IN THE LABORATORY

A Simplified Basal Electrode for Routine EEG Use

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Since Grinker's (*2*) original stimulation and recording of electrical activity from the "hypothalamic area" through the intact skull in man, other modifications of his technique have been devised. Grinker's lead consisted of a silver-plated needle electrode mounted on a firm rod and imbedded in the sphenoid bone by puncturing the mucosa. Schwab (*4*) devised a stiff, blunt metal rod which is held snugly against the posterior nasopharynx by means of a rubber balloon inflated in the nasopharynx. Recently, Greenblatt, *et al.* (*1*) utilized a telephone wire in combination with a wooden applicator stick to hold a rather sharply pointed electrode in place in the upper pharynx.

Each of the above methods has some of the following disadvantages:

(1) Apprehension and discomfort are caused by the passage of any sharp or dull, rigid metal body into the nasal cavity, and this is usually accentuated by a deviated septum.

(2) The difficulty in "fixing" the electrode in or against tissues often requires a nose and throat consultant and the use of a nasopharyngoscope.

(3) Rather heavy local cocainization is required to eliminate pain.

(4) Artifacts appear to be accentuated from local tissue trauma at the tip of the electrode and from movement of the rigid electrode in response to small contractions of pharyngeal muscles.

(5) There is danger of infection following any break in the mucosa.

In searching for a method to eliminate the above disadvantages, a lead has been constructed with excellent preliminary results. It consists of a 5″ length of #18 French rubber catheter with a snug fitting, smoothly rounded lead electrode sealed in the tip with rubber cement. Flexible insulated copper wire is attached to the blunt electrode and extends through the tube and out to the electrode box. To accomplish firm contact between the electrode and the posterior nasopharyngeal wall, the electrode is inserted, and the record is run with the patient supine and the head slightly lower than the body. (An ordinary adjustable barber-chair head rest fastened to the bed accomplishes this.) After insertion, the tube, which is nearly vertical when in position, is filled with liquid mercury which, because of its weight, presses the electrode firmly against the posterior nasopharyngeal wall. To prevent leakage of mercury, the body of the metal tip electrode is sealed to the inner surface of the rubber tubing with rubber cement.

Placing the lead is accomplished with ease and involves much less difficulty and discomfort to the patient than does the process of passing an ordinary stomach tube. The nostril presenting the least obstruction is sprayed with a 5% cocaine solution to shrink the turbinates. A small quantity of mineral oil is applied to the rubber tube for lubricating purposes, and the tube is passed slowly through the nasal cavity until a rather firm resistance is met. This is the posterior nasopharyngeal wall. At this point in the procedure the tube is filled with mercury, which insures firm contact.

The position of the inserted lead and the electrical activity from it are similar to the "basal sphenoid" lead of Greenblatt, *et al.* and appear to have less artifacts. Hoagland (*3*), who has used this lead as well as those of Grinker and Schwab, believes it to be superior for routine clinical use.

It is hoped that the description of this electrode, with its ease of construction, simplicity of application, and relative freedom from artifacts, will stimulate more frequent use of the "basal lead," which is of value in diagnosing and localizing tumors deep in the brain.

References

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Oscillographic Scatterplots Illustrating Various Degrees of Correlation[1]

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The random fluctuations of electrons in a resistor (or of ions in a gas tube) have many advantages, as sources of illustrative material for courses in statistics, over games of chance, actuarial experience, and scientific agriculture. A thousand cases—or a million—parade themselves before one's eyes in a single second. In 10 seconds one is almost willing to say that he has seen an infinite population. Moreover, the population is normal.[2] Its

[1] The demonstrations described herein were made in connection with research being carried out under contract with the U. S. Navy, Office of Naval Research (Contract N5ori–76, Report PNR–49).

[2] The statistical theory of white noise has been worked out by Nyquist, Rice (*2*), Uhlenbeck, Weisskopf, Weiss and Goudsmit, and others. They are not univocal on the subject of the theoretical normality of the distribution of instantaneous noise amplitudes, but an empirical demonstration of normality has been described by Dunn and White (*1*).

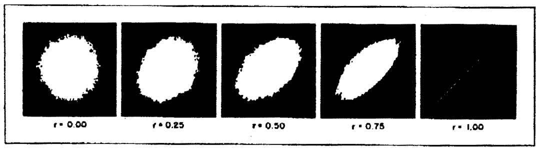

FIG. 1. Oscillographic scatterplots illustrating various degrees of correlation between two 'infinite' populations.

standard deviation can be varied by turning a knob. Random samples can be drawn at will: 2 cases, or 20, or 200.

There is, of course, no reason to stop with one population. The 5 photographs of Fig. 1 are oscillographic scatterplots illustrating various degrees of correlation between two populations. Fig. 2 shows random samples from correlated populations. The individual cases appear as bright dots on the face of the oscilloscope, whereas the 'infinite' population fills up the whole of an elliptical area.

