THE NATURE OF PSYCHOLOGY

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A SELECTION OF PAPERS, ESSAYS AND OTHER WRITINGS BY THE LATE

KENNETH J.W.CRAIK

EDITED BY

STEPHEN L.SHERWOOD

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EDITOR'S NOTE

The material presented in this book was selected by the three who wrote and signed the introduction. The original sorting of unfinished writings, reports, essays, and formal papers, which took a number of years, as well as the final editing, was completed by the undersigned.

Some errors may have occurred in transcribing Craik's often difficult handwriting, but, because most of his ideas appeared in more than one form or sketch, it is unlikely that their sense has been seriously misunderstood. In fact, perhaps the best reward for collecting the contents of this book was the possibility of observing the birth, growth, and mutation of many of his ideas.

Nothing has been added to his text. Where necessary, footnotes have been provided for clarity's sake.

S. L. SHERWOOD

Chicago
1964

INTRODUCTION

The published work and personal communications to his friends of K. J. W. Craik have been of great importance to the development of physiological psychology and of what has become cybernetics and human engineering. Knowing that not all of his scientific work had been published we obtained through the good offices of Lord Adrian, and by the courtesy of Sir Frederic Bartlett, the residual writings as they had been left by Craik. Thanks to Sir Frederic, one of us obtained also official sanction of the authorities concerned to have access to the literary legacy.[1] We regret that it has taken so long a time before things relevant to contemporary science could be separated from things that heretofore were of military significance or hereafter will be only of importance to the historian of personalities. But we believe that, had it been attempted earlier, the salient features would have been distorted for a want of perspective. The present selection and organization was the work of the summer of 1960: we are still convinced that the items presented here have been selected so as to convey, above all else, his manner of thinking and his modes of observation.

This was not easy, for at every step in the generation and control of his ideas he was wont to rework his former data and opinions in the light of new observations engendered by novel experiences and critical insights.

Many were tasks put to him as problems of practical necessity of the Second World War. In every case of which we have knowledge he was not content with the verbal formulation of the difficulty. Almost always he managed to experience the predicaments in his own person. Only then was he happy to put together a bread-board model of the problem in such a form that it could be tested by experiment. When his reproductions proved accurate or could be modified appropriately, then, and only then, was he willing to refine the model for precise, measurable experiments of perception and control. The clarity and novelty of his notions of the measurability of perception, and consequently of response, were sufficiently ahead of his own generation and his seniors to delay their acceptance until their obvious utility compelled a change in policy.

At the hazard of restating what to him seemed obvious, namely, that the mechanism of the percipient determined for him the observables of his world, we would refer the reader to that apparently simple text which cannot be evaluated with study on a first or even a second reading, called *The Nature of Explanation*. Here again, it will be found that, as in Clerk Maxwell's case, his question concerning the human brain is first, 'What

[1] None of his official publications or of his reports to authorities requested during wartime are included.

is the *go* of it?', and secondly, 'What is the *particular go* of it?' Such notions boast a history that goes back to the first paragraph of Thomas Hobbes's *Leviathan* and, through it, to the second volume of Descartes' *Dioptrics*, particularly to the argument based on the dissections at Leyden. From these, albeit indirectly, are descended his earlier critiques of the measurements of sensations written for the British Association for the Advancement of Science.

Bartlett's obituary of Craik, describing his untimely death, needs only one additional note: we have come upon about ten recorded presentiments of the circumstances of his lethal accident.[1]

He was extraordinarily aware of his prowess but he trusted his intellect and his devotion to fact. Aside from this we leave his character to his biography, for we do not conceive it our duty to convey the man except through his peculiar role in science as disclosed in his own literary fragments. Many of them are undated, and their sequence had to be guessed, sometimes from items on the reverse side of the paper on which they were scrawled or typed, or—with greater difficulty—from the maturity of the content itself.

