The basis of memory / by W.R. Bousfield.

THE BASIS OF MEMORY

W. R. BOUSFIELD
M.A., K.C., F.R.S.

NET 2/6 NET

PSYCHE MINIATURES
GENERAL SERIES

KEGAN PAUL

PSYCHE MINIATURES

General Series No. 14

THE BASIS OF MEMORY

PSYCHE MINIATURES

Each 2/6 Net

MEDICAL SERIES

Migraine	F. G. Crookshank, M.D., F.R.C.P.
Aphasia	S. A. Kinnier Wilson, M.D., F.R.C.P.
Rheumatic Diseases	M. B. Ray, *D.S.O.*, M.D.
Types of Mind and Body	E. Miller, M.B., M.R.C.S., D.P.M.
Dermatological Neuroses	W. J. O'Donovan, *O.B.E.*, M.D.
Diagnosis	F. G. Crookshank, M.D., F.R.C.P.
Medicine: and the Man	Millais Culpin, M.D., F.R.C.S.
Idiosyncrasies	Sir Humphry Rolleston, Bart., K.C.B., F.R.C.P.
The Constitutional Factor	Arthur F. Hurst, M.D., F.R.C.P.
**The Troubled Conscience*	Professor C. Blondel
**The Intelligence of the Normal Child*	Professor René Cruchet

GENERAL

Science and Poetry	I. A. Richards
Over-Population	P. Sargant Florence
Man Not A Machine	Eugenio Rignano
The Hunter in Our Midst	R. Lowe Thompson
Fee, Fi, Fo, Fum	H. J. Massingham
Myth in Primitive Psychology	B. Malinowski
The Father in Primitive Psychology	B. Malinowski
On History	A. L. Rowse
Economics and Human Behaviour	P. Sargant Florence
Fatalism or Freedom	C. Judson Herrick
Emergent Evolution	W. Morton Wheeler
Man A Machine	Joseph Needham
Intelligence	Claude A. Claremont
The Basis of Memory	W. R. Bousfield
Selene, or Sex and the Moon	H. Munro Fox
The Standardization of Error	Vilhjalmur Stefansson
**The Alchemy of Light and Colour*	Oliver L. Reiser
**Culture: A Symposium*	Elliot Smith and others
**Outline of Comparative Psychology*	R. J. Warden
**The Battle of Behaviorism*	Watson and McDougall
**The Mind of a Chimpanzee*	C. K. Ogden

* *In preparation*

PUBLISHED IN CONNECTION WITH

PSYCHE

A QUARTERLY JOURNAL OF GENERAL AND APPLIED PSYCHOLOGY

THE BASIS OF MEMORY

BY

W. R. BOUSFIELD
K.C., F.R.S.
Author of "A Neglected Complex"

LONDON:
KEGAN PAUL, TRENCH, TRUBNER & Co. Ltd
BROADWAY HOUSE, CARTER LANE E.C.
1928

Printed in Great Britain by
R. I. SEVERS, CAMBRIDGE

PREFACE

Whether Memory depends on "enduring traces" in brain structure (to use the language of Professor Semon), or whether it depends on records in "psychical structure" (to use the language of Professor McDougall) is a question of great importance. Apart from the theory of Memory, there are various physico-psychological phenomena, which appear to demand the postulation of a "psychical structure" for their satisfactory explanation. The whole matter is dealt with in its wider aspects in *The Mind and its Mechanism* (Kegan Paul & Co.). The present short essay has in view the fuller discussion in relation to Memory of the hypothesis of traces in "psychical structure". The two rival theories are both hypothetical, the question being which of them better fits the facts.

W. R. BOUSFIELD.

St. Swithin's,
Northwood, Middlesex,
Feb., 1928.

CONTENTS

CHAPTER I

INTRODUCTION

Memory involves a record of sensations, events, experiences and ideas. The nature and location of this record is still the subject of much speculation. One school holds that Memory may be referred to changes in cerebral or nervous structure which persist and serve as the foundation for the recall of the past. Another school postulates a psychic structure which is capable of receiving and retaining mnemic impressions. It is the development of the latter theory in a more concrete form in order to contrast it with the rival theory which is the object of this essay.

One of the best exponents of the theory of memory traces in material structure is Professor R. Semon, and his hypothesis of engrams is worked out in detail in *The Mneme* and in *Mnemic Psychology*. It is based upon a hypothetical permanent change which is assumed to be an after

effect of stimulation of the "irritable substance" which receives a sensory excitation. In man, this "irritable substance" is chiefly the cerebrum, but Semon extends his theory to all living matter in order to include memory, habit and heredity in both plants and animals. Sensory excitation undoubtedly causes changes, and when the excitation has passed there is left, according to Semon, an enduring modification of the irritable substance as its after effect. This enduring modification is called an *Engram*. Non-nervous substance may also be "irritable" and retain engraphic effects. The engram constitutes the mnemic record, which is latent, until by a renewal or application of a stimulus a memory image of the original situation is evoked. This awakening of the engram out of its latent state is called *Ecphory*. It may be brought about by various influences, such for instance as the operation of an associated engram.

Engrams generated in an organism either simultaneously or in quick succession are said to be associated and form an

engram complex. Semon illustrates this by his experience of a view of Capri from a point near Naples, and a simultaneous smell of boiling olive oil, and he says, "A definite olfactory excitation liberated by the odour of boiling olive oil never fails to ecphorise in me the associated engram Capri from a certain spot at Naples." Minor elements of an excitation complex may be indissolubly associated with the main impressions and act ecphorically upon these.

In Semon's own words—"When an organism has been temporarily stimulated and has passed after cessation of the stimulus into a state of secondary indifference, it can be shown that such organism,—be it plant, protist or animal—has been permanently affected. This I call the engraphic action of a stimulus, because a permanent record has been written or engraved on the irritable substance. I use the word engram to denote the permanent change wrought by a stimulus; the sum of such engrams in an organism may be called its 'engram store', among which we must distinguish

inherited from acquired engrams. The phenomena resulting from the existence of one or more engrams in an organism I describe as mnemic phenomena. The totality of the mnemic potentialities of an organism is its ' Mneme ' ".

Semon regards the majority of inherited dispositions as engrams. With reference to certain plants, such as Begonia, and certain lowly organisms such as Planarian, the segments of which cut almost anywhere and anyhow, are capable of developing complete individuals, he observes that the engram inheritance is not localized in special areas, but every portion seems to be in possession of the " entire inherited engram stock ". In man he recognizes a certain localization of engrams in the cortex " although it need not be of the kind which makes each nerve cell of the brain the repository for a specific engram." But as to " the nature of the change which the irritable substance undergoes —all that we can say is that the change in the irritable substance is most certainly a material change."

Semon's application of the engram

theory to the case of congenital instincts and to the ontogenesis of bees and ants is highly ingenious and suggestive, and we shall have occasion to refer to it later. We can without difficulty apply the engram theory to cases of somatic growth and development, but we shall point out the difficulties in the way of its application to psychic phenomena.

In passing we may note Bergson's view[1] according to which " the idea that the body preserves memories in the mechanical form of cerebral deposits —is not borne out either by reasonings or by facts." He claims to have " set forth reasons which make it impossible for us to admit or even to conceive traces of images deposited in any region of cerebral substance ", and concludes " that there cannot be in the brain a region in which memories congeal and accumulate ". In his view " in the form of motor contrivances and of motor contrivances only, it (the body) can store up the action of the past ". Bergson's theory is that " the past survives under two distinct

[1] *Matter and Memory.*

forms ; first in motor mechanisms, secondly in independent recollections " and that " consciousness retains the image of the situations which it has successively travelled, and lays them side by side in the order in which they took place ". In this view " Consciousness " appears to be the storehouse of memory images, but this seems to confuse " consciousness " (which only deals with images of which we are conscious) with " the unconscious " from which images have to be evoked.

As to the survival of memory in motor mechanisms, he tells us that " every perception is prolonged into nascent action." Thus the auditory perception of words is linked with the articulatory mechanisms so that " auditory impressions organise nascent movements." Such experiences " accumulate within the body a series of mechanisms wound up and ready to react to external stimuli." That which is retained is " the intelligently co-ordinated movements which represent the accumulated efforts of the past."

On this view, when we recall a poem

"learned by heart," the articulatory muscles repeat by "nascent movements" the past muscular experiences and give us the memory of the poem. This, however, does not seem to square with the facts. If we repeat aloud a poem which we have "learned by heart" we can perceive that the articulation of one line is *coincident* with a recall into consciousness of the *words that are to follow*. The memory of the words which we are about to articulate is present in consciousness whilst the preceding words are being articulated, so that there would have to co-exist the *actual* articulatory movements of the spoken words with the *nascent* movements which recall the words which are to follow. The co-existence of a set of actual movements with altogether different nascent movements seems improbable if not impossible.

For an example of the alternative school of theories of memory, we may refer to the chapter on Memory in Professor W. McDougall's *Body and Mind*. In place of enduring traces in protoplasmic structure he postulates as the basis of

memory enduring traces in mental or psychical structure. He observes—

"If we use the phrase 'the structure of the mind' to denote comprehensively the sum of those enduring internal conditions by which the play of mental process and the mode of behaviour of an organism are determined at each moment of its life, then we may say that experience modifies the structure of the mind, and that it is through the persistence of these modifications that past experience influences present behaviour and present mental process. Some part of the structure of the mind is innately determined or inherited, and all that is added to it or changed in it by the course of experience is usually and conveniently included under the term memory . . . We have now to enquire whether . . . all that is implied in the word 'memory' can be regarded as consisting in modifications of cerebral structure."

After the discussion of the various phenomena of memory he concludes that they "point to a view of the conditions of memory intermediate between the

two extreme views that have long been opposed to one another, the view that it is wholly conditioned by neural structure, and the view that it is conditioned wholly in some immaterial fashion." Such things as the repetition of the alphabet he attributes to habit lodged in neural structure. On the other hand, the importance of the *meaning* or significance of a sensory complex is the clue which McDougall takes as his guide not only in memory problems, but in various psychological puzzles to which we need not refer here. He observes that—" in so far as each sensory complex has evoked meaning in the past, it tends to revive it upon its reproduction and thus to reinstate the idea in consciousness. This is the process of the evocation of an idea upon the neural side. It plays only a subordinate part in the high processes of remembering. These are determined mainly from the psychical side. What is it then that persists in the psychical realm? Shall we say it is the meanings themselves? Clearly they do not persist as facts of consciousness—If then meanings

have no immediate physical correlates or counterparts in the brain, and if the meanings themselves do not persist, we must suppose that the persistent conditions of meanings are psychical dispositions. We must believe then that there persist psychical dispositions, each of which is an enduring condition of the possibility of the return to consciousness of the corresponding meaning." Habit too, according to McDougall,[1] involves a "mental structure" which is built up by experience. Instinct also involves an "innate mental structure."

The purpose of the present essay is to develop in a more concrete form the theory of psychical or mental structure as the basis of memory, and to show that it gives a good account of some mnemonic phenomena which do not receive a satisfactory explanation on the hypothesis of protoplasmic structures as the basis of memory.

[1] *Essay on Mental Evolution.* See *Evolution in the Light of Modern Knowledge.*

CHAPTER II

DEFECTS OF SEMON'S THEORY

It is not intended to argue at length the case of cerebral structure *versus* psychical structure, which has been dealt with far more fully by McDougall and other authors than space would permit here. Reference may be made to *The Mind and its Mechanism*[1] for a somewhat wider discussion of the matter upon the lines of the present theory. But some salient points must be noted.

We can get no direct evidence from physiology as to permanent change in cerebral cells which might form the foundation of memory, nor can we get any direct evidence that there is such a foundation in psychic structure. But we may consider the alternative theories in the light of the known phenomena of memory.

[1] P. and W. R. Bousfield (Kegan Paul).

Let us call the theory that memory is founded on changes in brain structure, the mechanical theory of memory, including in the term mechanical any kind of physical or chemical changes in cell structure or arrangement. All such changes involve the re-arrangement of the cells, or of the material molecules, or of the protons and electrons which constitute the cells. Molecular changes do undoubtedly take place under the influence of the sensory impressions or nervous impulses which play upon the cells, and it will be convenient to refer to these molecular changes in protoplasmic structure as engrams, to save coining another word. The question under discussion is whether such engrams are of permanent significance, or whether their significance is wiped out by metabolism. Are these changes fugitive, the *status quo ante* being functionally restored after sensory impression has passed, or do they give rise to permanent significant modifications of cell structure which serve as the foundation of memory?

