WITH SIX PLATES AND FIVE TEXT FIGURES

CONTENTS

I

INTERESTS, OPPORTUNITY AND MATERIALS

Two strong interests come to expression in this report: the one in the study of the adaptive or ideational behavior of the monkeys and the apes; and the other in adequate and permanent provision for the thorough study of all aspects of the lives of these animals. The values of these interests and of the tasks which they have led me to undertake are so widely recognized by biologists that I need not pause to justify or define them. I shall, instead, attempt to make a contribution of fact on the score of each interest.

While recognizing that the task of prospecting for an anthropoid or primate station may in its outcome prove incomparably more important for the biological and sociological sciences and for human welfare than my experimental study of ideational behavior, I give the latter first place in this report, reserving for the concluding section an account of the situation regarding our knowledge of the monkeys, apes, and other primates, and a description of a plan and program for the thorough-going and long continued study of these organisms in a permanent station or research institute.

In 1915, a long desired opportunity came to me to devote myself undividedly to tasks which I have designated above as "prospecting" for an anthropoid station and experimenting with monkeys and apes. First of all, the interruption of my academic

duties by sabbatical leave gave me free time. But in addition to this freedom for research, I needed animals and equipment. These, too, happily, were most satisfactorily provided, as I shall now describe.

When in 1913, while already myself engaged in seeking the establishment of an anthropoid station, I heard of the founding of such an institution at Orotava, Tenerife, the Canary Islands, I immediately made inquiries of the founder of the station, Doctor Max Rothmann of Berlin, concerning his plans (Rothmann, 1912).[1] As a result of our correspondence, I was invited to visit and make use of the facilities of the Orotava station and to consider with its founder the possibility of coöperative work instead of the establishing of an American station. This invitation I gratefully accepted with the expectation of spending the greater part of the year 1915 on the island of Tenerife. But the outbreak of the war rendered my plan impracticable, while at the same time destroying all reasonable ground for hope of profitable coöperation with the Germans in the study of the anthropoids. In August, 1915, Doctor Rothmann died. Presumably, the station still exists at Orotava in the interests of certain psychological and physiological research. So far as I know, there are as yet no published reports of studies made at this station. It seems from every point of view desirable that American psychologists should, without regard to this initial attempt of the Germans to provide for anthropoid research, further the establishment of a well equipped American station for the study not only of the anthropoid apes but of all of the lower primates.

[Footnote 1: See bibliography at end of report.]

In the early months of the war while I was making every effort to obtain reliable information concerning conditions in the Canary Islands, I received an urgent invitation from my friend and former student, Doctor G. V. Hamilton, to make use of his collection of animals and laboratory at Montecito, California, during my leave

of absence from Harvard. This invitation I most gladly accepted, and in February, 1915, I established myself in Santa Barbara, in convenient proximity to Doctor Hamilton's private laboratory where for more than six months I was able to work uninterruptedly under nearly ideal conditions.

Doctor Hamilton without reserve placed at my disposal his entire collection of animals, laboratory, and equipment, provided innumerable conveniences for my work, and in addition, bore the entire expense of my investigation. I cannot adequately thank him for his kindness nor make satisfactory acknowledgment here of his generous aid. Thanks to his sympathetic interest and to the courtesy of the McCormick family on whose estate the laboratory was located, my work was done under wholly delightful conditions, and with assistance from Ramon Jimenez and Frank Van Den Bergh, Jr., which was invaluable. The former aided me most intelligently in the care of the animals and the construction of apparatus; and the latter, especially, was of very real service in connection with many of my experiments.

