on monkeys of the risks of analgesics to induce tolerance and physical dependence in man. Many attempts have been made to account for tolerance. The most satisfactory available hypothesis is still the 'dual action' developed by Tatum, Seevers and Collins, according to which the drug combines with receptors both on the surface and within the nerve cell, which acquires resistance to narcotic effects. Physical dependence denotes the presence of an acquired abnormal state wherein the regular administration of adequate amounts of a drug has, through previous prolonged use, become requisite to physiological equilibrium. The degree of physical dependence often runs parallel with the development of acquired tolerance. Dr. Wolff agreed with Prof. Macdonald that there are good prospects of the discovery of analgesics which will be free from the undesirable properties of morphine while retaining its valuable actions.

Dealing with the work of the World Health Organization on drugs of addiction, Dr. Wolff stressed the importance of an early decision on the convertibility of innocuous compounds into drugs of addiction. A drug is regarded as 'convertible' when the ease of the conversion and the yield constitute a risk to public health, or where there is still uncertainty about that risk. Up to the present, all synthetic analgesics have proved to be addiction-producing. The fact that a drug can be used for a time on many psychologically normal patients under hospital conditions without addiction arising is no guarantee of its safety—a better test is to see whether or not in addicts it could adequately replace their usual drug.

There is a widespread misconception about the prognosis in the addict. Relapse is common because former addicts often remain emotionally disturbed. Yet the high incidence of relapse does not justify a refusal to treat the sufferers any more than in other chronic diseases. There is now a combined approach from the chemical, pharmacological, clinical, mental health, sociological and legal angles, reinforced by well-established international co-operation.

Mr. J. B. Pennybacker, neurological surgeon to the Radcliffe Infirmary, Oxford, read a paper on the contribution of surgery to the relief of pain. Drugs, he maintained, are best used for pains which are not expected to last long, such as that attendant on surgical operations or manipulations. Drugs are also important in painful incurable diseases, some of which being non-fatal cause untold misery over years.

Surgery has been most successful in relieving pain due to mechanical disorders and inflammatory processes. The hope that with expanding knowledge of the anatomy and physiology of the central nervous system many of the intractable pains such as headache, backache, facial neuralgia, post-herpetic neuralgia, painful amputation stumps or phantom limbs and causalgia following peripheral nerve injuries might be relieved by the neurological surgeon has been fulfilled only in part. Increasing knowledge of the pain pathway has increased the possibility of successful relief by dividing that path, and this has been done at various levels.

Section of peripheral nerves has a limited application because most nerves have motor fibres, because of the extensive overlap in innervation, because trophic changes follow complete denervation, and because divided nerves might regenerate and the pain return. Section of posterior nerve roots avoids motor paralysis but the other drawbacks of nerve section remain. Its greatest success is in trigemial neuralgia, probably the most severe of all pains, by section of the root behind the Gasserian ganglion.

The operation of cordotomy (division of the spinothalamic tract) has been practised since 1911, and though still used has not proved the hoped-for panacea, for relief often lasts for only a few months. In other countries small focal lesions have been produced in the optic thalamus, the great sensory nucleus in the base of the brain, using stereo-tactic methods. Excision of the relevant cortical area, which subserves the highest level of sensory perception, unfortunately sacrifices a good deal of ordinary sensation as well as pain, and the pain might persist or recur. Frontal leucotomy sometimes relieves a patient's misery, and he bothers no longer about his pain—or about anything else. Smaller lesions appear justifiable in some cases, to ease the pain of the last few months of a patient's life, not only for the patient's sake but also for the relatives who have to watch and suffer as well.

Mr. Pennybacker referred to the challenge of an ageing population in which the problem of finding relief from pain is increased. He doubts whether the development of 'pain clinics' is the answer, because interest there would be focused on a symptom instead of the disease. He found the greatest encouragement for the neurological surgeon in the discovery, twenty-two years ago, of how sciatica is often due to compression of a nerve root by a rupture of the intervertebral disk. This affords a satisfactory explanation for the pain and a certain method of curing it.