Doubtless, we have erred; but it has not been on account of our presumptions or interpretations of his words. The material from which we have garnered the present text includes his Ph.D. thesis, which, both factually and theoretically, should be available to any scientist working on vision, accompanied by his elegant observations on his own monocular solar scotoma, and an incomplete volume variously entitled 'The Mechanism of Learning', and 'The Mechanism of Human Action', of which the first two chapters had been completed; the third existed in two incomplete forms, and the remaining three in several fragmentary versions which we have not attempted to edit or cement with any words of our own. We suggest that the reader will enjoy the opportunity to do this for himself in the light of the whole history of this science, in which Craik engendered most of the notions which the last twenty years have elaborated and many of which have not yet borne the fruit we could expect in his orchard. The rest of the text is a collection of miscellaneous notes and memoranda selected to convey his mode of scientific inquiry and, above all, his grasp of the problems that have proved themselves of increasing relevance to how men know their world.

Not since the death of Keith Lucas have we who work on the nervous system had such cause to resent the untimely intervention of fate in the life of a scientist who had given us much and could have given us much more.

[1] As described by Sir Frederic Bartlett (p. xvii), Craik left St John's College in the evening of 7 May 1945; as is customary and ubiquitous in Cambridge, he rode his bicycle; he passed a parked motor car and its offside door opened unexpectedly. Craik collided and was thrown off his cycle into the path of an 'oncoming motor car'. See, for instance 4, p. 38.

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Ignorance of his official reports held back knowledge of the cyclical shutter of human perception and many other things which his work foreshadowed and which have had to be rediscovered. We regret that so much of what he knew about our knowledge of visual perception of position, direction of motion, and acceleration, has had to be rediscovered by Britain's friends, and we hope that in time to come his official reports will be available to all who seek a knowledge of the cyclical activity of the nervous system.

WARREN S. McCULLOCH
LEO VERBEEK
STEPHEN L. SHERWOOD

Old Lyme, Connecticut
Summer 1961

OBITUARY NOTICE*

KENNETH J. W. CRAIK, 1914–1945

Between the two wars a small group of British psychologists used to meet twice annually to discuss problems in which they were interested. On one of these occasions I was walking along a country road with Professor James Drever. He said, 'Next term I am going to send you a genius.' That was the first I heard of Kenneth Craik. It was a sufficiently startling introduction, and all the more so because I had long ago learned to have the deepest respect for Professor Drever's judgement about his students.

I then heard a little more about Craik's life, achievements and promise, and it was with the liveliest anticipation that I looked forward to seeing him in October 1936. Vividly I remember that first meeting. He came into my room at the Laboratory and my immediate impression was of a tall, rather powerful, spare frame; a face pale but full of life; a firm chin, straight mouth, singularly attractive dark eyes, and above a shock of black hair. From the beginning he was wholly 'at home', as we say, with any amount of genuine modesty, but not a scrap of false humility. He knew, and within a very few minutes I knew, of the power that was within him. We talked of what he had done, and more of what he would do. He was not then certain of what he would do in detail, for it was one of Craik's outstanding characteristics that there was very little which lay in the line of developing knowledge in which he was not profoundly interested.

At the Edinburgh Academy he had been a classic, and at the University of Edinburgh he had, with great distinction, studied philosophy under Kemp Smith. Professor James Drever has the honour—and a very great honour it is—of being the first to attract and hold him to the systematic study of psychology. But I am sure that all those who took part in his training would agree with me that a great amount of the best preparation for the work he was to do came from a most happy and free home life, which encouraged him to explore every path of opening interest, presented to him the widest possible outlook, and fostered a love of honest thinking. Particularly his holidays with his parents, by motor boat into remote parts of Scotland by sea and river, gave him independence, a capacity to deal with sudden emergencies, both small and large, and much knowledge of the natural life of flowers and beasts, and of the structure of the earth.