The method of converting the electronic fluctuations into graphic illustrations is quite simple. To produce a scatterplot with zero correlation, two randomly fluctuating voltages—the kinds used to produce 'white' noises—are used. One of the voltages is applied to the vertical plates, the other to the horizontal plates, of a cathode-ray oscilloscope. Under the orthogonal influences of the two randomly varying voltages, the beam of electrons that constitutes the writing arm of the oscilloscope traces out an erratic path on the fluorescent screen, a 'random Lissajous figure.' The beam moves so fast, however, that the details of its course cannot be followed. Its trace appears to fill up a considerable area—a circular area if the two fluctuating voltages are equal in intensity (cf. left-hand photograph, Fig. 1). The brightness of the trace diminishes with increasing distance from the center of the area,

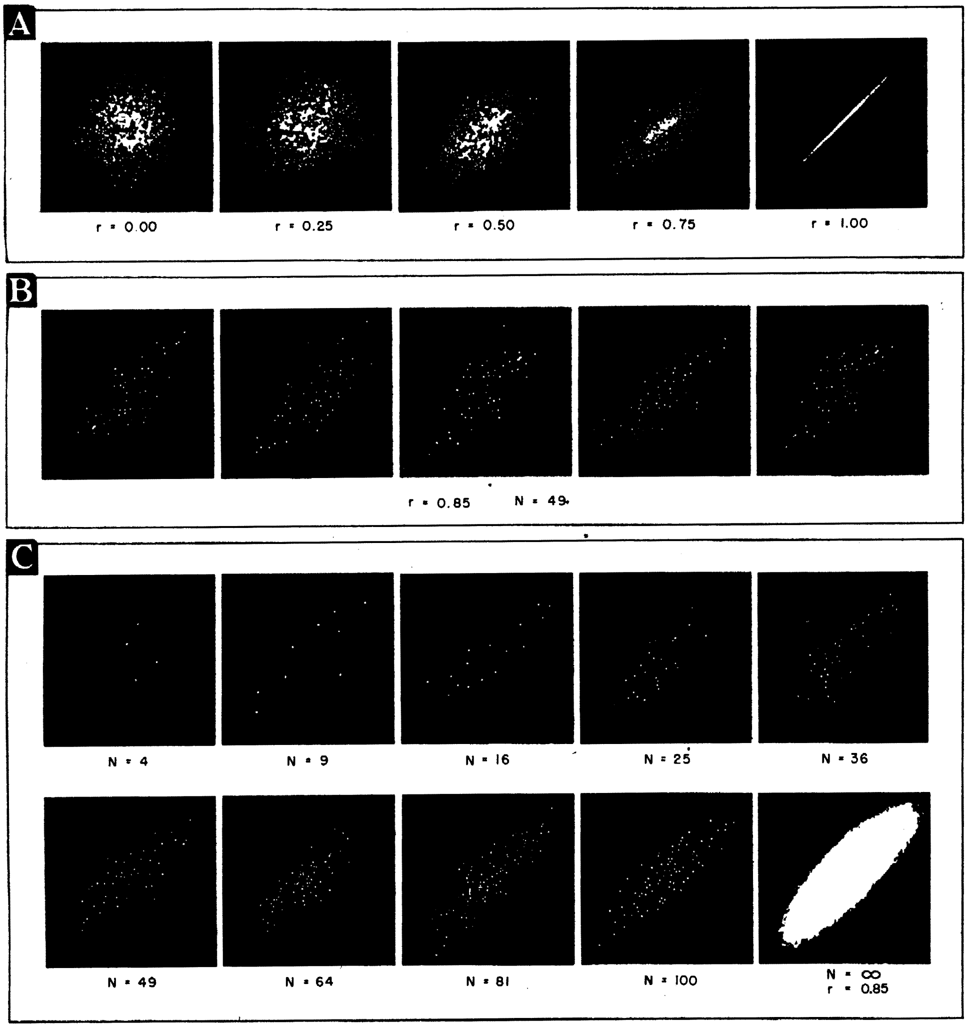

FIG. 2. Oscillographic scatterplots of random samples from correlated populations. The samples shown at A, from the populations of Fig. 1, were 'drawn' by blanking out all but very short segments of the fluctuating trace on the fluorescent screen. The 5 scatter diagrams at B were obtained by sampling from paired populations. The dissimilarities illustrate the 'errors' of random sampling. C shows how the scatter diagrams stabilize as N increases.

just as does the probability density in a zero-correlation scatterplot.

The pattern for $r = 1.00$ (right-hand trace, Fig. 1) appears when only one fluctuating voltage is used. The same white noise is applied to both the vertical and the horizontal plates of the oscilloscope, and the beam goes up whenever it goes to the right, down whenever it goes to the left. To produce the scatterplot for $r = -1.00$, it is necessary only to reverse the connections to the vertical (or horizontal) plates of the oscilloscope. Then the beam traces out a straight line with a slope of $-45°$.