A little reflection will show that *every*

material record must involve a re-grouping or re-arrangement of material molecules forming a definite pattern or grouping. On the large scale there are various modes of making a material record. Photography illustrates a method by which visual images may be recorded. Here the changes are chemical. Painting is another method of making a pictorial record. A phonograph illustrates the way in which sound records may be made for reproduction on a gramophone. Engraving is a kindred method by which pictorial and other records may be produced. Printing from type is a method by which ideas expressed as words may be recorded. Hieroglyphics may be cut in stone or formed on clay cylinders which may be baked to harden them and so make an enduring record.

Now all these and every other method by which a material record may be produced involve a significant *re-arrangement of material molecules.* We cannot conceive of a *material record* which does not involve a significant arrangement of the molecules of matter.

Since the mechanical theory of memory depends upon impressions on cerebral cells or irritable substance, this material record must involve some significant re-arrangement or re-grouping of material molecules.

Moreover this re-arrangement *must correspond with the nature of the impression which produces it.*

A letter Z picked out from a fount of type will not produce the impression B. The kind of record must depend on the particular sense organ which receives the impression as well as upon the particular impression which the sense organ receives. The cerebral impression produced by seeing the word Abracadabra in print, will be totally different from that produced by hearing the sound of the spoken word. The changes in cerebral cells produced by the impact of a sensation must be totally different according to whether they are produced by light vibrations or by sound vibrations. They must differ as much as a photograph differs from a gramophone record. Semon's conception of an engram there-

fore involves a molecular change, which is not wiped out by metabolism, but endures as a memory trace of *the particular kind of sensory impression which produced it.* In fact the record must consist of molecular changes the particular nature of which must accurately correspond to the physical or chemical forces brought into play by the particular sensory impressions. We cannot conceive that the engram produced by the sound of the word *scoundrel* could be ecphorised so as to evoke the word *villain.* It must be the sensory effect which is recorded and not the meaning or idea, and it is this sensory effect alone which could be reproduced.

The following experiment will illustrate the matter. Read carefully a paragraph of prose, in order to grasp its meaning and then proceed to write it out from memory. Of course with a short sentence a normal person may remember the whole, or with a long paragraph a person with an abnormal memory may retain it accurately. But for a paragraph of such length as to preclude its being

"learned by heart" by one perusal, if you are a normal person you will remember the sense but will not be able to reproduce the exact words. If you try to reproduce the paragraph in writing, you should be able to produce a respectable paraphrase of it conveying the whole meaning but in somewhat different words. Thus you may read aloud the following paragraph once slowly, so as to fully gather the precise meaning and then try to reproduce it in writing :—

"The speaker in his speech discussed the relative merits of two well-known historical characters who had both taken a notable share in the government of this country and both of whom had been the originators of marked social improvements for the benefit of their countrymen."

Your reproduction may be somewhat as follows :—

"The speaker compared the careers of two statesmen who had held important offices in the government of the country and had left their mark in legislation for the benefit of humanity."

The sensorial impressions of the words

in the first column below should have created engrams corresponding to the definite cell changes produced by the specific forces—chemical, physical, or mechanical—corresponding to the sensorial impressions. These engrams should be capable of reproducing the original words and none other. But the words in the first column below are replaced by the words in the second column.:—

discussed	compared
relative merits	careers
historical characters	statesmen
taken a notable share	held important offices
had been the originators	left their mark
social improvements	legislation
countrymen	humanity

Now if memory be a mechanical process, producing material changes in brain cells, those changes must be definitely related to the physical stimuli which produce them. We can imagine that the sound vibrations or the light vibrations which conveyed the words "*discussed the relative merits*" to consciousness,

might somehow have impressed the cerebral substance in such a way that it might be excited so as to reproduce the same words. The analogy of a gramophone record suggests that such a cerebro-mechanical process is possible, but it passes the wit of man to suggest any way in which a cerebral record produced by the sensory impression of the words "discussed the relative merits" could give forth on reproduction the words "compared the careers."

The molecular arrangements produced in cerebral cells by the impact of the words "discussed the relative merits", whether by sound or sight, must be totally incompetent *from the mechanical point of view* to give rise to the substituted words "compared the careers". It seems clear that no theory of cerebral cell impression can account for the different form which the revived memory image takes. And the reason is that the mechanical theory totally ignores the psychic element of *meaning*, the importance of which has been forcibly pointed out by McDougall. It is difficult to see in what way such an

experiment falls short of an absolute demonstration that the cerebral cell theory, or the theory of the engram in "irritable substance", is incompetent to account for the actual phenomena of memory.

As a further experiment showing the incompetence of mere sensorial impacts to account for the phenomena, try to memorise the following nonsensical sequence of words :—

"Mysteries find beyond of we penetrate however nature we which far margin probe we however beyond the into a cannot".

You may succeed in doing it after many trials, probably by unconsciously making some associations between words and group of words. But now try to memorise the same words when arranged so as to compose the following sentence :—

"However far we probe into the mysteries of nature we find a margin beyond which we cannot penetrate."

Probably you may be able to memorise this sentence in one careful reading, or at most, in two or three.

What is it that makes the difference?

If the memory depended merely on auditory or visual vibrations affecting the cerebral structure, there seems no reason why the first sequence of words should not be as readily memorised as the second sequence of the same words. Clearly it is the apprehension of the meaning in consciousness, when the words are arranged so as to convey a meaning, which makes all the difference. And if in a day or two we try to recall the sentence when the words have slipped our memory, we shall find that we can still recall the meaning, though it may be clothed in different words.

We may illustrate the importance of meaning, i.e. the psychic factor, as opposed to what may be called the engrammatic factor by the case of two boys who may endeavour to learn a new proposition of Euclid (which alas! few boys are set to learn now-a-days). The one reads it through once, follows the logical steps (the *meaning* of each step), and can at once write out the proof, though perhaps in quite different words from the

original. The other, after reading many times, may be able to write out some kind of proof, very likely with an accurate copy of the diagram and the lettering of it, but perhaps with the omission of some important step. And if the shape of the diagram is varied or the lettering changed he will be quite at sea. Both have received the same physical engrams, in the case of one boy many times repeated. But what counts is not the engrams but the meaning which they have conveyed.

Such illustrations clearly show that the *essential thing* in memory is not the words but ideas. When we recall the sequence of ideas, we may by chance clothe them in the same words or in different words. But what we really recall is the ideas with their meaning, and we cannot imagine that any mechanical record of ideas can be created by sensory impressions in mere cerebral structure. We cannot rationalize or picture any process by which anything but sensations can affect brain cells, or by which brain cells should reproduce

one set of sound sensations by a totally different set embodying the same ideas.

Now let us turn to another matter in which the mechanical theory of memory completely breaks down. Since the changes produced in cerebral cells must correspond to the sensorial impulses which produce them, we cannot conceive of an idea *per se* being impressed on cerebral cells without a definite sensorial impulse, whether of sound or sight or the like. Yet we can remember ideas and groups of ideas which are the product of pure thought, having had their origin in the mind without any external sensory impact. We may think out a philosophic system, or a scientific theory, when all the bodily senses are perfectly quiescent, and we can retain the memory of these thoughts without any sensorial impressions having been made upon the brain cells. In like manner intentions, resolutions and auto-suggestions, *unaccompanied by sensory excitations*, leave mnemonic traces. The mnemic registration of such matter cannot be envisaged as an engram in cerebral

substance due to mechanical stimulation.

Furthermore, it is said that the association links between ideas which play such a notable rôle in memory, are due to brain paths between material memory traces, and that there is an associational network connecting cells or clusters of cells which have received such traces. Now we are constantly forming new associations of ideas, and if this association depends upon a material link in the nature of a new brain path, we must be constantly generating new physiological paths. There is, of course, no evidence that the association fibres of the cortex play such a rôle, or that the growth of new psychic associations corresponds to the opening of new paths.

Perhaps a personal illustration may be permissible. The peculiar fact that the moon always turns the same side to the earth, once set me thinking. I called to mind the fact that the terrestrial tides must exert a constant drag upon the rotation of the earth, that the moon was once probably in a liquid state, that

the earth must then have produced an enormous tide upon the moon, and putting these ideas together, it appeared clear that the drag of this lunar tide would tend to check the rotation of the moon until the point was reached where the moon only rotated once upon its axis during its monthly revolution round the earth. A conviction was produced in my mind that such a theory was the only one that could account for the fact that the moon rotated exactly once upon its axis, whilst it revolved once round the earth. The correctness of this theory is not the point. By a process of pure thought a constellation of ideas was produced which included the theory and the facts upon which the theory was based. This constellation of ideas was firmly fixed in memory together with the associational links which bound the group together. There was no sensory stimulus to impress the brain and leave memorial traces of a mechanical kind. Nor was there any mechanical stimulus which could open new associational paths between cells supposed to contain material traces.

This personal experience is only intended to illustrate the point that by a process of pure thought new ideas and new groupings of old ideas may be formed, which are *completely preserved in memory without any sensory impressions.*

When we come to consider the rôle played by *attention* in memory, the above conclusions are greatly strengthened. The intensity of a mechanically produced record must depend upon the intensity of the forces which make it. For sensorial records the intensity of the recording forces depends upon the impacts upon the sensory receptors—eyes, ears and so on. The records in cerebral cells—if there be such records—must depend also on such intensity. Now we know that in fact the intensity of a memorial record depends upon the psychic factor of *attention.* Our retentiveness of a subject depends largely upon the attention which we give to the sensory impacts. We may hear a paragraph read, or read it ourselves, and if no attention is given, may have not the slightest recollection of its sense. We may listen to a sermon

in church and follow it up to a certain point where our attention wanders to some more interesting subject, and from that point we shall find that we have no recollection of the discourse. Yet the intensity of the sensory impacts upon our organs—the amplitudes of the sound or light vibrations which impress the sense organs—are not less because of our want of attention; and what is more, we can recall a train of aberrant thought—perhaps the solution of some business problem which was worrying us—though there were no sensory impacts to impress it and in spite of the whole sequence of sensory impacts from the preacher, which had nothing to do with our thoughts. On a mechanical theory of memory the cerebral cells should be equally affected whether we attend or not. We shall refer again to this case as the "sermon-problem case."

Attention means that there is a *reaction in consciousness* to the sensory impacts. Whether we attend or not, the sensory impacts have produced their effects upon the cerebral cells *before* consciousness

can play upon them. Whether consciousness plays upon them or not, the cerebral changes involved have taken place. But the fact that these cerebral changes are quickly evanescent unless they cause a reaction in consciousness, that is, in the psychic region, tends to show that engrams are fugitive and that memory depends upon the psychic factors. When once we recognize the effect of attention in consciousness as an active factor in producing a permanent memorial record, we have to admit the psychic factor in memory—the play of the mind upon the sensorial impacts—as being of primary importance.

The factor of attention also depends upon the selective action of *interest*. If two persons see a new play and give accounts of scenery, actors and speeches, their accounts will be found to differ in many particulars. Things which specially interest one person and therefore attract his attention and remain fixed in his memory, will be different from those which interest the other. The resulting memories are different, yet both should

have received the same series of engrams. Here again the introduction of the psychic factor is necessary for an explanation. We shall find as we proceed that there are other phenomena which permit of easy rationalization upon the psychic theory, but which do not lend themselves to the support of the engram theory.

If it appears that the play of the mind produced in consciousness is the real force for the intensive record of sensory impression, does it not seem more probable that this mind play produces its effect upon psychical structure rather than upon cerebral structure? The cerebral cells clearly have their office in receiving sensory impressions and passing on a resultant effect to consciousness. But having done this, must we not regard the cerebral cell as *functus officio* as regards the particular impression? A light image upon the retina produces a temporary physical or chemical effect upon the retina. But this done, and the resultant effect passed on to consciousness, the retina must be regarded as *functus officio* for that impression. Metabolic

changes quickly regenerate the retinal cells and restore them to their primitive condition. Is there any reason to suppose that there is any more permanent effect upon the cerebral cells which are also engaged in passing on the resultant effect of a sensorial impression to consciousness? It seems more reasonable to regard cerebral cells as organs for the transmission of sensations rather than as organs for their storage.

Such a view seems to be in conformity with the organization of the body as a whole. The body is furnished with various organs which discharge their functions but are not permanently demobilized in so doing. Cell changes take place but metabolism comes to the rescue and a recuperative effect ensues. Whether we consider the muscles of the heart or any other organ, the effects of normal use in debilitating the cellular structures are more or less quickly wiped out. It seems rational to regard the brain as organized upon the same scheme in this respect as the rest of the body.

If it appears that the theory of engrams

in protoplasmic structure fails to account for the psychic transformations of memory, we must examine the alternative hypothesis of traces in psychic structure. To surmount the difficulty we have to abandon our natural prejudice against recognizing something which our senses do not reveal to us. But we must remember that, except in the case of light and heat, our sense organs will only sense matter. Only a restrained scientific imagination which takes the form of a hypothesis can carry us further. In the case of the physical sciences we are up against an impassable boundary, unless we can envisage the etherial vibrations which enter into nearly every branch of physics. And in the case of the biological sciences we are also up against an impassable boundary unless we can envisage the impalpable psychical structure which enters into all mental phenomena.