When he came to Cambridge, Kenneth was absolutely certain that psychology was the subject which above all he desired to study, but he was

* Reprinted by permission of the *British Journal of Psychology* (from its General Section, 1946, **36**, 109).

still a little undecided: should he take for his field the higher mental functions, or should he elect to follow the traditional approach through research upon the special senses? He did not hesitate for long—that was his way always when the question was one which concerned a course of action affecting mainly himself. Already, for Professor Drever, he had begun some studies of brightness discrimination and dark adaptation. At Cambridge at that time was a very active group of research students and others at work upon sensorial problems, particularly of hearing. There was also—and this may easily have been the deciding factor—an exceedingly attractive workshop which captured his imagination from the moment at which he entered it. He decided to research on visual problems and particularly on visual adaptation and after-images.

Thus began three crowded and happy years. There was, I think, nothing in a very busy and contented Department which Kenneth failed to influence and to help. The very first time I met him, out from his waistcoat pocket came his famous working model of an internal combustion engine. Everybody who had any apparatus problems quickly learned to go to Craik for help, and I cannot remember any case of a vain appeal. He worked with extraordinary rapidity, both in devising and in making instruments and gadgets of all kinds.

But, sure of himself as he was, he never, as some people do, thought of himself as beyond the stage of learning. He went to all the courses he could. I think of him as one of the most stimulating students in my own Discussion Classes that I have had the great fortune to know. He broke out of the conventional limits of psychological training. He went to the Cambridge Technical School for a course on plumbing and welding. He did a lot of physiology and, later on, brain anatomy.

His activity was by no means confined to his own immediate topics. He worked with Oliver Zangwill on some problems of Gestalt Psychology. He was ready to be an observer in every experiment. At the Psychological Society he would come in, often a bit late, sit cross-legged on the floor, listen, and then start some lively discussion, sticking to his point with persistence and good humour, and with his wonderful enjoyment of his own jokes, some of which were very good.

In 1940 he obtained the Cambridge Ph.D., and then, a year later, having enlarged his dissertation considerably, he became, at the first attempt, a Fellow of St John's College, which he had joined when he came to Cambridge. The thesis was entitled, 'An Experimental Study of Visual Adaptation, and a Discussion of some more general Psychological Problems'. The title was characteristic. There are some people who take a specific problem, answer it, and pass on to something else. Their work may be very good, but it lacks true fruitfulness. Kenneth was not in that class. I do not think he ever did an experiment, however simple and small it may have appeared, which was not informed by some idea which took its issues at

once into a wide field of principle. This thesis, which has not yet been published, although it is greatly to be hoped that publication will come before long, is strongly marked by what became one of the leading ideas of all his work, a lively recognition of the interrelation of physical, physiological and psychological problems and issues. Already he was searching for and using physical analogies: 'The eye resembles a multi-range meter. . . . When set to any one range, or adapted to any one illumination, it is sensitive to rapid variations in illumination over a certain range. If it is adapted to a different illumination its whole range of sensitivity is shifted bodily to the new adapting illumination. This "range-setting" is automatic, since the change in adapting illumination itself occasions it. It accounts for the great precision of the eye in distinguishing small, rapid changes in illumination and its inability to detect slow ones, or to act as an absolute photometer.' At the same time he devised, carried out and discussed a number of new experiments dealing with the transmission and scattering of light by the eye media and with peripheral photochemical and neural processes. Further, he was able to combine all his results into an illuminating general study of adaptation from a psychological point of view proper and of its biological significance.

The dissertation was not fully completed when the war broke out. Kenneth came to me at once to discuss whether he should join one of the Fighting Services, which, for many reasons, he genuinely desired to do. The answer was plain, as he well knew. His very unusual equipment should be put at the service of any authority which needed it, naval, military, air or civilian. For many would need it; and in a very short space of time many did. From 1939 to 1945 it is the simple truth to say that he was a key man in the scientific service of the country.

