

THE SNARK WAS A BOOJUM¹

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THOSE of you who are familiar with the writings of Lewis Carroll will have recognized the title of this address as a quotation from his poem "The Hunting of the Snark." Anyone who has never read that masterpiece of whimsy must now be informed that the hunting party includes a Bellman, a Banker, a Beaver, a Baker and several other equally improbable characters. While they are sailing toward the habitat of their prey the Bellman tells his companions how they can recognize the quarry. The outstanding characters of the genus *Snark* are said to be its taste which is described as "meager but hollow," its habit of getting up late, its very poor sense of humor and its overweening ambition. There are several species of Snarks. Some relatively harmless varieties have feathers and bite, and others have whiskers and scratch. But, the Bellman adds, there are a few Snarks that are Boojums.

When the Baker hears the word, Boojum, he faints dead away, and after his companions have revived him he explains his weakness by recalling for their benefit the parting words of his Uncle.

If your Snark be a Snark, that is right:
Fetch it home by all means—you may serve it
with greens
And it's handy for striking a light.

But oh, beamish nephew, beware of the day,
If your Snark be a Boojum! For then,
You will softly and suddenly vanish away,
And never be met with again!

Much later in the story they finally discover a Snark, and it is the Baker who first sights the beast. But by great misfortune that particular Snark turns out to be a Boojum and so of course the Baker softly and suddenly vanishes away.

Thirty years ago in this country a small group of scientists went Snark hunting. It is convenient to personify them collectively in one imaginary

individual who shall be called the Comparative Psychologist. The Comparative Psychologist was hunting a Snark known as Animal Behavior. His techniques were different from those used by the Baker, but he came to the same unhappy end, for his Snark also proved to be a Boojum. Instead of animals in the generic sense he found one animal, the albino rat, and thereupon the Comparative Psychologist suddenly and softly vanished away. I must admit that this description is somewhat overgeneralized. A few American psychologists have done or are doing behavioral research that is broadly comparative. All honor to that tiny band of hardy souls who are herewith excepted from the general indictment that follows.

It is my aim, first, to trace the initial development and subsequent decline of Comparative Psychology in the United States. Secondly, I intend to propose certain explanations for the attitude of American psychologists toward this branch of the discipline. And finally I will outline some of the potential benefits that may be expected to follow a more vigorous and widespread study of animal behavior.

Instead of beginning with the uncritical assumption of a mutual understanding, let me define the basic terms that will be used. Comparative psychology is based upon comparisons of behavior shown by different species of animals including human beings. Comparisons between *Homo sapiens* and other animals are legitimate contributions to comparative psychology, but comparisons between two or more non-human species are equally admissible. Like any other responsible scientist the Comparative Psychologist is concerned with the understanding of his own species and with its welfare; but his primary aim is the exposition of general laws of behavior regardless of their immediate applicability to the problems of human existence. Now this means that he will not be content with discovering the similarities and differences between two or three species. Comparisons between rats and men, for example, do not in and of themselves constitute a comparative psychology although they

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may well represent an important contribution toward the establishment of such a field. A much broader sort of approach is necessary and it is the failure to recognize this fact that has prevented development of a genuine comparative psychology in this country.

PAST AND CURRENT TRENDS

The history of comparative behavior studies in America is reflected in the contents of our journals that are expressly devoted to articles in this field. They have been the *Journal of Animal Behavior* and its successor, the *Journal of Comparative and Physiological Psychology*. Animal studies have, of course, been reported in other publications but the ones mentioned here adequately and accurately represent the general interests and attitudes of Americans toward the behavior of non-human animals. I have analyzed a large sample of the volumes of these journals, starting with Volume I and including all odd-numbered volumes through 1948. I have classified the contents of these volumes in two ways—first in terms of the species of animal used, and second in terms of the type of behavior studied. Only research reports have been classified; summaries of the literature and theoretical articles have been excluded from this analysis.

Types of animals studied. Figure 1 shows the number of articles published and the total number of species dealt with in these articles. The number of articles has tended to increase, particularly in the last decade; but the variety of animals studied began to decrease about 30 years ago and has remained low ever since. In other words, con-

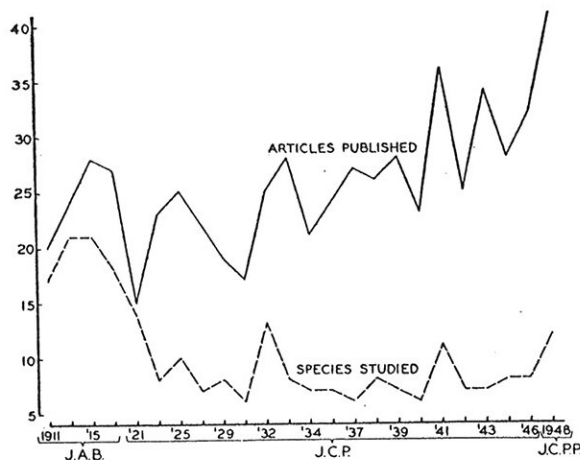


FIG. 1. Number of articles published and variety of species used as subjects.

tributors to these journals have been inclined to do more and more experiments on fewer and fewer species.