And it must be remembered that the notion of a protoplasmic engram is equally a product of the scientific imagination—to be judged by its *sequelae.*

For as Semon observes[1] "We are at present quite in the dark as to the special morphological nature of that surviving alteration in organic substance which we call an engram", and it may be added that we are likely to remain so.

[1] *Mnemic Psychology*, p. 172.

CHAPTER III

PSYCHOPLASM

We proceed therefore to the consideration of the alternative hypothesis, according to which the basis of memory is not a record in protoplasmic structure but in an immaterial "psychical structure". Such a structure involves the conception of a substance of which it is built. We have seen that there are many phenomena which the hypothesis of engrams in protoplasm will not explain. Yet engrams or mnemonic traces of a sort there must be in some substance, and this substance we shall call psychoplasm, a substance which we postulate as consisting not of material protons and electrons but of some other modification of the ether. This substance, which we call psychoplasm is as hypothetical as the ether, and no more so. Electrons and protons are etherial but material and do not satisfy the required conditions. Psychoplasm we may regard as a modi-

fication of the ether, and therefore as physical though immaterial. Our definition of matter, according to the present state of science, is a substance consisting of protons and electrons. As the basis of psychoplasm, we postulate some modification of the ether which is other than protons and electrons and therefore does not come under the definition of matter. We can readily envisage psychoplasm, as an etherial substance for we have the analogy of protoplasm which is built of the etherial constituents which form ordinary matter. Psychoplasm in our vocabulary stands for the immaterial substance of which the "psychical structure" is built. Protoplasm is composed of electrons and protons which are so widely spaced that more than 99% of every protoplasmic molecule is "empty space", that is, space occupied by ether. Professor Eddington has calculated that if all the protons and electrons (that is all the matter) in the human body were concentrated into a mass, without "empty space", it would occupy only about the volume

of the head of a pin. There is therefore plenty of room in every molecule not only for the open network of electrons and protons which constitute protoplasm, but also for a network of psychoplasm, permeating the protoplasmic network, still leaving 99% of the space to be occupied by the ether itself. If we regard psychoplasm as a universal concomitant of protoplasm, and therefore as a constituent of every living cell, we have the advantage of a conception which gives us a definite and intelligible hypothesis to which we can apply our facts. We have seen that the facts require us to postulate a substance which can receive impressions or memory traces both of sensations and of ideas. Let us call all such memory traces psychograms. We cannot conceive what engrams in protoplasm may be like but we have seen that the mechanical molecular rearrangements of which they must consist cannot give a good account of certain mnemonic phenomena. Neither can we conceive what psychograms in psychoplasm may be like. All we can say is that they must be of a different order

from the mechanical or molecular changes which would constitute material engrams. But we are compelled by the phenomena to envisage a substance which can receive impressions of ideas as well as of sensations, whereas protoplasm is a substance which, upon the engram theory, only receives mechanical traces of sensations. The dual conception of protoplasm and psychoplasm combined enables us to conceive of psychic traces involving the registration of pure ideas divorced from sensations, as well as of sensations.

It is a curious thing that Semon's theory is founded upon the basis of sensations only, produced by stimuli which leave behind resultant molecular changes. The mnemonic traces of pure thought do not come into his picture. He does not seem to have considered any case like the "sermon-problem" case, in which a problem is solved internally, leaving mnemonic traces, without any sensory stimuli and in spite of all the external stimuli of the sermon which leave no appreciable traces. The nearest approach to this is his consideration of mnemic

excitations which he regards as producing sensations, which themselves produce an engram. But that an internal mnemic excitation can produce those mechanical (including chemical and physical) stimuli which operate to produce an engram, seems to be inconsistent with the mechanical engram theory. But if this difficulty can be overcome, it still leaves the difficulty that a theory of mechanically produced engrams will not cover the case of the memory of pure thought without and in spite of external stimuli. For this we require the conception of an immaterial substance such as psychoplasm in combination with protoplasm.

The hypothesis presented differs somewhat from McDougall's conception since it contemplates not a metaphorical, but a real and physical structure (for every etherial derivative must be regarded as physical) which co-operates with the material brain and serves as a link between sensorial impressions and consciousness. Furthermore, the hypothesis includes in its purview the slightly different concept of " Mental Structure "

which is to be found in McDougall's *Essay on Mental Evolution*,[1] in which he refers to the *innate* or *racial mental structure* which is the carrier of instincts, and to the "*complex mental structure*" which is built up by experience. And it should be noted that it links up with McDougall's original conception of an immaterial organization which serves for the integration of sensory stimuli. For the development of this aspect, we may refer to *The Mind and its Mechanism*, but it will be worth while to quote in this connection the following passage from McDougall's *Body and Mind*.[2]

"When two stimuli are simultaneously applied to the sense organs of any normal human being, they produce a change in his consciousness which is their combined effect or resultant. This composition or combination of their effects does not take place in the nervous system; the two nervous processes are nowhere combined or compounded—they remain

[1]pp. 344-348 included in *Evolution in the Light of Modern Kmowledge*.

[2]P. 197.

throughout as distinct as if they occurred in separate brains, and yet they produce in consciousness a single effect, whose nature is jointly determined by both nervous processes. These facts can only be rendered intelligible by assuming that both processes influence or act upon some one thing or being, and since this is not a material thing, it must be an immaterial thing. Our intellect demands this conclusion, and to refuse to accept it is to mistrust the human intellect in a way which amounts to radical scepticism or Pyrrhonism".

Now the hypothesis which we are to develop combines the three aspects to which reference is made above—a psychic structure as the basis of memory, a mental structure as the basis of instinct and habit, and an immaterial organization which serves to integrate a complex of sensory stimuli. The conception of the etherial but immaterial substance which we call psychoplasm, which is to be regarded as a concomitant of protoplasm, appears to lend itself to all these three aspects. Our hypothesis is that

every living cell has not only a protoplasmic structure, which is the material basis of life, but also a psychoplasmic structure, which is the basis of psychic life, capable of being affected by psychic factors and of retaining mnemonic traces.

One advantage of the psychoplasmic conception is that it enables us to envisage the transmutation of mere sensory impressions of a mechanical or chemical or physical nature into their ideal or psychic equivalents. For the reasons which have been given, there are mnemonic phenomena which we cannot reconcile with a mechanical registration of sensations. Neither can we get rid of the necessity for the integration of sensations and their transmutation into ideas before they are registered as mnemonic traces. How this transmutation takes place we do not know, but the facts tell us that it does take place and that some substance other than protoplasm is required for the registration of the transmuted sensations.

One test of a hypothesis is its capacity for combining in one view diverse pheno-

mena. The hypothesis of the ether, although it is postulated as immaterial and we are ignorant of its inner constitution, commends itself because it groups together on a common basis, electricity, magnetism, light, heat and the constitution of matter. The hypothesis of psychoplasm though it is immaterial and we can have no knowledge of its inner constitution, yet will be found to group together so many vital phenomena that it is well worth trying out. For the consideration of the potentiality of this hypothesis in various fields, we must refer to *The Mind and its Mechanism.*[1] Here we are only concerned with it in its application to memory.

If applied to memory, it will be found that this hypothesis furnishes a meeting point for various apparently diverse theories of memory. Its relation to McDougall's theory of "psychical structure" and "mental structure" is obvious. Moreover, directly we conceive living matter or "irritable substance" as consisting not only of protoplasm but of psycho-

[1] Kegan Paul.

plasm, the engram theory of Semon becomes tenable, with but little change. The conception of an enduring modification of the " irritable substance " by sensory stimuli which Semon calls an engram, is free from the difficulties pointed out in the last chapter if the engram is made not in protoplasm, but in a substance of the nature which we attribute to psychoplasm.

Professor Rignano[1] and others hold the theory that " Memory " is the general and fundamental function of living matter. If every living cell contains not only protoplasm but psychoplasm, we can attribute to the cell a simple psychoplasmic structure corresponding to the simplicity of its life history, yet sufficient for a record of past experience. Each cell would have a mnemonic character stamped upon it by its phylogenetic experiences and adequate to its own comparatively simply ontogeny. For simple cells such as the amoeba and various cellular units

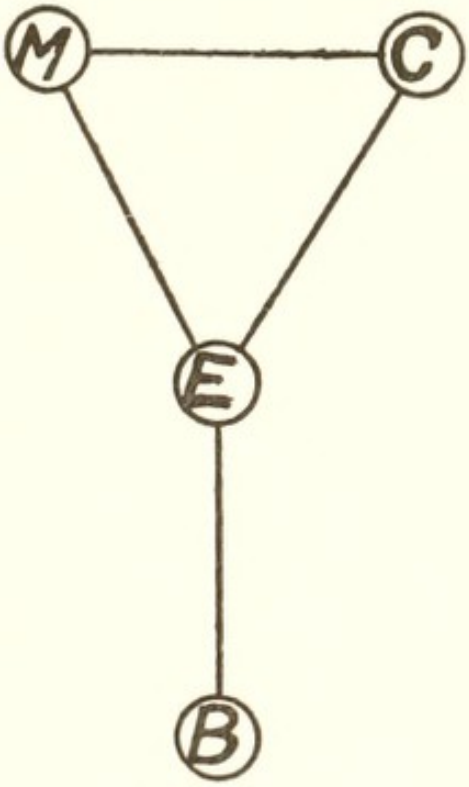
[1] *Biological Memory*—by Prof. Eugenio Rignano translated by Prof. MacBride (International Library of Psychology, etc.).

of the body, a relatively simple psychoplasmic structure would suffice. For the congeries of cells which make up a human brain, the psychoplasmic organization would be correspondingly complex, and we may refer to it functionally in man as the psychic brain, in contradistinction to the material brain. The notion of a psychic brain co-operating with the material brain,—the material brain responsive to sensory stimuli and the psychic brain responsive to the ideas into which the sensory stimuli are transmuted,—appears to furnish a clue to the solution of some difficult psychological problems. And in particular, it supplies an element which helps to assimilate some divergent theories of memory.

CHAPTER IV

THE MNEMA

We may indicate the relations between memory, sensations and consciousness by means of the accompanying diagram.



M stands for the psychic structure which receives and retains memory traces, to which the name MNEMA is given. B stands for the material

brain from which sensory impulses pass through E to consciousness C and to the mnema M. E stands for the EXCHANGE, i.e. the region in which sensory impulses from different areas of the cortex are combined and passed on to consciousness. E is also the region through which the impulses of motor ideas in consciousness pass to B in order to be implemented. The exchange E may be regarded as the gate or channel between the sensory tracts of the brain and the psychic region, for impulses either way. This view of E is of importance in the theory of hypnotism and of ideo-motor action, as E represents the point at which motor and sensory inhibitions are implemented. The theory as to the interaction between B and E is developed in *The Mind and its Mechanism*, but has little bearing on the subject of the basis of memory. All we need say is that the line B E represents functionally the channel through which impulses pass between the material brain and the psychic organ in either direction.

The exchange and the mnema are thus

purely functionally defined. We make no hypothesis as to their nature or their locality, or as to the nature or locality of consciousness. The mutual relations of the exchange, the mnema and consciousness are functionally well defined, but it will be understood that we are dealing with functions which may be separately considered, but not with tracts which can be separately located.

The distinction between the *mnema* (Greek μνημα) and Semon's *mneme* should be noted and at the same time the kinship between the concepts. The mnema on the present hypothesis is the "psychical structure" which receives and retains mnemonic traces. Semon's *mneme* is defined by him as "the totality of the mnemonic potentialities of an organism." The mnema contains the psychogram store (which corresponds to Semon's "engram store") in which it may be supposed that the "mnemonic potentialities" reside. Setting aside the fundamental difference between a protoplasmic engram and a psychogram, it will be found that a very large part of Semon's

psychology applies equally upon either basis of memory. Both depend on permanent mnemonic traces, in relation to which Semon's theories of ecphory, homophony and association may, with little change be utilized. This essay is chiefly concerned with the *basis* of memory and not with the many developments which can be worked out in a similar way on either hypothesis.

In our diagram, C stands for consciousness, which is open both to the Exchange E for integrated sensory impressions and also to the mnema M for records of experience. The facts indicate that there is a double road to consciousness, *via* the mnema and the exchange, and a double road to the mnema *via* consciousness and the exchange. The conception of these double paths is forced upon us by various phenomena, with which it will be found to be in harmony.