From the beginning I decided that he should have the fullest independence possible. He would have had it in any case; that I was glad and proud for him to have it make no difference, and never, during these incredibly busy years, did he once fail the trust we had in him, or once take any undue advantage of it. I am sorry, and even a little ashamed, that when I first sent him away, entirely by himself, to discuss some technical psychological problems about the role of the human operator in the manipulation of certain instruments of war, I wondered a little what sort of a show he would make. I need have had no misgiving and ought to have had none. In these years he was to meet and almost immediately to win the confidence of all sorts and conditions of men, from scientists of international repute in very many different subjects to laboratory assistants and working mechanics; from Admirals, Generals and Air Marshals to ratings, privates and airmen; from leaders in industry to the rank and file of the workers. When he made any definite pronouncement everybody was sure at once that he knew what he was talking about. When he did not know, he never pretended, but was eager and astonishingly quick to

learn. And when work was over for a time he was a thoroughly good companion.

The story of how he worked long, intense, absorbed days and nights; and of what he did, solving all manner of mechanical and electrical problems in his stride and getting at once to the point of his problems in simple but brilliant experiment, cannot here be at all fully told. He was a very active member of the Vision Committee of the Flying Personnel Research Committee; he belonged to the Military Personnel Research Committee, and some of his remarkable work concerned tank equipment; he was an original member and became the Chairman of the Target Tracking Panel of the Ministry of Supply, and was also on its Servo-mechanisms Panel. He wrote many reports, all concise and to the point, and almost all of them containing descriptions of highly original methods and results. Although these papers could not be published, they were widely known and sought after. Many of them carried further the work on vision, dealing with dark adaptation, the use of night photometers, and definitely establishing several of the basic principles in radar display. Others broke new ground in studies of the principles of bodily mechanics, and the physiology and psychology underlying the efficient combination of motor responses in the control of instruments.

One story I should like to record. Kenneth and I had been out to look at some new anti-aircraft equipment. We were being driven back to Cambridge in a light car, by a very accomplished Services chauffeur, at what may fairly be called a 'tidy pace'. The roads were greasy. For some time I had been trying to think how the conventional laboratory procedure for the study of fatigue might be supplemented in certain ways, perhaps improved. The common methods, based upon an investigation of simple and relatively isolated muscular and mental processes, seemed to me so devised that practically only three types of result could be recorded accurately: the amount of deterioration of work, checks and spurts in work, and the final collapse of work. I thought something was needed which would show clearly and exactly how skill, long continued, may change and perhaps disintegrate. So I asked Kenneth whether perhaps it would be possible to design an experimental cockpit, so that the essential control responses of the aircraft pilot, flying on instruments, could be accurately recorded, if necessary for long periods, and we should know, not only whether less or more work was being done, but also by what changes in the co-ordinated activities these, and other variations, were brought about. He jumped to the idea. He pulled out his wonderful black wallet, stuffed to overflowing with odds and ends of bits of paper, with their jotted notes in a strange handwriting about projected experiments, with dates of engagements seemingly in a terrific muddle, with impromptu drawings of apparatus. He found an available bit of blank space. A diagram began to grow.

OBITUARY NOTICE

We were driving down a steep hill. A car immediately in front suddenly stopped. So did we. We got into a terrific skid, made a right-angled turn and, by a bit of fine emergency control by our driver, came to a full stop with the front wheels of the car cocked high up on a steep bank a few inches from a thick-set hedge and in the hedge a number of uncomfortable-looking tree trunks. Kenneth straightened himself up from the side of the car, rubbing a bruised arm. He was grinning happily. This was just what he enjoyed. He went straight on with the job.

The very next day he was in the Laboratory workshop fashioning the experimental controls for the first Cambridge cockpit. The design was his. He and George Drew together did the work. The whole thing was a very brilliant and beautiful application of calculating-machine principle to a complex psychological problem. It was built in our own workshop, with slender resources and at trifling cost. It was to stand up to years of hard work, and first by the very expert research of Drew, and later by Dr D. Russell Davis, to open up what may well be a new chapter in experimental psychological development. For not only did it show that 'skill fatigue' is in many ways different from that deterioration which long spells of work may impose upon simple muscular and mental tasks, but also it demonstrated that it is possible to submit highly complex bodily and mental processes to exact and illuminating measurement.

