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PART I.

ORIGINAL COMMUNICATIONS.

ART. VIII.—*Report on Experiments on the Exact Action of Alcohol.*
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THE question as to the exact effect of alcohol in moderate doses is at present attracting a good deal of attention: some consider that although it is narcotic in large doses it is stimulant in small, whilst others consider the apparent stimulus, to quote the words of Dr. Edmunds, “as due to the finer shades of narcosis.” I have collected together reports of some of the experiments which throw light on this point, in the hope that others may be induced to follow up and extend the investigation and so help to set at rest this important point. It will, I think, be observed that, so far, all experiments go to show that the action of alcohol is from the first narcotic rather than stimulant.

Dr. Ridge's Experiments on Alcohol and the Senses.

Dr. Ridge has carried out an important series of experiments* to determine whether alcohol in small doses is a stimulant or narcotic. The following is an abstract of his results:—

1. *Feeling.*—An instrument was constructed with three points, the outer being half an inch apart and the middle movable by a rack and pinion in a line running between the others. The points were felt and not seen. The test consisted in the person moving the middle point until it was in his judgment equidistant between

* Medical Temperance Journal, April, 1882.

the others. A dial, concealed from the person experimented on, was divided into degrees. The average results of five experiments are given in the following table :—

	Average No. of degrees from exact centre of dial
Before Alcohol - - - -	23·
After 3ii. absolute alcohol - - -	37·96

2. *Weight*.—The judgment as to the amount of muscular force required to overcome different resistances formed the subject of this test. A weight was attached to a certain lever, and the person experimented on was required to slide another weight along an exactly similar lever until, in his opinion,¹ the weight appeared to be the same.

Ten experiments were tried, the doses of absolute alcohol ranging from 3ss. to 3iv., the average dose being 3 l·85. The general average of error before alcohol was 6·105 mm.; after it, 9·095 mm.

3. *Vision*.—This was tested by noting the distance at which a row of letters could be read by one eye. Ten experiments were tried, and doses of alcohol ranging from 3ss to 3iv. were given, the average dose being 3 2·3. The general average at which the letters could be read was—before alcohol, 9·375 feet; after alcohol, 8·538 feet.

Experiments Reported by Dr. Lauder Brunton.

Dr. Lauder Brunton thus describes^a the effect of alcohol on the time required for mental processes :—

“The processes generally investigated are—(a) the time required for simple reaction; (b) for discrimination; (c) for selection. The simple reaction is ascertained by marking on a chronograph the time when a signal is made, such as, for example, the exhibition of a coloured flag. As soon as this is seen by the individual experimented upon he marks the time upon the same chronograph by placing a finger upon a key which is connected with the registering electromagnet. The difference between the time of exhibition of the flag and the time registered by the electromagnet is equal to the time required for the transmission of the sensory impulse to the brain, for its transmission from the sensory to the motor tracts of the brain, for its passage down the motor nerves, and the latent period of the muscles.

“The time required for selection is ascertained in the same way,

^a Pharmacology.

but either a red or a blue flag may be shown, and he has to discriminate between them, and only to press when the one previously agreed upon is shown. The difference between the time of this experiment and the former, gives the time required for discrimination.

“The time required for decision is ascertained in the same way as the previous one, excepting that a different signal is to be made on the appearance of the red and of the blue.”

Dr. Brunton's summary is very interesting, as it shows both the physical and mental blunting caused.

“The influence of alcohol upon psychical processes is curious; for, while it renders them much slower, the individual under its influence believes them to be much quicker than usual.”

This peculiar psychical effect was also noticed by Dr. Parkes when making experiments as to work done with and without alcohol. He says of one soldier:—“He commenced the exercise and brandy period with the belief that the brandy would enable him to perform the work more easily, but ended it with the opposite conviction. . . . The brandy seemed to give him a kind of spirit which made him think he could do a great deal of work, but when he came to do it he found he was less capable than he thought.”

Dr. Parkes' and Wollonicz's Experiments on Alcohol and the Heart's Action.