In the subsequent discussion the speakers were asked about the relief of the pain of 'nervous tension' and the value of hypnotism in anæsthesia, in relieving pain and in the treatment of drug addiction. Dr. Wolff and Prof. R. R. MacIntosh expressed doubt about the efficiency of hypnotism unsupported by other measures.

THE VEHICLE AND ROAD SAFETY

THE increasing interest in the scientific attack on problems of road safety was shown by the fact that the whole of one of the opening sessions on September 2 of Section G (Engineering) at the British Association at Oxford was devoted to two papers on the safety of vehicles. The first paper was by Mr. G. Grime, of the Traffic and Safety Division of the Road Research Laboratory, and the second by Mr. D. Bastow, chief engineer, Jowett Cars, Ltd.

Mr. Grime set out to show where improvements are required in the design of vehicles, to demonstrate the urgent need for better maintenance of lights and brakes, and to consider how these improvements might be brought about.

To be able to see well is obviously of the greatest importance to a driver, and, in this connexion, startling figures were given to show the poor state of aim and maintenance of vehicle headlamps. Only about one-half of the headlamps examined in a survey carried out in 1952 were aimed within three degrees of correct aim, while one-sixth had deteriorated so badly that their light intensities were less than one-tenth of what they once were when new. All this leads to the inequalities of illumination which are the most potent factor in causing dazzle and poor seeing.

A similar situation, though not quite so disturbing, exists in regard to the brakes of vehicles in use on the

roads of Britain. A survey, made in 1948–50, revealed that about 7 per cent of vehicles require twice as great a distance to stop as that given in the Highway Code for brakes in good condition.

Mr. Grime gave reasons for concluding that the most effective way of making the necessary improvements in the maintenance of the vehicle to overcome present shortcomings in headlights, brakes, etc., is compulsory vehicle inspection. Evidence from the United States suggests that compulsory vehicle inspection and associated safety measures have resulted on the average in a 12 per cent reduction in deaths in the States where it is in force.

Comparatively small changes in the design of vehicles to improve visibility might perhaps lead to substantial reductions in accidents. The right-turning manœuvre is a dangerous one for almost all vehicles, and the fitting of properly designed and placed rear-view mirrors as standard on all vehicles including bicycles was advocated.

In emergency braking, especially on wet roads, steering control may be completely lost if both wheels on either front or rear axle lock. An efficient brake, arranged never to lock any wheel, whatever the friction between tyre and road, would therefore represent an important advance in the design of the vehicle, and would be particularly beneficial to motor-cyclists.

American research on the injuries suffered in car accidents shows that much could be done, by redesigning the interior of the car, to minimize the severity of these injuries. The most important requirements are the elimination of sharp edges and points, the fitting of resilient pads at appropriate positions, and the provision of safety belts or other means of holding the occupants in place during the accident. Mr. Grime suggested that the vulnerability of motor-cyclists to injury (about thirty times that of drivers of four-wheeled vehicles) might be reduced by enclosing their vehicles in saloon bodies and perhaps tying the riders into their vehicles with safety belts. There is already a tendency in the direction of making enclosed motor-cycles for reasons of weather protection.

Mr. Donald Bastow introduced his paper entitled "Vehicle Design for Safety" by referring to the great possibilities of reducing accidents which were afforded by improvements to the road system of Britain. An experiment by Mr. G. T. Bennett in the County of Oxford showed that, by relatively slight alterations to rural road junctions, a reduction of about one-third in the accident-rate at those junctions had resulted. There was little evidence from insurance premiums that vehicles of particular makes were more liable than others to be involved in accidents, and he considered that accidents were generally the result of human frailties rather than vehicle imperfections.

Like the previous speaker, Mr. Bastow considered that the first and most important safety requirement is all-round visibility, and proceeded to describe the methods employed in measuring and plotting the obstructions to the driver's vision. He considered that curved safety glass had done more than anything else to improve visibility, by enabling windscreen pillars to be placed farther back, and by making possible really large rear windows. Important accessories which are now coming into use on modern cars to improve visibility are windscreen-washers, powerful fresh air heating systems, and electrically heated rear-windows.

