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Comparative cognition in the 1930s

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According to the received view of the history of psychology, behaviorism so dominated psychology prior to the 1960s that there was little research in animal cognition. A review of the research on animal cognition during the 1930s reveals a rich literature dealing with such topics as insight, reasoning, tool use, delay problems, oddity learning, abstraction, spatial cognition, and problem solving, among others. Material on "higher processes" or a related topic was prominent in the textbooks of the period. Tracing academic lineages reveals such teachers as Harvey Carr, Robert M. Yerkes, and Edward C. Tolman as sources of this interest. The alleged hegemony of strict behavioristic psychology, interpreted as excluding research on animal cognition, requires revision. Some possible reasons for this neglect are suggested.

According to the received view of the history of the study of animal learning and cognition, there was much interest in animal cognition among early comparative psychologists, but that interest died with the advent of behaviorism, only to resurface with the "cognitive revolution" of the 1960s. According to a leading textbook in the field of comparative cognition, "it would not be exaggerating too greatly to say that from the 1920s until the 1960s or 1970s, American experimental psychology was virtually synonymous with behaviorism" (Roitblat, 1987, p. 52). Wasserman (1993) writes of "a long, fallow period [in the study of] the cognitive processes of animals" (p. 221). For Green (1996), "cognition simply was not a going concern in psychology before the 1950s" (p. 35).

As a critical part of this hegemony of behaviorism, it is argued, studies of cognitive processes were excluded during this period, as behaviorists sought to explain complex processes as a reflection of more simple processes of learning and conditioning. Thus, "at the beginning of the 1900s psychologists' study of cognitive processes in animals narrowed into the study of associative learning... The subfield of animal cognition arose in the 1970s" (Shettleworth, 1998, p. 6), and "so long as behaviorism held sway—that is, during the 1920s, 1930s, and 1940s—questions about the nature of human language, planning, problem solving, imagination, and the like could only be approached stealthily and with difficulty, if they were tolerated at all" (Gardner, 1985, p. 11).

This view of a "cognitive revolution," in the spirit of Thomas Kuhn, has been challenged by Leahey (1992), who pointed out that, during the years in question, behaviorism was less dominant than is portrayed by the received view. According to Leahey, "the central work of mentalistic psychology continued, but it was no longer thought of as the study of consciousness" (p. 313). Similarly, Greenwood (1999) has recently questioned whether "the much-touted historical 'hegemony' of behaviorism from the 1920s to the 1950s adequately reflects the rich diversity of research interests and practices during this period" (p. 18).

In this article, I argue that the study of animal cognition was alive and well during the 1930s—a critical period in the development of behaviorism. It was during the 1930s that some of the pinnacles of classical behaviorism were formulated; Clark L. Hull developed his mechanistic hypothetico-deductive theory of learning (e.g., Hull, 1937), Edwin R. Guthrie (1935) published his *Psychology of Learning*, Edward C. Tolman (1932) published his *Purposive Behavior in Animals and Men*, and B. F. Skinner (1938) published his classic *Behavior of Organisms*. Thus, I believe that it is especially significant that one can demonstrate the pervasiveness of research on animal cognition during this time. I shall not pretend that studies of cognition were dominant; they were not. There was, however, a considerable literature on animal cognition developed during the 1930s. Obviously, it would be nice to extend the study into the 1940s and 1950s; that is beyond the scope of the present article.

I shall focus on material published in general sources, such as textbooks, two major research programs, those of Norman R. F. Maier at the University of Michigan and Robert M. Yerkes at the facility that would be named the Yerkes Laboratories of Primate Biology (YLPB) in Orange Park, FL, and also material from many other psychologists using a variety of methods to study animal cognition during this period, loosely defined. The work of Edward C. Tolman during this period is relatively well known and under historical analysis elsewhere; it will be covered here but de-emphasized.

Loucks (1931) quoted Bertrand Russell as noting that "American rats, after frantically rushing about, solve a

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particular problem by chance, whereas German rats evolve a solution out of their inner consciousness" (p. 511). Some researchers of the 1930s believed there was more going on in the heads of rats than Lord Russell realized.

DEFINITIONS

The validity of the hypothesis depends, of course, on the definition of cognition. Cognition often is defined broadly so as to include all aspects of knowing, including sensation, perception, learning, remembering, and decision making (Barrows, 1996; Shettleworth, 1998). Roitblat (1987) defines comparative cognition as "the study of the minds of organisms" (p. 1) and goes on to discuss mind broadly so as to include "learning, remembering, problem solving, rule and concept formation, perception, recognition, and others" (p. 2). I shall use a more narrow conception of cognition that is focused on presumed mental activity of the sort that implies the operation of processes other than instinctive behavior and basic conditioning. I wish to focus on material often treated under the rubric of "higher processes," such as concept formation, insight learning, reasoning, and ideation. Even with this more restrictive conception of cognition, one finds a substantial literature in the 1930s.

What differentiates the literature to which I refer from the behavioristic learning literature are the categories adopted, the tasks chosen, the language used, and the underlying processes believed to be operational. The methods are generally behavioral, but the constructs proposed to explain results are not. In this literature, research is often described as concerned with insight, ideation, reasoning, or some such category. The tasks used generally are thought to require a more complex form of information processing than is required in the typical learning literature of the time. Mentalistic terminology appears in many, but not all, studies. Lashley (1935) believed that his cerebral lesions had not damaged a mechanism of association but had altered one concerned with behavior that might be described as reflecting hypotheses, abstraction, generalization, insight, and attention. Cowles and Nissen (1937) wrote of the role of "reward expectancy" (p. 345) in the delayed response problem. The core theme in all of these studies is that the researchers believed that the accomplishments observed in the animals could not be attained through basic learning processes but required the postulation of some higher (cognitive) processes.

For Greenwood (1999), what differentiates the early literature from that after the cognitive revolution is that cognitive processes were regarded as intervening variables during the earlier period but as hypothetical constructs later. However, this distinction is complex, and different interpretations are extant. The distinction was rarely made in the field of animal cognition of the 1930s, the period at hand. It is clear that at least some of the students of animal cognition at the time attributed a reality, or surplus meaning, to cognitive processes that suggests hypothetical constructs in the sense of Hilgard (1956).

COMPARATIVE COGNITION IN GENERAL SOURCES

Textbooks

The 1930s were a period of extraordinary textbook publication in comparative psychology. All devoted significant attention to cognitive issues. The categories used in different portions of these books are summarized in Table 1. Most devoted at least one chapter to a topic such as "higher mental processes" or "symbolic processes."

The standard text in the field for nearly 30 years had been Washburn's *The Animal Mind*; the fourth edition appeared in 1936. Given her background as a student of E. B. Titchener, it is perhaps not surprising that she adopted a mentalistic approach. Her key construct was the "memory idea," "the ability to recall a mental image of an absent stimulus" (p. 328). In her chapter on "Higher Mental Processes," Washburn reviewed studies using a variety of tasks and showed how she believed perspectives on the animal mind had changed from the dampening influence of Lloyd Morgan's canon to the psychology of her time.

Comparative psychology has a long history of edited textbooks, beginning with that of Moss (1934). In addition to chapters on "Discrimination," "The Neurology of Learning," "The Conditioned Reflex," "Learning," and "Theories of Learning," the book included a separate chapter by W. T. Heron (1934) on "Complex Learning Processes." This chapter included such topics as insight, reasoning, judgment, and abstraction. Such chapters became a staple in the successive edited texts in this field (Heron, 1942; Riopelle, 1960; Riopelle & Hill, 1973). The same material was covered in a slightly different organizational structure by Heron and Harlow in Calvin P. Stone's (1951) *Comparative Psychology* (3rd ed.).