Their first experiment^a was carried out thus:—A healthy soldier, aged twenty-eight, 5 feet 8 inches in height, and weighing 135 pounds, was put upon diet of 2 pints of milk and 28 ounces of oatmeal, and set a daily task of work to do. As soon as he got accustomed to the diet and the work, the observations were commenced. For 26 days his pulse was counted 8 times daily; it was not counted at night, for fear of breaking his rest and so injuring his health. For the first eight days he drank nothing but water; for the next six days he got alcohol in quantities increasing from one to eight ounces. Then for six days he got water, for three days six ounces of brandy, and for the remaining days water.

During the first eight days the average number of heart-beats in the 24 hours was 106,000; during the six days on which alcohol was taken, 120,492.

^a Proceedings of the Royal Society, Nos. 120 and 132.

The following table shows the quantity of alcohol taken, and the number of heart-beats over the average of the water period given on each day. The number 23,372 given as caused by six ounces of alcohol is the mean between the observations of the previous and following day; the number really counted was about 1,200 more, but could not be relied on, as the man was suffering from a slight feverish attack:—

Day of Experiment	Ounces of Alcohol	Heart-beats exceeded Average of Water- period by
9	1	9,240
10	2	6,812
11	4	17,900
12	6	[23,372]
13	8	28,844
14	8	30,420

Dr. Parkes' Experiments on Alcohol and Heart Beats.

Dr. Parkes tried another experiment to determine what effect alcohol would have on the heart beats during alterations of rest and work.

During this experiment no stimulants were given on the first twelve days; afterwards a constant quantity was given—viz., twelve ounces of brandy each day.

The following table gives the average heart-beats per minute during each phase of the experiments:—

Days	Occupation	Drink taken	Average pulse
1-6	Rest	Water	62·2
7-9	Exercise	Water	65·8
10-12	Rest	Water	63·6
13-15	Exercise	12 oz. of brandy	70·35
16-18	Rest	12 oz. of brandy	60·5

In experimenting on another healthy man, Dr. Parkes^a arrived at the following interesting result:—

The exercise and diet being uniform during a period of ten days, the mean daily pulse (nine two-hourly observations) was 70·65. Severe exercise being then taken during another period of ten days for two hours in the morning, in addition to what had been previously taken, the pulse in those two hours was augmented 16 beats per minute over the corresponding period; it fell, however, in the subsequent hours below the mean of the corresponding

^a On the Issue of a Spirit Ration in the Ashantee Campaigns. 1875.

period, so that the mean pulse of the day was 70·42 per minute. the same as in the ten days' period before the additional exercise. The heart, in fact, completely compensated itself, and the work by it was the same as on the days of moderate and of severe exercise.

Dr. Ridge's Experiments on Alcohol and Germination.

Dr. J. J. Ridge, struck with Claude Bernard's experiments as to the action of ether and chloroform upon germination, tried a number of experiments to determine the effects of small quantities of alcohol. The most striking experiment^a was placing a certain number of seeds in a certain amount of soil at the bottom of a number of bottles, then moistening the soil of some with plain water and of the others with dilute solution of alcohol, and corking up the bottles. Even such a weak solution as ·025 per cent. (about one drop in nearly half a pint) had a marked effect, and the effect of ·005 per cent. was perceptible. Growth was either prevented or hindered and depressed, and the production of chlorophyll opposed.

I have tried the same experiment myself and photographed the results, which are very striking.

Dr. Ridge on the Action of Alcohol on Micro-organisms, &c.

Dr. Ridge has also published^b the result of experiments as to the action of alcohol on micro-organisms and cell-protoplasm. The following experiments may be taken as samples:—

He placed under watch-glasses twelve eggs of a blow-fly, all laid at the same time, on blotting paper moistened with water or with water and alcohol in different proportions—namely, 2 per cent., 1 per cent., $\frac{1}{2}$ per cent., $\frac{1}{4}$ per cent., $\frac{1}{8}$ per cent., $\frac{1}{16}$ per cent., $\frac{1}{32}$ per cent.—the last being one drop in about one-third of a pint of water. The experiment resulted as follows:—

Percentage of alcohol	-	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	None
No. hatched in 24 hours	-	0	2	1	5	5	7	12	12

He further experimented in a similar way upon *Daphne pulex*, enclosing several of these in bottles under exactly the same conditions, but with different amounts of alcohol. The results were unequal, but sometimes striking. For example, the following table, giving result of Experiment II.:—

^a Medical Temperance Journal, January, 1880.

