BRAIN AND MIND.

By CHARLES I. MCLAREN, M.D.,
Melbourne.

PROFESSOR J. C. ECCLES, of the National University, Canberra, concludes his book on the neurophysiological basis of mind with the sentence: "For the scientist there should be no doubt that the problem of the interaction of mind and matter is a real problem, not a pseudoproblem arising from confusion in the use of words. We may agree with Sherrington and Schroedener that the 'nature of man' is the ultimate quest of science." The quest specially concerns the psychiatrist and every physician. But Sherrington has elsewhere made it clear how elusive the problem is. "The mental", he wrote, "is not examinable as a form of energy. No mere running round the cycle of the 'forms of energy' takes us across the chasm . . . Thought, feeling and so on are not amenable to the energy (matter) concept. They lie outside it. I therefore think brain is an organ of liaison between energy and mind but not a converter of energy into mind or *vice versa*."

With a like viewpoint the present President of the Royal Society, Professor E. D. Adrian, O.M., has written: "There is a fundamental difficulty which does not seem to me to be soluble at all by experimental science—the difficulty of connecting physical and mental events, of bringing thoughts into the framework which we use so effectively for describing our external world. I cannot myself see how further knowledge of brain physiology will help us to reconcile mind and matter."

The difficulty thus proclaimed by eminent scientists is recognized also by those whose primary discipline has been metaphysical. H. S. Ayer, Professor of Mind and Logic in University College, London, writes: "If what we are seeking is a bridge across a seemingly impassable river it will not help merely to elevate one of the banks." Nor will it. Nevertheless firm foundations on both sides are likely to prove *sine qua non* to the bridge we yet may see. Therefore we may be grateful and hopeful whenever we see foundations being laid more firmly and truly than those previously laid. We must be prepared also to reject any which have been essayed and have proved friable and crumbling. One such which I would mention is the outdated crude materialism which would make of mind or consciousness nothing but a functionless by-product, a so-called "epiphenomenon" of the evolutionary process. A militant materialist of a former generation put it thus: "The brain secretes thought as the liver secretes bile." But this mind "secretion", differing from bile and all other secretions, has no function, for by this same materialistic theory the cosmos is a closed energy system and its physically predetermined happenings cannot be affected by thought. I do not propose to develop an argument "to slay the slain" and further refute this irrationalism.

At the opposite extreme from materialism is the subjective idealism which says (in effect) that you and I and the other fellow not only "put up the moon" but the sun and stars and galaxies as well; which says that there is no sun except our idea of the sun. Of course, it is obvious that our consciousness of the sun is the only consciousness of it that we can have. But that there is no reality external to ourselves which brought to us consciousness of a sun, who can believe such amazing egoism? Practically, even those who call themselves subjective idealists do not act according to so wild a fantasy.

From these crumbling metaphysical speculations let us return for a while to the revelations of modern science. Thanks to the mathematicians and physicists, the physical universe can now be understood and subsumed in terms of one entity—energy, as expressed in the movements of atoms and electrons. This reduction of the cosmos is a marvellous and deeply satisfying achievement of thought and experiment.

Building upon this universal concept, and developing its implications to the relation of the brain with the rest of the material universe (note nothing is yet being said about relation of brain to consciousness), E. L. Hutton, Clinical Director of the Burden Neurological Institute, offers us the further concept of the brain as a "microcosm" and the rest of the universe as "macrocosm". The brain he sees as part and parcel of, and of like ultimate electrical nature with, the macrocosm in which and out of which it has developed. By reciprocal afferent and efferent impulses it changes and is changed by the cosmos or "surround", as Eddington calls it.

To quote Hutton: "The cortical patterns show extraordinary similarities in their temporo-spatial relationships to the patterns from which and to which their movements flow and in fact they appear to reproduce these on a smaller scale . . . the process exemplifies the system of feed-backs used in the electronic calculating machine." Quoting Adrian, Hutton further says: "The brain is large enough to allow for a great many different local patterns at any time and for all the complex interactions between them. It is large enough to have the external world mapped out by our sense organs, with reasonable detail for the things and events which are likely to matter."

So much for a quotation from Hutton. For further information about these ideas I must refer the reader to Hutton's informative article and to the one preceding it entitled "The Concept of the Schema in Neurology and Psychiatry", by Russell Brain, in the same volume ("Perspectives in Neuro-psychiatry").

