model results, have been carefully estimated to contribute uncertainties of ± 15 percent. Approximately two-thirds of all results fell within this range of experimental error.

Results of this critical experiment indicate that a quantitative theory accurate to approximately ± 15 percent for body surface potentials produced by normal ventricular depolarization may be based on the assumptions of a fixed-location equivalent dipole and a homogeneous, linear, resistive conducting medium. Torso shape and, more important, dipole location are critical factors that cannot be ignored. Although the results pertain to only a single subject, they are nevertheless suggestive that three-dimensional homogeneous torso models may be surprisingly pertinent for the establishment of an accurate, quantitative basis for human electrocardiography.

ERNEST FRANK
Moore School of Electrical Engineering, University of Pennsylvania, and
Edward B. Robinette Foundation, Hospital of the University of Pennsylvania, Philadelphia

References and Notes

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Compositional Lineation and Its Relation to Complex Folding

A three-dimensional study has been made of the form and relationships of compositional lineation in gneisses of several types.

Most of the linear units are composed of several or more grains of a mineral or minerals that form miniature chemical concentrations. As these mineral masses increase or decrease in number and size, the composition of the rock changes. They are approximately parallel to the plane of foliation or mineral layering.

Quartz, the latest mineral in the gneisses, forms linear masses in the plane of foliation that appear to be separate and scattered. Study in three dimensions, however, shows that these linear masses form a connected network of curving veins along small folds and also along curved fractures.

It is believed that the linear units were formed by metasomatism, with little or no change in volume along deviations of planar features undergoing movement of one wall or surface in relation to an opposite wall or surface (*1*). The thickest parts of the quartz veins are believed to have formed in the deviations nearest the tensional direction of the shear fracture, and the thinnest parts are believed to have formed in the deviations farther from the tensional direction. Such a vein may continue into parts of the planar feature that contain little or no quartz. The end of the vein is probably nearest to the theoretical position of the shear plane. The introduction and removal of minerals is believed to be synchronous with folding.

Oriented specimens of gneiss were mounted in brass cylinders, and photographic enlargements were made of many surfaces cut 1 mm apart. Tracings of the quartz veins or masses were made on transparent film. The resulting maps of these levels give information that is used to determine the relative direction of motion of the layers in the rock during its folding. Such determinations agree with results obtained by three other new methods that I have devised.

Synchronous folding of layered rocks along axial directions at large angles to one another appears to be common. Generally the folding on one axial direction has a relatively small radius of curvature around a large element of arc, whereas the folding on the other axial direction has a relatively large radius of curvature around a small element of arc (arcuate fold). Since folds are rarely analyzed and discussed in three dimensions, the folding that is related to the axis of relatively large radius of curvature around a small element of arc is usually neglected. Plane sections that are made to display the folding in an area are generally made transverse to the principal axis.

Compositional lineation and the axes of small drag folds appear to be perpendicular to the local line of slip. Therefore, these features are "approximately parallel" to the principal axial direction of folding where, as is described in the preceding paragraph, the effect of cross-folding is small.

The compositional lineation and axes of small drag folds are only in a small part approximately parallel to either of the two axes where the synchronous folding is pronounced along two crosswise axial directions. Generally these linear elements are markedly nonparallel to either of the axial directions.

The resultants of the vectors of slip have been used on models of cross-folds to analyze such deformation for orientation of compositional lineation and the axes of drag folds. Such diagrammatic models have been constructed for each of the several extreme structures. They can be used to bracket a natural example, after which a model can be made to show the variability of lineation orientation, the position of the main fold axes in relation to the lineation, and the direction of slip on certain parts of the fold.

Vectors have also been used on the planar features in the three-dimensional study of folding. The relative attitude of a planar feature on a fold, such as gneissic layering, as well as the lineation, should be comparable in some significant way with the other planar and linear structures of the same kind. One type of correlation is briefly described here.

The attitude of a planar feature may be described by the horizontal bearing and plunge of the lineation that lies in the plane of layering or foliation and the plunge of a line (slip line) that lies in the same plane and at 90° to the lineation. These two plunge angles are projected onto the horizontal plane as line vectors. The value of their resultant (R), together with the lineation bearing—which also lies in the horizontal plane—permits graphic delineation of relative normal pressures on the planar features and also the position of the axes of cross-folding.

I have devised geometric methods to show whether folding is the usual "competent" type or is the type caused by flowage (*2*). The latter was present in some rocks examined.

W. H. NEWHOUSE
Department of Geology, University of Chicago, Illinois

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Interaction of Reserpine, Serotonin, and Lysergic Acid Diethylamide in Brain

We have previously demonstrated that reserpine, a tranquilizing agent widely used in the treatment of psychotic states, potentiates the hypnotic effects of hexobarbital and ethanol in mice by a central action (*1*). 5-Hydyroxytryptamine (serotonin), a normally occurring substance suspected to be implicated in brain function (*2*), was also observed, in large dosage, to depress mice and to potentiate the action of hexobarbital in these animals (*3*). This potentiating action of serotonin

Table 1. Antagonism of the potentiating action of reserpine by LSD. Adult male mice were given the various drugs intraperitoneally. In the hexobarbital experiments, reserpine (5 mg/kg) and LSD (10 mg/kg) were given 1 hr before hexobarbital. In the ethanol experiments, reserpine (5 mg/kg) was given 1 hr before and LSD (10 mg/kg) was given in two divided doses 1 hr before and simultaneously with ethanol (4 g/kg in 50-percent solution). The duration of hypnosis is defined as the time from the loss to the return of the righting reflex. Values for duration of hypnosis are means ± standard deviation. Figures in parentheses indicate the number of animals in each series.