The collection of animals which Doctor Hamilton placed at my disposal consisted of ten monkeys and one orang utan. The monkeys represented either *Pithecus rhesus* Audebert (*Macacus rhesus*), *Pithecus irus* F. Cuvier (*Macacus cynomolgos*), or the hybrid of these two species (Elliot, 1913). There were two eunuchs, five males, and three females. All were thoroughly acclimated, having lived in Montecito either from birth or for several years. The orang utan was a young specimen of *Pongo pygmaeus* Hoppius obtained from a San Francisco dealer in October, 1914 for my use. His age at that time, as judged by his size and the presence of milk teeth, was not more than five years. So far as I could discover, he was a perfectly normal, healthy, and active individual. On June 10, 1915, his weight was thirty-four pounds, his height thirty-two inches, and his chest girt twenty-three inches. On August 18 of the same year, the three measurements

were thirty-six and one-half pounds, thirty-three inches, and twenty-five inches.

For the major portion of my experimental work, only three of the eleven animals were used. A growing male, *P. rhesus* monkey, known as Sobke; a mature male, *P. irus*, called Skirrl; and the young orang utan, which had been named Julius. Plates I and II present these three subjects of my experiments in characteristically interesting attitudes. In plate I, figure 1, Julius appears immediately behind the laboratory seated on a rock, against a background of live oaks. This figure gives one an excellent idea of the immediate environment of the laboratory. Figure 2 of the same plate is a portrait of Julius taken in the latter part of August. By reason of the heavy growth of hair, he appeared considerably older as well as larger at this time than when the photograph for figure 1 was taken. In plate II, figure 3, Julius is shown in the woods in the attitude of reaching for a banana, while in figure 4 of the same plate he is represented as walking upright in one of the cages.

Likenesses of Sobke are presented in figures 5 and 6 of plate II. In the latter of these figures he is shown stretching his mouth, apparently yawning but actually preparing for an attack on another monkey behind the wire screen. Figure 7 of this plate indicates Skirrl in an interesting attitude of attention and with an obvious lack of self-consciousness. The same monkey is represented again in figures 8 and 9 of plate II, this time in the act of using hammer and saw.

EXPLANATION OF PLATE II

FIGURE 3.—Orang utan, Julius, reaching for banana.

FIGURE 4.—Julius walking across his cage.

FIGURE 5.—*P. rhesus*, Sobke.

FIGURE 6.—Sobke stretching his jaws (yawn?) preparatory to a fight.

FIGURE 7.—*P. irus,* Skirrl.

FIGURE 8.—Skirrl using hammer and nail.

FIGURE 9.—Skirrl using a saw.

All of the animals except the orang utan had been used more or less for experiments on behavior by Doctor Hamilton, but this prior work in no way interfered with my own investigation. Doctor Hamilton has accumulated a large mass of the most valuable and interesting observations on the behavior of monkeys, and he more thoroughly understands them than any other observer of whom I have knowledge. Much to my regret and embarrassment in connection with the present report, he has thus far published only a small portion of his data (Hamilton, 1911, 1914). In his most recent paper on "A study of sexual tendencies in monkeys and baboons," he has given important information concerning several of the monkeys which I have observed. For the convenience of readers who may make use of both his reports and mine, I am designating the animals by the names previously given them by Hamilton. The available and essential information concerning the individuals is presented below.

List of animals in collection

Skirrl. *Pithecus irus*. Adult male.

Sobke. *P. rhesus*. Young adult male.

Gertie. *P. irus-rhesus*. Female. Born November, 1910.

Maud. *P. rhesus*. Young adult female.

Jimmy II. *P. irus*. Adult male.

Scotty. *P. irus* (?). Adult male.

Tiny. *P. irus-rhesus*. Female. Born August, 1913.

Chatters. *P. irus*. Adult eunuch.

Daddy. *P. irus*. Adult eunuch.

Mutt. *P. irus*. Young adult male. Born August, 1911.

Julius. *Pongo pygmaeus*. Male. Age, 4 years to 5 years.

When I arrived in Santa Barbara, Doctor Hamilton was about to remodel, or rather reconstruct, his animal cages and laboratory. This gave us opportunity to adapt both to the special needs of my experiments. The laboratory was finally located and built in a grove of live oaks. From the front it is well shown by figure 10 of plate III, and from the rear, by figure 11. Its location was in every way satisfactory for my work, and in addition, the spot proved a delightful one in which to spend one's time.

