERICK HARLOW

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BY JOSEPH B. SIDOWSKI AND  
DONALD B. LINDSLEY

**H**ARRY HARLOW was born Harry F. Israel in Fairfield, Iowa, the third of four sons born to Lon H. and Noble (Rock) Israel. For reasons unknown, he changed his name legally to Harlow while in college. After forty-four years of association with the University of Wisconsin (1930–1974), he became professor emeritus and retired to Tucson, Arizona, where he served as honorary research professor of the University of Arizona. In his later years, he suffered from Parkinsonism. He died of a brain tumor in 1981.

## ACADEMIC YEARS

Harry Harlow, as he himself described it, was a shy, retiring, and callow youth when he began his college studies at Reed College in Portland, Oregon, in 1923. After one year he decided to follow his brother to Stanford University, where he would receive his B.A. degree in 1927, majoring in psychology. His original intent had been to major in English, but an unfavorable grade in that subject and an exciting introductory course in psychology changed his mind. His poetic nature and an ability to use the English language in a humorous manner remained, later contributing greatly to his success both as a teacher and a professional lecturer.

While still an undergraduate, Harlow supported himself

working as an assistant to the experimental psychologist Walter R. Miles, who was elected to the National Academy of Sciences in 1933. As a graduate student at Stanford, Harlow came under the tutelage of Calvin P. Stone, who was elected to the Academy in 1943. As a graduate student, Harry held a teaching assistantship under Paul R. Darnworth in social psychology and research assistantships under Stone in behavioral studies on rats. His doctoral dissertation dealt with the social facilitation of eating behavior in rats, combining elements of his ongoing experiments as an assistant. Much later, Harlow said that he learned scientific methodology and techniques from Stone, but he always considered Miles his moral and ethical mentor.

He admired Lewis W. Terman, then head of the department of psychology, and learned about theory in psychology from him. Terman had been elected to the Academy in 1928. Toward the end of Harry's second graduate year, Terman wrote to Harlow's mother of his great progress in psychology and his preparation for academic teaching and research. However, later when Harry was seeking an academic position, Stone, Terman, and Miles all advised him to consider a junior college position because of a speech defect, which they thought interfered with his ability to articulate clearly and sometimes brought forth smiles when he said "wat" for rat!

Despite this advice, he accepted a position as an assistant professor of psychology at the University of Wisconsin in 1930, where he regularly taught the large introductory class in psychology. With determined application, his diction and enunciation steadily improved, and he became one of the most effective and popular lecturers on campus. It was probably with these student audiences that he developed his unhurried, clipped manner of speech that—along with his creative intellect and great wit—ultimately made him one of the

most entertaining, effective, and sought after speakers in all of psychology.

Hired as a comparative animal psychologist, Harlow arrived at the University of Wisconsin in 1930 to learn that there was no animal laboratory. However, he soon found a cramped cubicle in which to house his rats, which happened to be just below the office of the Dean of Men who didn't appreciate the odors wafting upward.

As a result, Harry was displaced from that location and given a small space in the University Medical School. There he began studies of the social facilitation of feeding responses in monkeys, an extension of his doctoral research with rats. But that space, too, proved vulnerable and temporary, and his first steps into a major career dedicated to the study of nonhuman primate behavior began at a bridge party, when the wife of the chairman of the psychology department suggested that he study primates at the local Vilas Park Zoo. The Zoo afforded an opportunity to work with a variety of primates, including an orangutan, baboons, and monkeys, experiences that were to prove invaluable and would lead to an unexpected turn in his career.

#### PRIMATE LABORATORIES AND RESEARCH

Harlow's first primate research facility consisted mainly of a few tables, a test tray, and test objects at the Vilas Park Zoo. In 1932 the University of Wisconsin made available to him a very small, two-story structure that had previously been the Forest Products Laboratory. It was badly in need of renovation. With his own meager funds and the aid of Walter Grether, Paul Settlage and other graduate students this was accomplished. The result was a usable research facility and the first real primate laboratory in Wisconsin's Department of Psychology.

Acquiring a small colony of monkeys, Harlow and his graduate students enthusiastically began developing new and unique ways to study primate behavior, both qualitatively and quantitatively. Using the oddity principle and matching-from-sample procedures they were able to study perceptual discrimination involving figures and patterns on visual displays or objects that differed in color, size, shape, or texture. By introducing time delays between stimulus presentation and opportunity to respond (method of delayed response), they could study both learning and memory decay. Combining different tasks in so-called test batteries they could explore and identify the nature and extent of "animal intelligence" in various species as well as in humans. In order to conduct these experiments in a uniform way they designed and built a standard piece of equipment, known as the Wisconsin General Test Apparatus (WGTA). This device was adopted and used by many investigators over the years, even until recent times.

One of the most significant discoveries Harlow and his associates made in their first primate laboratory dealt with the formation of *learning sets*, that is, the process by which animals "learn to learn." Their procedure was to present pairs of objects or patterns that differed in features such as size, color, and shape over a series of trials. The objects changed every few trials, and the animal gradually learned to abstract particular features that differentiated the correct response object from others. In this way, discrimination cues became generalized and a *learning set* was established. Harlow and his students, as well as others, exploited this technique in the study of brain lesions and other experimental variables.

The origin and concept of the *learning set* idea was not sudden. From 1939 to 1940, during a sabbatical year, Harlow held a Carnegie fellowship at Columbia University with

famed anthropologist Franz Boas. While at Columbia he attended a seminar by the German neurologist Kurt Goldstein and became familiar with his theories concerning abstract and concrete intelligence and learning, which relied heavily upon performance on block-sorting tests such as the Weigl or Vigotsky tests. In these tests small wooden blocks varying in size, color, and shape must be sorted and grouped according to one or more of such categorical features and the principle of a category identified. According to Goldstein, only humans are capable of abstract thought. Harlow tentatively disagreed. Upon returning to Wisconsin he pursued research that eventually demonstrated—contrary to Goldstein's view—that monkeys could also solve Weigl and Vigotsky type problems, suggesting certain levels of abstract thought and reasoning. These results, together with those from his earlier studies of oddity and matching-to-sample discriminations caused Harlow to focus on the question of methodology.

Limited by cost, upkeep, and availability of monkeys, Harlow was forced to ignore the usual experimental procedures of the time; that is, use of naive and different animals for each condition or problem, as was the practice with cheap and plentiful rodents. He used the same monkeys for the study of a variety of problems. If separate groups of monkeys had been used to learn single, simple discriminations, he might not have discovered the concept of *learning set*. He further realized that subjecting monkeys to series of similar but related problems paralleled the situations in which children learn.

At a time when Thorndikian trial-and-error learning was at variance with the "Ah ha!" solutions attributed by Gestaltists to sudden insight, Harlow presented results on multiple-problem solution to explain how animals learn-to-learn a problem-by-problem exposition of the bridges between trial-

and-error learning and insight. These results posed additional difficulties for the conditioning theories of Clark Hull and Kenneth Spence, influential learning theorists at that time. Sometimes bitter arguments ensued, but Harlow's results and interpretations could not be denied. His *learning set* results were enthusiastically received when presented in his Presidential Address before the Midwestern Psychological Association in 1948. The subsequent wide acceptance of these results undoubtedly enhanced his reputation as a creative scientist and with it his confidence in his general approach to scientific investigation. Ahead of their time, these studies oriented the methods and thinking of modern cognitive psychologists toward natural as opposed to contrived information processing.

Another notable accomplishment involved investigations of newly conceived and identified *curiosity* and *manipulation drives*, in cooperation with Robert A. Butler, Donald R. Meyer, and Harry's wife, Margaret Kuenne Harlow, a child psychologist. At a time when drives were considered to be wholly or partly physiological, Harlow and his associates established the fact that the curiosity and manipulation drives were intrinsic parts of the rhesus monkey's motivational structure. Food, water, and sex were not found sufficient or necessary to initiate behaviors resulting from curiosity and manipulation drives. Monkeys were just naturally curious and would work hard, if necessary, to satisfy their curiosity. They would, for instance, manipulate mechanical puzzles incessantly without the rewards deemed necessary by behavioral theorists of the day. Furthermore, Harlow's monkeys learned complicated tasks without being deprived of basic necessities such as food and water.

Along with the foregoing studies of a strictly behavioral and psychological nature, which had such an important bear-



ing on theoretical issues with regard to motivation, drives, and learning, Harlow and his colleagues engaged in a program of neurophysiological and behavioral studies in an effort to determine the role of the central nervous system, and especially the cerebral cortex, in conditioning, visual discrimination, learning, and memory. The need for more refined behavioral tests in connection with these brain lesion-behavioral studies led to the Wisconsin General Test Apparatus (WGTA) and to a great variety of test batteries and procedures.