For driving in fog, Mr. Bastow advocated the use of headlamps by day to give warning of approach and by night the use of two fog lamps to give a wide spread of light.

Next in importance to visibility comes the controllability of the vehicle, and here the speaker discussed, in simplified form, modern theories of steering, stressing the all-important role of the tyre. For ease of control, particularly by inexpert drivers, an 'understeering', that is, a stable rather than an 'oversteering' or unstable characteristic, is desirable. Springing also influences controllability, and the softer front springing which has become possible with independent front springing has helped in this respect by reducing variations of load on the front wheels.

Two practical problems in maintaining efficient braking are those of adjustment and of overheating with consequent fading of brake efficiency. A new development which may overcome both is the disk brake, with which a greater mechanical advantage may be employed.

Further considerations in favour of a non-locking brake were mentioned. Such a brake is already available for aeroplanes and may eventually become a commercial possibility for road vehicles.

In the discussion which followed the two papers, Mr. L. Bainbridge-Bell mentioned a very simple and cheap brake-testing device made in the form of a rectangular box, of such a size that when placed on a flat horizontal surface in the car, it fell over when a certain deceleration was exceeded.

In reply to a question by Sir Richard Southwell, Mr. Grime gave the results of a series of tests by the Road Research Laboratory comparing yellow with white light for headlamps. Two cars and twenty drivers were employed in the tests, which took place on a track, about half a mile in length, along which unlighted obstacles were placed. The cars were fitted with both white and yellow headlamps of the same design and giving the same beam distribution. They started simultaneously from opposite ends of the track using in turn either the white or the yellow headlights. Drivers were asked to record their preferences both when the opposing car was too far away to produce dazzle and when it was near. Tests were conducted with the track both dry and wet, and with correctly and incorrectly aimed beams. In tests of a different kind, the distances at which test objects could be seen were measured, this time with six observers.

The results may be summarized in the statement that all the differences found were small. The distances at which the target could be distinguished were on the average slightly greater (about 5 per cent) with yellow than with white light, but this increase is not a significant one. In the opinion tests with twenty observers, when there was no opposing glare, there was a significant preference for the white beam. When the cars approached near one another, although more observers considered the yellow beam less glaring than the white, there was a small majority in favour of the all-white system. It may therefore be stated with confidence that changing over to yellow light will not solve the headlight problem.

Dr. E. A. Watson directed attention to Fig. 13 of the first paper, which indicates that there is more glare from the modern British dipped headlamp than from headlamps on American roads. Since modern British and American dipped beams are very similar in characteristics, the difference suggests that British headlights are not properly aimed when they leave the manufacturer or agent.

Dr. Watson deprecated the unsafe practice of driving with sidelights in badly lighted streets.

Mr. B. G. Robbins brought up the question of improved windscreen wipers with blades travelling horizontally across the glass, and Mr. Bastow said that this is quite feasible though expensive. A wiper of this type was on the market some years ago but has been abandoned.

OBITUARIES

Prof. William S. Boulton

THE death on September 14 of Prof. William S. Boulton, emeritus professor of geology in the University of Birmingham, in his eighty-eighth year, has removed the last of the Victorian geologists. He was first an assistant of Lapworth's at Mason College, Birmingham, and later studied under Judd at the Royal College of Science, London, heading the examination list in geology. He stayed on for a fourth year as one of two assistants to Lockyer in his work on stellar photography, the other being Richard Gregory, later editor of *Nature*. The Victorians built on broad foundations! In 1890 Boulton returned to Mason College as demonstrator and assistant lecturer under Lapworth, and in 1897 went to University College, Cardiff, as lecturer in geology and geography, becoming professor there on the creation of the University of Wales in 1904.

Under Lapworth, engineering and mining students were taught the principles of geology, with some emphasis on their application to their particular professions, and with field-work as an essential part of the course—a novelty in those days. Boulton carried these ideas to South Wales and did a good deal of proselytizing through the medium of university extension lectures, to which he attracted large audiences, chiefly in the mining towns of the coalfield. He also was a contributor to and editor of a six-volume "Text-book of Practical Coal Mining".