The most successful textbook of the 1930s was Maier and Schneirla's (1935) Principles of Animal Psychology. In their chapter on "Higher Mental Processes," they covered studies "designed to exclude learning as the determining process in the animal's behavior" (p. 444).

The same general material was covered in a section on "Special Tests of Intelligence Level" within a chapter on "Testing Reactive Capacities" in Volume I of the comprehensive three-volume *Comparative Psychology* of Warden, Jenkins, and Warner (1935). The context in this work is slightly different, as the studies are presented as tests of higher forms of intelligence rather than of separate cognitive abilities.

The last of the 1930s textbooks was Norman L. Munn's (1933) *An Introduction to Animal Psychology*. This book is something of an outlier, as suggested by its subtitle, *The Behavior of the Rat*. Although dealing almost exclusively with rats, not generally thought of as the epitome

Table 1
Categories of Higher Process Studies Used in Textbooks of the 1930s

Heron (1934, 1942)
Complex Learning Processes
Insight
Reasoning
Use of tools
Delayed reaction
Multiple delayed reaction (1942)
Methods of bridging the interval
Double-alternation problem
Multiple-choice problem
Judgment
Abstractions and generalizations
Token rewards (1942)
Maier & Schneirla (1935)
Higher Mental Processes
Delayed reaction
Sudden drop in learning curve
Abstraction
Multiple choice
Reasoning
Other animal forms (Köhler and others)
Washburn (1936)
Higher Mental Processes
Delayed responses
Abstraction
The temporal maze
"Insight"
"Hypotheses"
Reasoning
Use of tools and mechanical devices
Recognition of Landmarks
Munn (1933)
Symbolic Processes
Delayed reaction
Multiple-choice problem
Double alternation in temporal maze
Warden et al. (1935)
Special Tests of Intelligence Level
Problem method
Multiple-plate task
Imitation task
Delayed-response method
Hamilton quadruple-choice method
Yerkes multiple-choice method
Box-stacking task

of cognition, Munn nevertheless discussed many of the standard topics in animal cognition of the time, including delayed reactions, the multiple-choice problem, and double alternation.

It is apparent that, through all of the textbooks of the period, a section on what we would now regard as comparative cognition was treated as an essential part. The organizational structure varies a bit from volume to volume, but, in general, the same material was covered in each work.

In the classic review of comparative studies in the major handbook of experimental psychology, S. S. Stevens' *Handbook of Experimental Psychology*, Nissen (1951) devoted over 40% of a chapter on phylogenetic comparisons to a section on "Cognitive Aspects of Behavior." Here, Nissen discussed such issues as the genesis of perception, pattern specificity, the selective process of attention, concept formation, and symbolization and language. Many of the studies discussed are from the time period emphasized in the present discussion. Nissen concluded that "it is in the cognitive rather than the motivational aspects of behavior that we find the significant axes of behavioral evolution" (p. 380).

Review Articles

Similar emphases can be seen in review articles of the time. In an article on "Cerebral Control Versus Reflexology," Lashley (1931) responded to an earlier criticism by Hunter (1930a) and defended the notion that the behavior of rats in a variety of situations required explanation in terms of central processes, as opposed to the peripheral reflexology suggested by Hunter. Tolman's (1932) *Purposive Behavior in Animals and Men* is full of suggestions regarding cognitive processes. He suggested that "behavior as behavior, that is, as molar, *is* purposive and *is* cognitive" (p. 12). Luh (1937) published an article entitled "A Comparative Approach Toward the Psychology of Cognition," in which he argued for a cognitive approach.

THE RESEARCHERS

Summarized in Figure 1 are the academic lineages of many of the psychologists who did work in animal cognition during the 1930s. Although there were many such psychologists, there are especially strong links to Edward C. Tolman of the University of California, Berkeley, Robert M. Yerkes, of Yale and the YLPB, and Harvey Carr, of the University of Chicago. Tolman, a Harvard PhD of 1915, established a major animal laboratory and trained some outstanding students at Berkeley. Otto L. Tinkplepaugh and John T. Cowles went from there to the YLPB. Yerkes, a Harvard PhD of 1902, not only produced an impressive group of his own doctoral students but also attracted those of others to work as staff members at the YLPB after completing doctorates elsewhere. Carr received a University of Chicago PhD in 1905, having worked with John B. Watson, James Rowland Angell, and John Dewey, among others. He became a tireless advocate of the functionalist school of psychology.

Of these three key figures, only Carr produced students who were especially effective in generating a third generation for the 1930s field of animal cognition. Carl J. Warden, a largely overlooked psychologist at Columbia University, produced the most, but W. T. Heron, at the University of Minnesota, and Walter S. Hunter, during his period at Clark University, also were effective in this regard.

Several others were important. Although Karl S. Lashley's 1914 PhD at Johns Hopkins was in Zoology, he functioned as a psychologist for most of his life. Lashley argued against a psychology based on chain reflexes and in favor of central regulation, finding himself between "the Scylla of reflexological dogma and the Charybdis of men-