In pioneering investigations with Stagner (1933) and Settlage (1939), as well as in one of his own studies (1940), Harlow sought to determine whether a classical Pavlovian conditioned response could be established in the cat if, during the normal training procedure, the paw-lifting response to the unconditioned stimulus (shock) was eliminated or modified by curare paralysis. Testing for the response to the conditioned stimulus (tone or light flash) was done after the curare paralysis had worn off. Apparently the assumption was that everything, including the motor discharge blocked by the curare at the neuromuscular junction, would be the same, except for the absence of the paw-lifting response to shock. After an appropriate period of training, and when the muscle was free of paralysis, they found that no conditioned response could be elicited. Although this appeared to be a landmark discovery, there were obvious flaws in the hypothesis, for proprioceptive feedback was also eliminated by the lack of movement caused by the curare. Furthermore, the result was subsequently shown by others to be inconclusive when it was found that curare had a depressing effect on the central nervous system, as well as a paralyzing action at the neuromuscular junction. Harlow then abandoned this type of research, but many years later he considered that decision

to be a mistake. In hindsight he felt that he had been on the verge of an important discovery that was not unearthed until years later by other investigators.

From about 1940 on, Harlow, his students, and associates made repeated attempts to determine the effects of brain lesions and ablations on the ability of monkeys to make sensory discriminations and perform various tasks on tests developed for use in the WGTA. Many of these studies resulted in important contributions, but very little of major significance evolved, compared with the earlier and later areas of investigation with which Harlow was associated. One set of studies conducted by Harlow and Dagnon (1943), Spaet (1943), and Campbell (1945) may be mentioned for its pioneering importance in the clarification of an issue with regard to the function of the prefrontal cortex in monkeys. Carlyle Jacobsen, working in the laboratory of physiologist John F. Fulton at Yale in the 1930s, had studied the delayed response performance of monkeys following prefrontal cortex ablations and found that the monkeys could not seem to determine which foodwells had been baited prior to the time-delay introduced in the delayed response test. Jacobsen reported that the prefrontal cortex lesions had caused a deficit in immediate and short-term memory.

Harlow and his associates had found variability in the performance of their lesioned monkeys, but there was clear evidence that some monkeys could manage the time-delays and other discriminations that would not have been possible with severe memory deficits. Instead, they attributed the variability and the sometimes poor performance to an inability to attend to the task and avoid distractions. These results, however, were antedated by the publications of Malmö (1942) and Finan (1942), who used equipment and procedures like Jacobsen's except that the experimental chamber was in complete darkness to insure that the monkeys' attention was

focused only upon the stimulus panels, thus avoiding distractions. These findings were later confirmed by French and Harlow (1962). Thus, Jacobsen's putative memory loss results could now be interpreted as due to distraction and inattention rather than an inability to form, store, and retrieve memories after prefrontal lobe ablations. Such results, whether interpreted as attention or memory deficits, had important implications for the performance of human frontal lobotomies, initiated in 1936 by the Portuguese neurosurgeon Antonio Egas Moniz and continued through the 1940s and into the 1950s before being generally abandoned, despite some reported improvement in depressive and other psychopathological conditions. Earlier recognition of the disadvantages of such operations as revealed by animal studies like Harlow's might have forestalled the vast number of lobotomies performed.

In 1932 Harlow moved into a two-story building that was to be his laboratory for the next twenty years. This building had less than the desirable amount of space in which to fit a small colony of monkeys, graduate students, postdoctoral visitors, laboratory equipment, and facilities for experimentation. It also lacked the necessary office and desk space for the analysis and storage of research data. Furthermore, it was in the early stages of the Depression and financial support was in short supply everywhere. There were, of course, no federal granting agencies at that time to support research and training fellowships for graduate students, as there would be later in the 1950s and beyond. These, however, were problems faced by most college and university professors lucky enough to have a job.

It is said, "Where there is a will, there is a way!" Harry had a will, and he found a way. He was highly motivated and had recently found a goal that would become a lifetime endeavor: focus on the rhesus monkey (*Macaca mulata*) as an

experimental model for the study of the neural and behavioral aspects underlying human psychology. He soon found that not the least of his problems was the upkeep and survival of his monkeys. Over the next twenty years he developed the experience and knowledge necessary to sustain primates over long periods of time within animal enclosures, though they enjoyed only a few summer months of the warm weather typical of their natural habitat. It was also in this laboratory that Harlow supervised his first Ph.D. student, Abraham Maslow, who later developed the self-actualization theory of motivation and was credited with being one of the founders of the humanistic psychology movement.

In 1953, the primate laboratory operations were moved from their initial location to a renovated cheese factory several city blocks from the campus. The motivational, learning, and neurophysiological-behavioral research was continued and expanded, resulting in a need for more monkeys. Fortunately, the space was now adequate. Because of import problems, disease, and the cost of the monkeys, the decision was made to start a breeding colony of rhesus monkeys. There was virtually no information available on the care and rearing of laboratory-born monkeys. Methods were devised through trial, error, and observation to enhance the probability that the newborns would survive.

Initially, forty infant rhesus monkeys were separated from their mothers and raised in separate cages. The result was disease-free animals that manifested bizarre and psychopathological behaviors. These abnormal behavior syndromes were attributed to the effects of early isolation and led to some of Harry Harlow's most fascinating and best-known research. The breeding, rearing, and nursery procedures proved successful overall, and a subsequent published report with A. J. Blomquist served as a guide for breeders in other animal installations, including zoos. Harlow's infant pri-

mate care methods were eventually adopted in many places around the world.

The availability of laboratory-born infants led to the study of the ontogeny of learning and the development of age-sensitive learning tests, some of which showed that learning-set formations did not develop until approximately twelve to eighteen months of age. They provided interesting data for comparison with the age-level stages of intelligence and mental growth established by Jean Piaget, the famous Swiss child psychologist. But the infant rhesus macaques were to produce even better known data, specifically in the areas of affection and love.

Harlow's research on affectional systems evolved primarily from a bizarre result of infant isolation: the inability to reproduce upon reaching maturity. This, of course, influenced the supply of research animals. To remedy this situation, Harlow thought of a way to provide "mothering" of a sort to the isolated infants by developing surrogate mothers. He had earlier noted the strong attachment of infant monkeys to their diaper cloths. This led him to the idea of a cloth-covered wire framework resembling a monkey mother. The concept of a surrogate mother was not new; it was Harlow's genius in creating simple experimental situations in which to use the surrogate that was novel and important. With the aid of graduate student Robert Zimmerman, surrogates were built to replace the biological mothers in attempts to "normalize" the behavior of the isolated infants. Some of the surrogates were made of bare wire; others were covered with terrycloth. Other maternal characteristics were added, such as protruding rubber nipples for the supply of milk, internal temperature controls for warming or cooling, and mechanical arrangements for providing gentle rocking motion. Subsequent studies showed that an infant's attachment to its surrogate mother was due as much to "contact comfort" as it was

to nourishment provided by feeding. Also, the warmth and rocking were found to be important factors.

Very important to Harlow was the fact that he had now found a way to raise disease-free monkey infants in isolation. Surrogate mothers now provided warmth, comfort, and sustenance in an environment that could be controlled and modified as required by experimental research programs. The tempo and scope of the infant monkey research now increased and many studies were undertaken, the results of which often interested psychoanalysts and challenged psychoanalytic theory as well as traditional learning theory.

When social development of surrogate-mother-raised and biological-mother-raised monkey infants was compared, it was found that natural genetic mothers were significantly better at socializing the young. The importance of peer relationships was studied by raising infants together and away from adult animals, and it was found that the presence of peers and play opportunities was important to the process of social development. Some of the data indicated that the peer-to-peer interactions were more important than those between mother and infant. Harlow reported that one of the most important relationships determining normal sexual behavior as adults was the peer play during infancy and childhood of these monkeys.

Laboratory research extended into the abnormal as well as the normal behaviors. The bizarre behaviors resulting from isolation were used as a basis for studying the long-term effects of isolation *per se*. Animals separated from their mothers at birth and isolated for periods of six months or longer showed deficits in social, sexual, and other behaviors. The longer the isolation, the worse the deficit. Impregnated, sexually mature female isolates showed few of the normal mother responses expected of rhesus females. In some cases these motherless-mothers grossly abused their newborns, in-

dicating the importance of early socialization in the learning of proper caretaking and mothering behaviors.

“Love created, love destroyed, and love regained” guided the affectional-systems research Harry pursued with his wife, Margaret Kuenne Harlow. Love was created by parental-infant, peer-peer, and surrogate-infant attachments. Isolation and separation led to its destruction. Systematic rehabilitation with a younger monkey (a peer, social-modeling therapist) resulted in love regained.

The reactions of isolate-raised infants separated from their mothers were akin to those of human infants suffering from anaclitic depression as described by British psychiatrist J. A. Bowlby. When peer-reared monkeys were separated for several days similar kinds of depressed behaviors were noted by Harlow and S. Suomi, and the pattern persisted.

Love was regained by rehabilitation, mainly with younger monkeys. A series of studies with infants isolated from birth for various periods of time indicated that placement with normal, same-age mates or with mature females who experienced normal mothering was essentially unsuccessful in socializing the “depressed” monkeys. The aggressive and dominant behaviors of these animals were not changed. However, placement of “depressed” monkeys with younger normal monkeys immediately upon release from isolation eventually led to play and socialization. This therapeutic technique, developed with Suomi, was later used with some success by others in rehabilitating institutionalized human children diagnosed as depressives.