Data represented in Figure 2 further emphasize the progressive reduction in the number of species studied. Here we see that the *Journal of Animal Behavior* contained nearly as many articles dealing with invertebrates as with vertebrates; but interest in invertebrate behavior fell off sharply after World War I and, as far as this type of analysis is capable of indicating, it never rose appreciably thereafter. The attention paid to behavior of invertebrates during the second decade of this century is also reflected in the policy of publishing annual surveys of recent research. Each volume of the *Journal of Animal Behavior* contains one systematic review devoted to lower invertebrates, another dealing with spiders and insects with the exception of ants, a third summarizing work on ants and a single section covering all studies on vertebrates.

Figure 2 shows that in the early years of animal experimentation sub-mammalian vertebrates, which include all fishes, amphibians, reptiles, and birds were used as experimental subjects more often than mammals. But a few mammalian species rapidly gained popularity and by approximately 1920 more work was being done on mammals than on all other classes combined. Now there are approximately 3,500 extant species of mammals, but taken together they make up less than one-half of one per cent of all animal species now living. A psychology based primarily upon studies of mammals can, therefore, be regarded as comparative only in a very restricted sense. Moreover the focus of interest has actually been even more narrow than this description implies because only a few kinds of mammals have been used in psychological investigations. The Norway rat has been the prime favorite of psychologists working with animals, and from 1930 until the present more than half of the articles in nearly every volume of the journal are devoted to this one species.

During the entire period covered by this survey the odd-numbered volumes of the journals examined includes 613 experimental articles. Nine per cent of the total deal with invertebrates; 10 per cent with vertebrates other than mammals; 31 per cent with mammals other than the rat; and 50 per cent are based exclusively upon the Norway rat. There is no reason why psychologists should

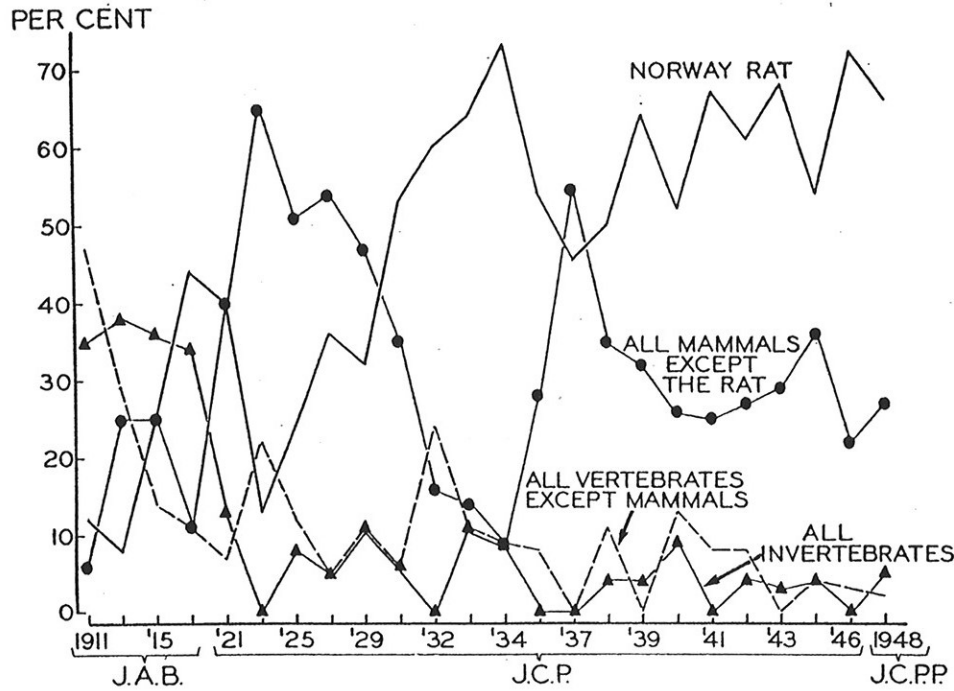


FIG. 2. Per cent of all articles devoted to various phyla, classes or species.

not use rats as subjects in some of their experiments, but this excessive concentration upon a single species has precluded the development of a comparative psychology worthy of the name. Of the known species of animals more than 96 per cent are invertebrates. Vertebrates below the mammals make up 3.2 per cent of the total; and the Norway rat represents .001 per cent of the types of living creatures that might be studied. I do not propose that the number of species found in a particular phyletic class determines the importance of the group as far as psychology is concerned; but it is definitely disturbing to discover that 50 per cent of the experiments analyzed here have been conducted on one one-thousandth of one per cent of the known species.