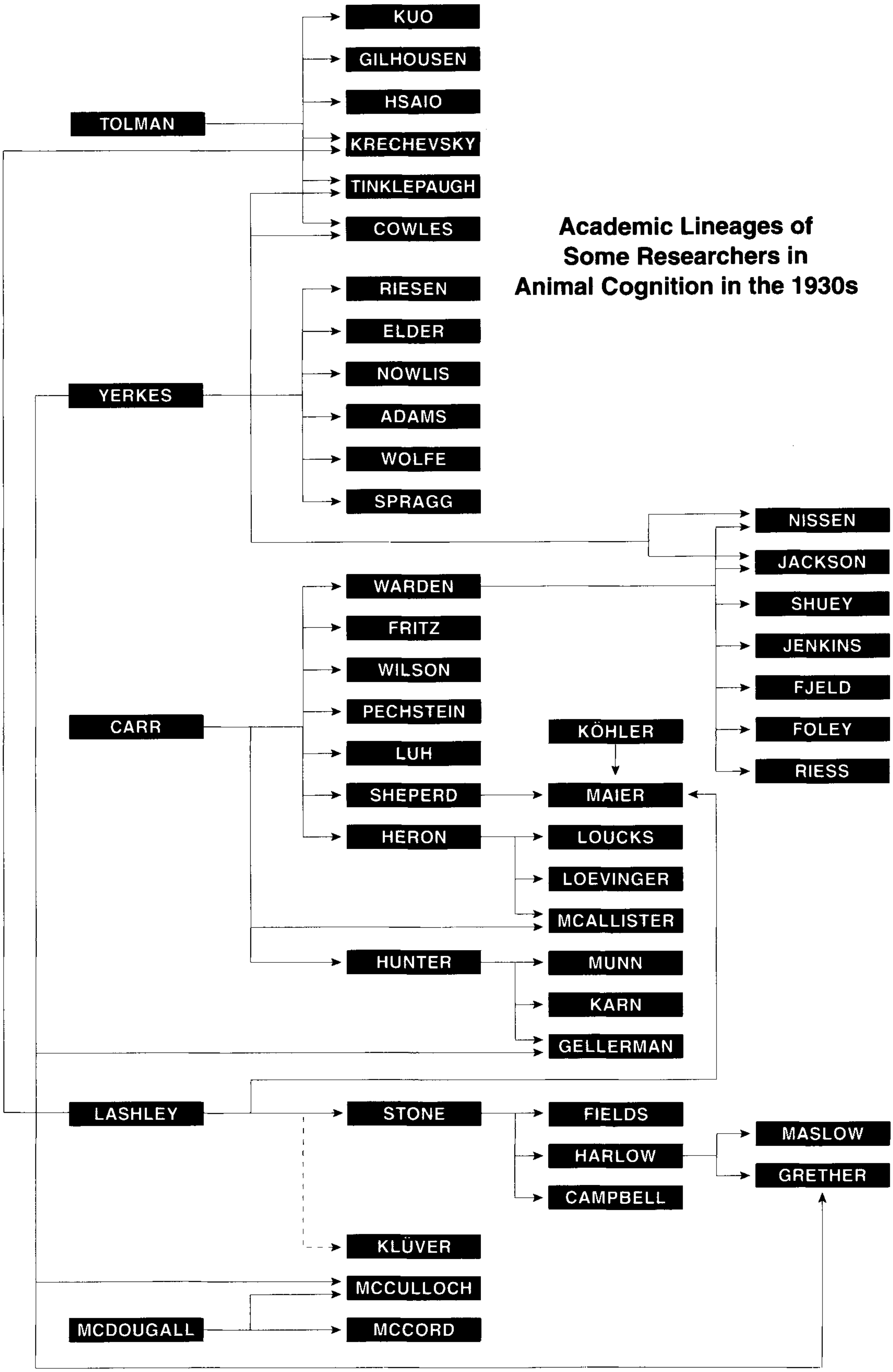

Figure 1. Academic lineages of some researchers in animal cognition during the 1930s.

talistic implication" (Lashley, 1938, p. 125). From Lashley, we can see a fourth generation through Calvin P. Stone to Harry F. Harlow to Abraham H. Maslow, later a famous humanistic psychologist, and Walter F. Grether.

Lurking in the background of this network was the influence of John B. Watson. He exerted a strong influence on both Carr and Lashley during their graduate training and was a good friend and frequent correspondent of Yerkes. It may seem strange that Watson, regarded as the founder of behaviorism, was perhaps the focal grandfather of 1930s research in animal cognition, but this is less surprising when one considers his functionalist background at the University of Chicago, where he received his PhD in 1903, and his early lines of research, rather than his hard-line behaviorism of the 1920s.

TWO MAJOR PROGRAMS

I now discuss the substantial programs of Yerkes and Maier, which illustrate the underlying theme that these psychologists believed nonhuman animals to be capable of cognitive performance that could not be explained by the associationistic hypotheses of the behaviorists of the day. While relying on behavioral observations and thus, in some sense, behaviorists, they believed that some more complex phenomena could not be explained by conditioning theory. In this they had a fundamental disagreement with such theorists as Edward L. Thorndike and Kenneth W. Spence.

Robert M. Yerkes, His Students, and His Associates

Robert M. Yerkes, who both conducted and oversaw much research at Yale University and the Yerkes Laboratories of Primate Biology in Orange Park, FL, was consistent and clear in his commitment to a language of a mentalistic cognition. In summarizing much of the work done at Orange Park, Yerkes (1943) wrote that a new type of "emergent neural process supplements trial-and-error procedure by making possible forms of behavioral adaptation which strikingly resemble those which in us are known to depend upon perception of relation, ideation, insight, or understanding" (pp. 169–170).

Ideation. Although Yerkes stopped short of proposing that these abilities matched our own, he proposed that performance in completing complex tasks reveals in chimpanzees "ideational processes." These ideational processes provided the basis for the research program in cognition at the Yerkes laboratories. He selected, among others, four primary areas of research as typifying the appearance of ideation and thus these processes: the string test, the box test, the selective transportation test, and the multiple-choice test.

Yerkes (1934) believed that these forms of behavior "obviously presage those expressions of human curiosity and originality we call invention and discovery" (p. 107). This ideational behavior differed from basic learning, as revealed by sudden solutions, and would be possible only in animals with the requisite neural apparatus. He believed such performance characteristic of only apes and men.

Language and symbolism. At a still more abstract and cognitive level, Yerkes and his colleagues sought evidence of the use of signs and symbols as precursors of linguistic capacity. They found evidence of what Yerkes regarded as real, but rather minimal, use of symbols in chimpanzees. Sign learning, for Yerkes, entailed the development of new meanings for stimuli as they become associated with particular events through repetition and could be a matter of simple conditioning. Symbols involved representation. Operationally, the imposition of delays provided a primary method with which the experimenters tested for symbolic representation. Yerkes and his associates sought evidence of symbolic processes in studies of delayed response, discrimination learning, and delayed reward. Much of this research is reviewed below.

Norman R. F. Maier

Norman R. F. Maier ran a very different, and less comprehensive, research program. Maier's work reflects his background; he spent part of his graduate career with the Gestalt psychologists at the University of Berlin before completing his PhD with John F. Shepard at the University of Michigan. He then spent 2 years at the University of Chicago working with Lashley.

During the 1930s, Maier conducted an extensive series of experiments on a process he termed "reasoning." He regarded behavior resulting from contiguous experiences as reflecting a learning process, or "process L," and that from isolated experiences as reflecting reasoning, or "process R." It was the ability to combine two noncontiguous experiences that Maier believed to reflect reasoning, and he worked and argued hard to establish that this was fundamentally different from conditioning. He wrote:

> The term reasoning implies that something new has been brought about, and that in some way, past experiences have been manipulated. It therefore seems that behavior patterns made up of two isolated experiences characterize what is meant by behavior which is the product of reasoning (Maier, 1931b, p. 336).

Maier relied mainly on "table problems" with rats. In one variation (Maier, 1929b), in a room with which the rats were already familiar, they were trained to climb three ringstand ladders in order to arrive at an elevated pathway that connected several items in the room. A table, one corner of which was screened off from the larger part of the surface, was in the room. The rats learned to go from the table to other parts of the room. For their second experience, the rats were guided to climb from the base of a ringstand to the pathway and thence to food, which had been placed on the corner of the table. The animal was tested by placing it on the table across from the screen to see if it would combine its two experiences and climb down from the table and back up to reach the elevated pathway and the food. Because they had to combine two separate experiences, Maier (1929b) concluded that the rats solve the problems "without 'trial and error,' but with intelligence and insight" (p. 88) and that "patterns or Gestalten" (p. 92) were involved.

The task resembles the *Umweg*, or detour problem. By varying the conditions somewhat, it could be made into one in which the rats had to learn to choose the shortest of several paths to a goal (Maier, 1929b). Maier (1929b) ran many variations on this fundamental experiment. In another variation (Maier, 1929a), it became a test of the delayed response.

In the three-table problem of Maier (1932d), three tables in a room were connected by an elevated pathway. The rats were permitted to explore the apparatus and then to feed on one of the three tables. They were then placed on one of the other tables to see whether they would use the pathway to get to the table that contained food. When he found that rats could do this, Maier concluded that the rats could reason.

Simultaneous with this rat research, Maier conducted a program of research on reasoning in humans (e.g., Maier, 1930b, 1931a, 1933, 1936) and published several review and theoretical papers (Maier, 1931b, 1937, 1940).

THE LITERATURE ON ANIMAL COGNITION IN THE 1930s

In this section, I summarize a broad range of studies of animal cognition from a variety of laboratories, including those of Yerkes and Maier. In the interest of space conservation, I emphasize the methods used and the conclusions reached, since these are most critical to the present argument. The procedures used by a wide variety of authors studying animal cognition are summarized in Table 2. Some of these classifications are somewhat arbitrary, since different authors might use the same task to infer different cognitive processes and a single author might postulate more than one process.