Harry and Margaret Harlow also collaborated in research on the activities of monkey nuclear families living in adjacent enclosures. The setting allowed for the study of infant interactions, fathering, and other relationships. Harlow pursued the research on monkey nuclear families and depression until his retirement from Wisconsin. He believed, however, that

his most significant contributions came out of his surrogate studies on love, isolation effects, and psychopathology. Harlow often said that when you work with monkeys, you think of human problems, and he believed that human data generalized to monkeys very nicely, if not vice versa.

From a general purview of his many scientific and professional publications, it is difficult to pinpoint a central theme. His main goal, it seems, was to study a single species, the rhesus monkey, to learn all he could about its behavior and cognitive processes, and to relate the results to humans. The first decade of his tenure at the University of Wisconsin was dedicated to finding suitable laboratory research facilities. Then he strove to find the best empirical methods for working with monkeys and to develop unique tests for assessing their sensory and perceptual abilities and the motivational circumstances under which they worked best at solving graded levels of problems and tasks. This led to the development of elaborate and creative test batteries and the WGTA, all of which benefitted and stimulated his many students and others throughout the world. He turned briefly to the cat to investigate further the nature of the conditioned response. During the next three decades Harry and his students and colleagues used monkeys and the WGTA tests to try to locate in each of the principal regions of the cerebral cortex the extent to which various functions were subserved, eliminated, or modified under the influence of anaesthesia, radiation, and ablation.

Understanding the neural basis of behavior never seemed to interest him as much as understanding behavior itself. He concentrated on behavior studies with monkeys throughout the last three decades of his life, opening up new vistas with regard to the cognitive aspects of behavior and the social and affective consequences of manipulation of the environment on early development. Harry Harlow was a deductive, qual-



itative empiricist and phenomenologist, whose greatest discoveries and contributions resulted from planned serendipity. Serendipity even entered into his poetry, which he created quickly and freely and often injected into his publications and talks.

#### OTHER SCIENTIFIC AND PROFESSIONAL ACTIVITIES

By his own admission, Harlow was more of a nativist, who believed in the inheritance of characteristics to a greater extent than many of his contemporaries in psychology. Yet this personal inclination was not strongly reflected in his research, which in its cognitive and social aspects emphasized environmental influences. He foresaw the importance of biochemistry in studies of behavior, and in 1958 he coedited a volume on the *Biological and Biochemical Bases of Behavior* with neurophysiologist Clinton N. Woolsey, also of the University of Wisconsin and a member of the National Academy of Sciences. The book resulted from a symposium they had planned jointly and was a pioneering example of interdisciplinary research. A year later he collaborated with N. A. Waisman, a pediatrician interested in the genetic basis of phenylketonuria in monkeys and humans.

Although not directly involved in the space program, the Wisconsin Laboratory supplied one of the first monkeys sent into space. In 1954 Harry cooperated with aerospace pioneer D. C. Simons on a series of stratospheric plastic balloon flights to study the effects on monkeys of exposure to radiation above 90,000 feet. (At the time, low energy, heavy nuclear particles of primary cosmic radiation could not be reproduced with available accelerators.) At about the same time, he was involved in investigating the behavioral effects of cortical implantations of radioactive cobalt.

During a two-year leave from the University from 1950 to 1952, Harlow served with the Department of the Army in

the Pentagon as chief of the Human Resources Branch. In that position, he was responsible for proposing the establishment of a Human Resources Research Office for the conduct of psychological research. The recommendation was implemented in 1951 and the office established on the campus of The George Washington University, with Meredith Crawford as its director. With Phillip Sapir of the National Institute of Mental Health, he collaborated in the cofounding of the NIMH Small Grants Program.

From 1951 to 1963, Harlow served as editor of the *Journal of Comparative and Physiological Psychology*, using that position to advance primatology. The proportion of publications dedicated to primate behavior increased noticeably over the twelve years of his editorship. He also encouraged the publication of articles on the developmental aspects of psychology and behavior, but the number of manuscripts in those areas proved disappointing.

In 1964, one of the seven national Regional Primate Research Centers was established adjacent to the University of Wisconsin Primate Laboratory. Harlow served as its director until 1971.

Harry F. Harlow was elected to the National Academy of Sciences in 1951 and to the American Academy of Arts and Sciences in 1961. At the 52nd meeting of the Society of Experimental Psychologists in 1956, he was awarded the Warren Medal for "a series of brilliantly conceived experiments on the behavior of monkeys, including studies of motivation, learning, and problem solving." From 1958 to 1959, Harlow served as president of the American Psychological Association; in 1960, he received its Distinguished Scientific Contribution Award for "curiosity and imagination which opened up new areas of research in animal behavior and enhanced the position of comparative psychology."

President Lyndon B. Johnson presented him with the Na-

tional Medal of Science in 1967, and in 1973 he received the Gold Medal Award of the American Psychological Association. Harlow accepted the Kittay Scientific Foundation Award in 1975 for his use of monkey models to study psychopathological behaviors. The Primate Laboratory at the University of Wisconsin was dedicated and named in his honor in 1984.

Harry Frederick Harlow was an unassuming man of many talents. He was a poet and gifted writer, an excellent bridge player, and a pretty good locally competitive tennis player. He was generous in sharing time and ideas with students who wished to set up primate laboratories elsewhere. His long walks with professional colleagues and graduate students were legendary, as were his many professional talks.

Harlow married Clara Mears in 1932. Two sons, Robert and Richard, were born of this union. In 1946 the marriage was dissolved and each party later remarried. In 1948, Harry married Margaret Kuenne, a child psychologist of note, with whom he collaborated on numerous research, publication, and editing activities. Two children, Pamela Ann and Jonathon, were born of this marriage. Margaret died of cancer in 1971. Shortly after her death, Harry and Clara, his first wife (then a widow) remarried. Upon his retirement from the University of Wisconsin in 1974, Harry and Clara moved to Tucson, Arizona, where Harry held an honorary appointment at the University of Arizona. He and Clara collaborated on several publications, the most notable being a book entitled, *The Human Model: Primate Perspective*, published in 1979. Harry died in 1981.

1932

- Social facilitation of feeding in the albino rat. *J. Genet. Psychol.*, 41:211–21.
- With H. Uehling and A. H. Maslow. Comparative behavior of primates: I. Delayed reaction tests on primates from the lemur to the orangoutan. *J. Comp. Psychol.*, 13:313–43.
- With A. H. Maslow. Comparative behavior of primates: II. Delayed reaction tests on primates at Bronx Park Zoo. *J. Comp. Psychol.*, 14:97–107.
- Comparative behavior of primates: III. Complicated delayed reaction tests on primates. *J. Comp. Psychol.*, 14:241–52.
- With R. H. Israel. Comparative behavior of primates: IV. Delayed reaction tests on subnormal humans. *J. Comp. Psychol.*, 14:253–62.
- With R. Stagner. Psychology of feelings and emotions: I. Theory of feelings. *Psychol. Rev.*, 39:570–89.
- Food preferences of the albino rat. *J. Genet. Psychol.*, 41:430–38.

1933

- With H. Yudin. Comparative behavior of primates: V. Delayed reactions in primates in horizontal and vertical planes. *J. Comp. Psychol.*, 16:143–47.
- With H. Yudin. Social facilitation of feeding in the monkey and its relation to attitudes of ascendance and submission. *J. Comp. Psychol.*, 16:171–86.
- With R. Stagner. Effect of complete striate muscle paralysis upon the learning process. *J. Exp. Psychol.*, 16:283–94.
- With R. Stagner. Psychology of feelings and emotions: II. Theory of emotions. *Psychol. Rev.*, 40:184–195 and 368–80.

1934

- With P. Settlage. Comparative behavior of primates: VII. Capacity of monkeys to solve patterned string tests. *J. Comp. Psychol.*, 18:423–35.

1936

- With P. Settlage. Concerning the sensory pathway in the conditioned reflex. *J. Comp. Psychol.*, 22:279–82.

With P. Settlage. The effect of application of anesthetic agents on circumscribed motor and sensory areas of the cortex. *J. Psychol.*, 2:193-200.

The neurophysiological correlates of learning and intelligence. *Psychol. Bull.*, 33:479-534.

1937

Experimental analysis of the role of the original stimulus in conditioned responses in monkeys. *Psychol. Rec.*, 1:62-68.

1938

With J. Bromer. A test-apparatus for monkeys. *Psychol. Rec.*, 2:434-36.

1939

With P. Settlage. The effect of curarization of the fore part of the body upon the retention of conditioned responses in cats. *J. Comp. Psychol.*, 27:45-48.

Recovery of pattern discrimination in monkeys following unilateral occipital lobectomy. *J. Comp. Psychol.*, 27:467-89.

With J. Bromer. Comparative behavior of primates: VIII. The capacity of platyrrhine monkeys to solve delayed reaction tests. *J. Comp. Psychol.*, 28:299-304.