Some studies of animal behavior are reported in journals other than the ones I have examined but the number of different animals used in experiments published elsewhere is even fewer. The six issues of the *Journal of Experimental Psychology* published in 1948 contain 67 reports of original research. Fifty of these articles deal with human subjects and this is in accord with the stated editorial policy of favoring studies of human behavior above investigations of other species. However, 15 of the 17 reports describing work on non-human organisms are devoted to the Norway rat.

During the current meetings of the APA, 47 experimental reports are being given under the auspices of the Division of Experimental Psychology. The published abstracts show that in half of these studies human subjects were employed while nearly one-third of the investigations were based on the rat.

Is the Experimental Psychologist going to softly and suddenly vanish away in the same fashion as his one-time brother, the Comparative Psychologist? If you permit me to change the literary allusion from the poetry of Lewis Carroll to that of Robert Browning, I will venture a prediction. You will recall that the Pied Piper rid Hamelin Town of a plague of rats by luring the pests into the river with the music of his magic flute. Now the tables are turned. The rat plays the tune and a large group of human beings follow. My prediction is indicated in Figure 3. Unless they escape the spell that *Rattus norvegicus* is casting over them, Experimentalists are in danger of extinction.

Types of behavior studied. I trust that you will forgive me for having demonstrated what to many of you must have been obvious from the beginning—namely, that we have been extremely narrow in our selection of types of animals to be studied. Now let us turn our attention to the types of be-

havior with which psychologists have concerned themselves.

Articles appearing in our sample of volumes of the journals can be classified under seven general headings: (1) conditioning and learning; (2) sensory capacities, including psychophysical measurements, effects of drugs on thresholds, etc.; (3) general habits and life histories; (4) reproductive behavior, including courtship, mating, migration, and parental responses; (5) feeding behavior, including diet selection and reactions to living prey; (6) emotional behavior, as reflected in savageness and wildness, timidity and aggressive reactions; and (7) social behavior, which involves studies of dominance and submission, social hierarchies, and interspecies symbiotic relations.

In classifying articles according to type of behavior studied I have disregarded the techniques employed by the investigator. It is often necessary for an animal to learn to respond differentially to two stimuli before its sensory capacities can be measured; but in such a case the article was listed as dealing with sensory capacity rather than learn-

ing. The aim has been to indicate as accurately as possible the kind of behavior in which the experimenter was interested rather than his method of studying it.

It proved possible to categorize 587 of the 611 articles. Of this total, 8.6 per cent dealt with reproductive behavior, 3.7 per cent with emotional reactions, 3.2 per cent with social behavior, 3.6 per cent with feeding, and 2.8 per cent with general habits. The three most commonly-treated types of behavior were (1) reflexes and simple reaction patterns, (2) sensory capacities, and (3) learning and conditioning. Figure 4 shows the proportion of all articles devoted to each of these three major categories.

The figure makes it clear that conditioning and learning have always been of considerable interest to authors whose work appears in the journals I have examined. As a matter of fact slightly more than 50 per cent of all articles categorized in this analysis deal with this type of behavior. The popularity of the subject has increased appreciably during the last 15 years, and only once since 1927