[Illustration: FIGURE 12.—Ground plan of Montecito laboratory and cages. Scale 1/120

L, laboratory; C, cages; A, experiment room in which multiple-choice apparatus was installed; B, E, additional rooms for research; D, store room and shop; Z, large central cage communicating with the eight smaller cages 1-8.]

Figure 12 is a ground plan, drawn to scale, of the laboratory and the adjoining cages, showing the relations of the several rooms of the laboratory among themselves and to the nine cages. Although the construction was throughout simple, everything was convenient and so planned as to expedite my experimental work. The large

room A, adjoining the cages, was used exclusively for an experimental study of ideational behavior by means of my recently devised multiple-choice method. Additional, and supplementary, experiments were conducted in the large cage Z. Room D served as a store-room and work-shop.

The laboratory was forty feet long, twenty-two feet wide, and ten feet to the plate. Each small cage was six, by six, by twelve feet deep, while the large compartment into which each of the smaller cages opened was twenty-four feet long, ten feet wide, and twelve feet deep.

II

OBSERVATIONAL PROBLEMS AND METHODS

My chief observational task in Montecito was the study of ideational behavior, or of such adaptive behavior in monkeys and apes as corresponds to the ideational behavior of man. It was my plan to determine, so far as possible in the time at my disposal, the existence or absence of ideas and the rôle which they play in the solution of problems by monkeys and apes. I had in mind the behavioristic form of the perennial questions: Do these animals think, do they reason, and if so, what is the nature of these processes as indicated by the characteristics of their adaptive behavior?

My work, although obviously preliminary and incomplete, differs from most of the previous studies of the complex behavior of the infrahuman primates in that I relied chiefly upon a specially devised method and applied it systematically over a period of several months. The work was intensive and quantitative instead of more or less incidental, casual, and qualitative as has usually been the case. Naturally, during the course of my special study of ideational behavior observations were made relative to various

other aspects of the life of my subjects. Such, for example, are my notes on the use of the hands, the instincts, the emotions, and the natural aptitudes of individuals. It is, indeed, impossible to observe any of the primates without noting most interesting and illuminating activities. And although the major portion of my time was spent in hard and monotonous work with my experimental apparatus, I found time each day to get into intimate touch with the free activities of my subjects and to observe their social relations and varied expressions of individuality. As a result of my close acquaintance with this band of primates, I feel more keenly than ever before the necessity of taking into account, in connection with all experimental analyses of behavior, the temperamental characteristics, experience, and affective peculiarities of individuals.

The light which I have obtained on the general problem of ideation has come, first, through a method which I have rather inaptly named the multiple-choice method, and second, and more incidentally, through a variety of supplementary methods which are described in Section IV of this report. These supplementary methods are simple tests of ideation rather than systematic modes of research. They differ from my chief method, among other respects, in that they have been used by various investigators during the past ten or fifteen years. It was not my aim to repeat precisely the observations made by others, but instead to verify some of them, and more especially, to throw additional light on my main problem and to further the analysis of complex behavior.

What has been referred to as the multiple-choice method was devised by me three years ago as a means of obtaining strictly comparable objective data concerning the problem-solving ability of various types and conditions of animals. The method was first tried with human subjects in the Psychopathic Hospital, Boston, with a crude keyboard apparatus which, however, proved wholly satisfactory as a means of demonstrating its value. It has since been

applied by means of mechanisms especially adapted to the structure and activities of the organisms, to the study of the behavior of the crow, pig, rat, and ringdove (Yerkes, 1914; Coburn and Yerkes, 1915; Yerkes and Coburn, 1915). The method has also been applied with most gratifying results to the study of the characteristics of ideational behavior in human defectives,—children, and adults,—and in subjects afflicted with various forms of mental disease. It is at present being tried out as a practical test in connection with vocational guidance and various forms of institutional examination, such as psychopathic hospital and court examinations.