Insight

With the appearance in English of Köhler's (1925) *The Mentality of Apes*, interest in the topic of insight was galvanized. The issue concerned whether performance could be explained with principles of Thorndike's trial-and-error learning or required a process such as insight.

Umweg problems. In the simplest task, the animal had to solve the detour (or *Umweg*) problem, which, in various guises, required that it move away from a goal in order to get around a barrier keeping it from the goal. As noted, some of the problems of Maier (1929b) can be viewed as *Umweg* problems. Hamilton and Ballachey (1934) reported fortuitous observations of a rat solving an *Umweg* problem.

Box stacking. The famous box test, in which the animal had to correctly place one or more boxes underneath a lure that had been suspended from the ceiling in order that it may reach the lure (Köhler, 1925), was one of Yerkes's favorite indicators of ideation. Working with Yerkes, Bingham found that chimpanzees were quite efficient at solving these problems. As evidence of ideation, Bingham (1929a, p. 56) listed "(a) abrupt changes; (b) reflective pauses; (c) anticipatory looks; (d) confluent acts; (e) transfers of skill and plan; (f) overnight solutions; [and] (g) transformation as revealed in corrective adjustments." Yerkes (1943) added an observation from work of Yerkes and Spragg (1937), emphasizing the suddenness with which solutions can be reached. Brainard (1930) compared the performance of children to that of apes and observed solutions consistent with Köhler's.

Stick problems. Köhler (1925) observed sudden solutions to a variety of stick problems in which animals had to use, and sometimes alter, sticks to rake in various incentives. Yerkes (1927a, 1927b) observed similar behavior in a gorilla. Pechstein and Brown (1939) studied the problem and concluded that solutions resulted from trial and error and from chance, rather than insight. By contrast, working at Yale, Jackson (1942) utilized stick tests similar to those used by Köhler (1925). Jackson contrasted the performance of younger animals, who seemed to act via trial and error, with that of older, experienced animals whose solutions "tended to be of the 'insightful' (sudden) type" (p. 234). These experiments can also be interpreted in the context of tool use (see below).

The box-and-pole test. Yerkes and Spragg (1937) used a box-and-pole test, in which a banana was placed out of reach in a long, narrow box with open ends that was anchored to the ground. The only way for the animal to get the banana was to use a long pole to push it out the opposite end. Yerkes and Spragg particularly noted the performance of one chimpanzee, Mamo, who, they felt, showed every evidence of having solved the problem suddenly as if with insight.

Simple inference. Grether and Maslow (1937) studied several species of monkeys in a situation that required that, when shown that one of two food cups was empty, they must select the other one. Grether and Maslow concluded that "mechanical principles, such as 'trial-and-error' and 'conditioning,' do not appear adequate to explain the 3 manners of attaining success on the problem" (p. 133) and favored Maier's "reasoning" interpretations.

Chain-and-stake problems. In an article on "insight and foresight in various animals," McDougall and McDougall (1931) used chain-and-stake problems in which an animal was chained to a tree and the chain was looped around a stake. When the animal moved as close to an incentive as possible under these circumstances, the incentive remained just out of reach. To solve the problem, the animal had to retreat and separate the chain from the stake so that it allowed full extension and access to the incentive. There is an obvious affinity to the *Umweg* tasks described above. The subjects solved the problem. The authors believed that the solutions reflected not only insight but foresight as well, and they criticized the Gestalt

Table 2
A Provisional Classification of 1930s Studies in Animal Cognition

General Articles and Reviews
Lashley (1931); Tolman (1932); Luh (1937)

Insight
Umweg Problems
Hamilton & Ballachey (1934)
Box Stacking
Bingham (1929a); Brainard (1930)
Stick Problems
Pechstein & Brown (1939); Jackson (1942)
Simple Inference
Grether & Maslow (1937)
Chain-and-Stake Problems
McDougall & McDougall (1931)
Puzzle Boxes
Adams (1929); McDougall & McDougall (1931); Lashley (1935); Pechstein & Brown (1939)

Reasoning
Maier Room-and-Table Problems
Maier (1929a, 1929b, 1930b, 1931a, 1931b, 1932a, 1932b, 1932c, 1932d, 1933, 1934, 1935, 1936, 1937, 1938a, 1938b, 1940); Wolfe & Spragg (1934); Campbell (1935); Maier & Curtis (1937); Maier & Sabom (1937); Maier & Sherburne (1938); Loevinger (1938)
Enclosed-Maze Problem
Shepard (1933)

Tool Use
Fritz (1930); Klüver (1933); Yerkes & Spragg (1937)

Delay Problems
The Delayed-Response Task
Tinklepaugh (1928, 1932); Harlow (1932); Harlow, Uehling, & Maslow (1932); Maslow & Harlow (1932); McAllister (1932); Yudin & Harlow (1933); Foley & Warden (1934); Keller (1934); Wilson (1934a, 1934b); Nissen, Carpenter, & Cowles (1936); Cowles & Nissen (1937); Nissen, Riesen, & Nowlis (1938); Harlow & Bromer (1939); McCord (1939a, 1939b); Yerkes & Nissen (1939); Cowles (1940); Nissen & Harrison (1941); Finch (1942)
Delayed Alternation
Loucks (1931); Elder & Nissen (1933); Nissen & Taylor (1939)
Delayed Matching to Sample
Finch (1942)
Delayed Reward
Riesen (1940)

Oddity Learning
McCulloch & Nissen (1937); Nissen & McCulloch (1937a, 1937b)

Double Alternation
Hunter (1929, 1930b); Hunter & Nagge (1931); Gellerman (1931a, 1931b, 1931c); Karn (1938); Karn & Malamud (1939); Karn & Patton (1939)

Multiple Choice
Yerkes (1934); Spence (1939)

String Problems
Adams (1929); Harlow & Settlage (1934); Klüver (1933); Trueblood & Smith (1934); Finch (1941)

Abstraction
Revesz (1925); Lashley (1938)
Attention
Maier (1930a); Lashley (1938)
Transposition
Perkins & Wheeler (1930); Schiller (1933)
Concept Formation
Fields (1932, 1935, 1936a, 1936b)

Spatial Cognition
Forward-Going Tendency
Dashiell (1930)
Cognitive Maps
Hsaio (1929); Tolman & Honzik (1930); Gilhousen (1931); Keller & Hill (1936); Kuo (1937)

Symbolism
Token rewards
Wolfe (1936); Cowles (1937)
Assorted Tasks
Yerkes & Nissen (1939); Nissen (1938); Nissen & Taylor (1939); Finch (1942)

Problem Solving
Jenkins Triple-Plate Problem Box
Jenkins (1927); Shuey (1931, 1932); Fjeld (1934); Riess (1934)
Cooperative Problem Solving
Crawford (1937, 1941)
Selective Transportation Test
Bingham (1929b)
Reversal Learning
Nissen, Riesen, & Nowlis (1938)

Hypotheses
Krechevsky (1932, 1933a, 1933b, 1935)

Imitation
Warden & Jackson (1935)

Language
Yerkes and Learned (1925)

psychologists for not incorporating foresight into their interpretations.

Puzzle boxes. With the puzzle boxes pioneered by Thorndike (1898, 1911), an animal was confined in a box and had to operate a manipulandum of some kind in order to escape. Although Thorndike believed that the problem was solved through trial and error, other interpretations were offered during the period under consideration. Adams (1929) used a similar approach and believed that he found evidence of insight as a special form of adaptation, and he sharply criticized behaviorists for trying to extend principles of conditioning to complex processes. McDougall and McDougall (1931) believed that actions in their puzzle boxes "clearly imply insight" (p. 254). Lashley (1935) found cerebral lesions to have little effect on learning but to interfere with performance in latch-box problems "and that retardation from cerebral lesions is due rather to disturbance of such function as are implied by the terms attention, insight and initiative" (p. 38). Pechstein and Brown (1939), by contrast, concluded that the performance of their primates in puzzle-box situations did not require the postulation of insight.