Craik's work was rendered possible by constant and generous support from many different quarters. But above all it was Sir Edward Mellanby and the Medical Research Council who had encouraged it, aided it without stint, and given it the widest opportunities. In 1944 the Medical Research Council agreed, should the University concur, to establish in the Cambridge Psychological Department a unit for Research in Applied Psychology. The offer was accepted and the unit established forthwith. The idea, the name, and above all the appointment of Kenneth Craik as the first Director of the unit were all due to Sir Edward Mellanby, to whom psychology in Cambridge already owed more than can be expressed. In spite of all his many other preoccupations Craik found the time to inspire every branch of the work of the unit in the most practical manner, showing an unusual power of leadership.

On 7 May 1945 Kenneth came into my room about 6.30 p.m. to tell me about his movements for the next few days, and to discuss plans. He was full of all the usual enthusiasm. We were to meet at St John's College a little later, for it was the anniversary of St John the Evangelist and the annual dinner, greatly abbreviated because of war conditions, was still held. Soon after the dinner began news came that Kenneth had had an accident. I left the College. It was the eve of V.E. day. Flags were flying, many people pursuing their cheerful plans. Back went my mind like a flash to another public holiday years ago when I had come out of the same College gates into a world at play, knowing that W. H. R. Rivers, whom

I had seen not long before full of vigour and plans, was lying dead. I went slowly to the hospital, and learned for certain what it seemed that for certain I knew already. There was nothing at all to be done. Kenneth was unconscious. He could not recover. Consciousness never came back to him, and that was a good thing; for if it had it would have meant pain and distress: these, at least, he escaped.

For the last six years—and they are the only ones I can write of with first-hand knowledge—Craik's life in Cambridge had been a very happy one. I often find myself wondering to what his power and its achievements were due. Partly they were due to an exceptionally acute and quick mind; partly to a controlled but agile imagination which was able to take practical problems, solve them, and at the same time use them in the interests of basic research; partly to a kind of training which gave him wide interests and a capacity for honest thinking, but did not prematurely tie him up in any specialism; partly, paradoxically, to a body that was not naturally very biddable, but which he so far trained that he became a most beautiful craftsman and no mean player of certain quick ball games; partly to a temperament which was appreciative before it was critical, so far as other people were concerned, so that he gave his best to them without reserve and got their best out of them without effort. Kenneth himself constantly acknowledged the fact that much of his success was due to his good fortune in having the most loyal experimental assistance, first from Mrs S. J. Macpherson and then from Miss M. A. Vince, and to his coming into a small group of people all intensely interested in the development of psychological science, and both critical and co-operative to an unusual degree. Behind and deeper than all these, and the many other similar influences which made him what he was, there were other things which maybe fewer people had the chance to know.

Happy these years were beyond question; but they had also their difficulties and indecisions, sometimes long and hard to resolve. He took tremendous physical risks, not always necessary ones either, and genuinely enjoyed them. More ordinary things could worry him. He had frequent long journeys, with much discomfort, little chance of food, and social encounters impossible to foresee and nothing whatever to do with the purpose of the journey, which were at times irksome to him. When the journeys were over he would joke about them, but their anticipation sometimes bothered him considerably and put him off his work. Making decisions about personal priorities which could perhaps seriously affect the careers of others he found very difficult, as perhaps most people do who have a wide tolerance for many different ways of thinking and for many different qualities of men. More important still, probably, were certain intellectual conflicts, never wholly settled, some of them with emotional roots deep in his earlier years.

