Meetings

Statistics and Probability

During the week of 2–8 March, an international conference on statistics and probability took place in the Mathematical Research Institute, Lorenzenhof, Oberwolfach, Germany. This conference exhibited the remarkable growth of interest in statistics on the continent of Europe. Also it emphasized a certain shift in emphasis in statistical research in general. For these reasons, a brief account of the conference may be of general interest.

As is well known, up to the end of World War II, the geographical location of research in statistics and in probability was extremely uneven. Statistical theory (that is, theories of tests of hypotheses, of estimation, and of decision functions) was developed mostly in English-speaking countries and was largely ignored in western Europe. Probability theory centered in France and in Russia, while English-speaking countries trailed behind. After the end of the war, this situation changed radically. The works of Bochner, Doob, Feller, and Loève brought this country to the forefront of probabilistic research, and, at the same time, there appeared in Europe several young centers of research in statistics which promise remarkable developments. In addition to this geographical redistribution of effort, the end of the war marked a change in the subject of statistical research which may justify a distinction between what may be called the classical and the modern theories of statistics. I propose to use the term *classical* to describe those sections of statistical theory that deal with *numerical* random variables. They may be exemplified (i) by measurements, subject to random error, of a given physical magnitude; (ii) by responses to a treatment of organisms selected at random from their population; (iii) by pairs of numbers of ions generated by a cosmic ray particle in two adjoining unit lengths of its path; and so on. In each of these cases we deal with a chance mechanism producing *numbers,* either singly or in pairs or in multiple groups. More recently, modern science and modern industry brought under consideration more complicated chance mechanisms, connected with the term *stochastic processes,* which, at a single trial, produce not just a single number or a finite set of numbers but more complicated mathematical entities, such as a function. In the classification proposed, the term *modern theory of statistics* is applied to the statistical theory relating to stochastic processes—that is, to random variables whose possible values are not numbers but functions.

The basis for this subdivision of statistical problems into the categories "classical" and "modern" is the difference in the mathematical apparatus needed for their treatment. Consider a classical problem of statistics with some n observable numerical random variables $X_1, X_2, \ldots, X_n$. The possible values of each X_i are numbers. Hence, if one visualizes the n-dimensional Euclidean space, a single observation on these variables can be represented by a single "point" with its first coordinate equal to X_1, its second coordinate equal to X_2, and so on. The probability that the random point $(X_1, X_2, \ldots, X_n)$ will fall within any specified region, say R, is then represented by the measure of this region. The theory of measure is based on the works of Borel and Lebesgue, developed early in this century and now commonly taught in all universities with reasonably developed mathematical programs. The situation is different with modern statistical problems in which the outcome of a single "trial" is a curve, say $f(x)$ for values of x between zero and unity. If one tries to extend to this case the representation of the outcome of a trial by a point, it is necessary to deal, roughly speaking, with as many coordinates as there are numbers between zero and unity—that is, the continuum. For "spaces" filled with points of this kind ("abstract spaces"), one needs a definition of "distance," of "measure," and so forth. Theories of these concepts (Hilbert spaces, Banach spaces, and so on) are of more recent origin and are included in our university programs only in the most advanced institutions.

As far as "modern" problems are concerned, it was logical and unavoidable that their probabilistic treatment should precede their statistical treatment. The priority here belongs to the Russian school of Kolmogorov and Khintchine. More recently, the remarkable book by Doob clarified many concepts and cleared new paths. While it is difficult to point out exactly the first attempts at statistical problems concerned with stochastic processes, we certainly owe a great deal to the Scandinavian school of Cramér, particularly to Grenander. However, modern statistical theory is still in its infancy. One reason for this state of affairs is the tendency of statisticians to concern themselves with the so-called "practical" problems suggested by various fields of application, and, until recently, both science and industry offered only problems with numerical random variables. However, currently one encounters a number of problems where the observable random variables are curves. One example must suffice. The "observations" by a radio telescope provide a single oscillating curve summariz-

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ing the radio emissions of all the sources located within a certain solid angle. Cosmological theories are concerned with the spatial distribution of these sources (one particular chance mechanism) and with the distribution of their individual intensities (another chance mechanism). Also, the records of emission of the cosmic radio sources are combined by the telescope with unavoidable "noise" (a third chance mechanism). The statistical problem here is to use the observable random curve in order to verify this or that cosmological theory. Modern industry provides similar problems. Thus, the domain of probability distributions in abstract spaces that, until recently, was frequently considered one of the dreams of abstract-minded pure mathematicians, is now rapidly becoming a domain of practical statistical problems. In order to stand up to these practical demands, the efforts of theoretical statisticians must be reoriented.