Consciousness in this scheme stands for the "awareness of the ego." We may regard consciousness as a screen upon which a twofold set of pictures may be simultaneously displayed so as

to blend together—pictures of the present through the exchange, and pictures of the past from the mnema. These pictures are super-imposed and blend into one, the sensory picture through the Exchange "ecphorising" or calling forth from the mnema the relevant picture of past experience. The "mind's eye" cons the total picture. As the mind's eye roves from idea to idea, one idea after another is brought into the centre of the field of consciousness, just as the movement of the physical eye brings one point after another of a landscape into the centre of the field of vision. As with the physical eye the field of vision is limited, so there is a margin to the field of consciousness where ideas are only dimly perceived and beyond which ideas are not perceived at all. As the mind's eye roves, and new linked ideas are brought near the centre of the field of vision of the mind's eye, that is of the field of consciousness, some ideas are pushed beyond the margin and other relevant ideas are brought within it. A primary idea may be always kept near the centre

of the field. Adjacent relevant ideas are by attention brought into closer relation with the primary idea as others are pushed out of sight. So the picture changes until, perhaps, by concentrated attention a new constellation of ideas is formed with the primary idea linked with all of them, and this constellation may sink into the mnema producing an appropriate psychogram which will serve for the recall of the whole group when an associational link is presented at a future time.

It will be noted that we are especially concerned with the genesis and retention of constellations of ideas, whereas Semon is primarily concerned with the record of sensations.

In the diagram, the joining lines indicate a flow in either direction. Thus mnemic materials pass from M to C and ideas pass from C to be recorded in M. Sensory impressions flow from B to E and thence to C for perception along with mnemic ideas from M. From C to M the perception or from E to M the sensory impression passes for record. The sensory

stimuli which affect the cortex pass from B to E, and the psychic stimuli upon which ideo-motor action depends pass from E to B.[1] The theory of Memory has primarily to do with the triangle MEC. From the mnema M there is a constant flow of ideas into C. What governs this flow is a kinship or linkage or association of ideas which we shall consider more fully later. This flow is largely automatic, but in controlled thinking, it may be directed by the ego. Every sense impression which passes from B to E and thence to M and C draws out or "ecphorises" a relevant mnemic record from M which also passes to C and amplifies the sensory impression. Most sensory impressions would be imperfect and would fail to carry their full meaning unless amplified from M. The relevant mnemic records of past experience combine with the sensory impressions from E to give full perception in C.

Thus a caricature of a known face consisting of half-a-dozen bold lines, may at once extract from the mnema the

[1]See the *Mind and its Mechanism*, Chapter VI.

image of the face, and relevant ideas relating to the person may also flow from the mnema into consciousness.

But the amplification of the sensory impressions is sometimes incorrect. A poor caricature may bring the wrong face to mind. A distant haystack may call up the picture of a house. Attention is directed in consciousness both to the sensory impression from E and the mnemic record from M and a process of comparison and judgment ensues.

The variety of the images which the mnema may furnish for the elaboration of imperfect sensory impressions is illustrated by Mr. Frank Smith's experiments,[1] in which a lantern slide picture is thrown upon a screen for one-thirtieth of a second, the spectators being severally asked to describe what they see. The mnemic traces ecphorised differ very widely.

The record in the mnema is called a psychogram to distinguish it from Semon's material record which he calls an engram. Semon's engram is a record in proto-

[1] *British Journal of Psychology*, 1914, VI, pp. 321-362.

plasmic structure, whereas the psychogram is conceived as a record in psychic structure, the substance of which is called psychoplasm to contrast it with protoplasm. We cannot conceive of the nature of such a psychoplasmic record. Nor can we conceive of the nature of a protoplasmic record. In both cases we have to be content with a functional description. There are obviously two classes of psychograms which however are closely connected. The psychogram or mnemonic trace which recalls to memory a landscape, a face, a tune or other sensory impression may be called a sensory psychogram. When ecphorised we may visualize the landscape, or the face, or hear (as it were) internally the tune. On the other hand the psychogram which enables us to recall a theory or an argument, or a generic idea may be called an ideal psychogram. The two classes seldom occur separately. The sensorial and the ideal are usually closely linked. We might place the psychogram which governs the motor movements of a habit in another class. But for the present purpose it is not

essential to pursue the classification of psychograms. The material point is that we can only conceive of Semon's engrams as being sensory in character, whilst the concept of a psychogram is sufficiently flexible to include purely ideal mnemonic traces. We have (in common with others) endeavoured to show that the notion of basing memory on permanent engrams in protoplasmic structure is untenable.

But if we replace this idea by that of permanent psychograms in psychoplasmic structure, most of Semon's inferences can be worked out on this basis and with a greater correspondence with mnemonic phenomena. Semon's Law of Engraphy is as follows :—

" All simultaneous excitations within an organism form a coherent simultaneous excitation complex which acts engraphically, that is, it leaves behind it a connected engram complex constituting a coherent unity."

His law of ecphory is as follows :—

" The partial recurrence of the energetic condition which had previously acted engraphically acts ecphorically on a

simultaneous engram complex, or more precisely described, the partial recurrence of the excitation complex, which left behind it a simultaneous engram complex, acts ecphorically upon the latter whether the recurrence be in the form of original or mnemic excitations."

If for "engram" and "engram-complex" we substitute "psychogram" these laws and their chief implications or corollaries apply with full force under the present theory. To ecphorise the engram is for the present theory to evoke a memory from a psychogram in the mnema by means of association. For this evocation from the mnemic psychogram, we shall find it convenient sometimes to use Semon's word "ecphorise." It will also be convenient to use the word engram to signify the modification of protoplasmic structure which undoubtedly takes place under the influence of a sensory stimulus. This engram will be the same as Semon's engram, except that in our view it will more or less quickly fade away under the influence of metabolism. The permanent thing will

be the psychogram, enduring when the engram fades. This denial of the permanence of the engram is forced upon us by the considerations stated in chapter II. But the influence of the transient engram in producing the primary image in consciousness is of the first importance.

When there is a sensory stimulation of the cortex, an engram is necessarily made, quite independently of whether there is a resulting effect in consciousness. The sound vibrations which impinge upon the ear and the light vibrations which impinge upon the eye must produce their resultant engrams in cerebral structure. Now this transient engram is the means and the only means, by which the primary image or idea is displayed in consciousness. It may not reach the focus of consciousness, if the field of consciousness is already filled. Such is the case of the man who is listening to a sermon, whilst his mind is occupied with some alien problem ; or the man who has the power of concentrated attention, and writes a letter with no knowledge of the subject of a conversation near by.

From the mechanical and physical point of view we must regard the engram as having been made through its duration is transient. There is some reason to think that a psychogram also may be registered in the mnema, even though utterly unobserved in consciousness at the time. How then are we to account for the fact that it appears to leave no memory trace? The answer must be that where there has been no attention, the association links necessary for recall are not established. The psychogram (if it be induced) is a solitary constellation, without links which would serve to evoke it. Yet as every idea (see next chapter) has an *entourage*, there is a possibility that some obscure link to the entourage of some idea in the constellation might, in rare cases, serve for the evocation of a memory of something to which little attention was paid at the time.

Attention is a factor of the highest importance in reference to mnemic impression, retention and recall. By attention in consciousness a meaning is given to the complex of sensory impressions.

By attention association links are forged which will serve to "ecphorise" the psychogram and elicit memory. Without such attention there may possibly be a record in the mnema, but the links which enable the situation to be recalled are not forged.

According to the present hypothesis, the first stage is the transient engram in B. This engram is the immediate cause of the image in consciousness which corresponds to the sensory impact. This is not a memory image. It is the primary image. It takes some time for metabolism to regenerate the cells modified by the sensory impact. During this time the primary image persists, but with fading strength. Usually various simultaneous sensory impressions in cerebral structure have to be passed on to the Exchange and sent forward to consciousness in an integrated form. To save complication, we may speak of these simultaneous cerebral modifications as if they constituted one engram. It is this complex engram, which through the Exchange, produces the primary image

in consciousness. Referring to the diagram, the influence of this complex Engram in B passes through E and divides into two streams. One goes to C to produce the primary image in consciousness. One goes to M to produce a mnemic record. And also when attention is given in consciousness to the primary image the influence from C flows to M as well as the influence from E to M, and the two together combine to make the record in M. Without this double flow to M the resulting psychogram appears to be of small intensity and difficult to recall.

Commonly observed phenomena seem to show that the engram persists for a longer or shorter time, and during this persistence the primary image in consciousness may also persist. Thus a visual engram persists for about 1/16th of a second in full force. Moreover that it takes a little time to fade is easily observed. Look at the face of a person sitting opposite to you in a railway carriage in a good light and then shut your eyes. You will still for a short time have a good picture of the face in consciousness.

This is not a memory image, but a residual image from the engram which has not yet faded. Of course with sufficient attention, it may lead to a true memory image. So you may perceive the number of a motor car which passed you, and retain a residual image of it for a short time, after which it fades. But if you have given attention to it the record may be more permanent. Thus with the number 6834, the mere fact of giving sufficient attention to note that the first two figures are double of the second pair, may fix it in the memory. The mnemic psychogram is the result of the influence E to M combined with the influence C to M.

The residual auditory image is of great importance. In listening to a conversation we must have in consciousness not only the sensory effect of the word being spoken but of the words which have just been spoken. The residual image of the words just spoken must be fused with the words being spoken.

As Professor Margaret F. Washburn points out :—

"The necessity from a practical point of view of some such arrangement is obvious. An object seen can often be looked at a second time; the characters not apparent at the first glance can be apprehended at the second. But a sound is usually fleeting, it is gone beyond recall in a few seconds, and what we did not apprehend while it lasted we must be able to catch in the memory after-image, or we shall lose it for ever."

It seems preferable to speak of this "memory after image" as a residual image.

If you hear a sound, such as the blast of a motor-horn, without particular attention, you can recall the exact sound for a short time afterwards, but not for long. This is the residual image. If however you have paid sufficient attention to compare it with your memory of other horn noises you may be able to recall it later. You have forged a psychic link and though the engram fades a psychogram may remain.

It may be worth while to summarize the foregoing very shortly. A sensory

stimulation produces an engram, which is the primary cause of an image in consciousness. The engram fades, but as long as it lasts it may produce a residual image. The influence of the sensory stimulation which produced the engram passes on through the Exchange to the Mnema and to Consciousness. If attention is given in consciousness, association links are created which are connected with the mnemic trace or psychogram and serve to "ecphorise it" and reproduce the situation at a future time. If there is no attention in consciousness, the situation is normally beyond recall.

An important function of the mnema is the summation or co-ordination of separate kindred partial impressions to form a complete or generalized psychogram. For instance, every visual impression of a given object is more or less a flat picture from the particular point of view. Fresh impressions of the same object from different angles become associated in one mnemic group until at length we attain a complete all round impression of the object, which, if our power of

visualization is sufficient, will enable us to call up a mental picture of the object from any angle. Or if we cannot visualize the object, we shall be able from whatever point of view it is presented, to recognize it by comparison with the mnemic presentation of the object in consciousness.

Again, in the case of objects of which there are many very dissimilar varieties, such for instance as dogs, all our separate impressions of different types of dogs, from a toy spaniel to a St. Bernard become associated in the mnema, so that we ultimately obtain as a psychic resultant a generic psychogram of the animal which we call a dog. So in the same way we obtain a generic psychogram of the object which we call a tree. All the features of trees which they have in common become associated in the mnema in a generic group, and when we see a tree, the species of which is unknown to us, we compare it with the generic mnemic presentation and recognize it as a tree, though of unknown species. We may say (see next Chapter) that all the different

species form an *entourage* around the generic idea.

Still more inclusive is the generic psychogram connected with the word *plant*. Our generic idea of the word plant has many hundreds of associations. A complex of sensations has given birth to an idea. It is difficult to think of the idea of a plant as being located in a material engram, or to think of the hundreds of associations between the word plant and members of the vegetable kingdom, as being represented by hundreds of association fibres. We will deal further with this in the next chapter.

Under the description of " homophony " Semon deals at great length with the blending of original excitations and mnemic excitations. Much of his analysis is applicable to psychograms equally with engrams. But our conception of a generic psychogram differs from his. He observes [1]" When we speak of a dog as distinguished from a wolf, we immediately have an abstract image of a dog which is the product of the homophony

[1] *Mnemic Psychology*, p. 277.

of thousands of separate engrams." Personally, if I try to evoke the image of the abstract dog, I get an image of a dog which is probably of the kind with which I am most familiar. This appears to show that the generic psychogram is not of an abstract dog but of the abstract *idea* of a dog. It is a psychic abstraction which cannot well be thought of in terms of thousands of engrams or of a cerebral engram which is their resultant. And as a psychic resultant of integration and combination the record of the abstract idea is best thought of as a psychogram, which includes the generic idea with an entourage of specific examples.

