

When the animal, to judge from the movements of the normal hind limbs, intended to walk forward, its exchanged fore limbs moved so as to make it walk backward, and upon amputation of the normally progressing hind limbs the backward movement went actually into effect.

This demonstrates that the reflex pattern for the fore limbs, in spite of the awkward consequences it entailed for these animals, had remained unchanged and unadjustable; the left spinal fore limb center continued to discharge a reflex sequence as if for a normal left limb, though such was now missing, and regardless of the fact that the central intention was turned into exactly the opposite effect by being picked up by the grafted right limb with its inverted anatomy. The same holds for the right spinal center in its dealing with a left limb substituted for the right limb.

Although the observations were extended over a period of several months and beyond metamorphosis, the reversed walking and swimming remained unchanged. This fact proves an utter lack of modifiability in the innate patterns of spinal reflex organization in amphibia. An anatomical disarrangement or inversion of the periphery results in functional activities which, in regard to the body, are correspondingly disarranged or reversed. The function remains under all circumstances "organ-correct", whereas it is "body-correct" only as long as the organ retains its normal anatomical relation to the body.

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Studies in Water Balance. 1: The Excessive Oxygen Usage Response of Dehydrated Animals to Water and Electrolytes.

HARRY A. DAVIS. (Introduced by E. B. McKinley.)

From the Department of Surgery, University of Chicago, and Department of Pathology, The George Washington University.

In certain forms of oedema, particularly those accompanying lipid nephrosis and certain nutritional states, there is present a marked lowering of the basal metabolic rate. For this reason, it seemed to be desirable to investigate the possible relationship of the total metabolism to water output and to the production of oedema. It has been suggested recently¹ that such a relationship does exist.

¹ Davis, H. A., *Science*, 1935, **81**, 493.

A number of investigators²⁻⁶ have shown that the ingestion of water increases the metabolism of the organism. In this study, we have endeavored to determine from a quantitative viewpoint, the significance of the oxygen consumption rate in the regulation of the output of water.

A series of 50 normal healthy dogs weighing between 7 and 15 kg. was used in this investigation. The animals were anesthetized with sodium barbital in a dosage of 250 mg. per kilo of body weight, in order to prevent movements which might alter the rate of oxygen consumption. Several control metabolic readings upon trained dogs before and after anesthetization showed that sodium barbital had relatively little effect upon the metabolic rate in the dosage recommended. Moreover, the readings were much more consistent in the anesthetized animal than in the unanesthetized. Fluid was administered by vein and by mouth in the form of 0.9% sodium chloride solution, 5% glucose solution and 10% sucrose solution in amounts varying from 2,000 to 4,000 cc. The rate of oxygen consumption was obtained by means of a Krogh respiratory apparatus, readings of 10-minute duration, taken before, during and after the administration of the standard solutions. The urinary bladder was emptied by catheter before each experiment, and the catheter was retained so that the total urine output during the experimental period was obtained. A second series of animals was deprived of water for periods lasting from 5 to 14 days. Food was freely allowed throughout the period of dehydration.

TABLE I.
Influence of Isotonic Sodium Chloride Solutions upon Metabolism of Normal Animal.

Exp.	O ₂ Consumption, cc. per min.		% Increase O ₂ Consumption	Urine Output cc.
	Before Injection	After Injection		
48	87.5	107.8	23.2	945
49	66.2	79.6	20.2	950
46	30.0	36.2	20.6	150
41	32.5	40.0	23.0	225
50	77.5	99.5	28.3	960

In Table I are shown the results of typical experiments in a series of normal animals. Following the administration of 0.9% sodium

² Feder, H., *Z. f. Biol.*, 1881, **17**, 531.

³ Wreath, S. R., and Hawk, P. B., *J. Am. Chem. Soc.*, 1911, **33**, 1601.

⁴ Verzar, F., *Biochem. Z.*, 1911, **34**, 41.

⁵ Lublin, A., *Z. Klin. Med.*, 1929, **109**, 371.

⁶ Grollman, A., *Am. J. Physiol.*, 1929, **89**, 157.

chloride solution, there is a gradual increase in the oxygen consumption rate to a point 100-600% above the initial rate. After stopping the ingestion of fluids, the rate returned to the initial level within one hour. In this series, the animals varied considerably in weight. Nevertheless, the increase in the oxygen usage per minute above the initial level differed only from 20% to 28%. In Table I, a definite relationship exists between the height of the oxygen consumption before and after fluid administration and the quantity of the output of urine.

In the dehydrated state the oxygen usage response to water and electrolytes is much greater. This is shown in Table II, where the increase in oxygen consumption rate per minute ranged between 32% and 277%. Transforming these figures into increase per 10-minute intervals, it is seen that the increase varies from 300% to 900% and more. Upon termination of the injection of the solution, the increase in oxygen usage returns to the initial level only after a period of several hours when anhydremia is present.

TABLE II.
Influence of Isotonic Sodium Chloride Solutions upon Metabolism of Dehydrated Animals.

Exp.	Duration of Dehydration days	O ₂ Consumption, cc. per min.			Urine Output cc.
		Before Injection	After Injection	% Increase O ₂ Consumption	
34	10	110	141.8	38.0	225
35	10	105	145.0	38.0	100
37	5	80	105.8	32.2	500
38	6	120	452.8	277.3	600
43	14	120	171.6	43.0	400

From the observation that the oxygen usage rate returns to the original level despite the fact that the animal still retains the greater portion of the fluid injected in the extravascular tissues, it might be suggested that fluid is more effective as a metabolic stimulant when it is present in the blood stream rather than when it lies in the extravascular tissue spaces. Recent work⁷ indicates that fluid is held in the blood stream for longer periods in anhydremia than in normal states. Thus the excessive oxygen usage response of the dehydrated organism to water may be related to this prolonged reservoir action of the blood. Possibly, however, other mechanisms are involved which render dehydrated tissues more susceptible to the metabolic stimulant action of water and electrolytes.

⁷ Davis, H. A., PROC. SOC. EXP. BIOL. AND MED., 1934, **32**, 210.