Among those who have done most to demonstrate the facts about the electrical working of the nervous system and especially of the brain is Professor J. C. Eccles, F.R.S. He not only makes it clear that the brain works as an electrically patterning mechanism, but also has been able to arrive at an approximation of the amount of energy which is necessary to alter one set of synaptic patterns to another set (with that altered physical patterning there occur corresponding altered states of consciousness). Eccles goes on to the novel suggestion that the amount of energy required to close one synaptic path and open another is so small that it may be supposed (certainly it cannot be experimentally disproved) that thought "influence" alone might effect the change. But if with Sherrington and Adrian we have been driven to think of consciousness and the spatio-temporal energy operations of the brain as disparate realities, do we get any nearer to a bridging of the chasm between them by being told that the amount of energy under consideration is very small? Is not such a suggestion reminiscent of Midshipman Easy's lady friend, who excused the coming of her irregular baby on the ground that it was "a very little one"?

Yet the logic not of a theory but of facts, especially the facts of the "conditioned reflex", does drive us to accept something very near to if not identical with Eccles's suggestion.

We know, for instance, that a red light may be the exciting cause of salivation for a dog; but a totally different kind of external stimulus, perhaps a whistle which uses a different quantity of energy, may effect the same result. Contrariwise, the animal may be conditioned so that the same stimulus produces different results. Thus it is clear that in fact it is "thought influence", the fact of meaning, which is the essential factor in determining what the result will be. But there is a constantly present factor in all cases—which invalidates Eccles's suggestions that thought influence alone effects results. Meaning is always attached to a quantity (greater or less) of physical energy. Always it is the case of a meaning-charged energy stimulus affecting a meaningfully expectant brain instrument.

Do we here begin to get a little nearer to our sought-for bridge? I think that if we weigh these facts in the light of certain conclusions arrived at by philosophically minded modern mathematical physicists, we do see, if not our bridge, at least a framework on which the bridge may be built. Sir James Jeans's conception of the nature of the material universe is that it presents itself to the mind of the investigating mathematician and physicist as an actuality which is also a logical structure. This view was even more explicitly expressed by an Australian contemporary of Jeans at Cambridge. The late Professor S. B. McLaren wrote in an Adams Prize Essay: "For me, matter is thought that has taken form."

The reason for such a conclusion on the part of a mathematical physicist seeking to probe the ultimate nature of matter is not difficult to understand. His mathematics and logic had enabled him to foretell (as Niels Bohr confirmed and further revealed) what the structure of the atom and the nature of the movements of the electrons would prove to be. When these mathematical prophecies were proved factual in the structure of the atom (our present ultimate in the material), it was then only one step further to say: "Matter itself is thought that has taken form."

There, I think, is a scaffolding for our bridge; and mathematics has yet another contribution to make which will help on in the bridgemaking. My mathematical friend, Mr. D. K. Picken, Master Emeritus of Ormond College, who has devoted much of his thought to the determination of the implication in mathematics of the infinite, stresses the fact that "what is contradiction in the finite becomes the commonplace of the infinite".

Though we have everyday demonstration of the fact of reciprocal influence of brain and mind, the one upon the other, yet the fact remains (as Sherrington points out) a paradox which in terms of finite brains and finite human consciousness admits of no solution. The equation must be raised to terms of the infinite. This can be done and has been done. Then, instead of considering human brain and human mind, we review a similar problem, but now in terms of the infinite; we consider on the one hand the material cosmos emerging out of primordial void and on the other the infinite Spirit[1] whose energy and word calls the material into being. We read: "God said . . . and there was." The world appeared. Then latest in the poem's "days" man, compacted of matter and spirit, was made —man conscious of the "dust of the earth" (and of the stars) from which he came, conscious also of the Creating Spirit in Whose image he was made.

Adrian, already quoted to the effect that further knowledge of brain physiology will not help us to reconcile mind and matter, went on to say: "But I am prepared to believe that 100 years from now it will be difficult to understand why we ever puzzled about it." For myself, I venture to think we do not need to wait 100 years or even a single day, and that the solution for our quest is to be found, if we will re-read the simple but profound words of the Bible poem of creation in the light of modern physics and physiology, of ideas about microcosm and macrocosm, of feed-back mechanism and mathematical philosophy, and most of all read it with open and child-like minds. The poem tells of the creation of matter patterned by the purposing energy of Spirit. It goes on to tell of reciprocal action between matter and Spirit. "God saw what He had made" and in that stimulus from the material (so I think we may describe it) came to the divine mind consciousness "that it was good".