To set up scatterplots for $0.00 < r < 1.00$, either of two procedures may be followed, and the demonstration of their equivalence serves to clarify one of the more confusing points in elementary correlation theory. Let us take the simpler procedure first:

We start with two random, normal variates, c and e. We then produce a second pair of variates, x and y, by taking $x = c$ and $y = c + e$. Then

$$r_{xy}^2 = \frac{\sigma_c^2}{\sigma_c^2 + \sigma_e^2},$$

in which σ^2 stands for *variance*. This relation is, of course, fundamental in the treatment of correlation from the point of view of analysis of variance. In the above equation, σ_c^2 is the variance associated with the regression line, and σ_e^2 is the mean square y-deviation from the regression line.

The variance of the distribution of the instantaneous voltages of a noise is simply the noise power. Noise powers are additive, just as are variances, and it is an easy matter, starting with noises c and e, to produce noises x and y. For x, by way of example, we take 1.00 power unit of c; for y, we add together 0.56 power unit of c and 0.44 power unit of e. If noise y is applied to the vertical plates of the oscilloscope and noise x is applied to the horizontal plates, we have the electron beam under the influence of two orthogonal variables that are so correlated that

$$r_{xy}^2 = 0.56/(0.56 + 0.44) = 0.56$$
$$r_{xy} = 0.75.$$

The beam traces out a random path that covers an elliptical area on the screen of the oscilloscope, plotting the scatter diagram for a correlation of 0.75 (fourth photograph, Fig. 1). For other positive correlations, the fluctuating y voltage is made up of c and e in other proportions (e.g. 25% c and 75% e for $r = .50$). To make scatterplots for negative correlations, it is necessary only to reverse the connections to the vertical (or to the horizontal) plates of the oscilloscope.

The procedure just described is capable of illustrating very dramatically the treatment of product-moment correlation in terms of analysis of variance. If noise e (the 'error' component of the y-distribution) is turned off, the line of regression of y on x appears. If e is turned back on gradually, error disrupts the relation: the ellipse grows fatter and r^2 decreases. Or if one starts out with nothing but error (vertical e against horizontal c) and then adds vertical c, he may watch the correlation grow. The idea of analyzing the total variance into components is easy to grasp when the components can be controlled at will.

It is sometimes of interest to regard the coefficient of correlation as an index of the degree to which two distributions, each containing a common component and a

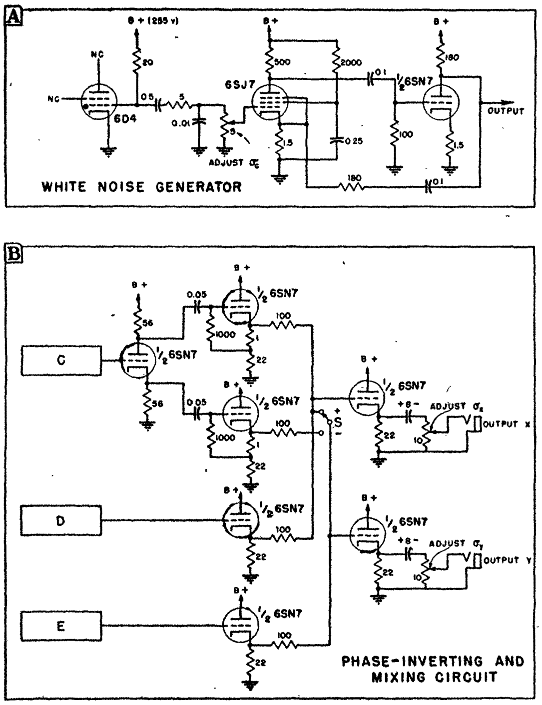

FIG. 3. Schematic diagram of the circuit used to produce correlated white noises: A is the basic noise-generating circuit. The random 'ionization noise' of the 6D4 gas tube is amplified in the pentode and triode vacuum tubes. Three of these noise generators are used. B shows the arrangement used to convert the three independent noises, c, d, and e, into two correlated noises, x and y. This is done by adding c and d to yield noise x, adding c and e to yield noise y. The strength of the correlation is then dependent upon the relative intensities of c, d, and e, which are readily adjustable ("adjust σ_c," etc.). The sign of the correlation is positive if the two c-components are in phase (switch S up), negative if the two c-components are out of phase (switch S down). Values of resistance are in kilohms; values of capacitance are in microfarads.