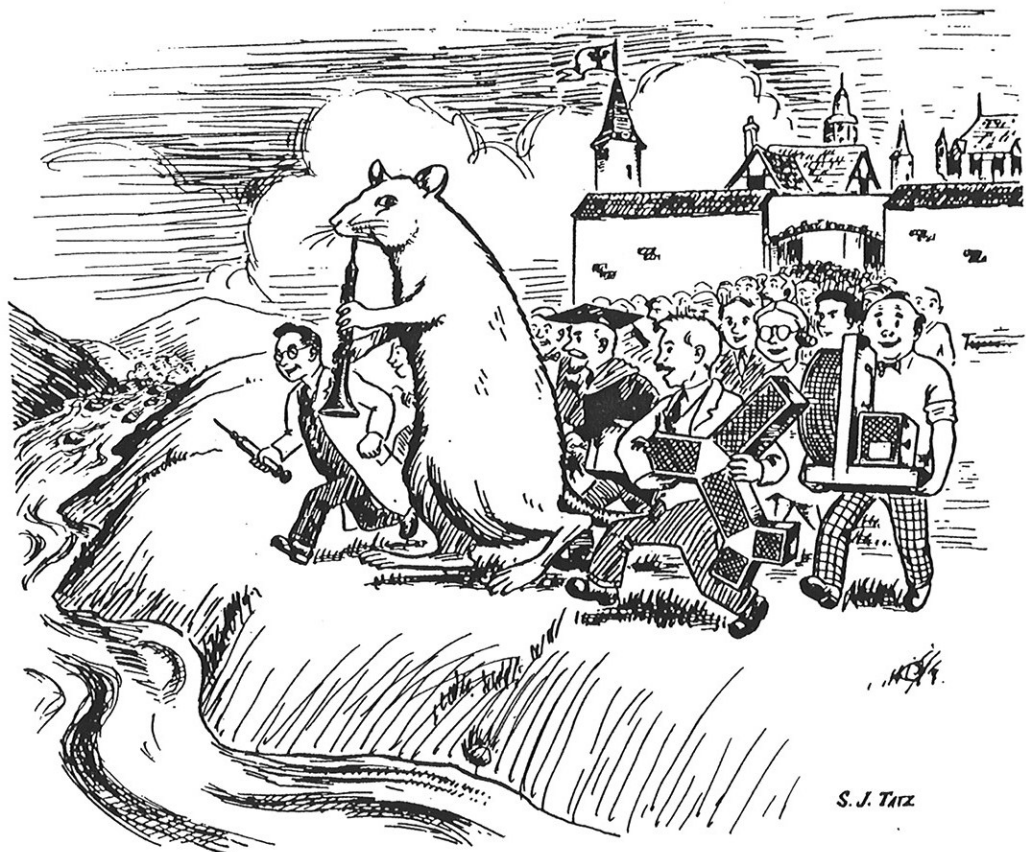


FIG. 3. Current position of many experimental psychologists.

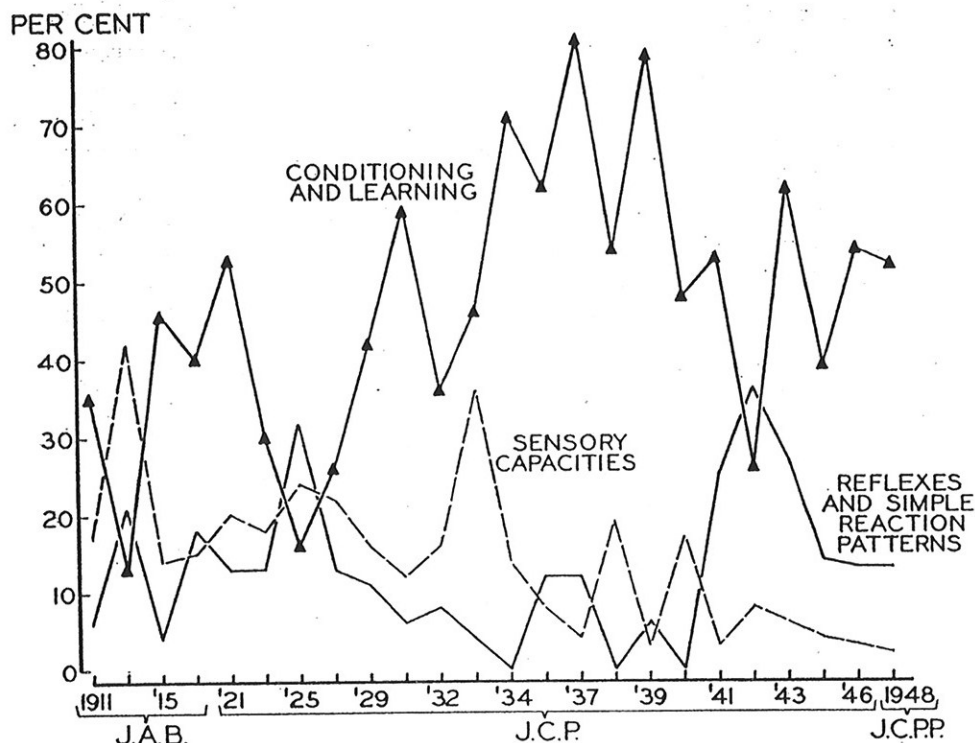


FIG. 4. Per cent of all articles concerned with various psychological functions.

has any other kind of behavior been accorded as many articles per volume. This occurred in 1942 when the number of studies dealing with reflexes and simple reaction patterns was unusually large. The temporary shift in relative emphasis was due almost entirely to a burst of interest in so-called "neurotic behavior" or "audiogenic seizures."