The conference in Lorenzenhof reflected both of the changes indicated: the change in the geographical distribution of effort in statistical research and the change from classical to modern statistical problems. Of the 42 participants, 32 were from Germany and ten were from other countries (three from the United States and one each from Austria, Czechoslovakia, Egypt, Finland, France, Holland, and Hungary). Each of the foreign visitors and nine Germans were asked to present papers. The contents of these papers are far too technical to be reported here, and the following brief enumeration is limited to cases where the contributions at the conference indicated the emergence of a new statistical research center on the continent of Europe. There appear to be at least five such centers, each inspired by an outstanding personality. Roughly, from West to East, these centers are Paris, Hamburg, Munich, Prague, and Budapest.

For quite some time Paris has been one of the foremost centers of research in probability. However, the theory of statistics seemed to attract less attention. Now this situation has changed, and the conferences at Lorenzenhof were much impressed by a very interesting statistical paper by Robert Fortet, a noted probabilist. This paper dealt with the theory of testing statistical hypotheses concerned with stochastic processes and established an intriguing connection with Shannon's theory of information.

Hamburg was represented by L. Schmetterer, leader of the group; by the recently appointed docent, Krickeberg; and by a group of promising graduate students. Incidentally, Schmetterer was responsible for the organization of the scientific program of the conference at Lorenzenhof. His own paper was probabilistic and dealt with limit theorems on groups. Krickeberg spoke on convergence

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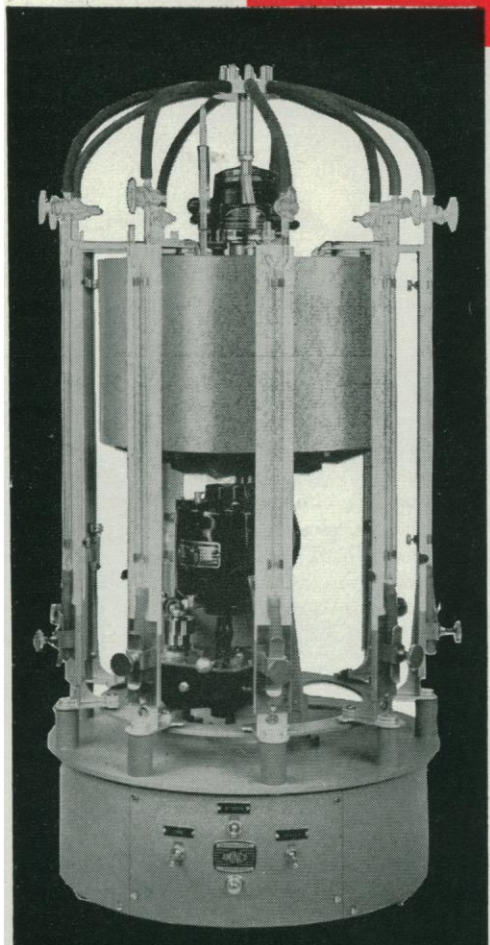

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of stochastic processes and exhibited signs of the influence of Doob.

The center of Munich provided four active participants, D. Bierlein, K. Jakobs, K. Gaede, and H. Richter. The first three spoke on problems of probability, while Richter dealt with Lindley's version of the statistical decision problem. The same problem was also treated by E. Brandau of Tübingen.

The two statistical groups of eastern Europe, one in Prague and the other in Budapest, were represented at the conference by their respective leaders, A. Spacek and A. Renyi. Their papers testified to the very intense and modern activity of the two groups and were loaded wtih material.

While several of the papers mentioned, and also some of those omitted from the above enumeration, were essentially probabilistic in character, they included distinct statistical elements. Also, predominantly, the papers presented dealt with modern problems.

Taking into account the activities of the new centers just described, together with those of the older centers in Holland, Denmark, Scandinavia, and Poland, all subject to a considerable extent to influences of the Russian school, one obtains the impression of a very strong drive now prevalent in Europe towards the development of an important new chapter of statistical theory.

