retroperitoneal, bulging forwards on the mesial aspect of the descending colon; the transverse colon and the splenic flexure were above it. The great omentum was adherent across the front of it to the descending colon. The liver, spleen, and other viscera were normal. A vertical incision was made through the peritoneum on the outer side of the descending colon, and the tumour was shelled out and removed. It contained five pints of clear, watery liquid, and was the cystic remains of the kidney. There was no recognizable renal tissue in it, but the ureter issued from its inner aspect at the lower point of trisection. The condition was one of valve ureter; there was no constriction by any abnormal vessel. The ureter itself was small in size. Three large renal vessels had to be tied and divided. The other kidney was larger than usual, but otherwise normal. The patient made a good recovery.

CASE V.—*Hydronephrosis due to Valve Ureter; Ureteroplasty; Recovery.*

A very stout married woman, aged 64, was admitted to Guy's Hospital on January 24th, 1928. In 1906 hysterectomy for fibroids was performed. Since 1914 she had had numerous attacks of severe pain in the right flank, below the costal margin, passing through to the back, below the last rib. For years these attacks were thought to be due to gall-stones. There was no history of jaundice, or of anything wrong with the urine or urination. In October, 1927, a bad attack developed, with high fever and "a swelling filling up nearly all the right flank, which was evidently a hydronephrosis." The symptoms gradually abated, and the patient was quite well until December 14th, when the signs recurred with severe pain, vomiting, and a large swelling reaching to the middle line, with a temperature of 103° F. This time the urine contained large quantities of pus. With rest, dieting, and large doses of potassium citrate the patient got fairly well, but the swelling did not entirely disappear; it could be felt in the right loin, which was dull behind and resonant in front. X-ray examination did not show any stone in the kidneys or ureters. Pus and only a little urine issued from the right ureter, whereas the left kidney was excreting plenty of normal urine, and the blood urea was normal.

Operation.—The right kidney was explored through the usual oblique incision in the loin. There was a large hydronephrosis containing offensive urine, the kidney was considerably but not hopelessly damaged, the ureter was normal but empty and completely obstructed at its origin high up on the inner wall of the greatly dilated pelvis; it was not constricted by any abnormal renal blood vessel. The obstruction was overcome by slitting up the pelvis and ureter at their union, the incision extending over an inch into each, and being joined with fine catgut in such a manner as to remove the valvular obstruction, after Finney's method of pyloroplasty. The patient made a good recovery.

THE SIGNIFICANCE OF REFLEX ACTION IN COLOUR VISION.*

BY

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WHEN the retina of the left eye has been stimulated by light of any pure spectral hue above a certain intensity it is found that the sensitivity of the right is enhanced for three colour sensations, which are invariably red, green, and violet. The predominant enhancement always occurs for the sensations complementary to the stimulating colour. If the intensity of the stimulus falls below a certain critical intensity, which for white light is about 0.25 metre-candle, the effect upon the right eye is opposite in character, since it inhibits or depresses the sensitivity of all three colour sensations. When the stimulating colour of sufficient intensity is applied to the right eye the measurements on that eye show that the one sensation, red, green, or violet, chiefly involved, if the stimulus is a simple colour, or the two if the colour is compound, as orange, yellow, and blue, are depressed in sensitivity, while the complementary sensations are enhanced.

These experiments, both contralateral and ipsilateral, may be readily explained by assuming the existence in the visual neural apparatus of a sensory reflex action, which may exercise either a facilitating or an inhibiting influence on the retinal sensitivity by which its responsiveness becomes enhanced or depressed. As the basis of the visual theory I am presenting is the existence of such a sensory

reflex, it is desirable to establish it with the greatest possible amount of experimental evidence.

In the sense of hearing, measurements have now been made in my laboratory by J. F. Allen which show that stimulation of one ear by a pure tone either enhances or depresses the sensitivity of the other in a manner similar to the contralateral effects in vision.

In the sense of taste, also, measurements show that stimulation of one side of the tongue by solutions of sugar, salt, acetic acid, and sulphate of quinine, depress and enhance the four gustatory sensations, both ipsilaterally and contralaterally, precisely as in vision. It is found that weak solutions of these substances inhibit gustatory sensitivity, just as feeble light inhibits retinal sensitivity; while in illustration of the facilitating process it is well known that distilled water stimulates the sweet taste after this has become enhanced in sensitivity by stimulation with an acid or a salt solution.