One of these sprang from his outstanding capacity for designing and

making instruments of all kinds. He found it hard to refuse any problem which gave him a chance to invent some new piece of apparatus, especially of the mechanical kind. There was a danger in this. He knew that it was to some degree interfering with his interests in basic research. Some of his later work, under the war stress, became in fact a little less rigorous than the earlier and a little less scientifically satisfying. There was a chance that he might find himself caught up in one long swirl of merely *ad hoc* investigations. But all those who knew him best were quite sure that this would not have been a lasting danger.

There was a more stubborn conflict than this one. Like many other people who have achieved striking originality Kenneth was exceedingly suggestible. Receptivity to ideas of all kinds and from all sources may well be one of the most effective conditions in the production of that sort of intellectual ferment out of which new developments arise. In Craik's earlier life most of the strongest influences came from people with profound artistic and humane interests. He gained and kept a love of beauty, particularly in poetry and in music, and treated the human mind as something unique, not capable of adequate expression in terms applicable to anything but itself. Then he came to an environment in which the strongest intellectual stimuli were scientific. Many of the people he knew well and most deeply respected were trying to find mathematical expressions for a large variety of relations between stimuli and the responses which they set up in animals and human beings. The long-standing psychological controversy about the quantitative nature of sensations fascinated him, and although his own studies in sensory adaptation convinced him that none of the earlier formulae proposed for the expression of this particular relationship between the gradation of stimuli and an accompanying gradation of response was adequate, he hoped and believed that more satisfactory formulae would be found. It may even be the case that his rather sudden switch over from the humanities to natural science led him to exaggerate the differences between the two points of view.

When he was seventeen, Kenneth wrote an essay on Immortality.* It is intended to demonstrate, or at least to declare, that there can be no satisfactory accounting for man's life and mind as if they were machines. The notion that keeps cropping up is that however anything may be constructed its beauty may well be something different from the manner and material of its making. 'And it is comforting to think that we need not despise the beauty of things because they consist only of electrical energy; but rather admire them whether they do or not.'

The only completed study of any length which he published was his small book on *The Nature of Explanation* (Cambridge University Press, 1943). In this he appeared at first sight to be taking up a position diametrically opposed to that of his early essay. He argued that perhaps the

* I am deeply indebted to his mother, Mrs M. Sylvia Craik, for a copy of this essay.

human mind and body operate exactly according to the mechanical principles of the complex calculating machine or certain developing forms of servo-mechanisms, regulating its output not only according to the quantity but also according to qualitative features of the input supplied by its appropriate stimuli. Others, watching these machines at work, have seen them as illustrations of how the human mind, faced with special problems, mostly of a practical character, has set to work to devise instruments which tackle them as nearly as possible with the results that the mind itself might achieve. He seemed to be trying to see them as evidence that in so far as they are successful, they show how the mind works, not in inventing the machines and using them, but in actually solving the problems. If, therefore, the flexibility of such machines could be so enormously increased that they could deal with as many and as varied situations as the mind and body can master, this would prove that they work just as the mind and body do, and, further, the principles explaining their operation would be exactly those principles which are used in the current explanation of the operations of any system called mechanical.

Both these inferences are dubious. Both seem a far cry indeed from the earlier essay which asserted that 'the mind is...a fit instrument for any research, and something to be treated with a reverence that we can never feel for what may turn out to be a novel and complicated kind of engine'.

Many a time in the last year or so I went to his room in the Laboratory and found him, with absorbed delight, experimenting with lovely self-regulating machines, adapting them to pick out and respond to stimuli in rapid sequence in a different manner from their reaction to stimuli in slower succession, and even to segregate and do something special about changes of shape, like kinks in a straight line. When they broke down, as they not infrequently did, he would look up with a rueful smile and go on trying. In those smiles I think that perhaps I was not wrong in finding some quiet but deep satisfaction. He was so honest that he had to go right through with the mechanistic hypothesis, pushing it to the uttermost. Yet with him, as with many another, there remained the conviction that man's life and search are a perpetual adventure, and that all our advances towards self-knowledge are promises without end.

F. C. BARTLETT