perceptible in vertical sections between the bacillary and the outer granule layers.

That the rods and cones are the percipient elements in the retina is now universally received, so that it needs hardly be mentioned; but it may be well to adduce the chief considerations on which this presumption rests. First, they alone of all the retinal tissues are so arranged as to be capable of receiving separate and distinct stimuli from small incident pencils of light. Next, their absence entails absence of perception. Mariotte's experiment proves this as regards the optic nerve disc, and the increase of the size of the blind-spot in myopia from posterior staphyloma, proportionately to the extent of the white atrophic crescent—a fact which is easily roughly verified—is another proof of the same thing; because here, together with the disappearance of the choroidal epithelium and chorio-capillaris, I have had opportunities of proving microscopically the absence of the cones and rods.

When we endeavour to press our inquiries further, and try to ascertain what may be the respective functions of the outer and the inner segment of the rods and cones, and in what respect the functions of the rods and cones differ, we meet with difficulties which have yet to be overcome.

As regards the first part of this inquiry, the high refractive index of the shafts, and their insulation by a coat of pigment in many animals, points to a physical optical rôle; while the association of a nucleus (an outer granule) with the appendage, suggests a more vital dynamical share. If this be so, then the junction between the shaft and appendage marks the line where, so to say, the physical vibrations of light are converted into nerve-force.

Towards the solution of the second point of the inquiry, Schultz contributes the important fact that nocturnal mammals, as the mouse, bat, hedgehog, have no cones; and that in owls they want the bright orange and ruby beads of diurnal birds; and from this he conjectures that the cones may be concerned in perception of colour.

The *outer granules*, to which I must now pass on, are not minute, angular, solid particles, as their name implies, but cells or nuclei of very appreciable dimensions. Their numbers are directly proportionate to those of the rods and cones; and it is very probable—I may say certain—that each outer granule is associated with a rod or cone, and this in one of two ways. When the rod or cone-appendage is large enough to hold it, the outer granule lies inside the appendage in the plane of the *membrana limitans interna*, or at its inner surface; but, when the appendage is too slender to contain the granule, it is joined to the granule by a communicating fibre, the length of which is determined by the distance between the inner end of the appendage and the granule. In either case, the appendage is prolonged inwards in the form of a band or fibre beyond the “outer granule” towards the next stratum. This fibre I call the primitive bacillary fibre, or the primitive rod or cone-fibre, when I wish to distinguish it more particularly.

The *intergranule layer*, which, as its name conveys, lies between the outer and the inner granules, is a fibrous stratum. Some of its component fibres are nervous, passing between the outer and inner granules, and others are connective tissue. Of the latter set of fibres, those which traverse the layer vertically belong to the system of connective radial fibres, known by the name of their discoverer, H. Müller. The others, which extend parallel to the direction of the layer, constitute its proper substratum; and amongst these lie imbedded small nuclei, and in some of the lower animals, *e.g.*, chelonians and fishes, large branched corpuscles of very considerable dimensions.

The *inner granules*, like the outer ones, are also cells or nuclei. According to their sizes, which vary much, they fall into two sets—smaller granules, everywhere numerous; and larger ones, most abundant near the inner surface of the layer, which I cannot distinguish from ganglion-cells. On the one side, the inner granules receive the fibres sent inwards towards them through the intergranular layer from the outer granules; and, on the other side, they send fibres inwards into the granular layer towards the ganglion cells.

The *granular layer*, as Schultz correctly pointed out, is resolved, by a sufficiently high magnifying power, into a very finely fibrillated spongy web, which manifestly hangs together with, and is in great part a derivative of, the connective radial fibres entering it. The only nervous elements occurring in it are the internuncial fibres which traverse it, and the outermost ganglion-cells bedded in its inner surface. The term granular, which simply expresses its appearance under a low power, is therefore preferable to that of grey vesicular or grey serous layer, which gives a wrong idea of its essential composition.