Combining the findings incorporated in Figures 2 and 4, one cannot escape the conclusion that psychologists publishing in these journals have tended to concentrate upon one animal species and one type of behavior in that species. Perhaps it would be appropriate to change the title of our journal to read "The Journal of Rat Learning," but there are many who would object to this procedure because they appear to believe that in studying the rat they are studying all or nearly all that is important in behavior. At least I suspect that this is the case. How else can one explain the fact that Professor Tolman's book, "Purposive Behavior in Animals and Men," deals primarily with learning and is dedicated to the white rat, "where, perhaps, most of all, the final credit or discredit belongs." And how else are we to interpret Professor Skinner's 457-page opus which is based exclusively upon the performance of rats in bar-pressing situa-

tions but is entitled simply "The Behavior of Organisms"?

INTERPRETATION OF TRENDS

In seeking an interpretation of the demonstrated tendency on the part of so many experimentalists to restrict their attention to a small number of species and a small number of behavior patterns, one comes to the conclusion that the current state of affairs is in large measure a product of tradition. From its inception, American psychology has been strongly anthropocentric. Human behavior has been accepted as the primary object of study and the reactions of other animals have been of interest only insofar as they seemed to throw light upon the psychology of our own species. There has been no concerted effort to establish a genuine comparative psychology in this country for the simple reason that with few exceptions American psychologists have no interest in animal behavior *per se*.

Someone, I believe it was W. S. Small at Clark University in 1899, happened to use white rats in a semi-experimental study. The species "caught on," so to speak, as a laboratory subject, and gradually displaced other organisms that were then being examined. Psychologists soon discovered that rats

are hardy, cheap, easy to rear, and well adapted to a laboratory existence. Because of certain resemblances between the associative learning of rats and human beings, *Rattus norvegicus* soon came to be accepted as a substitute for *Homo sapiens* in many psychological investigations. Lack of acquaintance with the behavioral potentialities of other animal species and rapid increase in the body of data derived from rat studies combined to progressively reduce the amount of attention paid to other mammals, to sub-mammalian vertebrates and to invertebrate organisms. Today the trend has reached a point where the average graduate student who intends to do a thesis problem with animals turns automatically to the white rat as his experimental subject; and all too often his professor is unable to suggest any alternative.

To sum up, I suggest that the current popularity of rats as experimental subjects is in large measure the consequence of historical accident. Certainly it is not the result of systematic examination of the available species with subsequent selection of this particular animal as the one best suited to the problems under study.

Concentration of experimental work upon learning seems to stem almost exclusively from the anthropocentric orientation of American psychology. Learning was very early accepted as embodying the most important problems of human behavior; and accordingly the majority of animal investigations have been concerned with this type of activity.

ADVANTAGES AND DISADVANTAGES OF CONCENTRATION

I have no wish to discount the desirable aspects of the course which experimental psychology has been pursuing. There are many important advantages to be gained when many independent research workers attack similar problems using the same kinds of organisms. We see this to be true in connection with various biological sciences. Hundreds of geneticists have worked with the fruit-fly, *Drosophila*. And by comparing, combining, and correlating the results of their investigations, it has been possible to check the accuracy of the findings, to accelerate the acquisition of new data, and to formulate more valid and general conclusions than could have been derived if each worker dealt with a different species. Something of the same kind is happening in psychology as a result

of the fact that many investigators are studying learning in the rat, and I repeat that this is a highly desirable objective.

Another valuable result achieved by the methods currently employed in experimental psychology is the massing of information and techniques pertaining to rat behavior to a point which permits use of this animal as a pedagogical tool. A recent article in the *American Psychologist* reveals that each student in the first course in psychology at Columbia University is given one or two white rats which he will study throughout the semester. This, it seems to me, is an excellent procedure. The beginning student in physiology carries out his first laboratory exercises with the common frog. The first course in anatomy often uses the dogfish or the cat as a sample organism. And college undergraduates learn about genetics by breeding fruitflies. But the usefulness of the rat as a standardized animal for undergraduate instruction, and the preoccupation of mature research workers with the same, single species are two quite different things.

Advanced research in physiology is not restricted to studies of the frog and although many geneticists may confine their personal investigations to *Drosophila*, an even larger number deals with other animal species or with plants. As a matter of fact, the benefits that students can derive from studying one kind of animal as a sample species must always stand in direct proportion to the amount of information research workers have gathered in connection with other species. The rat's value as a teaching aid in psychology depends in part upon the certainty with which the student can generalize from the behavior he observes in this one animal, and this in turn is a function of available knowledge concerning other species.

There is another obvious argument in favor of concentrating our efforts on the study of a single animal species. It is well expressed in Professor Skinner's book, "The Behavior of Organisms."

In the broadest sense a science of behavior should be concerned with all kinds of organisms, but it is reasonable to limit oneself, at least in the beginning, to a single representative species.