As no adequate description of the method has yet been published to which I can here refer, it will be necessary to present its salient characteristics along with a description of the special form of apparatus which was found suitable for use with monkeys and apes.

The method is so planned as to enable the observer to present to any type or condition of organism which he wishes to study any one or all of a series of problems ranging from the extremely simple to the complex and difficultly soluble. All of the problems, however, are completely soluble by an organism of excellent ideational ability. For the human subject, the solution of the easiest problem of all requires almost no effort, whereas even moderately difficult problems may require many repetitions of effort and hours or days of application to the task. In each case, the solution of the problem depends upon the perception of a certain constant relation among a series of objects to which the subject is required to attend and respond. Such relations are, for example, secondness from one end of the group, middleness, simple alternation of ends, or progressive movement by constant steps from one end of a group to the other.

It is possible to present such relational problems by means of

relatively simple reaction-mechanisms. In their essential features, all of the several types of multiple-choice apparatus designed by the writer and used either by him or by his students and assistants are the same. They consist of a series of precisely similar reaction-devices, any one or all of which may be used in connection with a given observation. These reaction-mechanisms are so chosen as to be suited to the structure and action-system of the animal to be studied. For the human being the mechanism consists of a simple key and the total apparatus is a bank of keys, with such electrical connections as are necessary to enable the observer to obtain satisfactory records of the subject's behavior. Let us suppose the bank of keys, as was actually the case in my first form of apparatus, to consist of twelve separate reaction-mechanisms; and let us suppose, further, the constant relation (problem) on the basis of which the subject is required to react to be that of middleness. It is evident that in successive trials or experiments the keys must be presented to the subject in odd groups, the possibilities being groups of 3, 5, 7, 9, or 11. If for a particular observation the experimenter wishes to present the first three keys at the left end of the keyboard, he pushes back the remaining nine keys so that they cannot be operated and requires the subject to select from the group of three keys the one which on being pressed causes a signal to appear. It is of course the clearly understood task of the subject to learn to select the correct key in the group on first trial. This becomes possible only as the subject observes the relation of the key which produces the desired effect to the other keys in the group. On the completion of a subject's reaction to the group of three keys, a group of seven keys at the opposite end of the keyboard may, for example, be presented. Similarly, the subject is required to discover with the minimum number of trials the correct reaction-mechanism. Thus, time after time, the experimenter presents a different group of keys so that the subject in no two successive trials is making use of the same portion of the keyboard. It is therefore impossible for him to react to spatial relations in the ordinary sense and manner, and unless he can perceive and

appropriately respond to the particular relation which constitutes the only constant characteristic of the correct reaction-mechanism for a particular problem, he cannot solve the problem, or at least cannot solve it ideationally and on the basis of a small number of observations or trials.

For the various infrahuman animals whose ideational behavior has been studied by means of this method, it has been found eminently satisfactory to use as reaction-mechanisms a series of similar boxes, each with an entrance and an exit door. An incentive to the selection of the right box in a particular test is supplied by food, a small quantity of which is placed in a covered receptacle beyond the exit door of each of the boxes. Each time an animal enters a wrong box, it is punished for its mistake by being confined in that box for a certain period, ranging from five seconds to as much as two minutes with various individuals or types of organism. This discourages random, hasty, or careless choices. When the right box is selected, the exit door is immediately raised, thus uncovering the food, which serves as a reward. After eating the food thus provided, the animal, according to training, returns to the starting point and eagerly awaits an opportunity to attempt once more to find the reward which it has learned to expect. With this form of the apparatus, the boxes among which choice may be made are indicated by the raising (opening) of the front door.

Since with various birds and mammals the box form of apparatus had proved most satisfactory, I planned the primate apparatus along similar lines, aiming simply to adapt it to the somewhat different motor equipment and destructive tendencies of the monkeys. I shall now briefly describe this apparatus as it was constructed and used in the Montecito laboratory.