Forward conditioning, backward conditioning, and pseudo-conditioning in the goldfish. *J. Genet. Psychol.*, 55:49-58.

1940

With F. Toltzien. Formation of pseudo-conditioned responses in the cat. *J. Genet. Psychol.*, 23:367-75.

The effects of incomplete curare paralysis upon formation and elicitation of conditioned responses in cats. *J. Genet. Psychol.*, 56:273-82.

1942

With J. Bromer. Acquisition of new responses during inactivation of the motor, premotor, and somesthetic cortex in the monkey. *J. Genet. Psychol.*, 26:299-313.

Response by rhesus monkeys to stimuli having multiple sign values. In: *Studies in Personality*, ed. Q. McNemar and M. Merrill, pp. 105-23. New York: McGraw-Hill Book Co.

Animal behavior. In: *Fields of Psychology*, ed. R. H. Seashore, pp. 171–96. New York: Holt, Rinehart & Winston.

## 1943

- With T. Spaet. Solution by rhesus monkeys of multiple sign problems utilizing the oddity technique. *J. Comp. Psychol.*, 35:119–32.
- With M. L. Young. Generalization by rhesus monkeys of a problem involving the Weigl principle using the oddity method. *J. Comp. Psychol.*, 36:201–16.
- Solution by rhesus monkeys of a problem involving the Weigl principle using the matching-from-sample method. *J. Comp. Psychol.*, 36:217–27.
- Physiological psychology. Part II. Physiological correlates of behavior. In: *Annual Review of Physiology*, ed. J. M. Luck, vol. 5, pp. 465–78. Palo Alto, Calif.: Annual Reviews Inc.
- With J. Dagnon. Problem solution by monkeys following bilateral removal of the prefrontal areas: I. The discrimination and discrimination-reversal problems. *J. Exp. Psychol.*, 32:351–56.
- With T. Spaet. Problem solution by monkeys following bilateral removal of the prefrontal areas: II. Delayed reaction problems involving use of the matching-from-sample method. *J. Exp. Psychol.*, 32:424–34.
- With T. Johnson. Problem solution by monkeys following bilateral removal of the prefrontal areas: III. Test of initiation of behavior. *J. Exp. Psychol.*, 32:495–500.
- With T. Spaet. Problem solution by monkeys following bilateral removal of the prefrontal areas: IV. Responses to stimuli having multiple sign values. *J. Exp. Psychol.*, 33:500–7.

## 1944

- Studies in discrimination learning by monkeys: I. The learning of discrimination series and the reversal of discrimination series. *J. Genet. Psychol.*, 30:3–12.
- Studies in discrimination learning by monkeys: II. Discrimination learning without primary reinforcement. *J. Genet. Psychol.*, 30:13–21.
- With M. M. Simpson. Solution by rhesus monkeys of a nonspatial delayed response to the color or form attribute of a single stim-

ulus (Weigl principle delayed reaction). *J. Comp. Psychol.*, 37:211-20.

## 1945

- With R. J. Campbell. Problem solution by monkeys following bilateral removal of the prefrontal areas: V. Spatial delayed reactions. *J. Exp. Psychol.*, 35:110-26.
- With S. Poch. Discrimination generalization by macaque monkeys to unidimensional and multidimensional stimuli. *J. Comp. Psychol.*, 35:353-65.
- Studies in discrimination learning by monkeys: III. Factors influencing the facility of solution of discrimination problems by rhesus monkeys. *J. Genet. Psychol.*, 32:213-27.
- Studies in discrimination learning by monkeys: IV. Relative difficulty of discrimination between stimulus-objects and between comparable patterns with homogeneous and with heterogeneous grounds. *J. Genet. Psychol.*, 32:317-21.
- Studies in discrimination learning by monkeys: V. Initial performance by experimentally naive monkeys on stimulus-object and pattern discriminations. *J. Genet. Psychol.*, 33:3-10.
- Studies in discrimination learning by monkeys: VI. Discrimination between stimuli differing in both color and form, only in color, and only in form. *J. Genet. Psychol.*, 33:225-35.

## 1946

- With M. Noer. Discrimination of ambivalent cue stimuli by macaque monkeys. *J. Genet. Psychol.*, 34:165-77.
- With M. Zable. The performance of rhesus monkeys on series of object-quality and positional discriminations and discrimination reversals. *J. Comp. Psychol.*, 39:13-23.

## 1947

- With P. H. Settlage. Effect of extirpation of frontal areas on learning performance of monkeys. *Assoc. Res. Nerv. Ment. Dis.*, 27:446-59.
- With E. M. Moss. The role of reward in discrimination learning in monkeys. *J. Comp. Physiol. Psychol.*, 40:333-42.
- With P. H. Settlage. An effective and nontraumatic method of handling monkeys. *Science*, 106:300.

1948

- With G. Andrew. Performance of macaque monkeys on a test of the concept of generalized triangularity. *Comp. Psychol. Monogr.*, 19: No. 1, Serial No. 100.
- With L. Grandine. Generalization of the characteristics of a single learned stimulus by monkeys. *J. Comp. Physiol. Psychol.*, 41:327-38.
- Studying animal behavior. In: *Methods of Psychology*, ed. T. G. Andrews, pp. 319-47. New York: John Wiley & Sons.
- With E. M. Moss. Problem solution by monkeys following extensive unilateral decortication and prefrontal lobotomy of the contralateral side. *J. Psychol.*, 25:223-26.
- With P. Settlage and M. Zable. Problem solution by monkeys following bilateral removal of the prefrontal areas: VI. Performance on tests requiring contradictory reactions to similar and to identical stimuli. *J. Exp. Psychol.*, 38:50-65.

1949

- Physiological psychology. In: *Annual Review of Physiology*, ed. J. M. Luck, pp. 269-96. Palo Alto, Calif.: Annual Reviews Inc.
- The formation of learning sets. *Psychol. Rev.*, 56:51-65.
- With M. K. Harlow. Learning to think. *Sci. Am.*, 181:36-39.
- With D. R. Meyer. The development of transfer of response to patterning by monkeys. *J. Comp. Physiol. Psychol.*, 42:454-62.

1950

- With R. T. Davis and P. H. Settlage. Performance of normal and brain-operated monkeys on mechanical puzzles with and without food incentive. *J. Genet. Psychol.*, 77:305-11.
- Learning and satiation of response in intrinsically motivated complex puzzle performance by monkeys. *J. Comp. Physiol. Psychol.*, 43:289-94.
- Performance of catarrhine monkeys on a series of discrimination reversal problems. *J. Comp. Physiol. Psychol.*, 43:321-39.
- Analysis of discrimination learning by monkeys. *J. Exp. Psychol.*, 40:26-39.
- With M. K. Harlow and D. R. Meyer. Learning motivated by a manipulation drive. *J. Exp. Psychol.*, 40:228-34.



1951

- With D. R. Meyer and P. H. Settlage. A survey of delayed response performance by normal and brain-damaged monkeys. *J. Comp. Physiol. Psychol.*, 44:17-25.
- With A. J. Riopelle, P. H. Settlage, and H. W. Ades. Performance of normal and operated monkeys on visual learning tests. *J. Comp. Physiol. Psychol.*, 44:283-89.
- With D. R. Meyer and P. H. Settlage. The effects of large cortical lesions on the solution of oddity problems by monkeys. *J. Comp. Physiol. Psychol.*, 44:320-26.
- With D. R. Meyer and H. W. Ades. Retention of delayed responses and proficiency in oddity problems by monkeys with preoccipital ablations. *Am. J. Psychol.*, 64:391-96.
- Thinking. In: *Theoretical Foundations of Psychology*, ed. H. Helson, pp. 452-505. New York: D. Van Nostrand.
- Levels of integration along the phylogenetic scale: Learning aspect. In: *Social Psychology at Crossroads*, ed. J. R. Roher, pp. 121-41. New York: Harper and Bros.
- Primate learning. In: *Comparative Psychology*, 3d ed., ed. C. P. Stone, pp. 183-238. New York: Prentice-Hall.
- Learning theories. In: *Current Trends in Psychological Theory*, ed. W. Dennis, pp. 57-84. Pittsburgh: University of Pittsburgh Press.

1952

- With R. Weiner. The effect of nembutal upon learned performances of the rhesus monkey. *J. Genet. Psychol.*, 46:43-50.
- With J. M. Warren. Discrimination learning by normal and brain operated monkeys. *J. Genet. Psychol.*, 81:45-52.
- With D. R. Meyer. Effects of multiple variables on delayed response performance by monkeys. *J. Genet. Psychol.*, 81:53-61.
- Learning. In: *Annual Review of Psychology*, ed. C. P. Stone, pp. 29-54. Palo Alto, Calif.: Annual Reviews Inc.
- With D. R. Meyer. Paired-comparisons scales for monkey rewards. *J. Comp. Physiol. Psychol.*, 45:73-79.
- With J. M. Warren. Learned discrimination performance by monkeys after prolonged postoperative recovery from large cortical lesions. *J. Comp. Physiol. Psychol.*, 45:119-26.
- Functional organization of the brain in relation to mentation and

- behavior. In: *The Biology of Mental Health and Disease*, pp. 244–53. New York: Hoeber and Co.
- With R. T. Davis, P. H. Settlage, and D. R. Meyer. Analysis of frontal and posterior association syndromes in brain-damaged monkeys. *J. Comp. Physiol. Psychol.*, 45:419–29.
- With J. M. Warren. Formation and transfer of discrimination learning sets. *J. Comp. Physiol. Psychol.*, 45:482–89.
- With R. W. Leary, P. H. Settlage, and D. D. Greenwood. Performance on double-alternation problems by normal and brain-injured monkeys. *J. Comp. Physiol. Psychol.*, 45:576–84.