One of the chief functions of the mnema is to supply us with appropriate words to express ideas in consciousness. As a matter of usage in various ways a single word may have various connotations or meanings. The mnemic record of the word becomes surrounded with an entourage of linked meanings to which it will respond (See next Chapter). The word will be evoked when it is desired to express an idea in consciousness with the relevant

meaning. Sometimes the response is difficult. It may be that there is no appropriate word to express the meaningful idea. An illustration may be given. I read the following sentence—"It is said that one of the most important functions of consciousness is to shield the mind from the memory of disagreeable experiences." It strikes me that the word *function* is not the right word, since it is hardly a function of consciousness to produce unconsciousness. It is something outside consciousness yet accompanying it. I grope about for a better word than "functions of" and try in succession attendants upon, attachment to, appendages to, characteristics of, concomitants of, co-operators with, collaborators with, appurtenances of, annexes to, adjuncts to, accessories of. The last two seem the nearest, and I get the idea more clearly expressed by writing "adjuncts to" instead of "functions of". Even then the sentence requires modification. The point is that this kind of groping in the mnema for the right word to express the idea which is in

consciousness is a psychic process which is not illuminated by the idea of engrams. Each of these alternatives has its own entourage of meanings—a constellation of ideas grouped around it by psychic links by means of which the particular alternative may be evoked when it is relevant, to be rejected if not found to fit the idea to be expressed.

The lodgment of determinants and complexes in the mnema is a matter of the highest practical importance, but it is a matter of general psychology on which it is not necessary here to enlarge. Both determinants and complexes are constellations of ideas lodged in the mnema which can readily be explained on the theory of psychograms. But they are difficult to explain on the theory of engrams. A free trade complex, or a protectionist complex, or a religious complex may be the result of Education. A materialistic complex, may be the result of a conflict.[1] Each would be represented by a group of psychograms

[1]See *A Neglected Complex* by W. R. Bousfield (Kegan Paul).

which would be evoked from the mnema when relevant to the subject in consciousness, or might operate outside the field of consciousness to secure the rejection of opposed ideas. When presented in consciousness with other materials they would enter into the determination whether of judgment or opinion or action. It is difficult to see how the theory of engrams mechanically produced by sensory stimuli could deal effectively with the psychic aspect of determinants and complexes.

CHAPTER V

ASSOCIATION AND SELECTION

We are unconscious of our stored memories until they are extracted from the mnema.

Recollection is the revival in consciousness of the impression, or situation, or constellation of ideas recorded in the mnema. It depends essentially upon ideal linkages or associations. A linkage between two ideas is set up when they are the component parts of a joint impression, especially when their mutual relation is a subject of attention. Of what is the essential nature of the psychic bond which constitutes a Linkage, we are in complete ignorance. We must accept it as a fact of experience, but we have seen that a psychic linkage is far more effective than an association of mere contiguity.

Two ideas joined by an associative link may be said to be relevant to one

another, but links attach ideas to one another, not only in pairs but in groups which may be extensive. *Every idea has an entourage of relevant ideas grouped around it* which may be very numerous. Thus if a hypnotised subject is told that he is Napoleon, the whole stock of his ideas as to Napoleon becomes available as a group, which enables him to act and speak the part so far as his stock of ideas goes.

The barrister with two cases on in two different courts is able, as he passes from one court to the other, to switch off his attention from one group to the other. He absorbed the two groups separately and is able to retain them and evoke them as separate groups.

Another kind of grouping is illustrated by the moon theory (ante p. 32). Here the invisibility of one side of the moon, the phenomena of tides, the original liquid state of the moon, the rotation of the moon, the earth's attraction, etc., were brought into a logical group which formed a constellation of ideas registered as a single psychogram consisting of

facts and conclusions grouped in a novel manner.

For the purposes of recall the strength of the different links depends upon many factors. Concentrated attention is of great importance. The repetition of the impression is an element. Psychic repetition plays the same rôle as attention and is usually of more importance than sensorial repetition.

When an idea is recalled to the centre of the field of consciousness and is examined in relation to kindred ideas, new linkages may be formed or the old linkages strengthened. The idea then sinks back into the mnema with an added entourage and will emerge again in due course with greater force and facility.

An emotional atmosphere connected with the impression will deepen it. The boys who are whipped at points on the boundary of a city will retain a more vivid recollection of the spots where castigation takes place. A strong linkage between the features of the spot and the notion of the city boundary will be set up.

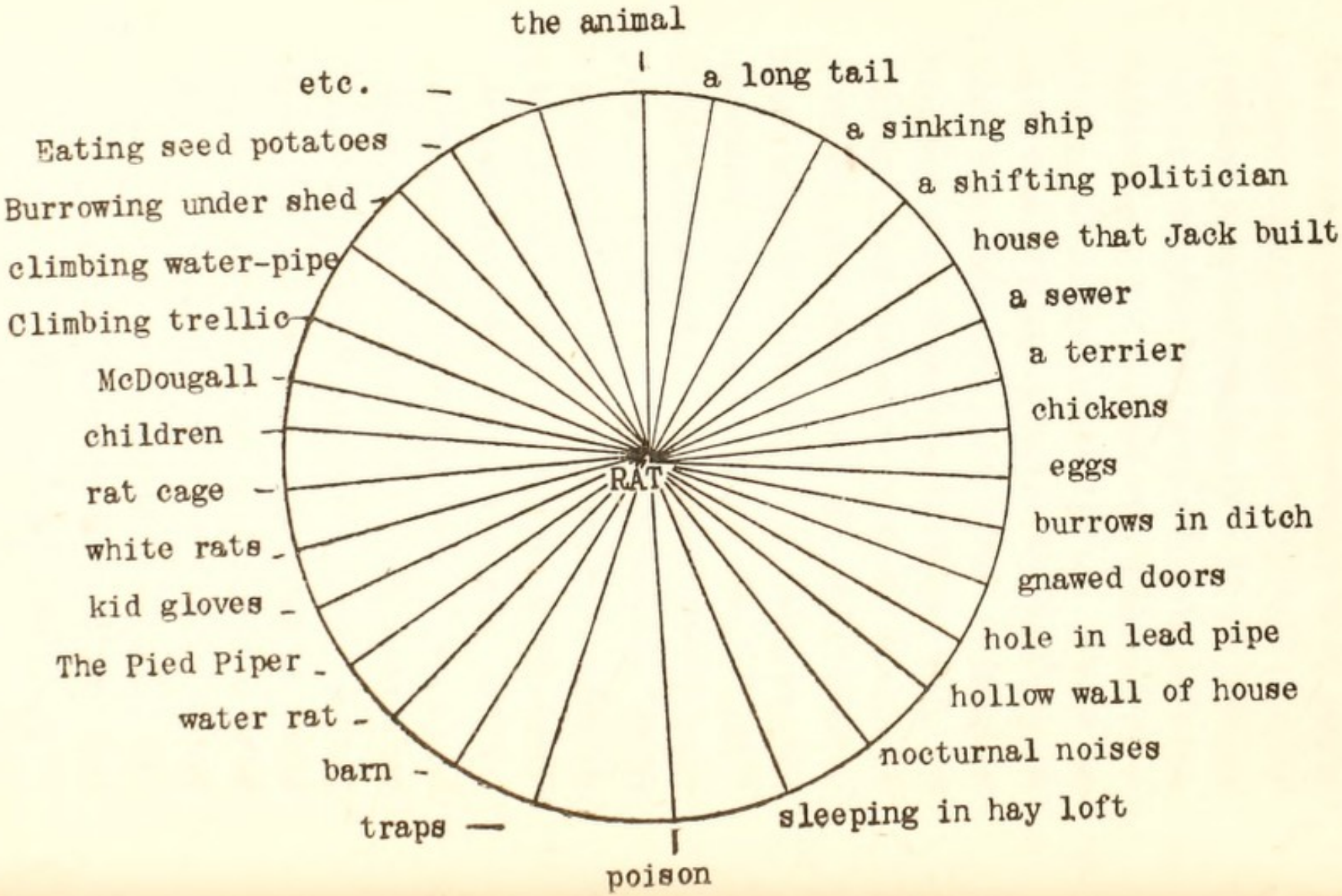
A mere relation of contiguity or con-

temporaneity will give rise to a much less intense linkage than a psychic relation involving attention and meaning. Thus you may note the number of a motor car in passing and remember it for five minutes to find that it appears to have passed entirely from memory. If, however, you have given sufficient attention to turn the visual sensation into an ideal form which imports a meaning, even a slender one, the memory may survive. If (say) the number was 1929 and you note that it is a unit more than the number of the year (1928) you have formed a psychic link which may recall it. Attention has given a meaning to an otherwise meaningless number, and so forged a link.

There are few ideas which have not an extensive entourage or system of linked ideas, dependent on the various experiences in which the principal idea was presented along with another idea. Thus the idea of a rat may be associated with the general appearance of the animal. On one occasion its long tail may for some reason make a special impression.

It may on different occasions be associated with the sinking ship, which rats proverbially desert, or with a politician who has "ratted" or shifted his allegiance to another party, or with "the malt that lay in the house that Jack built", or with a drain or sewer from which a rat may have emerged. So the idea of rat acquires many linkages, but half-a-dozen will suffice for illustration though the entourage may include fifty linked ideas arising out of different occasions where the idea of the rat was presented in consciousness simultaneously with another relevant idea.

I may set down a few personal associations with the word rat which occur to me in addition to those mentioned above :—terrier, chickens, eggs, burrows in a ditch, gnawing doors, hole in lead pipe, hollow walls of house, nocturnal noises, sleeping in hay loft, poison, traps, barn, water rat, the Pied Piper of Hamelin (with an entirely new set of linkages), kid gloves, white rats, cage and children, McDougall and his experiments, climbing trellis-work, climbing


RAT
the animal
a long tail
a sinking ship
a shifting politician
house that Jack built
a sewer
a terrier
chickens
eggs
burrows in ditch
gnawed doors
hole in lead pipe
hollow wall of house
nocturnal noises
sleeping in hay loft
poison
traps
barn
water rat
The Pied Piper
kid gloves
white rats
rat cage
children
McDougall
Climbing trellic
climbing water-pipe
Burrowing under shed
Eating seed potatoes
etc.

water pipe, burrowing under shed, eating seed potatoes, etc. These are represented in the diagram as part of my entourage of the idea "rat."

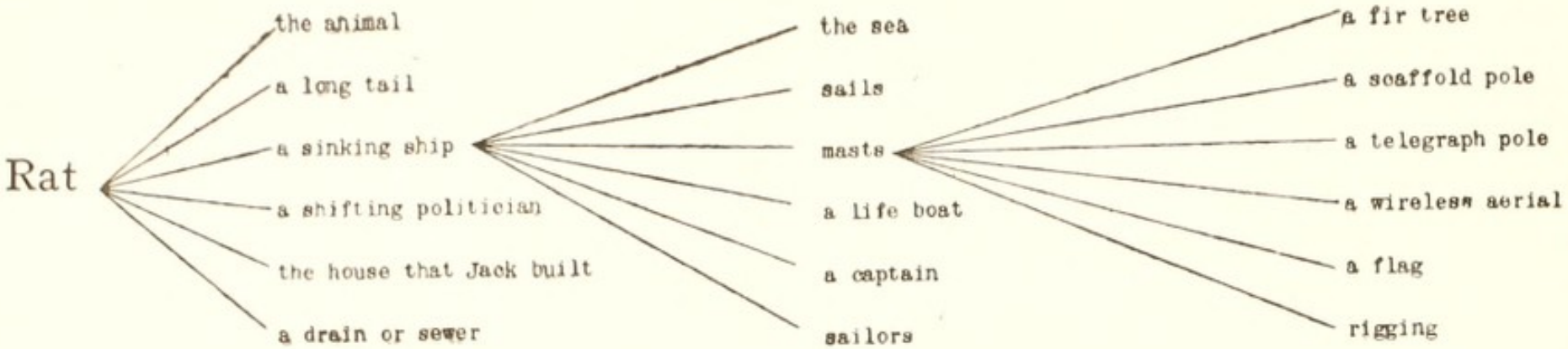
Professor Pear observes[1] "any thought of which we are temporarily aware is simply the apex of a pyramid of memories associated with it." Our diagram may be also taken as representing a view of Professor Pear's pyramid from above.