The present account would be incomplete without a few lines about the Mathematical Research Institute at Lorenzenhof. Erected in the hills of Schwartzwald early in this century, the Lorenzenhof was intended to serve as the hunting lodge of a magnate. In due course it became the property of the state and, in 1944, became the seat of the Mathematical Research Institute. Originally, the intention was to concentrate certain branches of war research in the institute. However, in practice, the Lorenzenhof became a refuge for some of the German mathematicians who, for various reasons, had to abandon their university positions. Currently, under the wise guidance of its director, W. Süss of Freiburg University, and of his colleague and friend, H. Kneser of Tübingen University, the activities of the institute consist of the organization of some 12 mathematical symposia per year. Each symposium is given to a separate mathematical discipline and lasts about a week. From time to time, individual mathematicians come to Lorenzenhof for a period of quiet work.

As a means for fostering research, the usefulness of the institute and of its symposia is supreme. Leisurely life in beautiful surroundings, divided between a moderate number of lectures, walks in the countryside, and occasional periods of good music, creates excellent opportunities for informal contacts and discussions which have a most beneficial influence on the development of mathematicians in Germany and, through a substantial attendance from abroad, also elsewhere. One cannot help asking: What about establishing a similar institution in the United States?

JERZY NEYMAN

Miller Institute for Basic Research in Science, University of California, Berkeley

Hot Laboratories

Abstracts for papers to be presented at the seventh Conference on Hot Laboratories and Equipment, to be held in Cleveland, Ohio, April 1959, are due on *15 September 1958* and should be sent to the program chairman: L. G. Stang, Jr., Brookhaven National Laboratory, Upton, N.Y. Deadline for papers will be announced later. Papers are invited on all phases of hot laboratories and equipment for handling radioactive material, including design, construction, operation, maintenance, decontamination, remodeling, shielding calculations, costs, and so forth.

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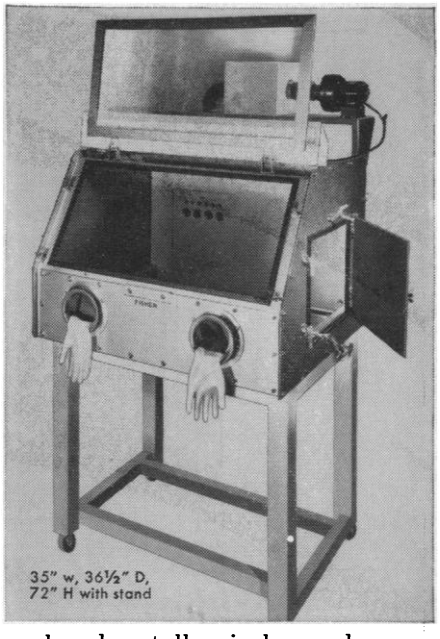

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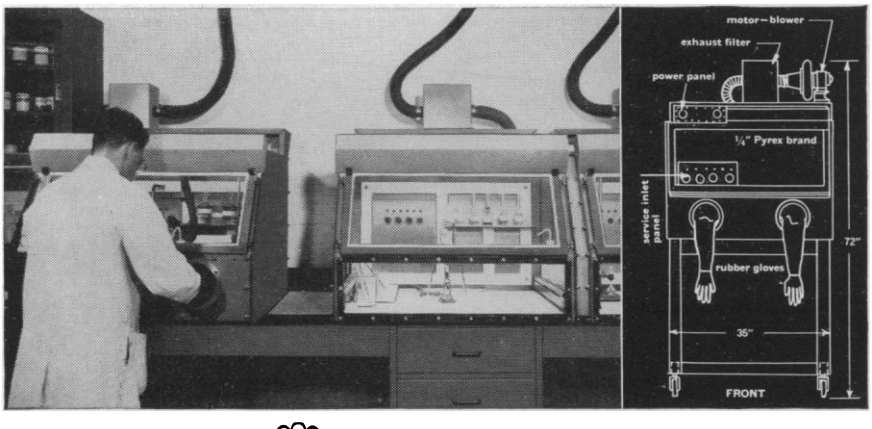

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First All-India Conference of Zoology

The Zoological Society of India is organizing the first All-India Congress of Zoology, to be held in Calcutta from 31 October to 6 November. This is the first time that an attempt has been made to bring together all the zoologists in India. A number of delegates from foreign countries are also expected to attend. Dr. B. S. Chauhan of the Zoological Survey of India, Calcutta, is the local secretary. The last date for submission of papers to be read before the congress is *15 August*.