Reasoning

Research aimed at demonstrating a reasoning process was done primarily by N. R. F. Maier as was discussed above. Maier (1932a) found that young rats were inferior to older ones in combining separate experiences. Maier (1932c) studied the effects of cortical lesions on tasks that he believed required just the learning process versus those that required reasoning. Whereas the lesions did not affect performance in the learning task, they caused decrements in the reasoning task in a manner consistent with Lashley's notions of mass action (i.e., the larger the lesion, the greater the deficit). Maier refined the lesion work in later studies (Maier, 1932b, 1934; Maier & Sabom, 1937). In later work, Maier (1938a, 1938b; Maier & Sherburne, 1938) required rats to integrate four separate experiences. Maier and Curtis (1937) studied within-day trends in problem-solving performance.

As might be expected, Maier's research proved controversial. Whereas Campbell (1935) supported Maier's distinction between learning and reasoning, Wolfe and Spragg (1934) repeated the experiments and concluded that "solutions were achieved in a manner entirely consistent with ordinary learning principles" (p. 469). Wolfe and Spragg used four different test situations, three of which were adaptations of apparatus used by Maier (1929a) and one a reproduction of Maier's (1932b, 1932c) three-table problem, in their critical reevaluation of Maier's work. Maier (1935) defended his distinction. Loevinger (1938) concluded that Maier's results reflected neither reasoning nor learning ability. The point to be emphasized is that throughout this whole, extensive program, the focal issue was that of whether the results could be explained with traditional learning principles or necessitated the postulation of some higher, more cognitive, process.

Maier's mentor, John F. Shepard (1933), believed he had demonstrated reasoning on the basis of experiments in an enclosed maze. From a central field, four alleys, 11–17 ft in length, led to four boxes. Rats were allowed to explore the maze, and food was then presented in one of the four boxes. Because they then went to the appropriate box, Shepard inferred that they displayed reasoning, "combination, in advance of the reaction, of factors from separate experiences, and where such separate experiences involve essential contradictory or differing elements which must be functionally recognized" (p. 149).

Tool Use

There is overlap between studies of tool use, including the box-and-stick problems and the box-and-pole problems of Yerkes and Spragg (1937), discussed above. In addition, Fritz (1930) observed a rat that used a wood shaving as a tool by dipping it into water repeatedly, licking the water from it each time.

Whereas R. M. Yerkes and A. W. Yerkes (1929) had proposed that there is a great gulf between the monkeys and apes regarding use of instrumentation, Klüver (1933) conduced a series of 207 experiments involving sticks, ropes, sacks, rings, and brushes with a cebus monkey and concluded that tool use was considerable and closer to that of the apes than suggested by Yerkes.

Delay Problems

Easily the most popular tasks in studies of animal cognition during this period were problems with built-in delays. The basic notion was that because an appreciable interval intervened between the presentation of the task and the opportunity for a response, some kind of representation had to be utilized.

The delayed-response task. In the most basic, and most popular, delay task, the delayed-response task introduced by Hunter (1913), the animal is shown which of several alternatives is correct and an interval is imposed before a response is possible. There were many variations on the delayed response theme during the period under consideration. McAllister (1932) placed the problem in the context of the natural history of animals in the field responding to stimuli not present at the time. Some of the studies were comparative in nature, the critical question being how long a delay could be tolerated by different species (e.g., Harlow, 1932; Harlow & Bromer, 1939; Harlow, Uehling, & Maslow, 1932; Maslow & Harlow, 1932; McAllister, 1932; Yudin & Harlow, 1933). Keller (1934) presented a critique of an earlier study by R. M. Yerkes and D. N. Yerkes (1928) suggesting that chimpanzees showed delayed responses with color as an isolated cue.

There was much interest in how the animals performed the tasks, particularly with respect to whether some bodily orientation was necessary to mediate the delay (e.g., McAllister, 1932; McCord, 1939b; Nissen, Carpenter, & Cowles, 1936; Tinklepaugh, 1928; Wilson, 1934a, 1934b). Cowles (1940) believed that performance in this situation was continuous with, and not qualitatively different from, that in other discrimination learning situations. McCord (1939a, 1939b) inferred only that the process involved in mediating the delay must be central rather than peripheral. Nissen, Riesen, and Nowlis (1938) studied delayed response learning in an apparatus in chimpanzees and concluded that a "symbolic mechanism" (p. 384) was operative but that it is highly developed for spatial cues and not for visual stimuli. Nissen and Harrison (1941) confirmed the importance of positional cues. Tinklepaugh (1932) found that chimpanzees did better than monkeys in a multiple-delayed-response task, in which the correct alternative in several pairs had to be retained simultaneously; several boys did more poorly than the apes (Tinklepaugh, 1932). By substituting a less preferred incentive for a more preferred one, Tinklepaugh (1928) elicited reactions that led him to believe that his "monkeys demonstrated ... representations standing for certain quantitative aspects of the reward" (p. 236), as well as which alternative was correct.

Delayed alternation. Less popular was the delayed-alternation task of Carr (1917, 1919), in which animals had to alternate successive responses with a delay imposed in between. The notion was that the cue is less obvious as it comes from the animal's own response. Loucks

(1931) studied the effects of cortical lesions, Elder and Nissen (1933) studied delayed alternation in raccoons, and Nissen and Taylor (1939) studied chimpanzees.

Delayed matching to sample. Finch (1942) extended the work on delayed response and added tests of delayed matching to sample, a procedure that has become quite popular in studies of animal cognition in recent years. He concluded that delayed matching to sample is easier for chimpanzees than is nonspatial delayed-response learning.

Delayed reward. Riesen's (1940) study of delayed reward was interpreted by both he and Yerkes as suggesting the operation of symbolic processes.

Oddity Learning

A program of research on oddity learning was conducted by Henry W. Nissen and T. L. McCulloch at the YLPB (McCulloch & Nissen, 1937; Nissen & McCulloch, 1937a, 1937b). They showed that chimpanzees could learn oddity problems but provided little speculation regarding underlying processes.

Double Alternation

In the double-alternation problem, an animal is required to respond in a pattern, such as left–left–right–right; thus, it encounters the same stimuli on successive runs and must make a different response on the two occasions. Hunter (1929, 1930b; Hunter & Nagge, 1931) used the double-alternation problem, which he had earlier introduced, in an effort to analyze the stimuli controlling the maze habit. He wished to discredit the hypothesis that rats learn mazes as a chain reflex, or proprioceptively controlled set of responses. On the other hand, he disagreed with Lashley's view that the underlying mechanism was entirely central. Rather, he thought that the animal "can supplement proprioceptive and exteroceptive stimuli with some symbolic process or with some central neural process" (Hunter, 1929, p. 535). The issue at hand, once more, was that of the presence of a central cognitive process.

The method was used in sets of studies from two other laboratories, both under the influence of Hunter. Gellerman (1931a, 1931b, 1931c) studied double alternation in monkeys and humans and concluded that the research "affords additional evidence that the double alternation temporal maze may be placed with the delayed reaction experiment as another method of demonstrating the presence of symbolic processes in human and infra-human subjects" (Gellerman, 1931a, p. 71). Similarly, Karn and his associates (Karn, 1938; Karn & Malamud, 1939; Karn & Patton, 1939) published three studies of cats and dogs in the double-alternation problem and drew a similar conclusion regarding the importance of symbolic processes.