Now each of the fifty ideas which experience may have linked to the word "rat", and which form its entourage may itself have fifty linkages and each of these another fifty and so on, in fact we may soon run into millions of linkages. The possible number of links is not limited by the number of single words in the language. For instance the word boy may play the leading part in many compound ideas. We may have as separate ideas a good boy, a bad boy, a white boy, a black boy, an errand boy, a call boy, a pretty boy, an ugly boy, etc., etc., etc. In the diagram a sort of genealogical tree of ideas related more or less remotely

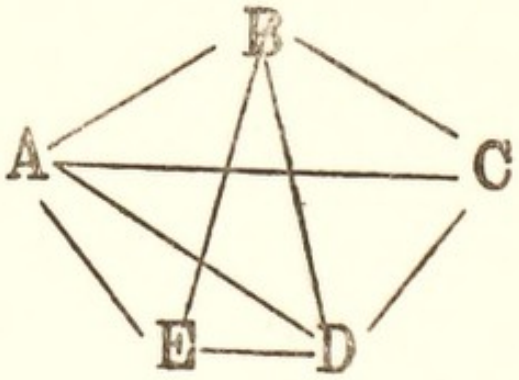
[1] *Remembering and Forgetting*, p. 86

to the word rat is given, but for reasons of space only six ideas are shown linked to the word rat, and of these six ideas, only one is expanded into six more and so on. In this diagram of three generations of ideas if there were space to show them, there would be six in the first generation, 36 in the second generation and 216 in the third generation, totalling 258, resulting from giving each idea only six linkages. How many there would be, for 100 words in 100 generations may be left to the reader to compute. Suppose the word rat to have ten linked ideas and each of these to have ten linked ideas and so on. Then a chain of only seven, would have ten million links. The idea that these linkages are represented by millions of permanent paths in cerebral structure seems fantastic. We cannot think it out in terms of protoplasm and we are driven to such a concept as psychoplasm as the carrier of these linkages.

Each of the two linked ideas has its own entourage of which it is the centre. Thus the ideas *rat* and *ship* have each an


Rat
the animal
a long tail
a sinking ship
a shifting politician
the house that Jack built
a drain or sewer
the sea
sails
masts
a life boat
a captain
sailors
a fir tree
a scaffold pole
a telegraph pole
a wireless aerial
a flag
rigging

entourage which intersects the other. The central idea may recall any idea in its entourage and any idea in the entourage may recall the central idea. Every idea may be part of the entourage of many other ideas. And in this statement we must understand the word idea, as including groups of relevant ideas. If we could make a map of all the ideas in the mnema with their linkages, we should have a diagram of enormous complexity. On a small scale suppose there is in the mnema a constellation of ideas A.B.C.D.E. They may



be linked in a string or linked in all directions as indicated in the diagram or in any other way. If a sensation brings (say) A into consciousness not only is the former experience of A

extracted from the mnema, but possibly the whole group or a prominent part of the group, say A.B.D. If attention is directed to B it may draw C and D and E into consciousness.

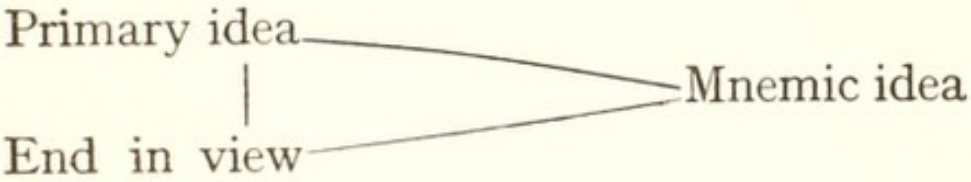
When without directive thought the mind is allowed to wander, we get ideas chasing one another in quick succession, until in a few seconds we may get far from the primary idea which started the train. Furthermore, we get not merely a confusing succession of ideas, but also a confusion of simultaneously presented ideas. Even in idle thinking this confusion is limited by the limitation of the field of consciousness. As with physical vision things too far from the centre of vision are so dimly perceived as not to count for much in the picture, so with consciousness the mind's eye, unless it roves, only covers distinctly a comparatively small area of the field. The ideas more forcefully linked to the primary idea are grouped around it in the field. Those less strongly linked, recede towards or over the margin of the field. With idle thinking these processes are almost automatic.

When thinking ceases to follow an automatic course the directive influence of attention comes in. The margin of the field of consciousness may be voluntarily contracted. Voluntary attention will energize some ideas and bring them into the centre of the field thereby driving irrelevant ideas towards or over the margin.

When the mind's eye is focussed on an idea it is brought into the centre of the field of consciousness. This primary idea will have an entourage of secondary ideas which we may regard as being grouped around the primary idea some without and some within the margin of the field of consciousness. The direction of attention to one of the secondary ideas may draw it into the centre of the field of consciousness, and it may become the primary idea which will extract other secondaries from its own entourage and so on. Or the mind's eye may rove over the secondaries still keeping the primary idea in the centre and causing a regrouping of the secondary ideas, with expulsion of some beyond

the margin, making room for other secondaries.

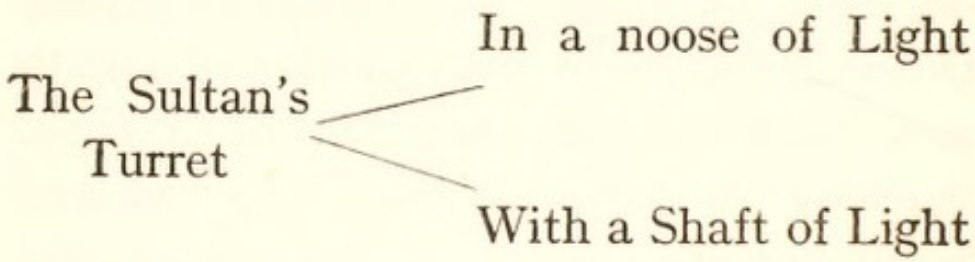
Dr. Driesch (*The Crisis in Psychology*, p. 61) regards the crowding of ideas as being kept in check by a " determining tendency ". The operation of this determining tendency in controlled thinking depends upon the directive and selective influence of the ego, in conjunction with the end in view, and upon the double linkage between the primary idea and the end in view and the mnemic idea and the end in view. This is illustrated in the diagram.



This double traction acts selectively upon relevant mnemic ideas. The joining lines may be compared with the analogy of chemical bonds.

The operation of the links which evoke an idea from the mnema may be usefully compared with Semon's idea of the stimulus which causes the " ecphory of an engram " in the case of " engram

dichotomy ". Semon gives as an example of engram dichotomy, the line at the end of the first stanza of FitzGerald's translation of the Rubaiyat of Omar Khayyam which varied in two editions so as to give the alternative readings :—



He observes—" We are left to wonder whether the engram ' turret ' will act ecphorically on ' in ' or on ' with '. Little doubt may be indulged, if of the two associations one is closer and therefore stronger ecphorically than the other."

He applies the theory of engram dichotomy to the case of the honey bee, in which each fertilized egg is capable of producing either a worker bee or a queen. At an early stage of grub development there is dichotomy, which permits either a worker bee engram or a queen bee engram to be ecphorised. The stimulus which determines which engram is ecphorised, is a chemical

stimulus resulting from the nature of the food supply.

This is an application to somatic growth, the discussion of which is outside our purview. But it is very suggestive as regards what we might call psychic engrams, but prefer to call psychograms. In the realm of ideas there is not merely dichotomy but polychotomy. The polychotomy of psychograms is a notable feature in the psychic realm, every idea having a numerous entourage of secondary ideas. But the stimulus which "ecphorises" the psychogram and determines which branch of the polychotomy shall be followed, is no longer a chemical stimulus but a psychic stimulus. This stimulus is determined by the primary idea, the idea of the end in view, the relevancy to both ideas of the mnemic idea to be drawn into the group, the strength of the links and the directive action of the ego in the concentration of attention. And in addition, there will be the influence of relevant determinants and complexes stored in the mnema. All these are compounded in the stimulus

which determines the "ecphory" of the branch of the polychotomy which shall be followed; or in our terminology, the selective traction of the primary idea upon the more or less relevant entourage of mnemic ideas which are linked to the primary idea. There may be more than one secondary idea drawn into the field of consciousness. The factor of attention or concentration, as the mind's eye roves from one idea to another which may be drawn into or near the centre of the field of mental vision, keeps the main idea and the end in view energized and central and drives to the margin less relevant ideas which may tend to intrude. And so, as attentive thinking proceeds, a new group of strongly linked relevant ideas is formed, which may sink as a new group into the mnema as thinking proceeds and can be recalled as a group when the end in view or the solution of a problem is reached. Such a description of the process seems to be in conformity with experience. It can be rationalized coherently in terms of the mnema and consciousness, but

not in terms of changes in cerebral structure.

It seems to be clear that the result of every thinking process which involves attention and comparison is to produce new psychic linkages. Existing ideas and constellations of ideas are evoked from the mnema into consciousness, and brought by thought processes into new relations to one another, bound together by the psychic linkages so created.

We may take the case of the moon theory (ante p. 32) elaborated by a process of pure thought working on old data never before brought into juxtaposition. This involves the association of a number of old memorial traces into a new constellation of ideas which forms the theory. The linkages are logical linkages of a psychic nature, without any external stimuli to produce molecular changes in neural structure. The same process occurs in the case of the sermon-problem (ante p. 34).

It seems clear that we can give no adequate account of such processes in

terms of a mechanical theory of engrams and neural association paths. We might rationally think of simultaneously created contiguous engrams as having a molecular connection which might serve the purpose of associative linkage. But when we see that such a theory is inapplicable to the case of pure thought linkages, it seems more rational to regard all association linkages as of a psychic nature. It is true that we can form no conception of the intimate psychic structure which constitutes such a linkage. Neither can we form any conception of the intimate mechanism of a thought process. But we know by experience that we can think without knowing how and we also know by experience that we can form pure psychic linkages without knowing how and without any external stimuli which might be considered to form molecular associations.

CHAPTER VI

HABIT

The theory of psychograms which we have postulated as the basis of Memory, is equally applicable to the explanation of *Habit*. To use popular language—Habit is experience crystallized in appropriate psychograms. We have no need to distinguish motor memories in a separate category. Let us take as a simple example, the acquisition of the walking habit by a child.

The walking habit involves the rhythmic control of certain muscles which determine the movements *inter alia*, of legs and feet. These muscles are controlled through synapses situated in the course of the nerve paths leading to the muscles. The synapses act as switches to regulate the flow of nervous impulses to the particular muscular elements involved. In learning to walk, voluntary control of the synapses is attempted, until by a trial-and-error process, the habit is

acquired and the synapses are readily operated in due sequence. The balancing process is of course of the first importance, but we need not complicate the illustration by its introduction. According to the present theory this process of trial and error creates a psychogram lodged in the mnema, which operates through the exchange to govern the orderly sequence of the synaptic switches. An ideo-motor impulse in consciousness ecphorises the relevant psychogram in the mnema and through the exchange excites the relevant muscles.

A motor-habit then, rests upon the same basis of psychograms as memory, but in the case of a motor habit, the psychogram when ecphorised serves to guide muscular movements, and its operation may be independent of consciousness. It would take us too far to discuss here the theory of voluntary ideo-motor action and the way in which by the method of trial-and-error it leads to habitual motor action.[1] It must

[1]This matter is discussed at length in *The Mind and its Mechanism*, Chapter VI.

suffice to say that the conception of a motor idea in consciousness may be said to cause two simultaneous excitations. Referring to the diagram on page 51 *ante*, one of these excitations travels by the path C M to the mnema and there ecphorises the relevant psychogram which controls the synaptic sequences. The other excitation travels by the path C E to affect the synapses in B in the manner determined by the psychogram which is ecphorised. For a series of rhythmic actions, such as walking, the tune set by the psychogram is repeated as long as desired.

Now let us contrast this theory with the theory which attributes habit formation to the creation of "permanent paths of low resistance" in the system of motor nerves and synapses. Before the creation of the habit, the synapses involved were subject to voluntary excitation, that is, their resistance could be governed in accordance with the voluntary motor idea conceived in consciousness. After the habit is formed, the resistance of these synapses is supposed to be

permanently lowered, so as to create paths of low resistance for the habit impulse. Now such a fixation is inconsistent with other uses of these synapses. The same muscular elements which come into use in walking are required in many other combinations for other purposes. Some of these purposes are habitual and each habit would require its own synaptic fixations. Other of these purposes are voluntary, and permanent synaptic fixations would interfere with voluntary use. If thousands of habits, involving all the muscles of the organism, were represented by permanent paths of low resistance due to fixations of the synapses, the use of the nervous system for voluntary non-habitual movements would be confused at every synapse.