Society Elections

■ Oregon Academy of Science: pres., C. R. Monk, Willamette University; v. pres., Lloyd W. Staples, University of Oregon; past pres., E. C. Gilbert, Oregon State College; sec., and representative to the AAAS Council, F. A. Gilfillan, Oregon State College, Corvallis, Ore.; treas., E. A. Yunker, Oregon State College.

■ National Association for Research in Science Teaching: pres., Thomas P. Fraser, Department of Science Education, Morgan State College, Baltimore, Md.; v. pres., Vaden W. Miles, Physics Department, Wayne State University; sec.-treas., Clarence M. Pruitt, University of Tampa, Tampa, Fla. The representative to the AAAS Council is George G. Mallinson.

■ American Society of Ichthyologists and Herpetologists: pres., Edward H. Taylor; treas., James E. Bohlke, Academy of Natural Sciences, Philadelphia, Pa.; sec., Roger Conant, Philadelphia Zoo, 34th St. and Girard Ave., Philadelphia 4, Pa. The vice presidents are: Boyd W. Walker, Department of Zoology, University of California; John C. Marr, La Jolla, Calif.; James A. Kezer, Department of Biology, University of Oregon.

Forthcoming Events

July

20–23. National Shellfisheries Assoc., 49th annual, Baltimore, Md. (P. A. Butler, U.S. Shellfisheries Laboratory, Gulf Breeze, Fla.)

20–27. Americanists, 33rd intern. cong., San Jose, Costa Rica. (33rd Intern. Cong. of Americanists, National Museum, P.O. Box 749, San Jose de Costa Rica, Central America.)

21–24. High Polymer Conf., intern., Nottingham, England. (Conference Secretariat, Dept. of Scientific and Industrial Research, Charles House, 5–11, Regent St., London, S.W.1.)

22–26. Brazilian Soc. for the Progress of Science, 10th annual, São Paulo, Brazil. Sociedade Brasileira para o Progresso da

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23–28. Continuous Cultivation of Microorganisms Symp. (by invitation), Prague, Czechoslovakia. (I. Malek, Inst. of Biology, Czechoslovak Akad. of Sciences, Narodni Tr. 5, Prague I.)

24–25. Computers and Data Processing, 5th annual symp., Denver, Col. (Electronics Div., Denver Research Inst., Univ. of Denver, Denver 10.)

25–29. Chromatic Discrimination in Animals and Man, ICSU symp., Paris, France. (H. Pieron, Collège de France, Place Marcelin-Berthelot, Paris 5e.)

28–30. Regulation of Cell Metabolism, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

28–2. Home Economics, 9th intern. cong., College Park, Md. (Congress Director, American Home Economics Assoc., 1600 20 St., NW, Washington 9.)

28–8. Statistical Summer Seminar, Dedham, Mass. (I. Weiss, Bell Telephone Labs., North Andover, Mass.)

August

4–9. Microbiology, 7th intern. cong., Stockholm, Sweden. (F. C. Harwood, Soc. of American Bacteriologists, c/o Waverly Press, Inc., Mt. Royal and Guilford Aves., Baltimore 2, Md.)

7–9. Electron Microscope Soc., annual, Los Angeles, Calif. (C. M. Schwartz, Battelle Memorial Inst., 505 King Ave., Columbus 1. Ohio.)

10–16. Radiation Research, intern. cong., Burlington, Vt. (H. M. Patt, Argonne National Lab., P.O. Box 299, Lemont, Ill.)

11–13. International Mathematical Union, 3rd general assembly, St. Andrews, Scotland. (F. Smithies, Mathematical Inst., 16 Chambers St., Edinburgh 1, Scotland.)

11–16. Occupational Therapists, World Federation's 2nd intern. cong., Copenhagen, Denmark. (Mrs. I. Worsoe, Hvidklovervej 10, Aarhus, Denmark.)

12–13. Economic Botany Conf., New York, N.Y. (D. J. Rogers, New York Botanical Garden, Bronx Park, New York 58.)