## 1953

- Mice, monkeys, men, and motives. *Psychol. Rev.*, 60:23–32.
- Motivation as a factor in the acquisition of new responses. In: *Current Theory and Research in Motivation: A Symposium*, ed. M. R. Jones, pp. 24–49. Lincoln, Neb.: University of Nebraska Press.
- Higher functions of the nervous system. In: *Annual Review of Physiology*, ed. V. E. Hall, vol. 15, pp. 493–514. Palo Alto, Calif.: Annual Reviews Inc.
- With J. C. Fay and J. D. Miller. Incentive size, food deprivation, and food preference. *J. Comp. Physiol. Psychol.*, 46:13–15.

## 1954

- Motivational forces underlying learning. In: *Learning Theory, Personality Theory, and Clinical Research* (The Kentucky Symposium), pp. 36–53. New York: John Wiley & Sons.
- With G. E. McClearn. Object discrimination learned by monkeys on the basis of manipulation motives. *J. Comp. Physiol. Psychol.*, 47:73–76.
- With R. A. Butler. Persistence of visual exploration in monkeys. *J. Comp. Physiol. Psychol.*, 47:258–63.
- With G. E. McClearn. The effect of spatial contiguity on discrimination learning by rhesus monkeys. *J. Comp. Physiol. Psychol.*, 47:391–94.

## 1955

- With N. C. Blazek. Persistence of performance differences on discriminations of varying difficulty. *J. Comp. Physiol. Psychol.*, 48:86–89.
- With L. E. Moon. Analysis of oddity learning by rhesus monkeys. *J. Comp. Physiol. Psychol.*, 48:188–94.

- With J. F. Hall and J. M. Warren. The effects of reserpine (serpasil) on the delayed response in monkeys. *J. Psychol.*, 40:159-61.
- With K. A. Schiltz and P. H. Settlage. Effect of cortical implantation of radioactive cobalt on learned behavior of rhesus monkeys. *J. Comp. Physiol. Psychol.*, 48:432-36.
- With G. M. French. Locomotor reaction decrement in normal and brain-damaged rhesus monkeys. *J. Comp. Physiol. Psychol.*, 48:496-501.
- With W. A. Mason and R. R. Rueping. The development of manipulatory responsiveness in the infant rhesus monkey. *J. Comp. Physiol. Psychol.*, 52:555-58.
- The brain and learned behavior. *Comput. Autom.*, 4:6-14.
- With L. E. Moon and C. P. Bogumill. Some effects of periodic x-radiation. *Science*, 122:1-2.

## 1956

- With R. A. Butler. The effects of auditory distraction on the performance of monkeys. *J. Genet. Psychol.*, 54:15-20.
- With R. A. Butler. Discontinuous pursuit performance by rhesus monkeys. *J. Genet. Psychol.*, 54:21-30.
- With L. E. Moon. The effects of repeated doses of total-body-x-radiation on motivation and learning in rhesus monkeys. *J. Comp. Physiol. Psychol.*, 49:60-65.
- With A. M. Schrier. Effect of amount of incentive on discrimination learning by monkeys. *J. Comp. Physiol. Psychol.*, 49:117-22.
- With A. M. Schrier and D. G. Simons. Exposure of primates to cosmic radiation above 90,000 feet. *J. Comp. Physiol. Psychol.*, 49:195-200.
- With N. C. Blazek and G. E. McClean. Manipulatory motivation in the infant rhesus monkey. *J. Comp. Physiol. Psychol.*, 49:444-48.
- With W. A. Mason and N. C. Blazek. Learning capacities of the infant rhesus monkey. *J. Comp. Physiol. Psychol.*, 49:449-53.
- Current and future advances in physiological psychology. *Am. Psychol.*, 11:273-77.

## 1957

- With L. H. Hicks, Jr. Discrimination learning theory: Uniprocess vs. duoprocess. *Psychol. Rev.*, 64:104-9.
- Experimental analysis of behavior. *Am. Psychol.*, 12:485-90.

- With R. A. Butler. Discrimination learning and learning sets to visual exploration incentives. *J. Genet. Psychol.*, 57:257–85.
- With I. E. Farber and L. J. West. Brainwashing, conditioning, and DDD (debility, dependency, and dread). *Sociometry*, 20:271–85.
- With J. M. Warren, R. W. Leary, and G. M. French. Function of the association cortex in monkeys. *Brit. J. An. Beh.*, 4:132–38.
- With A. M. Schrier. Direct manipulation of the relevant cue and difficulty of discrimination. *J. Comp. Physiol. Psychol.*, 50:576–80.

## 1958

- With W. A. Mason. Learned approach by infant rhesus monkeys to the sucking situation. *Psychol. Rep.*, 4:79–82.
- With W. A. Mason. Formation of conditioned responses in infant monkeys. *J. Comp. Physiol. Psychol.*, 51:68–70.
- With W. A. Mason. Performance of infant rhesus monkeys on a spatial discrimination problem. *J. Comp. Physiol. Psychol.*, 51:71–74.
- With A. M. Schrier. Effect of reserpine on avoidance of humans by rhesus monkeys. *J. Genet. Psychol.*, 59:149–55.
- The evolution of learning. In: *Behavior and Evolution*, ed. A. Roe and G. Simpson, pp. 269–90. New Haven: Yale University Press.
- With R. R. Zimmermann. The development of affectional responses in infant monkeys. *Proc. Am. Philos. Soc.*, 102:501–9.
- Ed. Harry Harlow and C. N. Woolsey. Behavioral contributions to interdisciplinary research. In: *Biological and Biochemical Bases of Behavior*, pp. 3–23. Madison: University of Wisconsin Press.
- The nature of love. *Am. Psychol.*, 13:763–85.

## 1959

- Learning set and error factor theory. In: *Psychology: A Study of a Science*, ed. S. Koch, pp. 492–538. New York: McGraw-Hill Book Co.
- With W. A. Mason. Initial responses of infant rhesus monkeys to solid foods. *Psychol. Rep.*, 5:193–99.
- Basic social capacity of primates. *Hum. Biol.*, 31:40–53.
- With M. Levine and B. Levinson. Trials per problem as a variable in the acquisition of discrimination learning set. *J. Comp. Physiol. Psychol.*, 52:396–98.

- With R. R. Zimmermann. Affectional responses in the infant monkey. *Science*, 130:421-32.
- Love in infant monkeys. *Sci. Am.*, 200:68-74.
- The development of learning in the rhesus monkey. *Am. Sci.*, 47:459-79.
- With M. Levine. Learning sets with one- and twelve-trial oddity problems. *Am. J. Psychol.*, 72:253-357.
- With H. A. Waisman, H. L. Wang, and R. R. Sponholz. Experimental phenylketonuria in the monkey. *Proc. Soc. Exp. Biol. Med.*, 101:864-65.
- With W. A. Mason and R. R. Rueping. The development of manipulatory responsiveness in the infant rhesus monkey. *J. Comp. Physiol. Psychol.*, 52:555-58.

## 1960

- With M. K. Harlow, R. R. Rueping, and W. A. Mason. Performance of infant rhesus monkeys on discrimination learning, delayed response, and discrimination learning set. *J. Comp. Physiol. Psychol.*, 53:113-21.
- Affectional behavior in the infant monkey. In: *The Central Nervous System and Behavior*, ed. M. A. B. Brazier, pp. 307-57. New York: Josiah Macy, Jr. Foundation.
- Primary affectional patterns in primates. *Am. J. Orthopsychiatry*, 30:676-84.
- With H. A. Waisman, H. L. Wang, and G. Palmer. Phenylketonuria in infant monkeys. *Nature*, 188:1124-25.
- With K. Akert, O. S. Orth, and K. A. Schiltz. Learned behavior of rhesus monkeys following neonatal bilateral prefrontal lobotomy. *Science*, 132:1944-45.

## 1961

- With A. J. Blomquist. The infant rhesus monkey program at the University of Wisconsin Primate Laboratory. *Proc. An. Care Panel*, 11:57-64.
- With L. R. Cooper. Note on a cebus monkey's use of a stick as a weapon. *Psychol. Rep.*, 8:418.
- With M. Levine and T. Pontrelli. Supplementary report: The effects of problem length on transfer during learning-set performance. *J. Exp. Psychol.*, 61:192.
- The development of affectional patterns in infant monkeys. In:

- Determinants of Infant Behavior*, ed. B. M. Foss, pp. 75–97. London: Methuen.
- With M. K. Harlow. A study of animal affection. *Nat. Hist.*, 70(10):48–55.
- With A. J. Riopelle. Stimulus and reward displays in discrimination learning. *J. Genet. Psychol.*, 98:183–86.
- With W. A. Mason. The effects of age and previous training on patterned-strings performance of rhesus monkeys. *J. Comp. Physiol. Psychol.*, 54:704–9.

