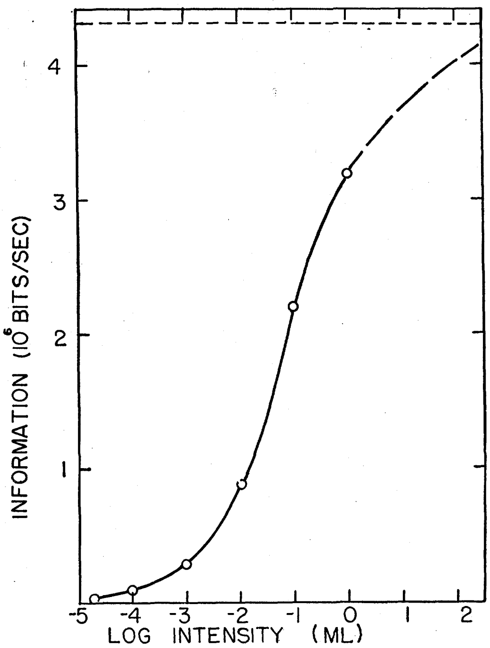

FIG. 2.

triple the capacity, and the increase is probably small compared to uncertainties in the data and methods of calculation.

Comparison with similar figures for the ear leads to interesting results. For "random" sound—i.e., sound evenly distributed in frequency and intensity throughout the hearing region—a capacity of 8,000 bits/sec has been calculated for the ear (*1*). Intense sounds will give a 10,000 bit/sec capacity, a result more nearly comparing to the high-illumination calculations of the present paper. A 430-fold difference, informationally speaking, is seen to distinguish the maximal capacities of the two receptors.

A factor of about 30 in the relative capacities of eye and ear can be accounted for by the ratio of nerve fibers leading from these organs (*13, 14*), but a further difference is evident in the efficiency with which an individual nerve fiber transmits information. The order of 5 bits/sec, av, can be produced by the 900,000 fibers of the optic nerve, compared with a maximum of about 0.33 bits/sec from each of the 30,000 fibers of the auditory nerve. This is clearly due to the greater independence with which the optic nerve signals are produced, in contrast to the prevalence of cooperative signals in the auditory bundles. The phenomenon of masking is less apparent in signals from the eye, which may be said to encode its observations more efficiently.

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The Percutaneous Absorption of Water

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The question whether externally applied water can penetrate the intact mammalian skin has long been debated. The gravimetric technique was employed in early experiments in which the subject was weighed before and after immersion. Working with human subjects, Stejskal (*1*) reported a retention of 200–300 g of water from the bath, Burr (*2*) observed a 5–7 g gain in body weight, and Pitta (*3*) reported a gain of 11.4–96.0 g, depending on the temperature of the bath. Schwenkenbecher (*4*) has criticized the results of Stejskal and others on the ground that the technique is not precise. More recently Whitehouse *et al.* (*5*) reported the results of carefully conducted experiments and concluded that water can pass inward through the human skin under certain conditions. These experiments have also been the subject of severe criticism, because the gravimetric technique was used, and Rothman (*6*) has claimed that water cannot pass through the mammalian epidermis.

Even if it can be proved that skin does take up water, none of the work so far reported offers final proof that this water enters the systemic circulation. Several investigators (*2, 7, 8*) have indicated that the answer to this question is important, and Burr (*2*) suggested that percutaneous absorption of even small amounts of water may exert a great influence on the water and mineral content of body fluids, on the circulation of nutrients, and especially on the exchange of substances between blood and tissues.