13–15. Electronic Standards and Measurements Conf., Boulder, Colo. (J. F. Brockman, National Bureau of Standards, Boulder.)

13–15. Industrial Applications of X-ray Analysis, 7th annual conf., Denver, Colo. (W. M. Mueller, Metallurgy Div., Denver Research Inst., University of Denver, Denver 10.)

13–19. Seaweed Symposium, 3rd intern., Galway, Ireland. (C. O. hEocha, Chemistry, Department, Univeristy College, Galway.)

13–20. Insect Pathology and Biological Control, intern. conf., Prague and Smolenica, Czechoslovakia. (J. Weiser, Inst. of Biology, Nacvicisti 2, Prague XIX, Czechoslovakia.)

13–20. International Astronomical Union, 10th general assembly, Moscow, U.S.S.R. (P. Th. Oosterhoff, IAU, Leiden Observatory, Leiden, Netherlands.)

15–20. World Medical Assoc., 12th general, Copenhagen, Denmark. (World Medical Assoc., 10 Columbus Circle, New York 19.)

17. American College of Hospital Administrators, 24th annual, Chicago, Ill. (ACHA, 620 N. Michigan Ave., Chicago 11.)

17–21. Health Conf., 7th annual, University Park, Pa. (M. Cashman, Pennsylvania Dept. of Health, P.O. Box 90, Harrisburg.)

18–19. American Astronautical Soc., Western meeting, Palo Alto, Calif. (N. V. Petersen, Lockheed Missile Systems Div., Palo Alto.)

18–21. Conservation Education Assoc., 5th annual, Salt Lake City, Utah. (S. D. Mulaik, Biology Dept., University of Utah, Salt Lake City.)

18–21. Heat Transfer, AIChE conf., Evanston, Ill. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

18–22. Clinical Chemistry Workshop, Houston, Tex. (Division of Clinical Chemistry, Dept. of Biochemistry, Baylor Univ., College of Medicine, Houston. 25.)

18–22. Occupational Medicine and Toxicology, 2nd Inter-American conf., Miami, Fla. (W. B. Deichmann, Dept. of Pharmacology, Univ. of Miami School of Medicine, Coral Gables, Fla.)

18–22. Plant Science Seminar, 35th annual, Big Rapids, Mich. (E. P. Claus, Div. of Pharmacy, Ferris Inst., Big Rapids.)

18–22. Semiconductors, intern. conf., IUPAP, Rochester, N.Y. (D. L. Dexter, Dept. of Physics, Univ. of Rochester, Rochester.)

18–23. New England Assoc. of Chemistry Teachers, 20th summer, Kingston, R.I. (J. A. Martus, College of the Holy Cross, Worcester 10, Mass.)

18–25. Religion in the Age of Science, 5th summer conf., Star Island, N.H. (Institute on Religion in an Age of Science, 280 Newton St., Brookline 46, Mass.)

20–23. Photofluorography, intern. cong., Stockholm, Sweden. (International Cong. of Photofluorography, P.O. Box 5097, Stockholm 5.)

20–27. Australian and New Zealand Assoc. for the Advancement of Science, 33rd cong., Adelaide, Australia. (J. R. A. McMillan, Science House, 157–161 Gloucester St., Sydney.)

20–27. Genetics, 10th intern. cong., Montreal, Canada. (J. W. Boyes, Dept. of Genetics, McGill Univ., Montreal, P.Q.)

21–23. American Farm Economic Assoc., Winnipeg, Canada. (L. S. Hardin, Dept. of Agricultural Economics, Purdue Univ., Lafayette, Ind.)

21–23. Chemical Organization of Cells, Normal and Abnormal, Madison, Wis. (J. F. A. McManus, Dept. of Pathology, Univ. of Alabama Medical Center, Birmingham.)

21–24. Cenozoic of Western Montana, field conf., Missoula, Mont. (A. E. Wood, Soc. of Vertebrate Paleontology, Dept. of Biology, Amherst College, Amherst, Mass.)

23–25. Rural Sociology Soc., annual, Pullman, Wash. (H. F. Lionberger, Dept. of Rural Sociology, Univ. of Missouri, Columbia.)

24–28. American Inst. of Biological Sciences, annual, Bloomington, Ind. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

The following 25 meetings are being held in conjunction with the AIBS meetings at Bloomington, Ind.