I cannot imagine that anyone would quarrel with Skinner on this point and I am convinced that many of the psychologists currently using rats in their investigational programs would agree with him in his implicit assumption that the Norway

rat is a "representative species." But in what ways is it "representative," and how has this "representativeness" been demonstrated? These questions lead at once to a consideration of the disadvantages of overspecialization in terms of animals used and types of behavior studied.

To put the question bluntly: Are we building a general science of behavior or merely a science of rat learning? The answer is not obvious to me. Admittedly there are many similarities between the associative learning of lower animals and what is often referred to as *rôte* learning in man. But the variety of organisms which have been studied, and the number of techniques which have been employed are so limited, it is difficult to believe that we can be approaching a comprehensive understanding of the basic phenomena of learning. It may be that much remains to be discovered by watching rats in mazes and problem boxes, but it is time to ask an important question. How close are we getting to that well-known point of diminishing returns? Would we not be wise to turn our attention to other organisms and to devise new methods of testing behavior before we proceed to formulate elaborate theories of learning which may or may not apply to other species and other situations.

Another very important disadvantage of the present method in animal studies is that because of their preoccupation with a few species and a few types of behavior, psychologists are led to neglect many complex patterns of response that stand in urgent need of systematic analysis. The best example of this tendency is seen in the current attitude toward so-called "instinctive" behavior.

The growing emphasis upon learning has produced a complementary reduction in the amount of study devoted to what is generally referred to as "unlearned behavior." Any pattern of response that does not fit into the category of learned behavior as currently defined is usually classified as "unlearned" even though it has not been analyzed directly. Please note that the classification is made in strictly negative terms *in spite of the fact that the positive side of the implied dichotomy is very poorly defined*. Specialists in learning are not in accord as to the nature of the processes involved, nor can they agree concerning the number and kinds of learning that may occur. But in spite of this uncertainty most "learning psycholo-

gists" confidently identify a number of complex behavior patterns as "unlearned." Now the obvious question arises: Unless we know what learning is—unless we can recognize it in all of its manifestations—how in the name of common sense can we identify any reaction as "unlearned"?

The fact of the matter is that none of the responses generally classified as "instinctive" have been studied as extensively or intensively as maze learning or problem-solving behavior. Data relevant to all but a few "unlearned" reactions are too scanty to permit any definite conclusion concerning the role of experience in the shaping of the response. And those few cases in which an exhaustive analysis has been attempted show that the development of the behavior under scrutiny is usually more complicated than a superficial examination could possibly indicate.

For example, there is a moth which always lays its eggs on hackberry leaves. Females of each new generation select hackberry as an oviposition site and ignore other potential host plants. However, the eggs can be transferred to apple leaves, and when this is done the larvae develop normally. Then when adult females that have spent their larval stages on apple leaves are given a choice of materials upon which to deposit their eggs, a high proportion of them select apple leaves in preference to hackberry. This control of adult behavior by the larval environment does not fit into the conventional pigeon-hole labeled "instinct," and neither can it be placed in the category of "learning." Perhaps we need more categories. Certainly we need more data on more species and more kinds of behavior.

Primiparous female rats that have been reared in isolation usually display biologically effective maternal behavior when their first litter is born. The young ones are cleaned of fetal membranes, retrieved to the nest, and suckled regularly. However, females that have been reared under conditions in which it was impossible for them to groom their own bodies often fail to clean and care for their newborn offspring. Observations of this nature cannot be disposed of by saying that the maternal reactions are "learned" rather than "instinctive." The situation is not so simple as that. In some way the early experience of the animal prepares her for effective maternal performance even though none of the specifically maternal responses are practiced before parturition.

It seems highly probable that when sufficient attention is paid to the so-called "instinctive" patterns, we will find that their development involves processes of which current theories take no account. What these processes may be we shall not discover by continuing to concentrate on learning as we are now studying it. And yet it is difficult to see how a valid theory of learning can be formulated without a better understanding of the behavior that learning theorists are presently categorizing as "unlearned."

POTENTIAL RETURNS FROM THE COMPARATIVE APPROACH

If more experimental psychologists would adopt a broadly comparative approach, several important goals might be achieved. Some of the returns are fairly specific and can be described in concrete terms. Others are more general though no less important.

Specific advantages. I have time to list only a few of the specific advantages which can legitimately be expected to result from the application of comparative methods in experimental psychology. In general, it can safely be predicted that some of the most pressing questions that we are now attempting to answer by studying a few species and by employing only a few experimental methods would be answered more rapidly and adequately if the approach were broadened.