Multiple Choice

Clearly, Yerkes's favorite method was that of his own devising—the multiple-choice test (Yerkes, 1916, 1934). Studies were done in a large, outdoor apparatus in which the animal moved through an entrance alley to a chamber onto which opened nine doors, each leading to a large box. On any given trial, some doors were open and some closed. The task of the animal was to pass through the correct door and box to obtain food. Within a problem, which box was correct was determined by a consistent rule, such as "the middle door," "the leftmost door," or "the second from the right end." Because a different set of doors would be open and available on each trial within a problem set, the actual door that had to be selected varied from trial to trial, though the same rule always applied. Yerkes regarded the problems as "relational," because the only predictable characteristic was the spatial relationship among varying sets of open doors. Yerkes (1934) studied 4 chimpanzees, reporting that the disappearance of errors was "abrupt" in six cases and by gradual approximation in eight cases. He concluded that the solution resulted from the "sudden discovery of the significant relationship" (p. 103) because of (1) the abrupt changes in error rate from 30% or more to 0%, (2) the fact that different boxes were open on different trials, and (3) the ability of the subjects "to respond correctly with ease and assurance" to new settings of open doors. Yerkes found little evidence of imitation, however.

The multiple-choice research was criticized by a number of authors (e.g., Hunter, 1916; Spence, 1939). With Yerkes's encouragement, Spence (1939) took up what was conceptually the same problem, albeit with a new "manual multiple-choice apparatus" that had earlier been used by Yerkes and Bingham. The entire apparatus fit on a single panel that could be attached to the animal's cage. Performance was much better than in the earlier work. Spence, however, remained unconvinced of Yerkes's ideational interpretation. He believed that the animals solved the problem by learning some kind of unspecified movements associated with perception. For example, if the animal was faced with selecting the middle of five boxes, it might fixate successively on three successive boxes starting from the left and reach a correct solution without appreciating that it was selecting the middle box. Spence noted that animals frequently reached the solution quite suddenly. However, he added that they often went from one incorrect strategy to another equally suddenly and sometimes switched abruptly away from a correct pattern to one that was incorrect. Yerkes (1943), however, clung to his ideational interpretation of his own results, dismissing Spence's as being from a situation so different that the results could not be meaningfully compared.

String Problems

In patterned-string problems the subjects had to choose between two or more strings, one of which was attached to a piece of food. Typically, they were crossed in patterns of varying complexity. During the period under consideration, the problem was used in several laboratories, with several species, and with several interpretations. Adams (1929) studied cats with string problems and suggested that their successful performance suggested the use of ideas or insight. Trueblood and Smith (1934) repeated the study with a larger sample and better controls and obtained less impressive results. They suggested that the results could be explained by a process of trial-and-error learning.

Harlow and Settlage (1934) used the problem with monkeys. They focused on interspecies comparisons, finding that several species of monkeys seemed to perform in a manner superior to all nonprimates but inferior to that of chimpanzees and humans. They noted that "simple tests are solved almost immediately by all monkeys (insight)" (p. 433). More complicated problems led to more complicated interpretations.

In the patterned-string tests of Finch (1941) at the YLPB, chimpanzees had to choose between two or more strings, one of which was attached to a piece of food. Seven of Finch's 8 chimpanzees solved all 11 problems given, including 2 problems that none of Harlow and Settlage's (1934) monkeys could solve. Furthermore, whereas the monkeys showed no improvement over successive trials, the chimpanzees did. Yerkes (1943) noted that humans typically solve such problems either by "immediate perception of the essential relation and correct response" (p. 157) or by trial and error, with a shift to the former with age. He implied that the chimpanzees too are responding in a cognitive-perceptual manner.

Klüver (1933) studied a large variety of problems in several species of monkeys, including some patterned-string experiments. He was especially interested in using the "pulling-in" method to alter the parameters of items at the ends of the strings, making the task really one of discrimination learning with the relevant stimuli attached to the ends of the strings. His results are difficult to summarize because the experiments were designed and interpreted within the context of his Gestalt-derived system. He was primarily interested in the relations between stimuli and the extent to which these relational aspects among stimuli were affected by variations in the characteristics of the stimuli. Thus, where the monkey had to make a discrimination in pulling in one of two weights attached to strings, Klüver found that he could make changes in both the relative and the absolute weights of the two boxes or change the material or appearance of the boxes without disrupting performance. He could thus study "equivalence of stimuli" (i.e., which stimuli were treated as if identical). The cognitive emphasis of focusing on the perceived relationships between stimuli that transcend their absolute characteristics is clear.

Abstraction

The term *abstraction* fits in that class about which there has been much controversy. It has been used in cases where the subject extracts certain information from a stimulus or sets of stimuli. Lashley was a strong believer, arguing that "equivalence tests show that so long as the abstract property which differentiates the positive figure from the negative is preserved, differential reaction persists" (Lashley, 1938, p. 186). He believed rats capable of abstraction but of a limited sort, especially oriented toward space.

Revesz (1925) studied the ability of monkeys to abstract color and form from stimuli and concluded that they lack the ability for what he termed *conceptual abstraction* but did posses an ability to "*cognize similarities on a sensory plane*" (p. 338) (italics in original). Thus, he believed that "apparent abstractive performances can be reduced to immediate cognition of similarity" (p. 338).

Attention. One form of abstraction is selective attention. Lovie (1983) analyzed the literature on attention from 1910 to 1960; relying almost exclusively on data from humans, he concluded that "work on attention and related topics was published continuously over this 50-year period" (p. 303).

In an article entitled "Attention and Inattention in Rats," Maier (1930a) suggested that errors in maze performance can result from either incomplete learning or inattention. When he varied the task, such as by changing the pathway pattern, rest period, or presence of a stimulus light, he found performance improved relative to that when the maze was left unchanged. He attributed the difference to attention and inattention.

Lashley (1938) used the Lashley jumping stand to study visual discriminations in rats. He presented various two-dimensional geometrical figures as stimuli. In critical tests, however, he found that the rats were attending to only parts of the figures and seemed to be ignoring the remainder. Thus, the animals appeared to be attending selectively to only a portion of what the experimenter regarded as the stimulus.

Transposition. In transposition problems, animals respond to relational, rather than absolute, characteristics of stimuli. Some authors regarded this as evidence of insight. Some of the experiments of Klüver (1933), just discussed, fit into the category of transposition.

Perkins and Wheeler (1930) studied the phenomenon in unlikely subjects, goldfish. They found the fish capable of responding to the relational aspects of stimuli and believed that the results could not be explained in terms of trial-and-error learning. Rather, they concluded that "*the usual criteria of insight are found in the behavior of the goldfish*" (p. 50) (italics in original). In this, they were following Helson (1927), who defined insight broadly as an "ability to respond to a part in the light of the whole, modification of activities to meet the exigencies of a situation in a manner we may call sensible, or the transposition of the general properties from one situation to another" (p. 380) and found evidence of insight (i.e., transposition) in rats.

Schiller (1933) observed intermodality transposition in minnows. Fish trained to respond to a "brighter" odor transferred the training to prefer a brighter light.

