theories of psychoanalysis, but leaves to the experimental psychologist the duty of putting these theories to a laboratory test, so far as may be possible; and some such experimental work is being done. "All in all, the theories of the pioneers in clinical work give us broader horizons and indicate the probable shape of the things to be investigated; but they can not provide us with a scientific foundation until other more statistical and experimental methods have confirmed them."

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SPECIAL ARTICLES

CHIMPANZEE HANDEDNESS

FEW reports have appeared on preferential hand usage in anthropoid apes; such data as have been presented have derived from scattered, largely non-experimental observations of a few animals. The present inquiry, utilizing 30 chimpanzees as subjects, is an attempt to determine if they use one or the other hand preferentially, how pronounced hand preference is in individual chimpanzees, and how right- and left-handedness is distributed in these animals.

Four test situations, demanding fairly precise, skilful manipulations and designed to preclude the subjects' procuring incentive in any way other than with one hand, were set up. All subjects were tested in their outdoor living cages; each was isolated while being tested. Manipulation (procuring pieces of fruit) was performed by the subjects through the 2-inch square apertures of their wire-netting cage-walls (diagonals of apertures were horizontal and vertical). Test situations were: (*A*) One end of each of 10 parallel strings, each 6 inches long, spaced at 3-inch intervals, was attached 1 inch from the edge of a board 30 inches square; with the strings stretched out on the board and perpendicular to edge of attachment, pieces of fruit were attached to the free ends of the strings; the edge of the board was placed against the cage-wall; hand used by subject in pulling- or raking-in each piece of fruit was tabulated; in this (and in the other situations) the board was quickly withdrawn if subject attempted to procure incentive in any way other than with one hand (such as with lips, feet or both hands); (*B*) 10 small pieces of fruit, spaced at 3-inch intervals and 1 inch from edge of board, were presented; (*C*) small pieces of fruit were placed individually under a small metal box which was hinged at end away from subject; subject procured incentive by reaching through a rectangular hole (1½ inches wide, 2 inches high) in a piece of ¼-inch plywood and upsetting metal box; hand so used was scored "preferred"; and (*D*) pieces of fruit were presented individually on a board 1 inch from cage-netting. Situation *A* was presented until subject had procured 100 pieces of fruit, then Situation *B* until subject had procured 100 pieces of fruit, and so on in the sequence *A-B-C-D-D-C-B-A*. Thus, for each subject, hand used was tabulated for 800 manipulations. Subjects were given 100 trials in a single session in one day, were not tested on immediately succeeding days.

Of the 30 chimpanzees tested, there were 22 adult females, 4 adult males (Bokar, Frank, Jack, Pan), 2 adolescent females (Beta, Gamma), 1 five-year-old female (Dina), and 1 three-year-old male (Fin).

Fig. 1, a bar diagram, shows the distribution of *right* hand use among the subjects for the combined trials of all situations (*i.e.*, the number of times in 800 trials each subject used right hand).

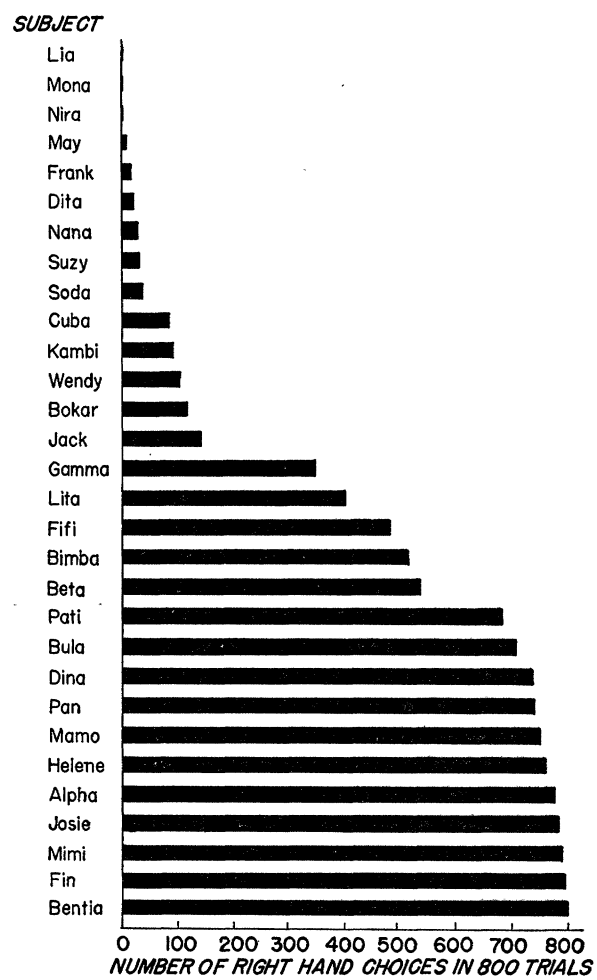

FIG. 1

From this figure, it will be seen that 18 of the 30 subjects used one hand (9 used right; 9, left) in more than 90 per cent. (720) of the 800 trials, and that 25 used one hand (11 used right; 14, left) in more than 80 per cent. (640) of the 800 trials. Examination of the protocols of the 5 animals (Gamma, Lita, Fifi, Bimba, Beta) who exhibited least-pronounced unilateral preference, shows that their detected low-handedness scores are largely attributable to low inter-test agreement, although low single-test reliability also contributes to their attenuation.

