

# Fantasy and Science Fiction

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*Every Story in This Issue NEW*

Eastward Ho!	WILLIAM TENN	5
Of Mind and Matter ( <i>article</i> )	ARTHUR C. CLARKE	20
The Black Retriever	CHARLES G. FINNEY	27
The Terribly Wild Flowers	GERALD KERSH	36
Unfortunately	FREDRIC BROWN	49
Recommended Reading ( <i>books</i> )	ANTHONY BOUCHER	50
Ballade of an Artificial Satellite	POUL ANDERSON	55
Have Space Suit—Will Travel ( <i>Conclusion</i> )	ROBERT A. HEINLEIN	56
The Bogey Man	WILBUR DANIEL STEELE	99
The Night of Lies	DAMON KNIGHT	114
The Men Who Murdered Mohammed	ALFRED BESTER	118

*"Coming Next Month" appears on page 129*

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*If, along with goodly thousands of others, you have experienced the pleasure of such Clarke books as PRELUDE TO SPACE or CHILDHOOD'S END (to mention only the first two that leap to mind), you need not be told of Clarke's delicate touch with science fiction or of his powerful grip on science fact. But Clarke is also a highly independent thinker, and a courageous one—as witness his determination to reason out, as a poetic materialist, the ultimate impact of the Cybernetic Revolution upon those imponderables we know as Mind and Body and Soul.*

## OF MIND AND MATTER

by **ARTHUR C. CLARKE**

FOR THOUSANDS OF YEARS THE human race has debated, with singular lack of agreement, such questions as the existence of the soul, the meaning of personality, the relationship between the mind and the body, and—above all—the possibility of survival after death. The fact that the debate is still just as heated as when it began in the Late Neolithic Period strongly suggests that the wrong questions have been asked, and certain spectacular developments of the last decade indicate, with equal force, that now is a good time to recast them into a form that makes sense.

Those developments are purely scientific—a fact which will upset a great many people with vested

interests in some of the pseudo-answers now current. They lie almost entirely in the fields of biophysics, neurology and electronics, and at first sight it may seem improbable that such areas of modern technology could have any conceivable relation to the great questions of philosophy and religion.

But four centuries ago, it would have seemed equally unlikely that several thousand years of cosmological speculation, culminating in the poetic fantasies of *Paradise Lost*, could have been swept away in a few decades by a couple of lenses in a tube. Today, we are witnessing another scientific break-through, in an area that affects us much more personally

than any astronomical discovery could possibly do.

It is now obvious that we are approaching, more closely than anyone would have dared to hope a few years ago, the basic secrets of life itself. Such fabulous tools as the electron microscope, which has given us clear pictures of the very building-blocks of living organisms, are showing us how the bridge was crossed between the world of inorganic materials and the richer world of life. It is only a matter of time before that bridge is crossed again in some laboratory; whether that moment is ten or a hundred years from now is not in itself important. Many details of the fantastically complex electro-chemistry of life will elude us for generations yet, but it cannot be doubted now that there is nothing inherently mysterious, or fundamentally unknowable, in the processes that build and power our bodies. That makes them none the less marvelous; real knowledge, when it dispels superstition, seldom diminishes awe. (For can the petty cosmos of Milton compare with the grandeur of the universe we know today?)

It seems possible that the brain will hold its secrets longer than the body, but even here remarkable advances have been made towards an understanding of the processes of memory and reason—all the complex of phenomena

which we group under the term "thought." In this case the scientific break-through has occurred at two distinct points; on the one hand the mechanism of the brain itself has been investigated, and on the other electronic devices have been built which show—often with startling realism—many of the behavior-patterns of sentient creatures. And perhaps most significant of all, the large-scale development of giant computers has done much to destroy the illusion that there is something transcendental about the brain, beyond all possibility of duplication or imitation by machine.

Almost all the basic activities of the mind have now been reproduced, more or less successfully, by electronic means. Memory, purposeful reaction to the environment, ability to draw logical or mathematical conclusions—these are now commonplace features of machines being mass-produced for the commercial market. The ability to learn from past experience—to profit from mistakes so that they will not be made again—has also been demonstrated on the laboratory scale. Even the all-too-human attribute of total unpredictability can be incorporated in a machine if desired; and sometimes it is desirable, in carefully-regulated amounts. For there are problems that can drive both men and machines crazy if they try to solve them, and then

the only thing to do is to make a random choice.