The cells of the ganglionic layer possess a very distinct roundish nucleus, imbedded in a pale and very soft protoplasm, about which there is not generally any distinct cell-wall perceptible. Often the nucleus only is visible, the protoplasm having been damaged in preparing the sections for the microscope. I believe that all the cells are branched.

The outer branches, which are the more numerous, run outwards into the granular layer to join those coming inwards from the inner granules, while their inner branches join the bundles of optic nerve-fibres.

These last radiate in a plexiform manner from the optic nerve entrance. Where there is a fovea centralis, as in men, apes, some birds, and reptiles, the nerve-bundles are so distributed that those only destined for the fovea and its surrounding maculae pass directly to it; while those bundles going to more distant parts beyond the fovea arch around it. With some exceptions, the nerve-fibres are devoid of the medulla, or white substance, of Schwann. In our own eyes, this ceases at the lamina cribrosa; and only pale fibres, equivalent to axis-cylinders, with perhaps an investment of the sheathing membrane, are produced into the retina.

The connective tissue-frame, which supports and holds together the nervous elements, consists of three segments. First, there are the two membranes;—the outer limiting membrane, which I have already described; and the *membrana limitans interna*, which some identify with the hyaloid capsule of the vitreous humour, but which I regard as a distinct membrane. This distinctness cannot be always demonstrated at pleasure; but I believe it to be a fact, because I have found the two membranes separated by inflammatory effusions, and because in the eyes of a Burchell's zebra, for which I was indebted to the liberality of the Zoological Society, I found a beautiful pavement epithelium on the outer surface of the capsula hyaloidea. The second member of the connective substances is a system of short pillar-like fibres, which arise by expanded wing-like roots from the outer surface of the *limitans interna*, and traverse vertically all the layers in a direction radial from the centre of the eye-ball. These are the fibres which, when originally discovered by H. Müller, were believed by him to link the percipient elements on the outer side of the retina—the rods and cones—with the conducting optic nerve-fibres at the inner surface of the retina, an error which he himself was one of the first to correct. These radial fibres (Müller's fibres) form a frame, which mechanically binds together the several layers in their order. Lastly, the retina contains a large amount of interstitial connective tissue, which is accumulated in larger quantity between the inner and outer granules, and between the inner granules and ganglionic layer, but which also pervades, in smaller quantity, all the nervous layers except the bacillary. Spinning an excessively fine web around the cells and fibres, it maintains them all in position, and it supports the blood-vessels when these are present. To sum up, the connective tissue occurs in three forms—membranous, as the *membrana limitans externa* and *interna*; fibrous, as Müller's radial fibres; and as an excessively finely fibrillated interstitial web.

[To be concluded.]

ON SLEEPLESSNESS IN INFANTS.

By EUSTACE SMITH, M.D., M.R.C.P.,

Physician Extraordinary to H.M. the King of the Belgians; Physician to the North-West London Free Dispensary for Sick Children; etc.

It often happens that infants, apparently in good health, are seized with wakefulness at night. The child will not sleep; he is uneasy, restless, peevish, breaks out into violent fits of crying, and is with difficulty pacified, even when hushed in his mother's arms. For this condition, numerous specifics have been recommended, ranging from “soothing syrups” to bromide of potassium. In almost all cases, however, careful inquiry will discover some special cause to which this nocturnal restlessness of the infant may be referred, the removal of which is followed by the disappearance of the troublesome symptom under consideration.

All acute diseases in the child are accompanied by more or less restlessness at night, and fever; but in these cases, unusual irritability of the infant during the day, and other symptoms pointing unmistakably to some derangement of health, will have been observed. It is when the child is, to all appearance, in good health, or when, at any rate, no symptoms of functional derangement have been noticed during the day, that sleeplessness at night becomes a condition often as puzzling to the medical practitioner, as it is distressing to those in immediate attendance upon the infant.