Besides eliciting the sensations of taste, stimulation of the tongue by solutions evokes an enhanced activity of the parotid gland by which the amount of saliva secreted in a given time is much augmented. Inhibitory effects also occur. Measurements show that both ipsilateral and contralateral actions take place with appropriate stimulation.

In the muscles it has been found by measuring the angle of elevation of the arm by post-contraction after stimulation has ceased that stimulation of the left arm affects the right in the same way that stimulation of one eye or ear affects the other, or stimulation of one side of the tongue influences contralaterally the sensations of taste on the other side and the secretory activity of the opposite parotid gland.

No contralateral experiments in the sense of touch were thought of at the time the investigation was made. But it was shown that ipsilateral stimulation of the fingers of one hand enhanced the sensitivity of the index finger in the same manner that stimulation of one part of a retina influenced the sensitivity of an adjoining area, or of one part of the tongue influenced adjacent receptors.

In all these cases it was found possible to express the measurements in a mathematical law, which states that some measure of the response is proportional to the logarithm of the intensity of stimulation. The formula, which is similar to Fechner's celebrated psycho-physical law is $R = k \log I \times c$, where R is the measurement of the sensation, I the intensity of stimulation, and k and c are constants.

The evidence cited has been set forth at length in numerous papers published by the writer and his students. It proves quite conclusively the identity of the actions in all the neural systems to which reference has been made. No exception will probably be taken to the explanation of the phenomena of secretion and muscular contractions by reflex action. It seems reasonable to conclude, therefore, that the identical behaviour of the sensory neural apparatus similarly results from reflex action of a sensory character by which the sensitivity of the receptor end-organs is controlled.

The theory of sensory action to which these investigations lead may be briefly stated as follows. When a suitable stimulus is applied to receptor organs the afferent nervous impulses excite characteristic sensations in the cortical centres, and in addition simultaneously evoke reflex impulses, which are conducted to the receptors, causing either depression or enhancement of their sensitivity. The function of the sensory reflex actions is to control the sensitivity of the receptor end-organs. The alteration of sensitivity occurs in receptors for other sensation qualities within the area stimulated, and extends ipsilaterally to adjacent areas and contralaterally to corresponding areas on the other side of the body. Thus stimulation of an area of the right retina by red light, for example, causes a sensation of red, while the reflex or inductive reaction extends to the green and violet sensations within the area stimulated, and to all three sensations in surrounding areas of the stimulated retina and to the corresponding area of the left retina as well. The inductive action of dim light of all hues is depressing in character, while that of bright colours is enhancing. After the retinal receptors,

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or, indeed, the receptors of any sense organ, have been stimulated, they recover their normal sensitivity by a series of oscillation of the reflex actions in which inhibition and facilitation periodically alternate with each other. The retina is depressed or enhanced in sensitivity for further stimulation according to the time that has elapsed since the first stimulation ceased.

This theory of sensory action affords a simple physiological explanation of many phenomena of colour vision, only a few of which may now be considered. As remarked above, it has been found that when the retina is feebly stimulated with white or coloured light the three primary sensations are all depressed in sensitivity, so that their responsiveness is much lessened. Vision therefore becomes doubly difficult in dim illumination, first, because the light is weak, and, secondly, because such light as there is lowers the retinal sensitivity. This behaviour of the eye is probably a factor of great importance in such ocular conditions as miners' nystagmus. On the other hand, if during some pathological condition of the retina it is desirable to secure visual relief for the eye, it will often be found advantageous for the patient to remain in a dimly lighted rather than a completely dark room. A person suffering from detached retinas once wrote to me that the greatest relief experienced in years was obtained under such conditions.

Experiments have revealed that the shortest wave-lengths of the spectrum, the extreme violet and blue, are as much as seven hundred times as powerful in exciting reflex action as the brightest yellow. This leads to the conclusion that violet especially functions chiefly as a retinal sensitizer. Artificial illuminants that are deficient in these rays are therefore devoid of an element most essential to visual efficiency. Probably this inductive power is also possessed by the longer ultra-violet rays, so that a moderate amount of this light, under certain conditions, may be beneficial to vision. Possibly the yellowish light of a miner's lamp suffers an additional disadvantage from the low intensity or absence of violet and ultra-violet radiation.