^b Annual Meeting, British Medical Association. August, 1890.

Percentage of alcohol	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	None
Next day -	- dead	living	living	living	living	living	living
After three days	- dead	dead	dead	dead	dead	living	living
After four days	- dead	dead	dead	dead	dead	dead	living

Action of Alcohol on Medusæ.

Romanes^a and Krukenberg^b have studied the action of alcohol on *Medusæ*. They found alcohol first greatly increases the rapidity of the contractions, so much so that the bell has no time to expand properly between them, and they are in consequence feeble and gradually die out. The reflex stimulation shortly ceases to produce any effect, but muscular irritability is longer maintained.

Dr. Richardson's Experiments on Medusæ.

Dr. B. W. Richardson tried some interesting experiments^c on the fresh-water *Medusæ* found in the Victoria Regia tank at Kew.

"A tube holding 1,000 grains of tank water at 80° F. was charged with one grain of absolute ethylic alcohol. When the diffusion of the alcohol throughout the tube was complete, a medusa was placed in it and observed side by side with another medusa in a tube of tank water. The action of the alcohol was very rapid and very decisive. Within two minutes the movements of the animal, which were counted at 74 in the minute, were entirely stopped, and it was beginning to sink to the bottom of the jar much shrunk in form. At the end of five minutes it lay at the bottom of the tube, a mere pearly speck of matter, while its fellow in the neutral tube was moving about quite unaffected. It was put into plain tank water at 80° F., and was left there for 24 hours, but it showed no sign whatever of resuscitation.

"Another alcoholic solution was made, in which the proportion was 1 grain of alcohol to 2,000 of water. Into this solution another active medusa was placed. It remained for four minutes swimming about lustily, and but little affected. It then began to move with less freedom, and at the end of another minute sank to the floor of the jar, shrunk and motionless. It was taken out at once and placed in tank water at the same temperature (80° F.), but it showed no sign of recovery, and shrunk, like the former, into a pearly mass, with soft fluffy margins.

^a Phil. Trans. 1886-7.

^b Vergleichend. physiologische Studien. 1880.
Asclepiad. Oct., 1888.

"A third solution was made, in which the alcohol was in the proportion of 1 part in 4,000 of tank water. A medusa was put into this solution with the same precautions as in the preceding cases. In five minutes the motions commenced to cease, and the animal sank into the lower part of the tube, when it collapsed, lost its transparency, and assumed more slowly, but quite as decidedly, the pearly semi-solid state.

"A fourth observation with alcohol was conducted as follows:—A solution of alcohol was formed in the proportion of 1 part of alcohol in 10,000 parts of the tank water at 80° F. Into this solution a medusa was put in the same way precisely as in the other experiments. The animal was watched for an hour, but without the indication of the slightest change in its motion or condition. To the water a fresh charge of alcohol was now added so as to ensure a proportion of 1 part in 5,000 of water. Again there was no appreciable effect. At the close of two hours more the alcohol was increased to the proportion of 1 part in 2,000 of water. To my surprise the animal remained still unaffected, although the same solution was fatal to other specimens plunged directly into it. After a lapse of over three hours more the strength of the solution was increased to 1 part in the 1,000. Again for a long time there was no effect; but in the course of an hour the movements became slower; they also gradually grew weaker, and by the end of four hours they ceased altogether, the structures undergoing precisely the same fatal change as in the others which had died rapidly in the same strength of solution.

"I have no doubt that the alcohol stops the vital movements of the medusæ by its action on the colloidal matter of which their delicate organism is composed. That it sometimes acts on man in a similar manner, leading to a change of structure in the delicate membranous expanses, is a view which, as is well known, I have long ago expressed, and which this research singularly and unexpectedly confirms."

Professor Martin's Experiments on Alcohol and the Heart's Action.