If the infant be very young, *hunger* is commonly the cause to which his restlessness is attributed by the mother; for the tendency of mothers is to refer all crying in their infants to that one cause. Occasionally they may be right. Infants nourished solely by the breast, and deriving their entire support from a scanty supply of watery milk, are almost constantly hungry. The amount of fluid they swallow is scarcely sufficient to satisfy their appetite even for the time; and, being

rapidly digested, the meal is soon followed by renewed demands for nourishment. After a few days of such a diet, the weakly condition of the infant, induced by semi-starvation, draws attention to his state of health; but crying at night from hunger is an invariable forerunner of his loss of flesh.

The milk may be considered to be scanty when the infant constantly requires the breast, and sucks with very great effort. A hungry infant will suck at any thing within reach of his lips. At night he is excessively peevish, but during the day he often lies quietly with one or both thumbs in his mouth, sucking at them until the skin is raw. At sight of the breast, he shews his desire for food by clenching his hands and flexing his limbs, and his cries usually cease at once. A child crying from gripping pains manifests little interest at sight of the breast, and is often with difficulty persuaded to take the nipple into his mouth.

When the milk is scanty, it is always of very inferior quality, but very abundant milk may be also very poor and watery. In this case the infant, instead of being peevish, is exceedingly drowsy, sleeping almost all day as well as at night, and occasionally falling asleep even while in the act of taking the breast, holding the nipple still in his mouth. When this occurs, suspicions of serous milk should always be excited.

By far the most common cause of restlessness at night is *injudicious feeding*, the child being stuffed with food, which, although not necessarily in itself injurious, is yet ill-adapted to the nourishment of the particular infant to whom it is given. It is a common practice amongst mothers—especially those of the poorer classes—to make up for any deficiency in the amount of breast-milk by farinaceous food, long before the digestive power of the child is suited to such a diet. The stomach of an infant of about two months old is thus often filled with a mass of starchy matters, which the absence of saliva will not permit him to digest. This mass, fermenting in his bowels, is a source of continual discomfort until it is evacuated. Even when cow's milk is used as an addition to the breast-milk, it is very frequently ill-digested, although diluted with water. The clot formed by the coagulation of cow's milk is particularly firm and solid, and differs very much in that respect from the clot of human milk, which is exceedingly light and flocculent. In very young infants, therefore, and in older infants of delicate stomachs, the digestive juices can make little impression upon the mass of curd. Feeding so conducted cannot be continued for long together, without producing very evident signs that the nutrition of the body is no longer efficiently maintained. The child, deriving very little nourishment from the food, which, however, he eagerly swallows, will soon begin to waste, in spite of his voracity. But before nutrition has become impaired so decidedly as to produce emaciation, certain symptoms are noticed shewing the uneasiness of the digestive organs; and one of the earliest of these signs is restlessness at night. The child starts out of his sleep crying violently. His skin is hot, his belly tense, his upper lip livid and drawn up at the corners; and the gripping pains from which he is suffering are shewn by the violent contortions of his body, and the uneasy, jerking movements of his limbs. Even when taken up into the arms of his mother he is not pacified, but breaks out into piercing cries, which nothing is able to quiet until he becomes exhausted. Other signs of his unsuitable food consist in frequent hic-cough, flatulence, sour eructations, and constipation. The sluggishness of the bowels is due to excessive secretion of mucus in the alimentary canal, excited by constantly renewed irritation of its lining membrane. The mucus being coagulated by the acid, resulting from the decomposition of starchy matters, covers the masses of food, and lines the inner surface of the bowel, so that the slippery surfaces glide over one another, and the contents of the intestine are not properly forced along. The stools themselves consist of little round masses, remarkably firm, and of a yellowish colour, exhibiting, when crushed, a cheesy appearance. They are evidently composed of curds and undigested farinaceous matter. The smell is often offensively sour, and they are accompanied by a considerable quantity of tough mucus, either covering the little lumps, or appearing in the form of strings, which have been mistaken for portions of parasitic worms.

This cause of wakefulness at night is so excessively common, that in every case where this distressing symptom is complained of, inquiry should at once be made into the diet of the infant, so that, by a proper adjustment of the quality and quantity of his food to his powers of digestion, the child may be supplied with a diet which he is able completely to assimilate. When this has been done, and the bowels have been assisted by a gentle laxative to expel their undigested contents, the improvement is immediate; the child sleeps soundly, and his irritability ceases at once.