Probably the most difficult problem in colour vision has been that of the explanation of simultaneous contrast. It has been the rock on which most of the theories of colour vision have been wrecked. The far-fetched theories of Helmholtz and Hering have admittedly failed to solve the problem. The explanation of the reflex theory is simple, founded upon ample experimental evidence, and equally adequate for both unioocular and binocular contrast. The general rule of contrast is that each contrasting colour appears modified, as if mixed with nearly the complementary of the other. If, for example, contiguous green and yellow patches are viewed by one eye, the green light stimulates all three colour sensations—red, green, and violet—in the corresponding retinal area, but predominantly the green. The inductive action of the yellow light enhances the sensitivity of all sensations in the green area, but predominantly the complementary violet sensation. The green light consequently will stimulate this sensation more than normally, with the result that the green colour appears bluish-green. In the yellow stimulated area the red and green sensations, whose equal excitation causes yellow, are stimulated more than the violet. The inductive action of green light, however, enhances predominantly the complementary red and violet—that is, purple—sensations, of which red is visually the more conspicuous. The yellow light will now stimulate the red sensation a little more than the green, and will consequently appear orange in hue. Thus both colours appear as if mixed with the complementary of each other. The same explanation applies to binocular contrast, for the reflex actions involved in the two cases are identical.

There are two well-defined types of abnormal colour vision, which are known as colour-blindness and anomalous trichromatic vision. Of the former, seven general classes are possible: three classes in which one of the three fundamental sensations—red, green, or violet—is defective; three classes in which two of the sensations are defective; and one class, total colour-blindness, in which all three sensations are defective.

According to the measurements of Abney, the white sensation is formed by equal stimulation of all three

sensations. In colour-blindness, therefore, no colour sensation can be entirely missing, since the colour-blind see white, while totally colour-blind subjects see all colours as white or grey. This indicates that in achromatic vision every colour always stimulates all the primary sensations equally. Colour-blindness, or colour defectiveness, seems to be due to the excessive development of the inhibitory reflex actions which may affect any one, any two, or all three primary sensations. The perceptual colour sensation pattern must consequently be modified to an extent depending on the degree and incidence of the inhibition.

In anomalous vision the colour sensations are supersensitive. The cases known seem to be limited to the red and green sensations. The explanation seems to be found in the excessive development of the enhancing impulses. According to this theory, both types of abnormal vision, particularly colour defectiveness, could be remedied if the efferent nerves could be stimulated at their cortical origin.

In the bulk of humanity there seems to be preserved a proper balance between the direct results of sensory stimulation and the reflex actions which are evoked by them. This condition is termed normal colour vision. About 4 per cent. of men have this balance disturbed by over-development of inhibition. They are accordingly selectively subsensitive in their defective colour sensations. Another proportion, equally great, have the normal balance disturbed in the opposite direction by over-development of the enhancing actions. Such persons therefore possess supersensitive colour sensations, or anomalous trichromatic vision.

Probably a similar grouping of people can be made in regard to every sense organ. The majority are normal, and smaller groups are either subsensitive or supersensitive. Possibly this principle may be generalized to cover the intellectual powers and the emotional and volitional faculties as well. For in all these divisions the normal, the supernormal, and the subnormal groups are well recognized. Thus the principle at which we have arrived from experiments on vision may have in the broad field of psychology the widest application.

The reflex theory strongly supports the trichromatic theory of Young. The facilitating reflex actions by which the complementary sensations of the exciting colour are enhanced provide a physiological explanation of those phenomena for which Hering assumed a chemical assimilative process in the retina. In these essential particulars, therefore, the two rival theories become harmonized.

AN OUTBREAK OF FOOD POISONING IN STAFFORDSHIRE.

I.—THE CLINICAL MANIFESTATIONS.

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THE following cases are reported on account of these peculiarities:

1. The rarity of the causal micro-organism (the American hog cholera bacillus) in this country.
2. The severity of the symptoms and the resulting high mortality.
3. The limitation of the infection to one family.

The disease was caused by the consumption of a pork pie, which was baked on April 9th and was purchased by the father of the family on April 13th. So far as can be ascertained the pie was not exposed to any contamination between the times of manufacture and consumption. It was consumed by seven children and their mother on April 13th, at 6.30 p.m., the mother taking only a small portion. The father and an older son did not