A like relationship is reflected in terms of the finite between the microcosm (man's brain) mirroring the macrocosm to man's finite mind. Man's consciousness depends on matter, is affected by it, but also controls it; for man, though he is not Creator, is creative in his purposes and in his refashioning of the world. Sherrington has expressed this interrelation of man and his environment in the diagram: Environment ⇆ Brain ⇆ Mind.

It is to be remembered that the environment or, as Sherrington calls it, "the surround" is both material and spiritual. Julian Huxley, who does not err on the side of minimizing the importance of man's material environment, emphasizes that man, because of his mind, lives in a new environment special to himself as a species, the "nuosphere", the world of the mind.

The implications of all this for the psychiatrist are obvious. The psychiatrist sees all too often the evidences of man's creaturely failings and of his humble origins; but (if the psychiatrist's own eyes are open) he may see also the creative powers of this being of matter and spirit.

He must therefore avail himself of every available resource, material and spiritual, for the treatment both of brain and of mind. It were folly to think that the physical alone can suffice, as it is superstition to think that the psychic alone can reshape an organically disorganized brain.

[1] "Spirit" I would define as Purpose at work to goals of good or evil. Compare the concept in Newtonian physics expressed in the definition: "A body is said to do work when it moves its point of application against resistance." We humans know spirit for this best of all reasons. We are beings of an order of reality who demonstrate and experience this fundamental energy.

STUDIES ON INFECTION IN THE RABBIT'S EYE WITH SPECIAL REFERENCE TO DRAINAGE IN INTRAOCULAR INFECTION.

By R. L. RAYMOND,
From the Unit of Clinical Investigation, The Royal North Shore Hospital of Sydney.

THE following studies on infection in the rabbit's eye were carried out with the objects set out below.

Part I: To investigate whether hyaluronidase by its spreading effect would cause drugs to enter the aqueous more readily when injected around the eyeball.

Part II: (*a*) To investigate whether the hygroscopic effect of glycerine drops on the cornea would accelerate the passage of subconjunctival fluid into the cornea. (*b*) To investigate whether the hygroscopic effect of glycerine would promote the healing of corneal infections.

Part III: (*a*) To investigate whether open drainage of the anterior chamber through the cornea was possible without destroying the eye. (*b*) If it proved possible, to investigate whether such open drainage of the anterior chamber was of value in combating intraocular sepsis.

PART I.

Hæmoglobin solution has been found by Holborow and Keech (1951) to be a suitable dye with which to follow the spreading effect of hyaluronidase. Most of the common dyes tend to inactivate the hyaluronidase. Bright red hæmoglobin solution, 0·25 millilitre, with an equal part of standard "Rhondase" (hyaluronidase) solution, was injected subconjunctivally in a rabbit. A control solution with distilled water instead of "Rhondase" was injected at the same time in the other eye. After one hour 0·25 millilitre of aqueous was removed from each eye with a fine needle and syringe. These were submitted to Dr. R. Lemberg, who reported that on naked-eye examination he could state that no measurable amount of hæmoglobin had entered the aqueous in either specimen. Repeat experiments produced the same result.

The passage of penicillin into the eye was assessed in the same way—that is, with and without the addition of hyaluronidase in the subconjunctival injection. Adrenaline was added to the injection in about half the experiments. The amounts of penicillin entering the aqueous were judged from the bactericidal power of aqueous withdrawn from the anterior chamber at varying periods after the injection and brought into contact with a penicillin-sensitive hæmolytic streptococcus.

The Almroth Wright slide cell technique was used in these experiments. The proportions of suspension of streptococci : defibrinated blood : penicillin-aqueous used were variously 1:16:16 or 1:20:20 or 1:25:25 or 1:40:40. The proportions 1:25:25 proved the most suitable. The dilutions of penicillin-aqueous used were 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048 and 4096.

The streptococci were taken from active infections in the hospital. The blood was human blood. The experiments were conducted on rabbits, and the aqueous was withdrawn with a tuberculin syringe and fine needle, which presented