Let us consider learning as one example. Comparative psychology offers many opportunities for examination of the question as to whether there are one or many kinds of learning and for understanding the rôle of learning in the natural lives of different species. Tinbergen (1942) has reported evidence indicating the occurrence of one-trial learning in the behavior of hunting wasps. He surrounded the opening of the insect's burrow with small objects arranged in a particular pattern. When she emerged, the wasp circled above the nest opening for a few seconds in the usual fashion and then departed on a hunting foray. Returning after more than an hour, the insect oriented directly to the pattern stimulus to which she had been exposed only once. If the pattern was moved during the female's absence she was able to recognize it immediately in its new location.

Lorenz's concept of "imprinting" offers the learning psychologist material for new and rewarding study. Lorenz (1935) has observed that young

birds of species that are both precocial and social quickly become attached to adults of their own kind and tend to follow them constantly. Newly hatched birds that are reared by parents of a foreign species often form associations with others of the foster species and never seek the company of their own kind. A series of experiments with incubator-reared birds convinced Lorenz that the processes underlying this sort of behavior must occur very early in life, perhaps during the first day or two after hatching, and that they are irreversible, or, to phrase it in other terms, that they are not extinguished by removal of reinforcement.

J. P. Scott's studies (1945) of domestic sheep reveal the importance of early learning in the formation of gregarious habits. Conventional learning theories appear adequate to account for the phenomena, but it is instructive to observe the manner in which the typical species pattern of social behavior is built up as a result of reinforcement afforded by maternal attentions during the nursing period.

The general importance of drives in any sort of learning is widely emphasized. Therefore it would seem worth while to study the kinds of drives that appear to motivate different kinds of animals. In unpublished observations upon the ferret, Walter Miles found that hunger was not sufficient to produce maze learning. Despite prolonged periods of food deprivation, animals of this species continue to explore every blind alley on the way to the goal box.

Additional evidence in the same direction is found in the studies of Gordon (1943) who reports that non-hungry chipmunks will solve mazes and problem boxes when rewarded with peanuts which the animals store in their burrows but do not eat immediately. Does this represent a "primary" drive to hoard food or an "acquired" one based upon learning?

Many experimentalists are concerned with problems of sensation and perception; and here too there is much to be gained from the comparative approach. Fring's studies (1948) of chemical sensitivity in caterpillars, rabbits and men promise to increase our understanding of the physiological basis for gustatory sensations. In all three species there appears to be a constant relationship between the ionic characteristics of the stimulus material and its effectiveness in evoking a sensory discharge. The investigations of Miles and Beck

(1949) on reception of chemical stimuli by honey bees and cockroaches provides a test for the theory of these workers concerning the human sense of smell.

The physical basis for vision and the role of experience in visual perception have been studied in a few species but eventually it must be investigated on a broader comparative basis if we are to arrive at any general understanding of the basic principles involved. Lashley and Russell (1934) found that rats reared in darkness give evidence of distance perception without practice; and Hebb (1937) added the fact that figure-ground relationships are perceived by visually-naive animals of this species. Riesen's (1947) report of functional blindness in apes reared in darkness with gradual acquisition of visually-directed habits argues for a marked difference between rodents and anthropoids; and Senden's (1932) descriptions of the limited visual capacities of human patients after removal of congenital cataract appear to support the findings on apes. But the difference, if it proves to be a real one, is not purely a function of evolutionary status of the species involved. Breder and Rasquin (1947) noted that fish with normal eyes but without any visual experience are unable to respond to food particles on the basis of vision.

I have already mentioned the necessity for more extensive examination of those patterns of behavior that are currently classified as "instinctive." There is only one way to approach this particular problem and that is through comparative psychology. The work that has been done thus far on sexual and parental behavior testifies, I believe, to the potential returns that can be expected if a more vigorous attack is launched on a broader front.

We are just beginning to appreciate the usefulness of a comparative study of social behavior. The findings of Scott which I mentioned earlier point to the potential advantages of using a variety of animal species in our investigation of interaction between members of a social group. Carpenter's (1942) admirable descriptions of group behavior in free-living monkeys point the way to a better understanding of dominance, submission, and leadership.

One more fairly specific advantage of exploring the comparative method in psychology lies in the possibility that by this means the experimentalist can often discover a particular animal species that

is specially suited to the problem with which he is concerned. For example, in recent years a considerable amount of work has been done on hoarding behavior in the laboratory rat. The results are interesting, but they indicate that some rats must learn to hoard and some never do so. Now this is not surprising since Norway rats rarely hoard food under natural conditions. Would it not seem reasonable to begin the work with an animal that is a natural hoarder? Chipmunks, squirrels, mice of the genus *Peromyscus*, or any one of several other experimental subjects would seem to be much more appropriate.

And now, as a final word, I want to mention briefly a few of the more general facts that indicate the importance of developing comparative psychology.