EXPLANATION OF PLATE IV

FIGURE 13.—Multiple-choice apparatus, showing observer's

bench and writing stand. FIGURE 14.—Apparatus as seen from observer's bench. FIGURE 15.—Entrances to multiple-choice boxes as seen from the response-compartment. FIGURE 16.—Apparatus as seen from the rear, showing exit doors, food receptacles, and covers for same.

The apparatus was built in room A (figure 12), this room having been especially planned for it with respect to lighting as well as dimensions and approaches. It was unfortunately impossible to obtain photographs showing the whole of the apparatus, but it is hoped that the four partial views of plate IV may aid the reader who is unfamiliar with previously described similar devices to grasp readily the chief points of construction. In this plate, figure 13 shows the front of the complete apparatus, with the alleyway and door by way of which the experimenter could enter. The investigator's observation-bench and record-table also appear in this figure, together with weighted cords used to operate the various doors and the vertically placed levers by means of which each pair of doors could be locked. Figure 14 is the view presented to the observer as he stood on the bench or observation stand of figure 13 and looked over the entire apparatus. Three of the entrance doors are shown at the right of this figure as raised, whereas the remainder of the nine entrance doors of the apparatus are closed. Figure 15 is a view of the entrance doors from below the wire roof of the apparatus. Again, two of the doors are shown as raised, and three additional ones as closed. The rear of the apparatus appears in figure 16, in which some of the exit doors are closed and others open. In the latter case, the food receptacles appear, and on the lower part of the raised doors of the corresponding boxes may be seen metal covers for the food receptacles projecting at right angles to the doors, while on the lower edge of each door is an iron staple used to receive a sliding bar which could be operated from the observer's bench as a means of locking the doors after they had been closed. The space beyond the exit doors was used as an alleyway for the return of the animals

to the starting point.

It will be necessary at various points in later descriptions to refer to these several figures. But further description of them will be more readily appreciated after a careful examination of the ground plan of the apparatus presented as figure 17 In accordance with the labelling of this figure, the experimenter enters the apparatus room through doorway 16, passes thence through doorways 17 and 10 to the large cage Z, from which he has direct access to the animals and can bring them into the apparatus. The multiple-choice mechanism proper, consisting of nine similar boxes (nine were used instead of twelve as a matter of convenience of construction, not because this smaller number is otherwise preferable) is labelled F. These boxes are numbered 1 to 9, beginning at the left. This numbering was adhered to in the recording of results throughout the investigation. The other important portions of the apparatus are the runway D, from which the subject at the experimenter's pleasure could be admitted through doorway 12 to the large response-chamber E; the alleyways G, H, and I, by way of which return to the starting point was possible; the observation bench C, with its approach step 13; and the observer's writing table A.

In the construction of this large apparatus, it was necessary to make provision for the extremely destructive tendencies of monkeys and anthropoid apes,—hence the apparent cumbersomeness of certain portions. It was equally necessary to provide for the protection of the observer and the prevention of escape of the subjects by completely covering the apparatus and alleyways with a heavy wire netting.

Each of the eighteen doors of the multiple-choice boxes, and in addition doors 11, 12, and 15 of the runway D, were operated by the observer from his bench C by means of weighted window cords which were carried by pulleys appropriately placed above the apparatus. Each weight was so chosen as to be just sufficient to

hold its door in position after the experimenter had raised it. For the convenience of the experimenter in the rapid operation of the twenty-one doors, the weights for the doors of runway D were painted gray, those for the entrance doors, white, and those for the exit doors, black.

In each entrance door, as is shown in figure 15 of plate IV, a window was cut so that the experimenter might watch the animal after it had entered a given box, and especially note when it left the box after having received its reward. This window was covered with wire netting. No such windows were necessary in the exit doors, but to them were attached heavy galvanized iron flanges which served to cover the food receptacles. One of these flanges is labelled o in figure 17. The food receptacles were provided by boring holes in a 2 by 4 inch timber securely nailed to the floor immediately outside of the exit doors. Into these holes aluminum cups fitted snugly, and the iron flanges, when the doors were closed, fitted so closely over the cups that it was impossible for the animals to obtain food from them.

