a restraining cage for the animal. Cards bearing visual figures are inserted in the doors. The same arrangement of the boxes may be successfully employed in the investigations of responses to brightness differences from reflected light by inserting standard neutral-tint papers in the doors. Buzzers or loud speakers mounted at the back of the boxes permit rapid investigation of differential responses to auditory stimuli. Determinations of responses to transmitted light are made by constructing diffusing screens and filter holders at the back of the boxes and inserting optical-glass plates in the doors. Intensity variations are quickly made by a series of neutral-tint filters (10.2 cm by 12.7 cm). For visual acuity measurements two boxes are mounted on runways, 5 cm wide by 215 cm long, and separated by a distance of 50 cm, which are connected to the end of the table. The animal is then required to make a differential response which is a function of the test stimuli (a horizontal and a vertical black line) at the end of the table. The stimulus distance is controlled by the position of the movable boxes along the elevated runways. When responses to moving stimuli are under investigation, boxes containing plate-glass backs are employed, and the shadows of moving figures projected upon optical-glass screens in the doors.

The following statements indicate something of the general nature of the visually controlled responses of the cat as determined by this method. Animals trained in the discrimination of visual patterns (circles and triangles of equal area) give generalized responses to similar forms of different brightness, size, figure-ground relation, etc., or are able to select a previously learned figure from among a number of different new patterns (8 animals). With transmitted light differences, the brighter of two lights may be decreased to a ratio of approximately 1.3 that of the second light at brightness levels of 0.5 and 50 apparent foot-candles and still elicit differential responses (7 animals). With reflected light differences, the threshold ratio is approximately 1.4 at a brightness level of approximately 40 apparent foot-candles (1 animal). The visual acuity varies with the stimulus distance, being best at 50 to 75 cm (0.45 to 1.7 minutes) and less precise at 100 to 125 cm (1.4 to 3.4 minutes), when the discrimination is based upon a black horizontal lines versus a black vertical line (2 animals). The threshold of discriminative response to a moving cross versus a non-moving cross is approximately 1 cm per second angular velocity (4 animals).[2]

In every case, the bona-fide nature of the responses may be established by check experiments made during the course of each investigation. The results indicate that the apparatus has the advantage not only of eliciting an unequivocal response which can be demonstrated to be a function of the differential stimuli presented, but also of providing general experimental conditions that are readily modifiable for different types of investigation and easily controlled. Olfactory influences, for example, are controlled by placing food behind the doors of each box, and by alternating the position of the stimuli independently of other parts of the apparatus. Extraneous auditory influences and cues from the experimenter are excluded, since the animal itself manipulates all movable parts of the apparatus when making a response, and since the observer is shielded from the apparatus by appropriate screens.

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[2] J. L. Kennedy and K. U. Smith, *Jour. Genet. Psychol.*, 46: 470–476, 1935.

THE "CONTOUR" CHART AND ITS IMPORTANCE IN PUBLIC HEALTH TABULATIONS[1]

IT is often necessary to express data in as little space as possible and at the same time make it immediately evident. I believe the chart herein described will aid in this respect.

Neyman[2] and Neyman and Pearson[3] used the term contour in describing lines representing a constant of different sizes of samples of population. Their diagrams were highly technical. Treolar and Wilder[4] also used the term contour with reference to lines in a highly technical diagram. In a recent study of the incidence of epidermophytosis[5] I have used the term with reference to certain charts. In these charts three factors are plotted: one, on the ordinate, one on the abscissa and a third on the chart. Increments plotted on the chart are equal. The term "contour lines" is used in the same sense on topographical maps in plotting equal increments of elevation or depression and they are defined as lines drawn for equal differences of elevation and hence steepness, or the reverse, according to whether they are crowded together or spread apart. As will be noted in my charts, the term contour is used somewhat broadly but in a highly descriptive sense.

In Fig. I, years are plotted on the abscissa, cumulative cases on the ordinate and age groups of 10 years on the chart. In this chart the term contour is used somewhat broadly, since the lines connecting the

[1] Contribution No. 59 from the Department of Biology and Public Health, Massachusetts Institute of Technology, Cambridge, Mass.