General advantages. For some time it has been obvious that psychology in this country is a rapidly expanding discipline. Examination of the membership roles of the several Divisions of this Association shows two things. First, that the number of psychologists is increasing at a prodigious rate; and second that the growth is asymmetrical in the sense that the vast majority of new workers are turning to various applied areas such as industrial and clinical psychology.

It is generally recognized that the applied workers in any science are bound to rely heavily upon "pure" or "fundamental" research for basic theories, for general methodology and for new points of view. I do not suggest that we, as experimentalists, should concern ourselves with a comparative approach to practical problems of applied psychology. But I do mean to imply that if we intend to maintain our status as indispensable contributors to the science of behavior, we will have to broaden our attack upon the basic problems of the discipline. This will sometimes mean sacrificing some of the niceties of laboratory research in order to deal with human beings under less artificial conditions. It may also mean expanding the number of non-human species studied and the variety of behavior patterns investigated.

Only by encouraging and supporting a larger number of comparative investigations can psychology justify its claim to being a true science of behavior. European students in this field have justly condemned Americans for the failure to study behavior in a sufficiently large number of representative species. And non-psychologists in

this country are so well aware of our failure to develop the field that they think of animal behavior as a province of general zoology rather than psychology. Top-rank professional positions that might have been filled by psychologically trained investigators are today occupied by biologists. Several large research foundations are presently supporting extensive programs of investigation into the behavior of sub-human animals, and only in one instance is the program directed by a psychologist.

CONCLUSION

If we as experimental psychologists are missing an opportunity to make significant contributions to natural science—if we are failing to assume leadership in an area of behavior investigation where we might be useful and effective—if these things are true, and I believe that they are, then we have no one but ourselves to blame. We insist that our students become well versed in experimental design. We drill them in objective and quantitative methods. We do everything we can to make them into first rate experimentalists. And then we give them so narrow a view of the field of behavior that they are satisfied to work on the same kinds of problems and to employ the same methods that have been used for the past quarter of a century. It would be much better if some of our well-trained experimentalists were encouraged to do a little pioneering. We have a great deal to offer in the way of professional preparation that the average biologist lacks. And the field of animal behavior offers rich returns to the psychologist who will devote himself to its exploration.

I do not anticipate that the advanced research worker whose main experimental program is already mapped out will be tempted by any argument to shift to an entirely new field. But those of us who have regular contact with graduate students can do them a service by pointing out the possibilities of making a real contribution to the science of psychology through the medium of com-

parative studies. And even in the absence of professorial guidance the alert beginner who is looking for unexplored areas in which he can find new problems and develop new methods of attacking unsettled issues would be wise to give serious consideration to comparative psychology as a field of professional specialization.

REFERENCES

1. BREDER, C. M. AND RASQUIN, P. Comparative studies in the light sensitivity of blind characins from a series of Mexican caves. *Bulletin Amer. Mus. Natl. Hist.*, 1947, 89, Article 5, 325-351.
2. CARPENTER, C. R. Characteristics of social behavior in non-human primates. *Trans. N. Y. Acad. Sci.*, 1942, Ser. 2, 4, No. 8, 248.
3. FRINGS, H. A contribution to the comparative physiology of contact chemoreception. *J. comp. physiol. Psychol.*, 1948, 41, No. 1, 25-35.
4. GORDON, K. The natural history and behavior of the western chipmunk and the mantled ground squirrel. *Oregon St. Monogr. Studies in Zool.*, 1943, No. 5, 7-104.
5. HEBB, D. O. The innate organization of visual activity. I. Perception of figures by rats reared in total darkness. *J. gen. Psychol.*, 1937, 51, 101-126.
6. LASHLEY, K. S. AND RUSSELL, J. T. The mechanism of vision. XI. A preliminary test of innate organization. *J. genet. Psychol.*, 1934, 45, No. 1, 136-144.
7. LORENZ, K. Der Kumpan in der Umwelt des Vogels. *J. f. Ornith.*, 1935, 83, 137-213.
8. MILES, W. R. AND BECK, L. H. Infrared absorption in field studies of olfaction in honeybees. *Proceed. Natl. Acad. Sci.*, 1949, 35, No. 6, 292-310.
9. RIESEN, A. H. The development of visual perception in man and chimpanzee. *Science*, 1947, 106, 107-108.
10. SCOTT, J. P. Social behavior, organization and leadership in a small flock of domestic sheep. *Comp. Psychol. Monogr.*, 1945, 18, No. 4, 1-29.
11. SENDEN, M. v. *Raum- und Gestaltauffassung bei operierten Blindgeborenen vor und nach der Operation.* Leipzig: Barth, 1932.
12. TINBERGEN, N. An objectivistic study of the innate behaviour of animals. *Biblio. Biotheoret.*, 1942, 1, Pt. 2, 39-98.

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