Professor Martin^a found that blood containing one-eighth per cent. by volume of absolute alcohol had no immediate effect upon an isolated dog's heart; that blood containing one-fourth per cent. diminished within a minute the work done by heart; and that blood containing one-half per cent. always diminished remarkably

^a Maryland Med. Journal. X 292.

heart-work and sometimes nearly destroyed it, so that not enough blood was pumped out of the left ventricle to supply the coronary artery.

Dr. Hammond's Experiment on the Action of Alcohol on the Nerves.

William A. Hammond, M.D., records^a the following interesting experiment showing the direct influence of alcohol on the nerves:—

“I was desirous of knowing how much of each of these conditions was due to the presence of alcohol in the blood circulating through the brain, and how much to disturbance in the quantity of blood normally present in this organ. I therefore arranged a series of experiments by which any increase or diminution of the amount of blood contained in the brain could be exactly determined. I then gave the animal an ounce of alcohol, diluted with an equal quantity of water. In fifty seconds I detected alcohol in the air expired from the lungs.

“In four and a half minutes the respiration was accelerated, the action of the heart became more rapid and strong, and the pupils were beginning to contract. Still there was no increase in the intercranial pressure, and I therefore knew that up to this time the amount of blood in the brain had not been augmented. In six minutes and a half the dog's gait was staggering, and though its movements were uncertain, as if suffering from vertigo, there was no paralysis. The intercranial pressure was still unaltered. The fluid remained stationary in the tube of the instrument for seventeen minutes. Then it began to rise slowly, and with this increase in the intercranial pressure paralysis of the posterior extremities supervened. As the amount of blood contained in the cranium became greater, the paralysis extended, the pupils dilated, and stupor ensued.”

Dr. Prout's Experiments on Alcohol and Carbonic Acid Exhalation.

Nearly 80 years ago Dr. Prout published observations on the effect of alcohol on the exhalation of carbonic acid. He wrote^b:—

“Alcohol and all liquors containing it which I have tried have been found to have the remarkable property of diminishing the quantity much more than anything else that has been made the

^a Philadelphia Times. April 22, 1888.

^b Observations on the Quantity of Carbonic Acid emitted from the Lungs during Respiration, at Different Times and under Different Circumstances. By William Prout, M.D. Annals of Philosophy. Nov., 1813,

subject of experiment. This was so unexpected on my part that I was prepared to meet with the reverse. I was first led, however, to suspect the accuracy of my opinions by observing that when I took porter with my dinner the quantity was always reduced much below the standard, while the reverse was the case when I only took water. This induced me to make some experiments on the subject, and their results were such as fully to persuade me that alcohol, in every state, and in every quantity, uniformly lessens in a greater or less degree the quantity of carbonic acid gas elicited, according to the quantity and circumstances under which it is taken."

The following portion of one of the tabular statements illustrates the general character of Dr. Prout's results:—

Hours of Observation	Observed Quantity of CO ₂ percentage in Respired Air			
12 0 noon	3.90			
12 30 p.m.	3.60	five minutes after taking 3i. of diluted alcohol.		
12 50 p.m.	3.45	"	"	3ii. "
1 20 p.m.	3.40	"	"	3ii. more "
2 15 p.m.	3.35			
2 45 p.m.	3.30			

Dr. Andrew Fife,^a M. Vierordt,^b MM. Hervier and St. Layer,^c Dr. Hammond,^d Dr. Smith,^e M. Perrin,^f Dr. B. W. Richardson,^g M. Lehmann,^h and others have also carried out observations on this point.

With the exception of Dr. Smith all these observers found alcohol, even in small doses, lessened the quantity of carbonic acid exhaled.

^a *Dissertatio Chemico-Physiologica Inauguralis de Copia Acidi Carbonici e Pulmonibus inter respirandum evoluti.* Edinburgh. 1814.

^b *On Respiration.* 1845.

^c *Gazette des Hôpitaux.* Feb. 20. 1849.

^d *American Journal of Medical Science.* 1836.

^e *Philosophical Transactions.*

^f *De l'Influence des Boissons Alcooliques prises à Doses modérés sur la Nutrition. Recherches Experimentales.* 1864.

^g *Cantor Lectures on Alcohol.* 1875.

^h *Physiological Chemistry.* Pp. 376, et seq.