American Bryological Soc., annual. (Mrs. V. S. Bryan, Botany Dept., Duke Univ., Durham, N.C.)

American Fern Soc., annual. (Miss M. E. Faust, 501 University Pl., Syracuse 10, N.Y.)

American Microscopical Soc., annual. (D. G. Frey, Dept. of Zoology, Indiana Univ., Bloomington.)

American Phytopathological Soc., 50th anniversary. (W. B. Hewitt, Dept. of Plant Pathology, Univ. of California, Davis.)

American Soc. for Horticultural Science, annual. (R. E. Marshall, Dept. of Horticulture, Michigan State Univ., East Lansing.)

American Soc. of Ichthyologists and Herpetologists, annual. (R. Conant, Philadelphia Zoological Garden, 34th and Girard Ave., Philadelphia 4, Pa.)

American Soc. of Limnology and Oceanography. (B. H. Ketchum, Woods Hole Oceanographic Inst., Woods Hole, Mass.)

American Soc. of Naturalists. (B. Wallace, Long Island Biological Assoc., Cold Spring Harbor, N.Y.)

American Soc. of Parasitologists, annual. (P. E. Thompson, Research Div., Parke, Davis & Co., Detroit 32, Mich.)

American Soc. of Plant Physiologists, annual. (G. R. Noggle, Dept. of Botany, Univ. of Florida, Gainesville.)

American Soc. of Plant Taxonomists. (R. F. Thorne, Botany Dept., State Univ. of Iowa, Iowa City.)

American Soc. of Zoologists. (S. Crowell, Dept. of Zoology, Indiana Univ., Bloomington.)

Biometric Soc., ENAR. (T. W. Horner, General Mills, Inc., 400 Second Ave., S., Minneapolis 1, Minn.)

Botanical Soc. of America, annual. (H. C. Bold, Dept. of Botany, Univ. of Texas, Austin 12.)

Ecological Soc. of America. (J. E. Cantlon, Dept. of Botany and Plant Pathology, Michigan State Univ., East Lansing.)

Mycological Soc. of America, annual. (E. S. Beneke, Dept. of Botany and Plant Pathology, Michigan State Univ., East Lansing.)

National Assoc. of Biology Teachers. (P. Fordyce, Broad Ripple High School, Indianapolis, Ind.)

Nature Conservancy. (G. B. Fell, 4200 22 St., NE, Washington 18.)

Phycological Soc. of America, annual. (W. A. Daily, Dept. of Botany, Butler Univ., Indianapolis 7, Ind.)

Potato Assoc. of America, annual. (R. V. Akeley, Crops Research Div., USDA, Plant Industry Station, Beltsville, Md.)

Society for Industrial Microbiology, annual. (C. L. Porter, Dept. of Biological Sciences, Purdue Univ., West Lafayette, Ind.)

Society of Protozoologists, annual. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana.)

Society for the Study of Development and Growth. (R. O. Erickson, Dept. of Botany, Univ. of Pennsylvania, Philadelphia 4.)

Society of Systematic Zoology. (R. E. Blackwelder, Box 500, Victor, N.Y.)

Tomato Genetics Cooperative. (E. C. Stevenson, Horticulture Dept., Purdue Univ., West Lafayette, Ind.)

24–29. Atmospheric Diffusion and Air Pollution, intern. symp., Oxford, England. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

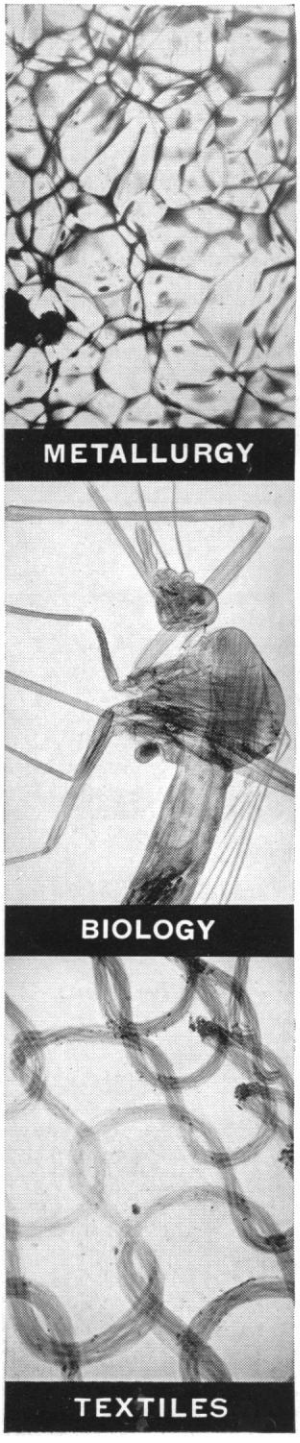
24–29. Mental Health, world federation, 11th annual, Vienna, Austria. (Miss E. M. Thornton, World Federation for Mental Health, 19 Manchester St., London, W.1, England.)