It must be remembered that plumpness in an infant is no proof that his feeding is judiciously conducted. Badly fed children may be exceedingly fat, as we sometimes see in cases of commencing rickets,

where the adipose tissue is in great excess, although the general nutrition of the body is by no means satisfactory; and, in commencing rickets partly from this cause, but partly, no doubt, from another cause which will be afterwards referred to, sleeplessness and irritability at night are exceedingly common symptoms.

Cold feet are a not unfrequent cause of wakefulness in infants. Delicate infants, in whom the circulation is languid, are very subject to coldness of the extremities; and gripping pains in the belly are common accompaniments of the same condition. In all cases of abdominal pain in infants, the feet should be at once examined. When these are found to be cold, warming them by frictions with the hand, or by hot applications, usually causes the manifestations of pain to cease.

The feet in infants should be always carefully warmed before the children are put to bed; and should, in cold weather, be afterwards wrapped in flannel, or be covered with thick woollen socks.

In *hereditary syphilis*, infants are exceedingly fretful at night; and, by their uncontrollable crying, are a source of great distress to the mother. This symptom is usually the first sign of the disease, preceding the snuffling and the other characteristic symptoms of the outbreak of the inherited taint. The crying is possibly excited by nocturnal pains in the bones, similar to those affecting adults previous to the outbreak of the constitutional symptoms. On the appearance of the rash, the sleeplessness does not subside, but it soon disappears under the influence of specific treatment—a few doses of grey powder being sufficient to produce this result.

Worms, in older children, are well known to be a common cause of night terrors and restlessness; but even in infants, crying at night is sometimes found to be due to this cause. Amongst the poorer classes, where infants are allowed early to share in their parents' meals, it is not so very uncommon to find them suffering from the presence of oxyuris vermicularis. To give one instance out of many which have lately come under my notice: A child of nineteen months, well nourished, strong on his legs, who had walked from the age of ten months, had cut eighteen teeth, and could talk, the mother said, well, was brought for fits of violent screaming, which began about 8 P.M., and lasted the greater part of the night. From the condition of the tongue, worms were suspected,* and a purgative of rhubarb and jalap brought away a large quantity of the small thread-worms. Afterwards, a careful regulation of the diet, and the administration of compound decoction of aloes, with a little iron, soon restored the alimentary canal to a healthy condition. The night screaming ceased from the very commencement of the treatment.

Besides the causes which have been enumerated, there are two others of not uncommon occurrence, and which are frequently overlooked. One of these is the influence of *habit* upon the infant. Children who are too much petted and indulged, easily contract habits which are sources of great annoyance, not only to themselves, but also to those through whose uncalculating tenderness the habit has been acquired. Thus, in young children little attention should be paid to cries excited by other causes than actual suffering or discomfort. Cries from wilfulness or fretfulness should be entirely disregarded. If a young child, whose diet is properly arranged, and who has taken his usual meal before being put to bed, wake crying in the night, the mother may satisfy herself that his cries are not produced by cold feet or colicky pains; and if the skin be not hot, and no cause can be discovered for his restlessness, he should be left in his cot to cry himself to sleep. If not, and he be taken up and hushed in the arms of his mother, the probabilities are very strongly in favour of his waking and crying at about the same hour on the succeeding night, and requiring to be pacified by the same means. A habit is thus gradually acquired, which it is very difficult afterwards to overcome. Infants accustomed to be suckled at frequent intervals during the night are also exceedingly restless. This is a practice which cannot be too strongly condemned. Children should be accustomed early to take no food during the night. A very young infant, who has been suckled immediately before the mother retires to rest, will do well until five or six o'clock on the following morning without a further supply of nourishment. He is easily made to understand that this is a rule which cannot be infringed, and will wake and sleep again without disturbance if he knows it is useless to complain.