## 1962

- Effects of radiation on the central nervous system and on behavior—general survey. In: *Response of the Nervous System to Ionizing Radiation*, ed. T. J. Haley and R. S. Snider, pp. 627–44. New York: Academic Press.
- Development of affection in primates. In: *Roots of Behavior: Genetics, Instinct, and Socialization in Animal Behavior*, ed. E. Bliss, pp. 157–66. New York: Harper (Hoeber).
- The heterosexual affectional system in monkeys. *Am. Psychol.*, 17:1–9.
- With T. E. Cadell and H. A. Waisman. EEG changes in experimental phenylketonuria. *Electroencephalogr. Clin. Neurophysiol.*, 14:540–43.
- With M. K. Harlow. The effect of rearing conditions on behavior. *Bull. Menninger Clin.*, 26:213–24.
- With M. K. Harlow. Principles of primate learning. In: *Lessons from Animal Behavior for the Clinician*, ed. S. A. Barnett, pp. 37–48. London: National Spastics Society.
- Development of the second and third affectional systems in macaque monkeys. In: *Research Approaches to Psychiatric Problems*, ed. T. T. Turlentes, S. L. Pollack, and H. E. Himwich, pp. 209–29. New York: Grune & Stratton.
- With G. M. French. Variability of delayed-reaction performance in normal and brain-damaged rhesus monkeys. *J. Neurophysiol.*, 25: 585–99.
- With J. M. Lockhart. The influence of spatial configuration and percentage of reinforcement upon oddity learning. *J. Comp. Physiol. Psychol.*, 55:495–501.
- With M. K. Harlow. Social deprivation in monkeys. *Sci. Am.*, 207:136–46.

With J. E. King. Effect of ratio of trial 1 reward to nonreward on the discrimination learning of macaque monkeys. *J. Comp. Physiol. Psychol.*, 55:872-75.

With B. Seay and E. Hansen. Mother-infant separation in monkeys. *J. Child Psychol. Psychiatry*, 3:123-32.

The effects of early experience on affectional behavior in monkeys. In: *Biological Influences in Mental Health*, pp. 27-33. Fifth annual research conference. Michigan Department of Mental Health.

## 1963

With H. A. Cross and H. J. Fletcher. Effects of prior experience with test stimuli on learning-set performance of monkeys. *J. Comp. Physiol. Psychol.*, 56:204-7.

With G. M. Sterritt and E. Goodenough. Learning set development: Trials to criterion vs. six trials per problem. *Psychol. Rep.*, 13:267-71.

An experimentalist views the emotions. In: *The Expression of Emotion in Man*, ed. P. H. Knapp, pp. 254-65. New York: International Universities Press.

With M. K. Harlow and E. W. Hansen. The maternal affectional system of rhesus monkeys. In: *Maternal Behavior in Mammals*, ed. H. L. Rheingold, pp. 254-81. New York: John Wiley & Sons.

The maternal affectional system. In: *Determinants of Infant Behaviour II*, ed. B. M. Foss, pp. 3-33. London: Methuen.

## 1964

With K. Akert and K. A. Schiltz. The effects of bilateral prefrontal lesions on learned behavior of neonatal, infant, and preadolescent monkeys. In: *The Frontal Granular Cortex and Behavior*, ed. J. M. Warren and K. Akert, pp. 126-48. New York: McGraw-Hill Book Co.

Early social deprivation and later behavior in the monkey. In: *Unfinished Tasks in the Behavioral Sciences*, ed. A. Abrams, H. H. Garner, and J. E. P. Tomal, pp. 154-73. Baltimore: Williams & Wilkins.

A behavioral approach to psychoanalytic theory. *Sci. Psychoanal.*, 7:93-113.

With B. Seay and B. K. Alexander. Maternal behavior of socially

- deprived rhesus monkeys. *J. Abnorm. Soc. Psychol.*, 69:345–54.
- With G. L. Rowland and G. A. Griffin. The effect of total social deprivation on the development of monkey behavior. In: *Recent Research on Schizophrenia, Psychiatric Research Report 19*, ed. P. Solomon and B. C. Glueck, pp. 116–35. Washington, D.C.: American Psychiatric Association.

## 1965

- With H. A. Waisman. Experimental phenylketonuria in infant monkeys. *Science*, 147:685–95.
- With H. A. Cross. Prolonged and progressive effects of partial isolation on the behavior of macaque monkeys. *J. Exp. Res. Pers.*, 1:39–49.
- With M. K. Harlow. The effects of early social deprivation on primates. In: *Desafferentation Experimentale Et Clinique*, ed. J. de Ajuriaguerra, pp. 67–77. Geneva, Switzerland: Georg & Cie S.A.
- With R. O. Dodsworth and M. K. Harlow. Total social isolation in monkeys. *Proc. Natl. Acad. Sci. USA*, 54:90–97.
- Ed. Harry Harlow, A. M. Schrier, and F. Stollnitz. *Behavior of Non-human Primates*, vol. I and II. New York: Academic Press.
- With M. K. Harlow. The affectional systems. In: *Behavior of Non-human Primates*, vol. II, ed. Harry Harlow, A. M. Schrier, and F. Stollnitz, pp. 287–334. New York: Academic Press.
- With B. K. Alexander. Social behavior of juvenile rhesus monkeys subjected to different rearing conditions during the first six months of life. *Zool. J. Physiol.*, 71:489–508.
- With R. L. Raisler. Learned behavior following lesions of posterior association cortex in infant, immature, and preadolescent monkeys. *J. Comp. Physiol. Psychol.*, 60:167–74.
- Sexual behavior in the rhesus monkey. In: *Sex and Behavior*, ed. F. A. Beach, pp. 234–65. New York: John Wiley & Sons.
- With B. Seay. Maternal separation in the rhesus monkey. *J. Nerv. Ment. Dis.*, 140:434–41.
- With G. Griffin. Induced mental and social deficits in rhesus monkeys. In: *The Biosocial Basis of Mental Retardation*, ed. S. F. Osler and R. E. Cooke, pp. 87–106. Baltimore: The Johns Hopkins Press.
- Total social isolation: Effects on macaque behavior. *Science*, 148:666.



1966

- With M. K. Harlow. Affection in primates. *Discovery*, 27:11-17.
- With M. K. Harlow, R. O. Dodsworth and G. L. Arling. Maternal behavior of rhesus monkeys deprived of mothering and peer association in infancy. *Proc. Am. Philos. Soc.*, 110:58-66.
- With G. D. Mitchell, E. J. Raymond, and G. C. Ruppenthal. Long-term effects of total social isolation upon behavior of rhesus monkeys. *Psychol. Rep.*, 18:567-80.
- The primate socialization motives. *Trans. Stud. Coll. Physicians Philadelphia*, 33:224-37.
- With E. W. Hansen and R. O. Dodsworth. Reactions of rhesus monkeys to familiar and unfamiliar peers. *J. Comp. Physiol. Psychol.*, 61:274-79.
- With W. D. Joslyn, M. G. Senko and A. Dopp. Behavioral aspects of reproduction in primates. *J. Anim. Sci.*, 25:49-65.
- With M. K. Harlow. Effect de la privation precoce de contacts sociaux chez les primates. *Rev. Med. Psychosom. Psychol. Med.*, 8:1-24.
- With G. A. Griffin. Effects of three months of total social deprivation on social adjustment and learning in the rhesus monkey. *Child Dev.*, 37:533-47.
- With M. K. Harlow. Learning to love. *Am. Sci.*, 54:234-72.
- With G. D. Mitchell, G. C. Ruppenthal, and E. J. Raymond. Long-term effects of multiparous and primiparous monkey mother rearing. *Child Dev.*, 37:781-91.
- With B. Seay. Mothering in motherless mother monkeys. *Br. J. Soc. Psychiatry*, 1:63-69.

1967

- With M. K. Harlow. Reifungs-faktoren im Sozialen Verhalten. *Psyche: Z. Psychoanal. Anwendung*, 21:193-210.
- With A. S. Chamove and G. D. Mitchell. Sex differences in the infant-directed behavior of preadolescent rhesus monkeys. *Child Dev.*, 38:329-35.
- With G. D. Mitchell, G. A. Griffin, and G. W. Møller. Repeated maternal separation in the monkey. *Bull. Psychon. Soc.*, 8:197-98.
- With M. K. Harlow. The young monkeys. *Psychol. Today*, 1:41-47.
- With G. L. Arling. Effects of social deprivation on maternal behavior of rhesus monkeys. *J. Comp. Physiol. Psychol.*, 64:371-77.