The situation has been somewhat confused by the determination of the computer-designers not to let the popular name "electronic brains" be applied to their offspring. For once, however, the public, and not the experts, is right. Today's computers are electronic brains by any reasonable definition of the phrase. It is true that they have the intelligence of single-minded tapeworms (though they usually possess much better memories), but this does not alter the basic situation.

Important though electronic computers will be in science, business and technology, it is their profound philosophical implications which we are concerned with here. For they have shown—in principle, at least—that though Mind needs a vehicle, that vehicle can be of many forms.

Before we see where this leads us, it is necessary to deal with a persistent red-herring. Many people have been so impressed by the gulf between even the most advanced electronic computer and the most moronic human mind that they have denied the possibility of bridging it. The brain of a man, it has been pointed out, contains approximately ten billion fundamental switching units, capable of cross-connection in an almost infinite number of ways. A much-quoted "proof" that no

electronic equivalent of the brain is possible states that such a machine would have to be as large as the Empire State Building and would need as much water as flows over Niagara to keep its billions of vacuum tubes cool.

It is amusing to see how quickly this has become an argument that such a machine is perfectly possible. Since the first computers were built, the bulky, heat-generating vacuum tube has been largely replaced by the rice-grain-sized transistor. We no longer need the whole Empire State Building: one floor will do, and the existing plumbing will provide all the cooling water required. But even this reduction in scale has now been surpassed; the transistor itself is challenged by the yet tinier and still more efficient cryotron (a switch literally as big as a hair, operating on the principle of superconductivity). It is believed that one of today's giant computers could be packed into a small suitcase if it were redesigned with cryotrons as its fundamental circuit elements. So much, then, for the Empire State School of computer criticism.

All this does not mean that we will be able to build electronic equivalents of the human brain in the near or even the remote future. But the feat is not intrinsically impossible, and when one looks back at the progress of technology during the past hundred

years, one would be very foolish indeed to declare categorically that this will never be achieved. Most top-rank computer scientists, if they let their hair down, would probably agree that sooner or later we will find ourselves dealing with mechanical entities which will pass every conceivable test for intelligence and self-awareness which we might apply to another human being. They will contain fewer units than many electronic systems already in existence—the telephone network of the United States, for example—though they will be a great deal more complicated.

A good many people find it somehow degrading to realize that the human brain, like the human body, is "only" an electro-chemical machine and flatly refuse to admit it. This attitude is completely absurd. The Taj Mahal is "only" a mass of stone; the roof of the Sistine Chapel only plaster and paint. *The material is unimportant; the pattern is all that matters.* Should an athlete feel that sport is worthless because of the undeniable fact that his body is an elaborate artifice of pumps, levers and elastic fibres? Of course not; indeed, it adds zest and interest to his performance. (It is no coincidence that the first man to run a mile in four minutes is a doctor.) It may well be that we will learn to think properly and effectively only when we know

how we think.

We must not commit the elementary error of supposing that the mechanism of the human brain is necessarily similar in detail to that of today's—or tomorrow's—electronic computers. It is certainly not, if only because of the different structural elements involved. This, however, is quite unimportant; what matters is that memory, personality—all the components which make up every human being and distinguish him from all other men who have ever lived—are ( ) the by-product of data-storage and processing in an extremely complex computer of some kind. (That blank parenthesis, by the way is to allow you to insert the word 'merely' if it helps your feelings. It will affect the situation just about as much as the actions of Kipling's "Village that Voted the Earth was Flat".)

It may be no serious oversimplification to say that a man is the sum of his abilities—the circuit networks through which he observes the external world and decides what to do about it—and his memories—the storage banks holding his accumulated experience. There may be other components, but these are the basic ones which between them largely, and perhaps completely, account for the personality and behavior of every one of us.

The storage of information can

be carried out in many ways—by marks on paper, by grooves in wax, by holes punched in cards—or, as Nature appears to do it, by coding based upon molecular structures like immensely elongated Yale keys. The physical basis is immaterial; as stated before, only the pattern itself matters. And from this simple fact, the most awe-inspiring results follow. Even those readers who have found nothing surprising or controversial in what has gone before had better fasten their seat-belts at this point!

One characteristic of a pattern is that it can be reproduced; a good example is the way in which endless indistinguishable copies of a symphony can be stamped out from a master-recording. (Indistinguishable? Not strictly speaking, but the differences can be made so small that they are of no practical importance.) Now the duplication of a human personality would be an immensely more difficult problem—but it is not a *fundamentally different one*. We cannot at this primitive stage of our technology, begin to guess how it could be achieved, any more than Beethoven could have imagined how a performance of the Ninth Symphony could be snatched out of time and saved for eternity.