Exhaustion of nerve-force, the reaction following over-excitement of the nervous system, is another not uncommon cause of wakefulness at night in children. Children of three or four years old, after the excitement of a child's party, or a visit to some place of amusement, are often found to be troubled with sleeplessness; the child either finding a difficulty in composing himself to sleep, or waking up after a short slumber.

* I have elsewhere described an appearance of the tongue, which is very characteristic of the condition of the stomach and bowels so often accompanying the presence of worms in the alimentary canal.—See *Wasting Diseases of Infants and Children*, 8vo. London: 1868.

The same thing is frequently seen in young infants who have been played with and over excited immediately before being put to bed. The infant is uneasy and restless, starting frequently, and waking up with a fretful cry. This is not found with all infants, but is especially noticeable in those of delicate organisation and great impressibility of the nervous system, and is, therefore, a frequent symptom of commencing rickets, where the irritability of the nervous system is very great.

Sleeplessness in infants is thus produced by many different causes, each of which will require a different method of treatment for its removal. To look upon such a condition as a distinct disease, removable by any so-called specific, is in the highest degree unphilosophical and unpractical. Opiates, and perhaps bromide of potassium, may be occasionally useful in quieting excessive irritability of the nervous system, and may be, therefore, of service in the treatment of sleeplessness arising from the last two causes which have been mentioned; but to employ either as a universal remedy in such cases would be at least useless, even if it were not injurious. The screams of an infant suffering from an accumulation of undigested food—to take the commonest case—may certainly be quieted for the time by a narcotic; but so long as the cause remains, the screams will be renewed as soon as the soporific effect of the drug has had time to pass away. In such a case, bromide of potassium produces no effect whatever. In every case of sleeplessness in infants, the cause may be easily ascertained by careful investigation; and, when it is discovered, there is little difficulty about its removal.

AN ADDRESS

DELIVERED IN

THE SECTION OF PHYSIOLOGY,

*At the Annual Meeting of the British Medical Association,
in Leeds, July 1869.*

By JOHN HUGHES BENNETT, M.D., F.R.S.E.,
President of the Section.

GENTLEMEN,—Three years ago, in the Address in Medicine which I had the honour of delivering at Chester, I reviewed the existing state of medicine as a science and as an art. I pointed out that the former, by which may be understood physiology, was now so far advanced, owing to the progress of collateral sciences, that one could by its aid solve most of those problems which rendered the latter so uncertain. In other words, it was my endeavour to show that certain questions as to whether any remedial agents or plan of treatment could produce a definite influence on the living body, was now within the reach of experiment. I argued, therefore, that what we required was combined labour to solve these problems, and that, if this British Medical Association would advance the necessary funds, exact knowledge might be made to assume the place of vague opinion. As a result of the appeal then made, grants of money were given to a Committee under my direction, which undertook to answer the question whether mercury was or was not a cholagogue—and this question, after two years' laborious inquiry, has been decisively answered in the negative. No pains have been spared by the Committee in making their inquiry exhaustive. Their experiments and observations were so planned, so carefully performed, and so fully considered, that up to this time no adverse criticism has been advanced. The results have been laid before full meetings of the Association in Dublin and in Oxford, and before the Physiological Section of the British Association for the Advancement of Science, at its last meeting in Norwich. They have also been extensively published, and no one has endeavoured to show that they were erroneous. It may, therefore, now be received as an unquestionable fact, contrary to the almost universal opinion which previously existed, that mercury has no special action on the liver, nor possesses any power whatever of increasing the flow of bile from that organ. The Committee has further shown that such action and power have been also erroneously attributed to taraxacum and podophylline. Considering that, up to this moment, every book, and every lecturer on the *Materia Medica* and on Therapeutics, has assumed that these drugs do possess the properties referred to; further, that they have been universally given to stimulate or control biliary formation; and, lastly, that to this end their administration in countries where hepatic diseases are common, has been such as too frequently to injure rather than benefit mankind—the demonstration of such an error must be admitted to be of the utmost importance to medical knowledge and to medical practice. It may be said, as it has been said, that this in no way alters the value of mercury as a purgative. But if this drug, henceforth, is only to rank

in such a category—that is, as an *evacuator* and not a *secreter* of bile, many other aperients, less dangerous to the system, will answer the purpose.