24–30. Prehistoric and Protohistoric Science, 5th intern. cong., Hamburg, Germany. (Büro des Internationalen Kongresses für Vor- und Frügeschichte, c/o Fremdenverkehrs- und Kongresszentrale, Hamburg 1, Bieberhaus, Hachmannplatz.)

25–28. Institute of Mathematical Statistics, annual, Cambridge, Mass. (G. E. Nicholson, Jr., Dept. of Statistics, Univ. of North Carolina, Chapel Hill.)

25–28. Mathematical Assoc. of America, 39th summer, Cambridge, Mass. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

Erratum: The correct address for the Society for the Scientific Study of Sex is 1 E. 42 St., New York 17, N.Y. The society will hold its first meeting on 8 November at the Barbizon-Plaza Hotel in New York.



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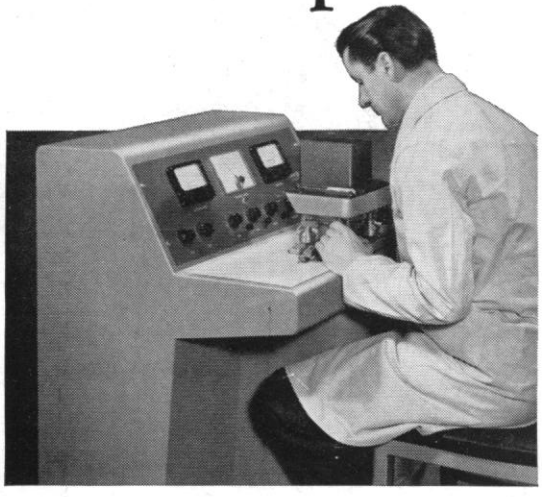

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Letters

Withdrawal versus Withholding of Positive Reinforcement

C. B. Ferster (*1*) in his experiments used withholding of food reinforcement (called by him withdrawal of positive reinforcement) in differentiation of conditioned motor reflexes. It seems, however, that under the circumstances of his experiments, the procedure cannot be considered as "the withdrawal of positive reinforcement" nor as "the withdrawal of the situation in which the reinforcement occurs." The situation in which the reinforcement occurred was only partially changed by switching off of the overhead lamp, or by appearance of the red light, and in spite of the fact that the animal performed the movement (pressing of the key), the reinforcement was withheld. The differentiation which was attempted in these experiments developed slowly and was only a partial one, because the reinforcement was withheld regularly only when the movement occurred during periods when the red light appeared, whereas in the absence of the red light the reinforcement was applied irregularly.

Ferster emphasizes in his report the analogy between the punishment and the withholding of positive reinforcement, both of which had as a result the elimination of the conditioned movement. But I think that there is a very important difference between the two events: the punishment, whether used in classic conditioning (type I) or in escape or avoidance conditioning (type II) (*2*), can give rise to new conditioned movements, whereas the differential inhibition can only eliminate some preexisting conditioned movements. The suggestion that punishment and differentiation have common "aversive" features is, as of the present time, based only on introspective impressions.

In my own experiments (*3*), when real withdrawal of positive reinforcement was used, a new kind of behavior was obtained. These experiments consisted in the withdrawal of food during the act of eating. The withdrawal was signaled by an acoustic stimulus applied 5 to 10 seconds beforehand. After several such trials the animal stopped eating when the stimulus sounded and turned away from the food tray. This conditioned "cessation reflex" was later differentiated: the food was withdrawn after one of the stimuli, but after another it was not. During the action of the first stimulus the dog turned away from the food, but during the action of the other (that which was not reinforced by withdrawal of food), he ate without interruptions.

Thus, both the inhibition produced by