Hypnotic	Duration of Hypnosis		
	Hypnotic alone	Hypnotic + Reserpine	Hypnotic + Reserpine + LSD
	(*min*)	(*min*)	(*min*)
Hexobarbital (100 mg/kg)	19 ± 6 (12)	68 ± 14 (7)	32 ± 12 (8)
Hexobarbital (150 mg/kg)	63 ± 11 (15)	140 ± 10 (15)	67 ± 14 (15)
Ethanol	40 ± 9 (9)	all > 300 (9)	54 ± 11 (12)

was found to be antagonized by lysergic acid diethylamide (LSD), a compound that produces profound mental disturbances in man (*4*). This paper describes experiments which indicate that LSD also antagonizes the potentiating action of reserpine on hexobarbital and ethanol and that reserpine induces the release of large amounts of serotonin from body depots.

The sleeping times of mice given reserpine and hexobarbital were compared with those of mice given reserpine, hexobarbital, and LSD. Animals given hexobarbital alone served as controls. It was found that reserpine exerted a marked potentiation on the effects of hexobarbital but that LSD antagonized this potentiating action (Table 1). Similar experiments, using ethanol as the hypnotic, again showed that reserpine exhibited a strong potentiating action that was blocked by LSD (Table 1). No effect on the hypnosis produced by hexobarbital or ethanol was observed when LSD was given alone.

The observed similarities of reserpine and serotonin suggested the possibility that some actions of reserpine might be mediated through the release of serotonin normally present in body depots. To test this possibility, reserpine was administered to dogs and the resultant urinary excretion of 5-hydroxyindoleacetic acid (5HIAA), a major metabolite of serotonin (*5*), was measured.

Eleven animals each received, intraperitoneally, 3 mg of reserpine per kilogram of body weight. Urine was collected over a number of 2-hr periods and 5HIAA was determined by the method of Udenfriend *et al.* (*6*). This method involves extraction of the 5HIAA into ether, reextraction of the material into buffer, *p*H 7, and the formation of a colored derivative by reaction with nitrosonaphthol and nitrous acid. In each animal the rate of excretion of 5HIAA-like material markedly increased following the administration of reserpine, remained elevated for 8 hr or more, and gradually dropped to below the normal value (Fig. 1, typical experiment).

The apparent 5HIAA in urine following the reserpine administration was identified by paper chromatography with two solvent systems as described by Udenfriend *et al.* (*6*). Additional evidence for the identity of the material in urine was provided by comparing the absorption spectra of the chromophores resulting from the reaction between the nitrosonaphthol-nitrous acid reagent and the apparent and authentic 5HIAA. These were found to be identical. Finally, the distributions of apparent and authentic 5HIAA between ether and water at various *p*H values were compared according to the procedure of Brodie and Udenfriend (*7*). Both compounds were found to have the same partition ratios.

The excretion of 5HIAA in three of the dogs was determined after a second dose of reserpine was administered the next day (Fig. 1). An increase in 5HIAA excretion did not reoccur. This suggests that the first dose of reserpine had depleted the serotonin depots in the body and that they had not yet been replenished.

Serotonin and reserpine exert a common central potentiating action that is antagonized by LSD. This suggests that certain actions of reserpine may be mediated through the liberation of serotonin. In accord with this hypothesis, there is a marked increase in the urinary excretion of 5-hydroxyindoleacetic acid in dogs following administration of reserpine.

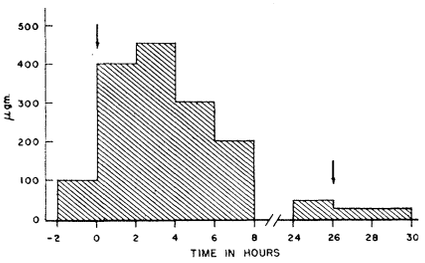

Fig. 1. Effect of reserpine on urinary excretion of 5-hydroxyindoleacetic acid (5HIAA) in the dog. Arrows depict times at which reserpine, 3 mg/kg, was injected intraperitoneally.

PARKHURST A. SHORE
STANLEY L. SILVER
BERNARD B. BRODIE
Laboratory of Chemical Pharmacology, National Heart Institute, Bethesda, Maryland

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Osmotic Pressure

In his recent communication J. H. Hildebrand (*1*) has given an interesting account of the role played by osmotic pressure in the theory of solutions. He has omitted, however, to point out the dual nature of the common conception of osmotic pressure; for that reason it is perhaps worth while to expand his explanation with some additional remarks.

Hildebrand uses the term *osmotic pressure* (*1*, p. 117) in the sense of the "... pressure of the solute against a membrane permeable only to the solvent." The pressure of the solute arises from the thermal motions of the solute molecules and, as originally pointed out by van't Hoff, is analogous to the pressure of a gas. In this sense, the osmotic pressure is a measure of the tendency of the solute to expand.

The second picture of osmotic pressure arises from the classical osmotic experiment in which a solution is separated from pure solvent by a semipermeable membrane. From this experiment, the osmotic pressure is defined as the hydrostatic pressure that must be applied to the solution in order to stop the flow of solvent through the membrane. This is the original and, as I shall demonstrate, the exact definition of osmotic pressure.

It has been customary to assume that the pressure of the solute against the membrane is intimately related to the hydrostatic pressure of the classical experiment. In fact, it has often been implied that, in some obscure way, the solute pressure is the cause of osmosis. Haldane (*2*), in 1928, pointed out that it was illogical to assume that the pres-