In the present study a tracer technique was used. Cylindrical wire containers with adjustable metal collars kept the animals in position and prevented the ingestion of D_2O. Young male rats weighing approximately 120 g were immersed for 6–7 hr in a mixture of 6 parts of H_2O and 4 parts of D_2O, maintained at a constant temperature of 35° C. The animals were then removed from the bath, drained, anesthetized lightly with ether, removed from cages, and quickly dissected to expose the heart. Blood samples were drawn from the pumping heart, using a syringe. Water was distilled from the blood samples,

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TABLE 1

Rat No.	Rat shaved	Wt of rat (g)	Length of immersion (hr)	D_2O in immersion liquid (mole %)	D_2O in blood (mole %)
1	yes	119	7	41.0	3.27
2	"	128	6½	40.6	0.72
3	no	118	6½	42.2	1.37
4	"	110	6½	40.9	1.42
5	"	118	6	40.1	0.70
6	yes	140	6	39.1	.80
7 (control)	no	152	6	0.0	.0
8 (")	"	170	5½	.0	.0
9 (")	"	198	6	.0	.0
10 (")	"	200	6	0.0	0.0

purified, and analyzed for deuterium content by the method of Keston, Rittenberg, and Schoenheimer (*9*). The results of these analyses are presented in Table 1.

It is evident from Table 1 that the deuterium oxide content of the blood of the test animals varied considerably even though they had been immersed in deuterium water for approximately the same period of time. The average deuterium oxide content of the blood of this group of animals was 1.38 mole %. The high deuterium oxide content of the blood of the test animals as compared with the controls is proof that the heavy water in which they were immersed penetrated through the skin and entered the systemic circulation.

It may be suggested that this D_2O entered the body in inspired air. This is not possible, for, if it is assumed that the air was 100% saturated with 40% deuterium oxide, and that all the deuterium oxide was retained by the lungs, rat No. 5 would have had to inhale about 840 liters air/min to reach a blood value of 0.70 mole % after 6 hr.

In three instances the fur from the trunk portion of the animal was removed by clipping and by an application of adhesive tape, two days before the immersion. This did not appear to influence the penetration of deuterium oxide, possibly because the hair did not interfere with the wetting of the skin of the immersed animal.

In a subsequent series of experiments (Table 2) rats were held so that only their tails were immersed in about 40% deuterium oxide. After the tails had

TABLE 2

Rat No.	Tail length	Length of immersion	D_2O in blood (mole %)
11	—	6½ hr	0.08
13	7 in.	6 "	.18
13	6 13/16 "	6 " 10 min	.23
14	6 10/16 "	6 " 10 "	.08
15	6 8/16 "	5 " 45 "	.07
16	6 8/16 "	5 " 45 "	0.09

been immersed for approximately 6 hr, the average content of deuterium oxide in the blood was 0.12 mole %. A rough calculation indicates that the area of the tail is approximately 1/10 the area of the whole body of these rats. It would seem, therefore, that on a square cm basis the rate of penetration of deuterium oxide through the skin of the body and the skin of the tail was the same.

These experiments were not designed to determine whether a loss of water molecules through the skin had taken place. It cannot be stated dogmatically that there was a net uptake of water, a fact which all earlier investigators (*1, 2, 3, 5*) attempted to demonstrate. Indeed, it is possible that their results were indefinite because there was an exchange of water molecules.

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Social Fitness versus Reproductive Fitness

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It has been an axiom in genetics that if a mutant gene is to spread in a large population it must confer a selective advantage upon the individuals in which it occurs. In the broadest sense this axiom is true for man as well as for other organisms. One reason for a more detailed consideration of specific genes in man is that a deleterious gene that lowers social fitness could increase reproductive fitness.

Social fitness could be measured by an individual's contributions to civilization in the form of cultural heredity. Such gifts to the present and future might be either material or intellectual or both.

Reproductive fitness could be measured by an individual's contribution of his genes to future generations as demonstrated by the number of his descendants. The exact wording of these definitions may be ignored, but the ideas expressed are useful for an understanding of this paper. The "fitness" of a genotype has been defined in detail by Fisher (*1*), by Haldane (*2*), and by Penrose (*3*), and they use the term "fitness" as a measure of reproductive effectiveness. Consequently, the idea of reproductive fitness is well established in human genetics.

The presence of an inverse correlation between the