residual component, overlap. This treatment differs from the one based on analysis of variance in that, now, the x distribution also contains an 'error' component:

$$x = c + d$$
$$y = c + e$$
$$\sigma_d = \sigma_e.$$

And, now, r (not r^2) is equal to the ratio of the common variance to the total variance:

$$r_{xy} = \frac{\sigma_c^2}{\sigma_c^2 + \sigma_e^2}.$$

To set up scatterplots on this basis, three white noises, c, d, and e, are required. For a scatterplot for $r = 0.75$, we apply 0.75 power unit of c both to the vertical and to the horizontal plates; then we add in 0.25 power unit of e

to the vertical plates and 0.25 power unit of d to the horizontal plates. Under the influence of the fluctuating electrostatic forces, the beam traces out a scatterplot indistinguishable from the one for $r = 0.75$ produced, as described earlier, with two fluctuating voltages. Again, the dynamics of the situation display themselves dramatically when the various components are turned on and off individually.

The illustrations thus far have dealt with 'infinite' populations. The only equipment required has been a multichannel noise generator (see Fig. 3) and a cathode-ray oscilloscope. The next step is to draw random samples from the populations and thereby to illustrate the fluctuations of random sampling. What we want to do is to take, every now and then, a very quick look at the moving beam—a look so short that we can see only one 'case' per glance. In this way, we draw a random sample by making what is in effect a place selection from a collective. We must take care not to glance too often at the unfolding population, or we will encounter a technical difficulty,[3] but if our noises are good white noises (uniform spectra to 20 kilocycles), it is permissible to look as often as 2,000 times/sec. Then, the persistence of vision being what it is, we will see, at any one time, a sample of about 200 cases. If we have set up a correlation of 0.85, the scatterplot will look like the second to last photograph in Fig. 2C.

It is necessary, of course, to have mechanical or electronic assistance if we are to look, and then not to look, 2,000 times/sec. An episcotister can be set up in front of the oscilloscope. But it is much neater to modulate the brightness of the beam of the oscilloscope by using a train of pulses (instead of a steady potential) to accelerate the electrons. This reduces the pattern on the screen of the oscilloscope to a display of bright spots, each spot representing one 'case' in the scatterplot. By varying the repetition frequency of the pulses, it is possible to present random samples of almost any size (see Fig. 2). The demonstration is considerably more dramatic when viewed directly than it is in still photographs because the observer actually sees the scatterplot fluctuate.

[3] The beam must move far enough, between our glances, for the successive cases to be essentially unrelated. If we look too often, we will see the beam twice in nearly the same place, and this is clearly incompatible with random sampling.

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Book Reviews

Die deutschen wissenschaftlichen Bibliotheken nach dem Krieg. Georg Leyh. Tübingen: Verlag von J. C. B. Mohr (Paul Siebeck), 1947. Pp. 222.

In general, German scientific libraries have suffered much more heavily than other types of special libraries or the general university libraries encompassing the sciences as well as the humanities. During the war, scientific libraries were the legitimate objectives of Allied aerial attacks, and after the war they suffered particularly heavily from confiscation by one of the occupying nations.

Immediately after the war Georg Leyh, who recently retired as director of the University of Tübingen Library, conducted an extraordinarily careful survey of German research libraries. He examines the extent of damages sustained during the war to books, buildings, catalogues, and personnel and makes valuable suggestions for future policies. To summarize adequately Dr. Leyh's book would be too extensive an undertaking for the space at our disposal. However, a brief examination of the fate of the scientific and technological libraries will give some idea of what has happened to all types of research libraries in Germany.

Beginning alphabetically with Berlin-Charlottenburg, seat of Germany's leading Technische Hochschule, we have the dismal picture of a complete loss, the library, along with the main building of the university, having been completely destroyed in an air raid on November 22, 1943. The remains of the library were taken to Rossla, in the Harz Mountains, where many new purchases were added to the collection. In addition, some of the scientific books in the former Preussische Staatsbibliothek (now Öffentliche Wissenschaftliche Bibliothek) were sent to Rossla. However, in January 1946 everything except some of the catalogues was confiscated.

The great special libraries in Berlin proper are in a very serious condition, if they exist at all. The library of the Reichsministerium für Ernährung und Landwirtschaft exists today only in the form of 40,000 volumes in the libraries of the Reichsnährstand and the Landesbauernschaft. The remainder was stored near Küstrin and subsequently confiscated. Although most of the Deutsche Heeresbücherei was burned, some important parts are still in storage. The remains of the Statistisches Reichsamt and Reichspatentamt libraries were confiscated. The building of the Reichsgesundheitsamt was destroyed, and those parts of the library that were saved were taken over by the Deutsche Zentralverwaltung für Gesundheitswesen in the Russian zone. The Zentralbibliothek der Staatlichen Museen suffered heavily from bombardment and confiscation, and some of its holdings are still stored in western Germany. The irreplaceable library of the Botanischer Garten in Berlin-Dahlem was completely destroyed in 1943, and subsequent acquisitions are still in storage. Large