Concept formation. It should be remembered that studies of concept formation were an interest of Clark L. Hull (1920). Paul E. Fields (1932) conducted a set of experiments on concept formation in rats, concentrating on the ability of the animals to develop concepts of geometric figures. He found, for example, that rats could respond selectively to triangular shapes even when he varied such characteristics as the area and position of the stimuli. He concluded that the rat "can react to qualities inherent in a particular pattern, and that it can perceive 'identity in diversity'" (Fields, 1932, p. 67). He went further, stating that "the rat can react to the total organization (Gestalt) of a pattern without previous training to that particular pattern" (p. 67). In later studies, Fields (1935) studied the problem in improved apparatus; Fields (1936a) found good retention of the capacity; and Fields (1936b) found concept formation in raccoons to be superior to that in rats.

Spatial Cognition

Forward-going tendency. In his studies of maze learning, Dashiell (1930) found that rats appeared to establish some kind of direction orientation that acts independently of specific stimuli to keep them moving in the general direction of the food box. He noted that the animals could not be simply integrating a pattern of chain reflexes and speculated that it must be "set up by some kind of kinesthetic or organic posturing or set" (p. 69).

Cognitive maps. The study of Tolman and Honzik (1930) has been widely cited. In one of their three mazes that allowed any of several routes to be taken to reach a goal, rats learned to take the shortest path. When that was blocked, they took the next shortest path. Tolman and Honzik interpreted their results in relation to the principle of insight and, indeed, entitled their article "'Insight' in Rats." They concluded that insight was "definitely proved" (p. 230). In fact, their study followed an earlier one suggested by Tolman to one of his students (Hsiao, 1929), who also reported evidence of insight. However, several studies also appeared that questioned the necessity of postulation a process of insight in such situations (Gilhousen, 1931; Keller & Hill, 1936; Kuo, 1937). Indeed, Kuo (1937), a student of Tolman, stated that "such terms as 'insight,' 'reasoning,' 'intelligent,' or 'ideational behavior,' and the like, are lazy substitutes for a more careful laboratory analysis" (p. 186).

Symbolism

Among the best known studies from the YLPB during this period, and the most notable efforts at studying symbolism, were those of token rewards; Yerkes (1943) treated these as indicative of sign learning. In the study conducted by Wolfe (1936), chimpanzees were permitted to work for poker chips, as tokens for food, by manipulating a lever in a special apparatus. Either immediately or at the end of a session, the animal could exchange the tokens for food by using a "chimpomat" vender apparatus. Wolfe concluded that the tokens "came to function as secondary or surrogate rewards" (p. 72). Wolfe's work was extended by Cowles (1937). Tokens were found to support learning in such tasks as simple position habits, complex, five-choice position habits, visual size discrimination, visual color–pattern discrimination, and delayed response. Both authors were more cautious than Yerkes in applying mentalistic terms to the behavior, although Wolfe was reluctantly willing to regard the tokens as signs or symbols for the chimpanzees under limited restrictions.

Yerkes and Nissen (1939) found evidence of what they believed to be only rudimentary symbolic processes in chimpanzees. Nissen et al. (1938) reported the results of several related experiments involving variations on basic discrimination learning between a white panel and a black panel, one of which led to food. The idea was that the subjects would have to respond to the color of the stimulus, thus eliminating positional cues, as the positions were changed between baiting and the opportunity to respond. Nissen et al. (1938) believed that a symbolic mechanism was necessary for the subjects to solve the problem as they did. However, they concluded that this mechanism is highly developed for spatial cues, but not for visual stimuli.

The work was followed up by Nissen and Taylor (1939) with tests of delayed alternation with nonpositional cues. The subject, Moos, succeeded in the task, thus providing further evidence of some symbolic capacity when dealing with visual stimuli. Furthermore, Finch (1942) extended the work on delayed response and added tests of delayed matching to sample; he concluded that delayed matching to sample is easier for chimpanzees than is nonspatial delayed-response learning.

Yerkes was still more impressed with the results of Riesen (1940). Yerkes and Riesen believed that, where there was a delay of reward, especially with nonspatial problems, symbolic processes must be at work. Subjects given extensive training on color discrimination tasks performed very well, sometimes achieving solutions with one or no errors. Riesen concluded that "this suggests that, if given the proper previous experience, animals can achieve sudden solutions characteristic of problem-solving by means of symbols" (p. 50). Riesen further concluded that evidence of representation, or use of symbols, could be found in a variety of tasks, including learning with delayed reward, delayed response, reasoning tests, and test of insight or single-trial learning. Like Yerkes, he believed that symbolic functions were commonly used with spatial stimuli but that, with other stimuli, were difficult to find.

Problem Solving

The topic of problem solving overlaps with several already discussed but is a convenient category for several types of studies.

The Jenkins triple-plate problem box. The Jenkins problem box was developed by Thomas N. Jenkins (1927) in Carl J. Warden's laboratory at Columbia University. The chamber was round, with a food chamber in the center and a start box fitted to the outside. Three metal plates were fitted on the floor surrounding the food chamber. The animal had to step on any combination of these three plates in order for the food chamber to be opened. Jenkins believed it to be a method that could be used with good control with many species. Shuey (1931, 1932) studied kittens in the apparatus in an effort to locate their level of intelligence in relation to that of other species. Riess (1934) found the performance of rats and guinea pigs to be markedly inferior to that of kittens. On the other hand, Fjeld (1934) found superior performance in rhesus monkeys.

Cooperative problem solving. In the basic paradigm used by Meredith P. Crawford in studying cooperative problem solving, he trained individual chimpanzees to solve a problem and then altered the problem so that 2 animals had to cooperate to achieve a solution. The animals were generally effective in this endeavor. Crawford (1937) trained each to get an incentive by using a rope to pull a box to its cage. The box was then made too heavy for one individual to pull it in. With some guidance from the experiment, the animals learned to cooperate in solving the problem. The course of development of cooperation in two other problems was similar to that in the rope-pulling task. In a related study (Crawford, 1941), chimpanzees were trained to push four colored panels in a particular sequence in order to obtain a reward. For tests of cooperation, the panels were divided so that each animal had access to two of them, and both received rewards for successful completion of the task of pushing the panels in the correct order. The chimpanzees learned to watch each other, in order to synchronize the order in which the panels were pressed, and the older ones learned to solicit when it was the other's turn to make a response.

The selective transportation apparatus. The selective transportation apparatus (Bingham, 1929b), one of Yerkes's indicators of ideation, differed from most other tests in that the incentive was inside of a cage, 6 ft square and 3 ft high, and the chimpanzee was on the outside looking in. The incentive, such as a banana, was suspended from the ceiling of the cage on a rod that ran on a track set in the ceiling of the apparatus. A knob was fixed to the top of the rod. The animal's task was to move the knob along the track so that the incentive would be moved to one of several small doors, where it could be reached. Progress in solving the problem went somewhat slowly. Bingham (1929b), however, was more interested in the manner in which the problems were solved than in their rate; he concluded that ideation was involved on the basis of a number of factors, including the versatility of the animals, as they could show abrupt changes, sudden initiation, and correction of errors. He was also impressed with their consistent orientation toward the goal, anticipatory responses when the goal was nearly within reach, fluent solutions, and sudden changes in the time curves, among other features. Not surprisingly, Yerkes (1943, p. 162) agreed with Bingham's conclusions.

Reversal learning. Nissen et al. (1938) studied reversal learning in chimpanzees and found that after an initial decrease, the rate of learning generally increased. This is suggestive of learning to learn.

Hypotheses

Working in Tolman's laboratory, Krechevsky (1932) came to believe that rats do not solve maze problems by a gradual accumulation of habit strength, but, rather, they form successive hypotheses concerning the problem, and their behavior in learning problems reflects these hypotheses. Thus, "the learning process *at every point* consists of a series of integrated, purposive behavior patterns" (Krechevsky, 1932, p. 532). He explored this hypothesis in several situations (Krechevsky, 1932, 1933a) and also studied hereditary influences (Krechevsky, 1933b) and brain mechanisms (Krechevsky, 1935).