[2] J. Neyman, *Biometrika*, 18: 1926, 406.

[3] J. Neyman and E. S. Pearson, *Biometrika*, 20–A: 1928, 175–235.

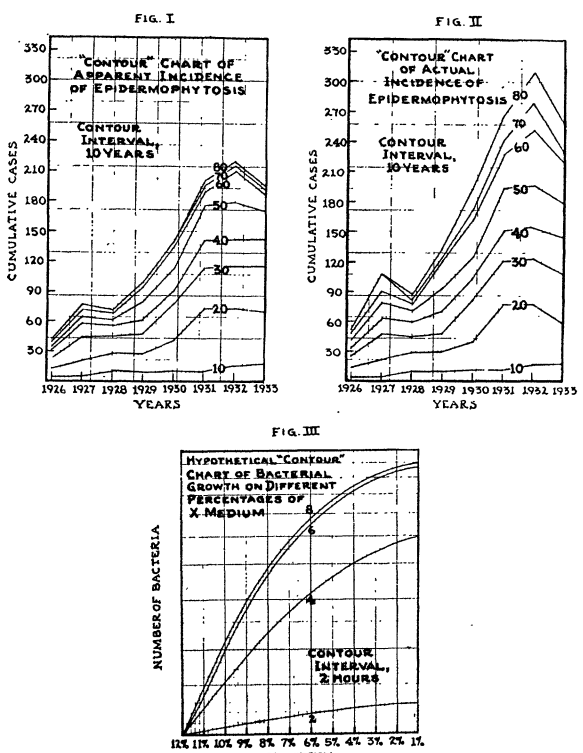
[4] A. E. Treolar and M. A. Wilder, *Ann. Math. Stat.*, 5: 1934, 340.

[5] J. W. Williams, *Arch. Dermat. and Syph.* In press.

points do not bound areas in continuous space. This figure we have labeled a "Contour Chart of Apparent Incidence," since age groups of population were not considered.

Fig. II is similar to Fig. I, with the exception that age groups of population have been taken into account. It is therefore called a "Contour Chart of Actual Incidence." In order to take the age group of population into account the following formula was used: $\frac{P}{U} = F$, where P (Peak) is the age group of largest number and U the age group for which the factor F is desired. This factor is then multiplied by the number of cases in the particular age group concerned so as to correct for variation in age groups of population.

In the above figures it will be noted that the lower incidence is in the lower and higher age groups. This



is accounted for by less chance of exposure to the etiological agent. In addition, in the higher age group difficulty in getting to clinics might lead to greater neglect of a minor ailment. It will be noted in these charts that there is a somewhat general distribtuion of the disease indicating lack of development of immune bodies to the etiological agent. If, instead of epidermophytosis, we should plot chicken-pox the incidence would be large and almost entirely in the younger age group, indicating great contagion and development of immunity. Thus Fig. II is a chart taking into consideration not only yearly incidence with reference to age groups but also with reference to age group distribution of population, contagiousness of the disease and development of immunity to the disease. Many uses can be made of contour charts. For example, a hospital or public health department might plot diseases on the abscissa, cumulative cases on the ordinate and years or months on the chart and thus keep a record of the diseases in which they were interested or they might plot diseases on the abscissa, cumulative cases on the ordinate and age groups on the chart.

In Fig. III I have plotted on the abscissa concentration in percentages of a medium which we will call X, on the ordinate increase in the number of organisms and on the chart two hourly intervals. Semi-logarithmic paper is used so as to show proportionate increase with reference to the actual number of organisms present. In this instance the lines may be considered as bounding areas in continuous space and the term contour as used in a stricter sense than in the previous figures. This, too, is a compact way of recording and tabulating the data obtained.

In conclusion, I have submitted a chart which is considered of great value in recording public health and other data. It is simple and inclusive. While it might be considered in the category of composite charts the term "Contour Chart" is more descriptive and indicates that the increments on the chart are equal. It is felt that the "Actual Contour Chart" will encourage workers to take into consideration oftener such factors as age groups of population, etc., and thus promote the publication of more significant data.

I wish to thank F. F. Stephan, editor of the *Journal* of the American Statistical Association, for his helpful criticism.

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