Furthermore, even if fixed paths of low resistance would serve for the walking habit on smooth ground, we have to remember that the same muscles, with a number of others, have to be used for walking on rough ground, when stones and other obstacles are strewed in the way. Every step may have to

be consciously taken as a voluntary act, and each step differing from the last. Many of the muscles required are the same as in rhythmic walking, but if the requisite synapses have been fixed for the rhythmic habit, they will be unable to respond to requirements which vary at each step. The conclusion seems to be forced upon us that to cope with all the varieties of steps required, the machinery of motor nerves and synapses must be kept intact for all the required voluntary movements and not burdened with synaptic fixations. Psychograms will come into action as ecphorised by the situation and may be of various kinds learned by experience. But cases would often occur where each step would have to be thought out with but little guidance from experience, and muscles would have to be used in quite unfamiliar ways. Fixations in the nervous system would be hindrances when not required.

It is the same question again as we met with in the case of cerebral cells. Are we to regard these cells as returning

to their original uses when an excitation has been effaced by metabolism, or are we to regard them as being devoted to mnemic purposes and incapable of being again utilized for their original purposes? So with nerves and synapses which constitute the nervous system. Are we to regard these as returning to a normal state when they have been used in the course of habit formation, or are we to regard them as being permanently changed and so put out of action except for the particular habit?

It seems more reasonable to regard the organism as one on which many tunes can be played without impairing the facility for playing other tunes. Obliteration of effects of use, and regeneration of cells seems to be the pervading scheme of the whole material organism.

Directly we regard habit, like memory, as leaving its traces in psychic structure instead of in protoplasmic structure, all difficulty disappears—except the difficulty which some people have in believing that there is such a thing as psychic structure. All parts of the proto-

plasmic structure are (like the retina of the eye) after use regenerated by metabolism to serve again their proper uses.

From the point of view of habit, we therefore regard the protoplasmic structure of the organism as machinery for affecting the psychic structure of the organism by building up psychograms which in their turn will enable the psyche to govern the movements of the material structure in a more efficient manner. It is these psychograms so created in psychic structure which we regard as the "motor memory" of the organism. In principle, these psychograms which govern the motor activities of the organism, do not differ from the psychograms which affect the mental activities of the organism.

Similar reasoning applies to the grafting of a restraining habit upon an instinct. The instinct of pecking at a small object is innate in the newly hatched chick. At first it is unable to distinguish between nasty caterpillars and nice ones, but it soon learns by experience to avoid the nasty caterpillars and restrain the pecking

instinct. It is suggested that this restraint is brought about by a loop line of controlling cells which are activated by the sight of the nasty caterpillar and operate to restrain the pecking impulse. But the psychogram theory saves us from the improbable theory of the formation of a loop line. Here, as in many cases, the study of hypnotic phenomena gives us the clue. If we say to a hypnotized person—"When you see a biscuit stamped with the name MacHuntley, you will know that it contains poison and will refuse to eat it", we know that such a suggestion would be carried out, and we attribute this to the formation of an anti-psychogram by the suggestion, which is ecphorised by the sight of the name MacHuntley. Suggstions of this sort which inhibit sensations and actions are the commonplace phenomena of hypnotism, and their simplest explanation is given by the theory of psychogram formation. So in the case of the chicken, the experience of two or three or more nasty caterpillars operates as a suggestion even more forcible

than a hypnotic suggestion, and creates a restraining psychogram which comes into operation when the tag of the nasty caterpillar is presented to the vision of the chick.

We may generalize and infer that even in the normal state all suggestions to be carried out at a future time on the presentation of the suitable tag which is to ecphorise them, result in the formation of psychograms in the mnema to evoke action when the tag is presented. To develop this further would carry us too far, but we may illustrate it by the case of a nurse who was told under hypnosis that whenever she said " Sir " to the assistant physician she would scratch her temple with the right hand—a suggestion which was unconsciously carried out.

Thus it will be seen that on the present hypothesis, the phenomena of memory and of habit are both referable to the same basis—the formation of psychograms in the mnema. Consciousness is not necessarily involved in the implementation of motor psychograms, in fact

many habits are more accurately carried out in the absence of attention. Some people, not particularly musical, can play on the piano without the music, something which they remember because they have played it many times before. But if they think about it, they may be unable to carry on. The unconscious motor memory is the most effective.

The centipede was happy quite
    Until the toad in fun,
Asked her which leg went after which?
Which worked her mind to such a pitch
She lay distracted in the ditch
    Considering how to run.

CHAPTER VII

FORGETTING

The theory of forgetting is by no means simple. It seems easy to think of a memory trace being wiped out—whether engram or psychogram. But such a theory does not fit the facts. Freud observes that "no psychologic theory has yet been able to account for the connection between the fundamental phenomena of remembering and forgetting. To-day forgetting has perhaps become more puzzling than remembering". We do not get much light on the puzzle until we realize the effect of conflicting determinants in the elucidation of which the engram theory is not very helpful.

Much of the psychology of forgetting may be stated in terms which do not depend upon the particular hypothesis which we adopt as the basis of memory. But on the other hand, some of the phenomena of forgetting cannot be worked

out in terms of the cerebral engram theory, which gives a much less satisfactory account of them than the theory of psychical structure. This is especially the case where psychic factors are involved. Thus I may say to my gardener "When you start work to-morrow please plant out those geraniums." *Primâ facie* his memory can be explained as the result of a cerebral engram, impressed by the hearing of my speech, which is ecphorised by his sight of the geraniums. On the other hand, if I think to myself, or resolve "To-morrow I will plant out those geraniums" here there is no materially impressed engram. The memory trace is impressed by pure thought, and the engram theory does not help us.

It is said by some who hold the engram theory that loss of memory is often attributable to physiological decay of the recording cells. Undoubtedly the majority of our memories do vanish beyond normal recall. If you try to evoke the memories of the incidents of the last twelve months, you may

recall all the more prominent, but inevitably for every one you remember a hundred will be forgotten. Try to remember what dishes you had for dinner on each day a month ago, and if you are a normal person you will have proof of the above.

On the other hand there are phenomena which in the view of some psychologists lead to the inference that nothing is ever really forgotten, that is to say put outside the possibility of recall. This view rests upon the fact that many memories of long ago, which under ordinary circumstances would never be recalled, can under hypnosis or by analysis be brought to light. And there are cases which show that under abnormal conditions, pathological or otherwise, memories may be revived which are again forgotten when normality is restored. But such cases do not throw much light on what is the true basis of memory, since such rememberings and forgettings seem to be compatible with either theory.

Generally, forgetting may be said

to mean the exclusion of a latent memory from the field of consciousness. Upon either theory recollection depends upon the evocation from the memory box, whether it be the psychic mnema or the material brain, of memory traces there stored, whether psychograms or engrams. And it may be stated as a broad general principle that *no memory can be evoked without the aid of a relevant association link or tag to ecphorise the record.* This may be taken as a rule without exception, and applies equally to either theory of the basis of memory. There may be apparent cases of something jumping into consciousness without your realizing the tractive link. But it is always there, even if it cannot be traced. The examples which Freud has investigated lead to the firm conclusion that no mental process is spontaneously generated. We need not go so far as to assent to the universal determinism which Freud advocates. But if we exclude telepathy and the determination of the will, we may assent to the proposition. Anyhow, so far as memory

is concerned, we are led to the conclusion that the evocation of a memory does not take place without the presentation of an appropriate tag. So much is common to the cerebral engram hypothesis and to the psychogram hypothesis.

Bearing this in mind, a large part of our forgettings require no further explanation. It is by attention that links are forged which serve to evoke memories. Most trivial matters escape recollection because they have occurred without sufficient attention to forge the association links necessary for recall.

In the next place we may consider incidents which received enough attention to forge weak links, and here again an explanation of forgetting is available upon either hypothesis as to the basis of memory. The factor of competition is generally sufficient to account for such lapses of memory. You may forget to post a letter because you have so many other things to think about. The mnema is always open to consciousness. Trains of ideas are always passing through consciousness, one idea in

consciousness may have fifty tags, each tending to evoke a linked idea from the mnema. Ideas which come through tend to evoke other ideas. So a memory may easily be crowded out. The working of the element of competition in excluding memories so as to make one dependent upon a note book or a diary, is a familiar thing to a busy man.

Furthermore, with reference to the various tags which are always being presented in consciousness, it is a matter of observation that these tags differ in strength or effectiveness. A feeble tag stands little chance in competition with stronger tags.

The importance of the strength of a tag is illustrated by the occasions on which one has to get out at an intermediate station on the tube and forgets to do so. One may look at the name of each station as it is passed, but one may be so absorbed in the newspaper at the critical station as to forget to get out. Personally I have found that if at the station before that at which I have to alight, I say to myself internally

but *emphatically* "At the next stop you will jump up and get out", the psychogram if strongly created, will act automatically, even if one is absorbed by interesting news. One may believe that such a psychogram may act upon the motor nerves through the exchange, without the intervention of consciousness, as in some cases of hypnotic suggestion.[1] But that is another story.

The strength of a tag may depend on frequent repetition. Your own telephone number has been so often attended to that you recall it without difficulty. So the numbers of those of your friends with whom you often communicate. But there are other numbers which you might wish to remember occasionally, but fail to do so. There is a competition with the more important numbers which is fatal.

Such cases as the above show that practical forgetting of things is often not inconsistent with the possibility of their recall. The records may remain but the memories to which they would give

[1]See *The Mind and its Mechanism*, p. 168.

rise may be crowded out or not evoked for lack of sufficiently prominent association tags to evoke them. So far, either theory of the basis of memory will serve.

Sensory tags like the smell of boiling olive oil can readily be expressed in terms of engrams, but when we turn to purely psychic tags, the theory of cerebral engrams no longer satisfies us. There is a large class of forgettings which are "motivated from the unconscious" or in our terminology "unconsciously motivated from the mnema". The mnema may supply rival determinants which come into conflict outside the region of consciousness and determine a lapse of memory.

Tags which involve meaning may be classed as psychical determinants, as opposed to mere sensory determinants and they are much more effective than tags of mere simultaneity or sequence. In the recitation of a passage committed to memory, the end of one sentence serves to evoke the following sentence, and so on, even without attention to

meaning, but the factor of meaning introduces a much more secure nexus. Ordinarily both elements co-operate,—though some people are able to become word-perfect with little or no reference to meaning—as for instance in learning a passage in a language which is unfamiliar. But there are cases in which being word-perfect may lead to forgetting instead of remembering, if in the recitation attention is fixed on the words and diverted from the meaning.

I may instance a personal case of forgetting through relying on verbal tags instead of psychic tags. It was the first time I had opened a debate at the Cambridge Union. I carefully prepared a somewhat lengthy speech and "learned it by heart" until in the solitude of my room, I was word-perfect. Somewhere about the middle of my speech my attention was diverted, and I lost the verbal tag which should have carried me on to the next sentence. I stopped dead for some seconds (being cheered in the meantime), and I could not pick up my discourse at the point

where I stopped but succeeded by a mental struggle in getting on the track again with the omission of some paragraphs. The conclusion impressed upon me was that a mere verbal tag, such as may carry one on from sentence to sentence in a recitation, was but a broken reed upon which to rely in a connected argument. One may rely upon the verbal sequence and may at the same time think of something else and lose the thread of the argument. The tags furnished by the psychic continuity of meaning to which the mind is all the time giving attention, can alone be relied upon in such cases. I have made some hundreds of speeches since, but never again did I try to " learn a speech by heart " ! If the thread of your argument has been well thought out, trust to the occasion to find the appropriate words. If you cannot do this, you had better read your speech.

In the second volume of Sir Sidney Lee's *Life of King Edward VII*,[1] a similar incident is related. The occasion was

[1] P. 592.

a speech by the King at a meeting with the Tsar. We may extract the passage.

"Before the banquet Russian journalists and others asked for a copy of the King's speech. The King said he knew what he should say but had nothing written. When Fisher expressed surprise at the lack of an *aide-memoire*, the King told him that he did learn a speech off by heart when President Loubet came to England. He memorized it in the garden of Buckingham Palace, but when he got up to speak could not remember it, 'and had to keep on beginning again at the beginning' so 'Never again'".

To understand the effect of unconscious motivation in remembering and forgetting, we must have regard to the supreme rôle which determinants play in mental processes. The phenomena of hypnosis illuminate their operation, but whilst in hypnosis we see this operation in a magnified form, we must realize that it is an every day normal operation in the human mind. You give a glass of vinegar and water to a hypnotised subject to drink and suggest

to him that it is port wine. The suggestion has two effects. It inhibits the passage through the exchange to consciousness of the sensations which would otherwise be attendant upon the drinking of vinegar, and it evokes from the mnema the recollection of the taste of port wine which is carried to consciousness as a substituted sensation. Two determinants are implanted by the suggestion, one inhibitive and the other positive. The effect on consciousness is the resultant of these determinants.