Imitation

Since the early work of Thorndike, imitation has been regarded as suggestive of cognitive processes, though the literature has produced results that are mixed at best. During the 1930s, Warden and Jackson (1935) studied imitation in rhesus monkeys using the "Warden duplicate-cage method," which enabled 2 monkeys to face duplicate puzzle problems in adjacent cages. Warden and Jackson found considerable imitation in about half of their tests and concluded that the tendency to imitate is orthogonal to problem-solving ability.

Language

I have found no overt studies of language during the 1930s. Just a few years earlier, however, Yerkes and Learned (1925) published *Chimpanzee Intelligence and Its Vocal Expression*. They catalogued, using musical notation, the various sounds made by chimpanzees.

PERSPECTIVE

Having established that the study of animal cognition was alive and well during the 1930s, it appears appropriate to provide some speculations concerning the context within which this research existed and its subsequent fate.

Two related questions concern the extent to which this tradition was marginalized at the time and the reasons that it has been ignored by most authors writing about the period.

Marginalization

Although there was much research in animal cognition, more behavioristic psychologists nevertheless prevailed. The premier journal of the time was the *Journal of Experimental Psychology*. The only study cited here that appeared in that journal was that of Helson (1927). Students of cognition did better in the *Journal of Comparative Psychology*, but numerous studies appeared in such less prestigious journals as the *Journal of Genetic Psychology, Comparative Psychology Monographs*, and *Genetic Psychology Monographs*. It would appear that the more prestigious the journal, the more it was dominated by the less cognitive approaches. The behaviorists appear to have controlled access to the prestigious journals.

The Cognitive Approach

During the period under study, experimental psychologists were especially concerned with defending the scientific nature of their discipline. Psychology, conceived as the study of consciousness, had reached a dead end. The newer approaches were more positivistic, and anything that appeared likely to shift the field back to the older ways was shunned by the hard-nosed experimentalists. Because cognition had been so closely associated with consciousness, many opposed cognitive approaches and the mentalistic terminology often associated with it in favor of more descriptive and positivistic approaches.

Experimental psychologists wanted to be perceived as scientific. What could appear more "scientific" than the theorems and postulates of which Hullian theory was composed (e.g., Hull, 1943)? All variables were defined in terms of measurable observations rather than speculations about the inner working of the mind.

Furthermore, the cognitivists' speculations could not compete with the polished behavioristic theories. Hull's was a comprehensive theory; the cognitivists could point to complex phenomena that seemed not to fit the Hullian paradigm, but they offered no truly integrative theory in its place. Hull offered what appeared to be mathematical precision.

Power and Personalities

A number of other factors seem relevant. During this period, experimental psychology was dominated by a group of hard-nosed experimentalists based in prestigious Northeastern schools, especially Yale University. They dominated the prestigious Society of Experimental Psychologists (SEP) and especially the feeder group for the SEP, the Psychological Round Table, which drew its entire membership from this region (Benjamin, 1977). They developed a classical "good old boy" network that excluded many outsiders. Men such as Kenneth W. Spence and Donald Marquis went on to lead and control programs at the major universities. They were extremely gifted scientists but also were effective in academic politics. The talent at Yale in the 1930s may rarely have been matched in one place and time in the history of psychology. They formed a close network. Men such as Tolman, Maier, and Yerkes, by contrast, were peripheralized to some degree by geography and pedigree. Tolman was on the West Coast, further from the center of power then than it is now.

The cases of Maier and Yerkes, leaders of the two most substantial programs, are instructive. Maier was a somewhat contentious Midwesterner who not only was involved in the cognitive research but was embroiled in a controversy with some of the same Eastern scientists concerning the genesis of seizures in rats in conflict situations (Dewsbury, 1993). He was not trusted. Maier was told that he had been blackballed for membership in the SEP, negative comments were relayed to him by his friends, he had difficulties in placing his students, and he reported difficulties in getting his articles accepted in APA journals (Dewsbury, 1993; Popplestone, 1967). He eventually left the field to become a successful industrial psychologist. He recalled that "it was this type of control over the journals that forced me to change research areas" (Maier, 1966).

Although a member of the Yale faculty, Yerkes was of another generation, and his mentalistic approach was not widely respected by more reductionistic psychologists during the 1930s. He had established the Orange Park laboratories in 1930. By the mid-1930s, however, the primary funding source, the Rockefeller Foundation, was having second thoughts about the direction of the laboratory and sought the opinion of such scientists as Karl S. Lashley, Edward C. Tolman, and Heinrich Klüver. They were critical of many aspects of Yerkes's running of the laboratories, including what they perceived as a rather old-fashioned naturalistic approach as opposed to the more reductionistic approaches that were beginning to take hold. By the end of the decade, Yerkes was forced to resign the directorship as the only way to save the laboratories. Thus, the two biggest proponents of cognitive research in the 1930s eventually left the field.

Many histories, those generally termed "Whig" histories, are written by and about the winners of controversies (Stocking, 1965). They often tend to downplay the contributions of the other side. It appears fair to suggest that the behaviorists dominated the playing field and influenced the construction of a history that ignored the substantial activities of those working on cognitive studies.

Genetic Influences?

As noted above, Bertrand Russell was quoted as noting that "American rats, after frantically rushing about, solve a particular problem by chance, whereas German rats evolve a solution out of their inner consciousness" (Loucks, 1931, p. 511). The same contrast became a common laboratory joke, according to which the rats of Tolman and other cognitivists were viewed as buried deep in thought, whereas the Hull–Spence rats only behaved. Some relatively obscure research suggests the possibility that there may indeed have been a genetic difference between the two populations of rats. Jones and Fennell (1965) and Fabric (1965) compared the behavior of Long-Evans rats, favored in Tolman's studies, with that of the black-hooded strain derived from a nonemotional strain developed in a study by C. S. Hall of selective breeding that became the foundation of the Spence colony. It should be noted that these strains became established slightly after the period emphasized here. Jones and Fennell found gross differences in the behavior of the two populations in a U-maze. The Long-Evans animals were deliberate and highly exploratory. The "Spence animals" were more active and "seemed almost oblivious to their environment" (Jones & Fennell, 1965, p. 294). With some qualifications, the authors concluded that "the findings of this study favor the view that genetic differences were involved in the great debate over the nature of learning" (p. 295). Fabric studied the two strains in several situations, including elevated runways, favored by Tolman, and enclosed runways, favored by the Spence school. In general, the Tolman rats appeared less emotional and performed better on elevated runways, whereas the Spence rats did better in walled situations. Fabric (1965, pp. 51–52) concluded that "the Long-Evans animals perform better on elevated mazes and runways while the Hall–Spence animals performed better in closed alleys than on elevated runways." Thus, there may have been a genetic difference between the two colonies that may have been selected to behave in the manner preferred in each laboratory. It is worth stressing that these are suggestive studies only and that more substantial and carefully reviewed research would be required to establish the phenomenon definitively.

CONCLUSION

There is abundant evidence that the 1930s, far from being a period in which studies of comparative animal cognition were snuffed out by the onslaught of behaviorism, was a period of very active and vigorous investigation of cognitive processes in animals. By this I mean that there was much interest in, and controversy about, the possibility that animals were capable of learned behavior that could not be explained by processes of basic conditioning but, rather, required the postulation of some higher processes. I would not argue that comparative animal cognition in the 1930s was the same as that in the 1990s; I do suggest, however, that it was an important era in the history of the field.

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