The basic problem is that of recording and playing back—using those terms in a general sense—

the vast quantity of information involved in defining personality and memory. Yet the actual storage space required is quite small. If Nature manages to compress the pattern of a human body into a couple of cells invisible to the eye, and the memories of a lifetime into a lump of jelly six inches across, is it expecting too much to suppose that Man may one day perform the same feat with a few cubic yards of electronics? After all, we could now pack the Library of Congress into a shoe-box if we had to, and the amount of information there must be comparable with that defining an individual human being.

It therefore follows that, in a strictly scientific sense, reincarnation is theoretically possible. If one could reproduce the physical pattern of an individual down to the molecular fine-structure which is the library of the mind, there would be no way of distinguishing himself between the original and the duplicate. It would be totally meaningless to ask "Which is really John Doe?" They would both be.

If you think that this is absurd fantasy, of no practical importance, you have a surprise coming. For it happened to *you* during the last few months; it will have happened to me by the time you read these words. This is a simple statement of fact—though a fact that could never have been

imagined before the tools of modern science were turned upon the mechanism of life.

The atoms in our bodies are in a state of constant flux, being replaced so rapidly by others from the food we eat that we are completely rebuilt every few weeks. Even the bones are involved in this ceaseless ebb and flow of matter. Every one of us moves through the world like a flame, seeking fuel from his environment, assembling it into a momentary pattern, then rejecting the smoke and ash. Only the flame is — relatively — unchanging, until it gutters to extinction at the end of life.

It has been said that no man ever steps twice into the same river; it is almost equally true that no man ever looks at his face twice in the mirror. The flow of flesh may be slower than the movement of water to the sea, but it is no less inexorable.

We are involved, therefore, in a kind of continuous reincarnation almost as marvellous as any other type that has ever been postulated. At the same time, we can see that another popular idea of the mystics — transmigration through lower animals — can have no logical basis. The personality and memory of a human being could no more be squeezed into the limited storage capacity of any other vertebrate (still less an invertebrate) than could the en-

tire musical heritage of mankind be recorded on a 6-inch disc.

The above argument now enables us to give a definite and somewhat unexpected answer to the ancient question of immortality. What happens to us when we die can differ in no significant way from what happens to the information punched on an I.B.M. card — when the card is burned. But suppose the information is also stored in another place and is used to prepare a fresh card. There would then be no way of distinguishing between the old card and the new.

Some people may console themselves with the thought that such "master-cards" (using the term in a completely general sense to mean any suitable storage device) may exist somehow, somewhere; others will consider such an attitude slightly egocentric. Yet even if no records are in existence from which anyone alive today could be re-created, this may not always be the case. If it seems absurd to talk of storing a human being on a few miles of tape, that is only because we cannot yet build the input and output devices which could perform the feat. If the day should ever come when this is possible, Death will have lost its power over the minds of Men.

I have little doubt that a great many people will consider these speculations naively mechanistic,

because they cannot reconcile such imponderables as personality, intelligence — even the Soul, if one cares to use the word — with the concepts of electronics or Information Theory. Such an attitude is a hang-over from Nineteenth Century materialism — though this charge will make many critics doubly indignant. By the word "machine," far too many otherwise educated people still envisage a contraption of cogs and cranks and levers: they are still mentally in the steam-engine era. They cannot imagine the subtlety and sophistication of the great computers which are now leaving the laboratory, some of which may comprise a million circuit elements and be as large as a house — *yet contain practically no moving parts*, though they may carry out a hundred thousand operations a second. The machines we are building now differ in kind as well as degree from all that mankind has ever seen before — and their evolution is barely beginning.

No one can say where it will lead, but glimpsed vaguely in the mists of the future is a dream —

I will not say a possibility—which has long been hinted at in most of the religions of the world. Since pattern alone is important, can mind and intelligence exist without matter? In the relationship between, for example, purely electrical entities or packages of radiation? There is some evidence that space itself has a fundamental structure, and could therefore in principle be used as a medium for storing and processing information.

And thus, Intelligence, which arose from the interactions of matter and has used it as a vehicle for so many ages, may at last break loose from its origin, as a butterfly escapes from the prison of its chrysalid. And like the butterfly climbing into the summer sky, it may go on to orders of experience completely beyond the reach of its earlier metamorphoses.

Where are we today in the hierarchy which, ages hence, may culminate in something which only the word "Spirit" can describe? Are we the chrysalis, the larva — or merely the unhatched egg?