1968

- With A. J. Blomquist, C. I. Thompson, K. A. Schiltz, and M. K. Harlow. Effects of induction age and size of frontal lobe lesions on learning in rhesus monkeys. In: *The Neuropsychology of Development: A Symposium*, ed. R. L. Isaacson, pp. 79–120. New York: John Wiley & Sons.
- With G. R. Kerr, A. S. Chamove, and H. A. Waisman. Fetal PKU: The effect of maternal hyperphenylalaninemia during pregnancy in the rhesus monkey (*Macaca mulatta*). *Pediatrics*, 42:27–36.
- Learning and memory in primates. In: *Attuali Orientamenti Della Ricerca Sull Apprendimento E La Memoria*, ed. D. Bovet, F. Bovet-Nitti, and S. Oliverio, pp. 139–56. Rome: Accademia Nazionale dei Lincei.
- With G. W. Møller and G. D. Mitchell. Factors affecting agonistic communication in rhesus monkeys (*Macaca mulatta*). *Behaviour*, 31:339–57.
- A primate. *Science*, 165:274.

1969

- With M. K. Harlow. Effects of various mother-infant relationships on rhesus monkey behaviors. In: *Determinants of Infant Behaviour*, ed. B. M. Foss, pp. 15–36. London: Methuen.
- With C. I. Thompson and J. S. Schwartzbaum. Development of social fear after amygdectomy in infant rhesus monkeys. *Physiol. Behav.*, 4:249–54.
- William James and instinct theory. In: *William James: Unfinished Business*, ed. R. B. McCleod, pp. 21–30. Washington, D.C.: American Psychological Association.
- Age-mate or peer affectional system. In: *Advances in the Study of Behavior*, ed. D. S. Lehrman, R. A. Hinde, and E. Shaw, vol. 2, pp. 333–83. New York: Academic Press.
- With G. R. Kerr, A. S. Chamove, and H. A. Waisman. The development of infant monkeys fed low phenylalanine diets. *Pediatr. Res.*, 3:305–12.
- With S. J. Suomi. Apparatus conceptualization for psychopathological research in monkeys. *Behav. Res. Methods Instrum.*, 1:247–50.
- The anatomy of humour. *Impact Sci. Soc.*, 19:225–39.

- With G. R. Kerr and A. S. Chamove. Environmental deprivation: Its effect on the growth of infant monkeys. *J. Pediatr.*, 75:833–37.
- With C. S. Furchner. Preference for various surrogate surfaces among infant rhesus monkeys. *Bull. Psychon. Sci.*, 17:279–80.
- With K. A. Schiltz and M. K. Harlow. Effects of social isolation on the learning performance of rhesus monkeys. In: *Proceedings of the 2nd International Congress of Primatology*, ed. C. R. Carpenter, vol. 1, pp. 178–85. Basel/New York: Karger.

1970

- With S. J. Suomi. The nature of love—simplified. *Am. Psychol.*, 25:161–68.
- With S. J. Suomi and J. K. Lewis. Effect of bilateral frontal lobectomy on social preferences of rhesus monkeys. *J. Comp. Physiol. Psychol.*, 70:448–453.
- With S. J. Suomi and W. T. McKinney. Experimental production of depression in monkeys. *Mainly Monkeys*, 1:6–12.
- With A. C. Deets. Nipple preferences in nursing singleton- and twin-reared rhesus monkey infants. *Dev. Psychol.*, 2:159–62.
- With C. I. Thompson, A. J. Blomquist, and K. A. Schiltz. Learning in rhesus monkeys after varying amounts of prefrontal lobe destruction during infancy and adolescence. *Brain Res.*, 18:343–53.
- With S. J. Suomi. Induction and treatment of psychiatric states in monkeys. *Proc. Natl. Acad. Sci. USA.*, 66:241.
- With S. J. Suomi. Induced psychopathology in monkeys. *Eng. Sci.*, 33:8–14.
- With A. S. Chamove. Exaggeration of self-aggression following alcohol ingestion in rhesus monkeys. *J. Abnorm. Psychol.*, 75:207–9.
- With J. W. Davenport and A. S. Chamove. The semiautomatic Wisconsin general test apparatus. *Behav. Res. Methods Instrum.*, 2:135–38.
- With K. A. Schiltz, A. J. Blomquist, and C. I. Thompson. Effects of combined frontal and temporal lesions on learned behaviors in rhesus monkeys. *Proc. Natl. Acad. Sci. USA.*, 66:577–82.
- With A. S. Chamove and H. A. Waisman. Abnormal social behavior in phenylketonuric monkeys. *J. Abnorm. Psychol.*, 76:62–68.
- With A. C. Deets, S. D. Singh, and A. J. Blomquist. Effects of bilat-

- eral lesions of the frontal granular cortex on the social behavior of rhesus monkeys. *J. Comp. Physiol. Psychol.*, 72:452-61.
- With M. K. Harlow. Developmental aspects of emotional behavior. In: *Physiological Correlates of Emotion*, ed. P. Black, pp. 37-58. New York: Academic Press.
- With S. J. Suomi and C. J. Domek. Effect of repetitive infant-infant separation of young monkeys. *J. Abnorm. Psychol.*, 76:161-72.
- With S. J. Suomi and G. P. Sackett. Development of sex preference in rhesus monkeys. *Dev. Psychol.*, 3:326-36.
- With A. C. Deets and A. J. Blomquist. Effects of intertrial interval and trial 1 reward during acquisition of an object discrimination learning set in monkeys. *J. Comp. Physiol. Psychol.*, 73:501-5.

1971

- With W. T. McKinney and S. J. Suomi. Depression in primates. *Am. J. Psychiatry*, 127:1313-20.
- With S. J. Suomi. Abnormal social behavior in young monkeys. In: *Exceptional Infant: Studies in Abnormalities*, ed. J. Hellmuth, vol. 2, pp. 483-529. New York: Brunner Mazel.
- With J. L. McGaugh and R. F. Thompson. *Psychology*. San Francisco: Albion Publishing Co.
- With A. J. Blomquist and A. C. Deets. Effects of manipulating incentive visibility during the baiting phase of delayed-response problems. *Learn. Motiv.*, 2:67-74.
- With S. J. Suomi. Social recovery of isolation-reared monkeys. *Proc. Natl. Acad. Sci. USA*, 68:1534-38.
- With L. A. Rosenblum. Maturation variables influencing sexual posturing in rhesus monkeys. *Arch. Sex. Behav.*, 1:73-78.
- Early problem learning and early social learning. In: *The Second Western Symposium on Learning: Early Learning*, ed. M. E. Meyer, pp. 41-75. Bellingham: Western Washington State College.
- With M. K. Harlow and S. J. Suomi. From thought to therapy: Lessons from a primate laboratory. *Am. Sci.*, 59:538-49.
- With S. J. Suomi and S. D. Kimball. Behavioral effects of prolonged partial social isolation in the rhesus monkey. *Psychol. Rep.*, 29:1171-77.
- With J. P. Gluck. The effects of deprived and enriched rearing conditions on later learning: A review. In: *Cognitive Process of Non-human Primates*, ed. L. E. Jarrard, pp. 103-19. New York: Academic Press.
- With M. K. Harlow, K. A. Schiltz, and D. J. Mohr. The effect of

- early adverse and enriched environments on the learning ability of rhesus monkeys. In: *Cognitive Processes of Nonhuman Primates*, ed. L. E. Jarrard, pp. 121–48. New York: Academic Press.
- With S. J. Suomi. Production of depressive behaviors in young monkeys. *J. Autism Child. Schizophren.*, 1:246–55.
- With M. K. Harlow. Psychopathology in monkeys. In: *Experimental Psychopathology*, ed. H. D. Kimmel, pp. 203–29. New York: Academic Press.
- With C. I. Thompson, A. J. Blomquist, and K. A. Schiltz. Recovery of function following prefrontal lobe damage in rhesus monkeys. *Brain Res.*, 35:37–48.
- With W. T. McKinney, Jr., R. G. Eising, E. C. Moran, and S. J. Suomi. Effects of reserpine on the social behavior of rhesus monkeys. *Dis. Nerv. Sys.*, 32:735–41.
- With W. T. McKinney, Jr. Nonhuman primates and psychoses. *J. Autism Child. Schizophren.*, 1:368–75.

## 1972

- With W. T. McKinney, Jr. and S. J. Suomi. Vertical-chamber confinement of juvenile-age rhesus monkeys. *Arch. Gen. Psychiatry*, 26:223–28.
- With S. J. Suomi. Social rehabilitation of isolate-reared monkeys. *Dev. Psychol.*, 6:487–96.
- With M. K. Harlow, E. W. Hansen, and S. J. Suomi. Infantile sexuality in monkeys. *Arch. Sex. Behav.*, 2:1–7.
- Love created—love destroyed—love regained. In: *Modeles Animaux Du Comportement Humain*, No. 198, pp. 13–60. Paris: Editions du Centre National de la Recherche Scientifique.
- With S. J. Suomi. Depressive behavior in young monkeys subjected to vertical chamber confinement. *J. Comp. Physiol. Psychol.*, 180:11–18.
- With W. T. McKinney and S. J. Suomi. Repetitive peer separations of juvenile-age rhesus monkeys. *Arch. Gen. Psychiatry*, 27:200–4.
- With J. P. Gluck and S. J. Suomi. Generalization of behavioral data between nonhuman and human animals. *Am. Psychol.*, 27:709–16.
- With M. K. Harlow. The language of love. In: *Communication and Affect*, ed. T. Alloway, L. Krames, and P. Pliner, pp. 1–18. New York: Academic Press.
- With J. B. Sidowski and S. J. Suomi. Enhancing social attachment

through fear. A study of infant monkeys. *Bull. Psychon. Soc.*, 29:323.