At Cardiff he built up a reputation as a teacher of geology and geography, and as a consulting geologist in coal mining and water supply; and on Lapworth's retirement from Birmingham in 1913 he was appointed as his successor. The First World War interrupted all university work; but after it Boulton brought the whole of the Geology Department under one roof—it had previously been partly in the new buildings at Edgbaston and partly at Mason College—and under his guidance it expanded greatly while retaining the ideals of Lapworth with respect to pure research and the application of academic geology to engineering, mining and later to the oil industry. Boulton became acknowledged as one of the most outstanding authorities on the geological side of water supply, and he practised as a consultant for many years after his retirement from the University on reaching the age limit in 1932.

Boulton rendered public service on the Geological Survey Board, the Safety in Mines Research Board, the Government Inland Water Survey and the Council of the Geological Society; he was president of Section C (Geology) of the British Association in 1916, of the South Staffordshire and Warwickshire Institute of Mining Engineers (1922–23), vice-president of the Geological Society (1934–35) and dean of the Faculty of Science both at Cardiff and Birmingham.

Apart from his investigations in connexion with coal and ironstone mining and water supply, most of which naturally remains unpublished, Boulton's early interests were petrographical. Later he made valuable contributions to our knowledge of the red rocks between the Coal Measures and the Trias in the Midlands; but it is particularly as a teacher, administrator and consultant that Boulton will long be remembered by colleagues and by a host of students now scattered all over the world.

L. J. WILLS

Prof. Antonio Minto

PROF. ANTONIO MINTO, whose death is reported at the age of seventy-four, was for long years one of the best known and most influential figures in Italian, especially Etruscan, archæology. As professor in Florence, as 'soprintendente' for northern Etruria, and as president of the Istituto di Studi Etruschi, he came to occupy a commanding position in this field.

Born at Pieve di Sacco near Vicenza in 1880, the first part of his archæological life was spent in Greece, where he worked with Halbherr and Pernier. Then came the First World War. Afterwards he worked in Campania (1922–24), until, in 1924, he was appointed 'soprintendente' in Florence. There he remained until the end of his working career (he retired in 1951), and it is with Florence and northern Etruria that his name will always be particularly associated.

Under his direction the reorganization of the Museo Archeologico in Florence, begun in the reign of Milani, was largely completed. The original home of the Museum, the Palazzo della Crocetta, was enlarged by the addition (1930–40) of the long series of galleries that now house the greater part of the Museo Topografico, and was itself largely rearranged so that a great quantity of material was made readily available to students. The vision that had been Milani's, of Florence as the centre for Etruscan, and indeed Italic, studies, was shared by Minto, although he could never realize it fully. He had to endure the existence of another 'soprintendenza' for southern Etruria and the sight of the rich results of the new excavations at Vulci and Cervetri going to the Villa Giulia in Rome. He was, however, able to bring to birth the Istituto di Studi Etruschi with its home in Florence, and its annual, *Studi Etruschi*, published there (1927 onwards). Moreover, the extraordinarily rich collections of the Florentine museum, logically arranged and fully exhibited, together with the attitude of its directorate that makes study in the museum easy, have enabled it to maintain its position as the best single place in which to study Etruscan civilization.

Minto was not a great original scholar, not an intellect with the imagination to open up vast new vistas: his great service was in making material available and encouraging study. His work in the Museum was one result of this guiding principle. His writings, which were numerous, were nearly all publications of material that came into his control. New finds in his province were usually made known comparatively quickly and comparatively fully. His only two major publications were, characteristically, excavation reports: one of the remarkable early necropolis at Marsiliana d'Albegna excavated by the Prince Don Tommaso Corsini (published in 1921); the other of his own most important excavations, at Populonia (published in 1943). Besides these excavations, he undertook many less exciting investigations, notably at Heba, Saturnia and Sestino, of which notices appeared in the *Notizie degli Scavi*.

W. L. BROWN