But there are other important problems which physiological experiment has the means of solving with like certainty; and I have now to ask whether the Association is to stop in its attempt to further scientific and practical progress? Can we not appoint another Committee, and entrust to it the solution of another great difficulty in medicine?

Let me refer shortly to one of these difficulties, the practical value of which cannot be too highly estimated, one, which if scientifically investigated, must throw a flood of light on the whole subject of therapeutics, and one which is certainly within the reach of careful experiment.

It has been proved beyond the possibility of doubt, that certain medicinal agents, such as morphia, atropine, conium, digitaline, strychnine, woarara, and others, possess distinct, yet apparently opposing, actions on the nervous system. Some of them act primarily on the brain; others on the spinal cord. Some excite and others paralyse nervous action. Some keep persons awake, such as green tea; others put them asleep, such as morphia. One certainly excites the motor powers of the cord, such as nux vomica; another as certainly depresses or paralyzes it, such as hemlock. These facts necessarily give rise to a question, that, in the present state of science, requires to be authoritatively answered. It is this.—Does there exist an antagonism between these substances, and, if so, to what extent? In other words, what truth is there in the idea that one drug is capable of counteracting the agency of another. Does it follow that, because we can excite the motor powers of the cord with strychnine, that when so excited we can tranquillise them with hemlock? Again, how far does the combination of drugs having similar or different actions assist or impede their influence? Further, to what extent are these substances capable of controlling functional or organic diseases of the nerve centres? Without entering into other inquiries that such an investigation naturally suggests, I think no one will doubt the utility of having the questions I have put *positively answered*; and, for example, the fact ascertained whether, as has been suggested, tobacco really is an antidote to strychnine, or whether coffee, tea, or belladonna, are or are not antagonistic in their action to opium.

The instruments of precision now in the possession of the physiologist, enable him to determine many of these questions with the utmost exactitude. All that is required is time and labour properly directed, and a careful report of the results. But the experience acquired in directing the Edinburgh Mercurial Committee has satisfied me that it will be impossible to carry out a sustained effort in this or any other direction without means to remunerate the investigators. Not only would the actual expense for drugs, instruments, animals and their food and service, be considerable, but the unrequited and unacknowledged work in all Committees must be remunerated. It should be remembered that special skill, knowledge, and reputation, must necessarily be merged in that of the Committee as a whole, and thereby the great stimulus for individual research, that is reputation, cannot exert itself. Thus, while to attain perfect results, Committees composed of men who excel in different departments are absolutely essential, no return whatever for the time, skill, and knowledge expended can be hoped for without money. In every Committee, some men must work more than others. Certain manipulations are best performed by one or two persons. The chemist has to make laborious analyses and calculations. The physiologist has to perform delicate experiments, and, too often, unpleasant operations on living animals. The histologist has to sacrifice much time in microscopical observations, in drawing, and in putting up numerous preparations. The pharmacist has to furnish the purest drugs, which frequently have to be procured or prepared for the purpose. Even keeping the minutes of such a joint investigation, comparing them with each other, presiding over the discussions to which they give rise, and compiling from the whole a careful report, is in itself a great labour. No one, or at least few, can expect that in any given inquiry such varied researches and such trouble could be continuously carried on for years without remuneration, and with the certainty that the most able individual efforts will only throw honour on a general committee, the names of the members of which may be altogether unknown.

It is worthy of consideration, therefore, how far an annual grant out of the funds of this Association, say to the extent of £200, might not be made, for investigations of this nature. If the plan succeeded, and the funds admitted it, not one only, but several Committees, by and bye, might be engaged in chasing away medical difficulties. Our JOURNAL would be the necessary recipient of the results, and the means of diffusing the information arrived at. The annual meetings, at which some great medical truth evolved, or some error refuted, would receive increased interest, and thus all the different departments of our