With A. S. Chamove and H. J. Eysenck. Personality in monkeys: Factor analysis of rhesus. *Q. J. Exp. Psychol.*, 24:496-504.

1973

With W. T. McKinney, Jr., and S. J. Suomi. Methods and models in primate personality research. In: *Individual Differences in Children*, ed. J. C. Westman, pp. 265-87. New York: John Wiley & Sons.

With A. J. Blomquist and A. C. Deets. Effects of list-length and first-trial reward upon concurrent discrimination performance. *Learn. Motiv.*, 4:28-39.

With M. A. Novak. Psychopathological perspectives. *Perspec. Biol. Med.*, 16:461-78.

With L. D. Young, S. J. Suomi, and W. T. McKinney, Jr. Early stress and later response to separation in rhesus monkeys. *Am. J. Psychiatry*, 130:400-5.

With D. M. Baysinger and P. E. Plubell. A variable-temperature surrogate-mother for studying attachment in infant monkeys. *Behav. Res. Methods Instrum.*, 5:269-72.

With K. A. Schiltz, C. I. Thompson, D. J. Mohr, and A. J. Blomquist. Learning in monkeys after combined lesions in frontal and anterior temporal lobes. *J. Comp. Physiol. Psychol.*, 83:271-77.

With J. P. Gluck and K. A. Schiltz. Differential effect of early enrichment and deprivation on learning in the rhesus monkey (*Macaca mulatta*). *J. Comp. Physiol. Psychol.*, 84:598-604.

With A. S. Chamove. Avoidance learning in phenylketonuric monkeys. *J. Comp. Physiol. Psychol.*, 84:605-12.

With A. S. Chamove and L. A. Rosenblum. Monkeys (*Macaca mulatta*) raised only with peers. A pilot study. *Anim. Behav.*, 21:316-25.

With W. T. McKinney, Jr., and S. J. Suomi. New models of separation and depression in rhesus monkeys. In: *Separation and Depression, Clinical and Research Aspects*, ed. J. P. Scott and E. C. Senay, No. 94, pp. 53-66. Washington, D.C.: American Association for the Advancement of Science.

With S. J. Suomi and M. L. Collins. Effects of permanent separation from mother on infant monkeys. *Dev. Psychol.*, 9:376-84.

- With A. S. Chanove and G. R. Kerr. Learning in monkeys fed elevated amino acid diets. *J. Med. Primatol.*, 2:223–35.
- With P. E. Plubell and C. M. Baysinger. Induction of psychological death in rhesus monkeys. *J. Autism Child. Schizophr.*, 3:299–307.

## 1974

- Induction and alleviation of depressive states in monkeys. In: *Ethology and Psychiatry*, ed. N. F. White, pp. 197–208. Toronto: University of Toronto Press.
- Les affectivites. In: *L'Attachement*, ed. R. Zazzo, pp. 58–72. Paris: Delachaux et Niestle.
- With H. E. Lauersdorf. Sex differences in passion and play. *Per-spec. Biol. Med.*, 17:348–60.
- With G. C. Ruppenthal, M. K. Harlow, C. D. Eisele, and S. J. Suomi. Development of peer interactions of monkeys reared in a nuclear-family environment. *Child Dev.*, 45:670–82.
- Maternal and peer affectional deprivation in primates. In: *Experimental Behaviour: A Basis for the Study of Mental Disturbance*, ed. J. Cullen, pp. 85–98. Dublin: Irish University Press.
- With S. J. Suomi. Induced depression in monkeys. *Behav. Biol.*, 12:273–96.
- With A. C. Deets. Adoption of single and multiple infants by rhesus monkey mothers. *Primates*, 15:193–204.
- With S. S. Suomi and M. A. Novak. Reversal of social deficits produced by isolation rearing in monkeys. *J. Hum. Evol.*, 3:527–34.

## 1975

- With S. J. Suomi. Generalization of behavior from monkey to man. In: *Psychology*, ed. G. Lindzey, C. Hall, and R. F. Thompson, pp. 34–35. New York: Worth.
- With S. J. Suomi. Effects of differential removal from group on social development of rhesus monkeys. *J. Child Psychol. Psychiatry*, 16:149–64.
- Ethology. In: *Comprehensive Textbook of Psychiatry*, ed. A. M. Freedom, H. K. Kaplan, and B. J. Sadock, pp. 317–36. Baltimore: Williams & Wilkins.
- With P. M. Nealis, A. Carpentier, and S. J. Suomi. Dynamic stimu-

- lus display for the WGTA. *Behav. Res. Methods Instrum.*, 7:291–93.
- With S. J. Suomi. Experiencias tempranas y psicopatología inducida en monos rhesus. *Revista Latinoamer. Psicol.*, 7:205–29.
- With C. E. Mears. Play: Early and eternal. *Proc. Natl. Acad. Sci. USA*, 72:1878–82.
- Lust, latency and love—Simian secrets of successful sex. *J. Sex. Res.*, 11:79–90.
- With M. A. Novak. Social recovery of monkeys isolated for the first year of life: 1. Rehabilitation and therapy. *Dev. Psychol.*, 11:453–65.
- With J. S. Meyer, M. A. Novak, and R. E. Bowman. Behavioral and hormonal effects of attachment object separation in surrogate-peer-reared and mother-reared infant rhesus monkeys. *Dev. Psychol.*, 8:425–36.
- With S. J. Suomi, C. D. Eisele, and S. A. Grady. Depressive behavior in adult monkeys following separation from family environment. *J. Abnorm. Psychol.*, 84:576–78.
- With S. J. Suomi. The role and reason of peer relationships in rhesus monkeys. In: *Friendship and Peer Relations*, ed. M. Lewis and L. A. Rosenblum, pp. 153–85. New York: John Wiley & Sons.
- With W. T. McKinney and S. J. Suomi. Experimental psychopathology in nonhuman primates. In: *New Psychiatric Frontiers, American Handbook of Psychiatry*, ed. D. A. Hamburg and H. K. Brodie, vol. 6, 2 ed., pp. 310–34. New York: Basic Books.
- Monkeys, men, mice, and motives. In: *Psychological Research: The Inside Story*, ed. M. H. Siegel and H. P. Zeigler, pp. 3–22. New York: Harper & Row.

## 1976

- With S. J. Suomi, M. L. Collins, and G. C. Ruppenthal. Effects of maternal and peer separations on young monkeys. *J. Child Psychol. Psychiatry*, 17:101–12.
- With G. C. Ruppenthal, G. L. Arling, G. P. Sackett, and S. J. Suomi. A 10-year perspective of motherless-mother monkey behavior. *J. Abnorm. Psychol.*, 85:341–49.
- With S. J. Suomi. The facts and functions of fear. In: *Emotions and Anxiety: New Concepts, Methods, and Applications*, ed. M. Zuckerman and C. D. Spielberger, pp. 3–34. Hillsdale, N.J.: Lawrence Erlbaum Associates.



With S. J. Suomi and R. DeLizio. Social rehabilitation of separation-induced depressive disorders in monkeys. *Am. J. Psychiatry*, 133:1279–85.

## 1977

With C. Mears. The power and passion of play. *New Sci.*, 73:336–38.

With P. M. Nealis and S. J. Suomi. The effects of stimulus movement on discrimination learning by rhesus monkeys. *Bull. Psychon. Soc.*, 10:161–64.

With S. J. Suomi. Production and alleviation of depressive behaviors in monkeys. In: *Psychopathology: Experimental Models*, ed. J. Maser and M. E. P. Seligman, pp. 131–73. San Francisco: W. H. Freeman.

Birth of the surrogate mother. In: *Discovery Processes in Modern Biology*, ed. W. R. Klemm, pp. 133–50. Huntington, N.Y.: R. E. Krieger.

With S. J. Suomi. Early separation and behavioral maturation. In: *Genetics, Environment and Intelligence*, ed. A. Oliverio, pp. 197–214. Amsterdam: Elsevier.

## 1978

With S. J. Suomi. Early experience and social development in rhesus monkeys. In: *Social and Personality Development*, ed. M. E. Lamb, pp. 252–71. New York: Holt, Rinehart & Winston.

With C. E. Mears. The nature of complex, unlearned responses. In: *The Development of Affect*, ed. M. Lewis and L. A. R. Rosenblum, pp. 257–74. New York: Plenum Press.

## 1979

With C. Mears. *The Human Model: Primate Perspectives*. Washington, D.C.: V. H. Winston & Sons (Halsted Press).