We may look upon every psychogram as a determinant. Given the necessary tag to wake it into action, it will produce its appropriate effect, whether upon thought or action. This effect may or may not be recognized in consciousness. It may be a positive or a negative effect. A determinant which tends to produce thought or action may be called a positive determinant. A determinant which tends to inhibit thought or action may be called a negative determinant. The phenomena compel us to recognize that such determinants may be active and operate

outside the field of consciousness and so produce unconscious motivation from the mnema.

To take a simple example of an oft-quoted type. You decide to write a letter on the morrow which you know will entail disagreeable consequences to yourself or the recipient. A psychogram of your intention is registered which should determine your action, but at the same time there is unconsciously registered a psychogram which records your aversion and your desire to put off the evil day. You forget to write the letter or put it off time after time and ultimately forget it. There we have a simple example of unconscious motivation from the mnema. The two determinants may engage in conflict without necessarily involving any recognition of the conflict in consciousness.

A single instance of this kind might be accounted for by the factor of competition and would carry us no further. But in his *Psychopathology of Every Day Life* Freud had analyzed a number of convincing examples, which leave no

doubt that such motivation from the unconscious is a real factor in many cases of forgetting. In the discussion of his own personal instances of name forgetting, Freud observes—"An incessant stream of self reference flows through my thoughts concernng which I have no inkling, but which betrays itself through such name-forgetting." The instances which he gives are accounted for by a professional complex or a family complex or a personal dislike or reference of some kind. Space forbids the quotation of his cases, which are analyzed at some length, but we may quote one short illustrative case which is cited by Freud from Jung.

"Mr. Y. falls in love with a lady who soon afterwards marries Mr. X. In spite of the fact that Mr. Y was an old acquaintance of Mr. X, and had business relations with him, he repeatedly forgot the name, and on a number of occasions, when wishing to correspond with X, he was obliged to ask other people for his name."

In this case it is clear that his dis-

appointment created a desire to extrude X from his mind, and this became registered in the mnema as a determinant. The rationale of this kind of forgetting is not enlightened by the theory of engrams. The result is dependent on psychic conditions which cannot be elucidated in terms of engrams. But in terms of competing psychograms which give rise to opposing determinants, there is no difficulty in rationalizing such forgetting.

The phenomena of repression furnish examples which are still more illuminating. Freud's investigations lead to the conclusion that there is a mechanism in the mind (which he calls the censor) which tends to exclude the memory of disagreeable things from consciousness. Upon the present hypothesis one would infer that the circumstances create a psychogram which operates as a counter-determinant to oppose the emergence of the memory. It is difficult to see how this could be expressed in terms of engrams.

Certain sentiments may take rank

as complexes and have a similar effect. A sentiment may be defined as a permanent mental disposition with reference to an object, and therefore is, like a complex, founded on a constellation of ideas lodged in the mnema. It is therefore well fitted to cause unconscious mnemic motivation, which may obviously, under appropriate circumstances, give rise to forgetting.

Certain cases of amnesia in which a chronological group of memories relating to a day, or a year, or even half a lifetime are wiped out, owing to a shock or lesion of the brain, are very instructive. One case which will serve as an illustration, we may quote in full.[1]

In the month of September, the Hon. F. Strutt was thrown from a dog-cart and sustained a fracture of the base of the skull which rendered him unconscious, and he remained so until the following February. "Then it was found that he had lost all memory not only of the accident but of the events of *some days before*. The accident was on a Monday

[1] *Mind*, Oct., 1887, p. 636.

and he had perfect recollection of where he had been and what he had done *up to the morning of the previous Monday*; from that time onwards he could recall nothing. The week had been an unusually busy one, full of incidents that he might well remember, and as it happened he wrote a letter to his mother on the day before the accident detailing the events of the previous days.—He sold some cattle and paid the money into his bank: heard one afternoon a lecture given by a friend to an Archeological Society and entertained the members afterwards at his house; attended a public concert; presided at a meeting for University-Extension; wrote, printed and sent out an important circular to a number of Boards of Guardians, took the chair at a public supper; spoke at a great political demonstration; received family intelligence that particularly interested him and finally; just before the accident, was engaged in a transaction of business of quite special importance to himself. Of all this and more everything has clean vanished from him; except only that

he imagines that he has some faintest reminiscence of a dark woman singing and of a number of people on a lawn —but not till after reading his letter which mentions the one and suggests the other."

We must apply to this case our knowledge as to the grouping of mnemic traces. Take for instance the school programme for a week—four hours arithmetic, three hours English grammar, two hours geography, four hours French, etc., etc.,—distributed over the week. As a matter of experience the new acquisitions in each subject form accretions to the old group of knowledge in each subject. The memory traces of a term include an arithmetic group, a French group, etc., available for examination purposes as clear cut groups. The original cerebral traces, visual, auditory, etc., must be allocated to definite areas of the cortex. The final mnemic traces are redistributed into their appropriate psychic groups.

Now in the case cited, the fortunate occurrence of the letter written before

the accident shows that a great variety of engram or cerebral traces during the preceding week must have been distributed to all the appropriate areas of the cortex. On the engram theory since the engram is the residue of the original sensory impression, the mnemic traces were lodged where the engram impressions were made, that is to say, all over the cortex in the appropriate sensory areas. They must therefore have been deposited locally side by side with all kinds of old engrams embedded in "irritable substance". But it seems difficult to imagine an injury which would pick out and destroy all the engrams deposited during the preceding week, scattered about among the older engrams, and yet leave the older engrams untouched.

No plausible theory of engram grouping will account not only for the observed facts of psychic grouping, but also for the case of the destruction of a chronological group of memories belonging to a definite period. We must regard the local engram traces as being fugitive and

serving merely to pass on the impressions through a kind of clearing house where they are sorted out into their appropriate psychic groups. The temporary passage of the impressions through the relevant sensory areas must be followed by their redistribution according to meaning to the existing psychic groups to which they are relevant. The machinery for this seems to involve the exchange, which receives the sensory impressions, standing in such a relation to the mnema and to consciousness that the sensory impressions become psychic meanings which are diverted to existing relevant groups in the mnema or form new groups which may be related to existing groups. That the events of the week did form a coherent psychic group is indicated by the letter written before the accident in which these events were recorded as a group.

If the record were by means of cerebral engrams the grouping would be according to the sensory areas in the cortex where the impression was made, and the locality of the record would differ according to the particular sensation involved. If

sensations were visual, we should find the engrams in one locality, if auditory in another locality, if mixed, the impressions relating to one incident might be scattered in different localities. It is only under the transformation that takes place under the threefold influences of the exchange, the mnema and consciousness that we can conceive of these different sensations being integrated and recorded as groups.

There are many facts which tend to show that the injury which causes amnesia is really due to the psychic shock involved and not to the local cerebral lesion. Indeed there are cases in which on the one hand a large destruction of brain substance does not appear to affect memory, and on the other hand a purely psychic shock without any material injury does cause amnesia. But to examine these cases in detail is beyond the scope of this essay.

CHAPTER VIII

CONCLUSION

Much, indeed most, of the psychology of memory may be explored without reference to the nature of the mnemonic traces upon which memory depends. When we attempt to correlate the phenomena with either hypothesis as to the nature and location of memory traces, we often find that either hypothesis will serve. But there are certain phenomena which enable us to judge between rival hypotheses, and we have endeavoured to consider them in relation, on the one hand, to the theory of memory traces in cerebral structure, and on the other hand to the theory " that there persist psychical dispositions, each of which is an enduring feature of the psychical structure " which form the basis of memory.[1]

It may be observed that in our discussion

[1]McDougall, *Body and Mind*, p. 343.

of rival theories we have been setting one *hypothesis* against another. Semon states that when an organism has been temporarily stimulated and has passed into a state of secondary indifference a permanent engram has been established and that "the change in the irritable substance is most certainly a material change". But this is really pure hypothesis, and not fact, just as much as the theory that the permanent change is in psychic structure.

In endeavouring to elucidate the theory of memorial traces in "psychical structure" we have introduced certain terms which enable us to analyse the conceptions which are necessarily involved. A "psychical structure" capable of carrying traces must consist of something, and this something has been called psychoplasm, to distinguish it from the protoplasm which is the basis of material structure. That element of the psychic structure which carries the memorial traces has been called the mnema. The traces in psychic structure have been called psychograms to distinguish them

from engrams in irritable substance. The hypothesis involves the transformation of the sensorial impulses which impress the cortex into the psychical impulses which impress the mnema, and the element of the psycho-physical apparatus which effects this transformation and transmission has been called the exchange. The triangular relation between the mnema, the exchange and consciousness, illustrated by the diagram in Chapter IV is a summary of their mutual functional relations, which is justified, so far as function is concerned, by psychological phenomena, if we adopt the hypothesis of psychic traces as opposed to engram traces. As the diagram indicates, sensory impressions are passed on through the exchange both to the mnema and to consciousness. Consciousness derives its ideas both from sensory impressions and from the mnema, The mnema is fed both from sensory impressions and frem consciousness. The exchange is simply the gateway between the brain and the psychic region. Hence on the psychical hypothesis our terminology

and the relative functions involved are clearly justified.

The question as between the one basis of memory and the other, involves a principle which is theoretically of fundamental importance. According to the engram hypothesis, the body is a machine every sensory thrill of which clogs the machine by storing up impressons in its " irritable substance " which involve permanent fixations. Sensory experiences are supposed to demobilize the cells through which the experience came, and turn such cells from their active uses to passive storehouses of the past. The acquisition of habits is supposed to partially demobilize the nerves and synapses involved, so as to make easy paths for the facilitation of particular habits at the expense of the voluntary purposes of the nervous system.

The other view is that the body is a machine which is being constantly regenerated so that every cell is constantly restored by metabolism to functional activity. The cerebral cells are structures through which sensory impressions pass,

but they are mere relays between the material sense organs and the psychic organization.

The storage of experience takes place not in these relaying cells but in the psychic structure where these sensory impressions are integrated and idealized.

Let us recapitulate some of the points where the first hypothesis fails whilst the second succeeds in elucidating the phenomena.

The first point is, that if engrams of a permanent character are impressed in "irritable substance" by sensations to form the basis of memory, these engrams should correspond to the sensations. Thus if we receive an auditory engram containing the word "Generalissimo", it should not when ecphorised give us instead the word "Commander-in-Chief". On the mechanical theory this seems incontestable. Yet what often happens is that our normal memory is of ideas expressed in other than the original words.

Again, the engram theory fails to account for the rôle of meaning. The

engram of a string of meaningless words should be as readily ecphorised as when the same words are arranged so as to have a meaning, but this is not the case.

The engram theory is based upon the view of a sensory action of a mechanical kind which leaves a permanent impress on "irritable substance". In the case of a new constellation of ideas produced by pure thought without any sensory impressions we may have a perfectly good recollection, as in the case of the "sermon problem" and the moon theory. Not only are there no sensory impressions in such a case, but the thoughts may be mnemonically registered in spite of adverse sensory impressions.

The engram theory does not account for the enormous importance of attention as a factor in memory. Conflicting engrams may be simultaneously made, yet recollection is only of the series to which attention was paid.

The psychic association links upon which much of our memory depends, do not receive any adequate explanation on the engram theory.

Habit and memory rest upon the same basis on the psychic theory. Upon the engram theory, habit is only explicable upon the additional hypothesis of the formation of permanent paths of low-resistance through nerves and synapses. Such a theory involves the immobilization of a large part of the system by which voluntary movements are made.

The rôle of suggestion and of determinants both in relation to habit and memory imply a psychic factor which does not find a rational explanation on the engram theory.

The importance of meaningful association links as compared with other linkages finds no explanation upon a mechanical theory. Psychic links which involve a continuity of meaning are powerful where mere verbal links are feeble.

The phenomena of forgetting which are motivated from the "unconscious" (i.e. the mnema) find no adequate elucidation on the engram theory. For illustrations, reference may be made to Freud's *Psychopathology of Every Day Life*. The theory that things disagreeable

may create anti-psychograms or counter-determinants is not expressible in terms of engrams. Complexes or personal dislikes often furnish such counter-determinants, which may be expressed in terms of psychograms.

Finally, the cases of amnesia for a shorter or longer period in which a chronological group of memories is wiped out, run counter to the engram theory. Memories appear to be grouped by their psychic relationships, but the engram theory would necessitate cerebral local groupings determined by the various kinds of sensory impressions. A chronological group might be scattered all over the cortex, and we cannot conceive of the elision of such a group due to a brain lesion, which should leave unaffected previous engrams deposited in the same regions.

On the whole, the theory that engram traces are fugitive, lasting only long enough to provide residual images, whilst the resulting psychograms furnish the enduring basis of memory, seems consistent with all the facts, and not incon-

sistent with any of the phenomena. The corporeal organization of brain and nerves is kept intact for all its functions, without being encumbered and debilitated by permanent changes due to the performance of those functions. The storage of memory and habit is the function of the psychical structure.