Admittedly, increasing the number of test-situations should result in a more adequate determination of chimpanzee handedness; however, the present work does not pretend to explore more than a rather narrowly limited aspect of chimpanzee lateral organization. So far as test-reliability is concerned, precise mathematical statement is difficult because of the bimodality of the distributions involved; test-retest scores of Situations *C* and *D* each show handedness shifts for one subject, *A* for 5, *B* for 6 subjects (*i.e.*, subjects used one hand for more than 50 of the first 100 trials of a given situation, the same hand for fewer than 50 of the second 100 trials of the same situation). Twenty animals gave no such inversions, 7 gave only one each, while the other 3 animals each gave two inversions.

Summary: (1) Of 30 chimpanzees tested, 25 exhibited marked handedness. (2) Detected right- and left-handedness were almost equally distributed in the group of animals. (3) Each of 9 chimpanzees used right hand, 9 used left hand, in more than 90 per cent. (720) of 800 trials (4 test-situations); each of 11 chimpanzees used right hand, 14 used left hand, in more than 80 per cent. (640) of 800 trials.

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CHANGE FROM SELF-INCOMPATIBILITY TO SELF-COMPATIBILITY ACCOMPANYING CHANGE FROM DIPLOIDY TO TETRAPLOIDY

IT has very recently been determined for fifteen different self-incompatible plants of *Petunia axillaris* (Lam.) B. S. P. (*P. nyctaginifolia* Juss.) that the change from a diploid condition (2n = 14 chromosomes) to a tetraploid condition (4n = 28 chromosomes) was accompanied by a change to self-compatibility in fertilization and seed formation.

These plants were grown from seeds. By treatment with solutions of colchicine from one to three tetraploid branches were obtained on each plant while the other branches remained diploid. The flowers on the tetraploid branches were somewhat larger than those on the diploid branches and their pollen grains were larger and many had four germinal pores instead of three. The diploid and the tetraploid conditions were verified for several of the plants by counts of the chromosomes in pollen mother cells during stages of the reduction divisions.

For all these plants the results of controlled and proper pollinations demonstrated that the normal and potentially highly fertile flowers of the diploid branches were self-incompatible and produced no seeds or even rudimentary capsules to normal self-pollination but that the self-pollinated flowers of tetraploid branches on the same plants produced extra large capsules that were well filled with seeds.

Pistils of flowers on the self-incompatible diploid branches developed into capsules with many seeds when pollinated from flowers of tetraploid branches on the same plant. But all tests thus far made for tetraploid × diploid combinations on the same plant have failed to yield any seeds. Also unpollinated pistils of emasculated flowers set no seed either on diploid or on tetraploid branches.

Numerous studies in recent years have demonstrated that the physiological reactions of both self-incompatibility and cross-incompatibility within many species of homomorphic flowering plants are correlated with, and determined by, special hereditary factors and that incompatible reactions involve genetic similarity in respect to special factors or combinations of them.

For the fifteen plants here reported each is self-incompatible in its diploid branches. In the cells of the tetraploid branches on each of these plants there is a duplication of the chromosomes and also, presumably, of the genetic factors which produce self-incompatibility. But this duplication results in a reversal in the reactions of fertilization, and at least one, if not more, of the classes of pollen that segregate from the tetraploid complex is able to function in the production of seed after self-pollination.

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THE PHOTOCHEMICAL SPECTRUM OF CYTOCHROME OXIDASE IN HEART MUSCLE[1]

THE respiratory ferment of yeast and acetic acid bacteria has been shown by Warburg and his associates[2] to exhibit a photochemical absorption spectrum

[1] This work was carried out by the author during the tenure of a Finney-Howell Research Foundation Fellowship (1939–41). It was aided by a grant made to Dr. Kurt G. Stern by the Jane Coffin Childs Memorial Fund for Medical Research.

[2] O. Warburg and E. Negelein, *Biochem. Zeitschr.*, 214: 64, 1929. F. Kubowitz and E. Haas, *ibid.*, 255: 247, 1932.