[Illustration: FIGURE 17.—Ground plan of multiple-choice apparatus in experiment room A. Scale 1/60

A, record stand; C, bench for observer; B, step as approach to C; D, alleyway leading to E, response-compartment; F, one of the nine (1-9) similar multiple-choice boxes; G, H, alleyways leading from boxes to starting point at D; I, alleyway used by experimenter as approach to rear of apparatus; W, W, windows; P, alleyway; Z, large cage; 16, entrance to room A; 17, entrance to apparatus and thence via 10 to cages; 18, entrance to alleyway 1; 11, 15, entrances to D; 12, entrance to E; 13, entrance door of box 5; 14, exit door of box 5; o, cover for food receptacle.]

As originally constructed, no provision was made in the apparatus for locking the entrance and exit doors of the several boxes when

they were closed. But as two of the subjects after a time learned to open the doors from either outside or inside the boxes, it became necessary to introduce locking devices which could be operated by the experimenter from the observation bench. This was readily accomplished by cutting holes in the floor, which permitted an iron staple, screwed to the lower edge of each door, to project through the floor. Through these staples by means of a lever for each of the nine boxes, the observer was able to slide a wooden bar, placed beneath the floor of the room, thus locking or unlocking either the entrance door, the exit door, or both, in the case of any one of the nine boxes.

Since figure 17 is drawn to scale, it will be needless to give more than a few of the dimensions of the apparatus. Each of the boxes was 42 inches long, 18 inches wide, and 72 inches deep, inside measurements. The alleys D, I, and H were 24 inches, and G 30 inches wide, by 6 feet deep. The doors of the several boxes were 18 inches wide, by 5 feet high, while those in the alleyways were 24 inches wide by 6 feet high. The response-compartment E of figure 17 was 14 feet 4 inches, by 8 feet, by 6 feet in depth. In order that the apparatus might be used with adult human subjects conveniently, if such use should prove desirable, the depth throughout was made 6 feet, and it was therefore possible for the experimenter to walk about erect in it.

The experimental procedure was briefly as follows: A small quantity of food having been placed in each of the food cups and covered by the metal flanges on the exit doors, the experimenter raised door 11 of figure 17 and then opened door 10 and the door of the cage in which the desired subject was confined. After the latter, in search of food, had entered the runway D, the experimenter lowered door 11 to keep it in this runway, and immediately proceeded to set the reaction-mechanisms for an experiment (trial). Let us suppose that the first setting to be tried involved all of the nine boxes. Each of the entrance doors would

therefore be raised. Let us further suppose that the right door is defined as the middle one of the group. With the apparatus properly set, the experimenter next raises door 12, thus admitting the animal to the response-compartment E. Any one of the nine boxes may now be entered by it. But if any except number 5, the middle member of the group, be entered, the entrance door is immediately lowered and both the exit and entrance doors locked in position so that the animal is forced to remain in the box for a stated period, say thirty seconds. At the expiration of this time the entrance door is raised and the animal allowed to retrace its steps and make another choice. When the middle box is chosen, the entrance door is lowered and the exit door immediately raised, thus uncovering the food, which the animal eats. As a rule, by my monkeys and ape the reward was eaten in the alleyway G instead of in the multiple-choice box. As soon as the food has been eaten, the exit door is lowered by the experimenter, and the animal returns by way of G and H to runway D, where it awaits its next trial.

As rewards, bananas and peanuts were found very satisfactory, and although occasionally other foods were supplied in small quantities, they were on the whole less constantly desired than the former.

Four problems which had previously been presented to other organisms were in precisely the same form presented to the three primates. These problems may be described, briefly, by definition of the right reaction mechanism, thus: problem 1, the first mechanism at the subject's left; problem 2, the second mechanism at the subject's right (that is, from the end of the series at the subject's right); problem 3, alternately, the first mechanism at the subject's left and the first at its right; problem 4, the middle mechanism of the group.

It was my intention to present these four problems, in order, to