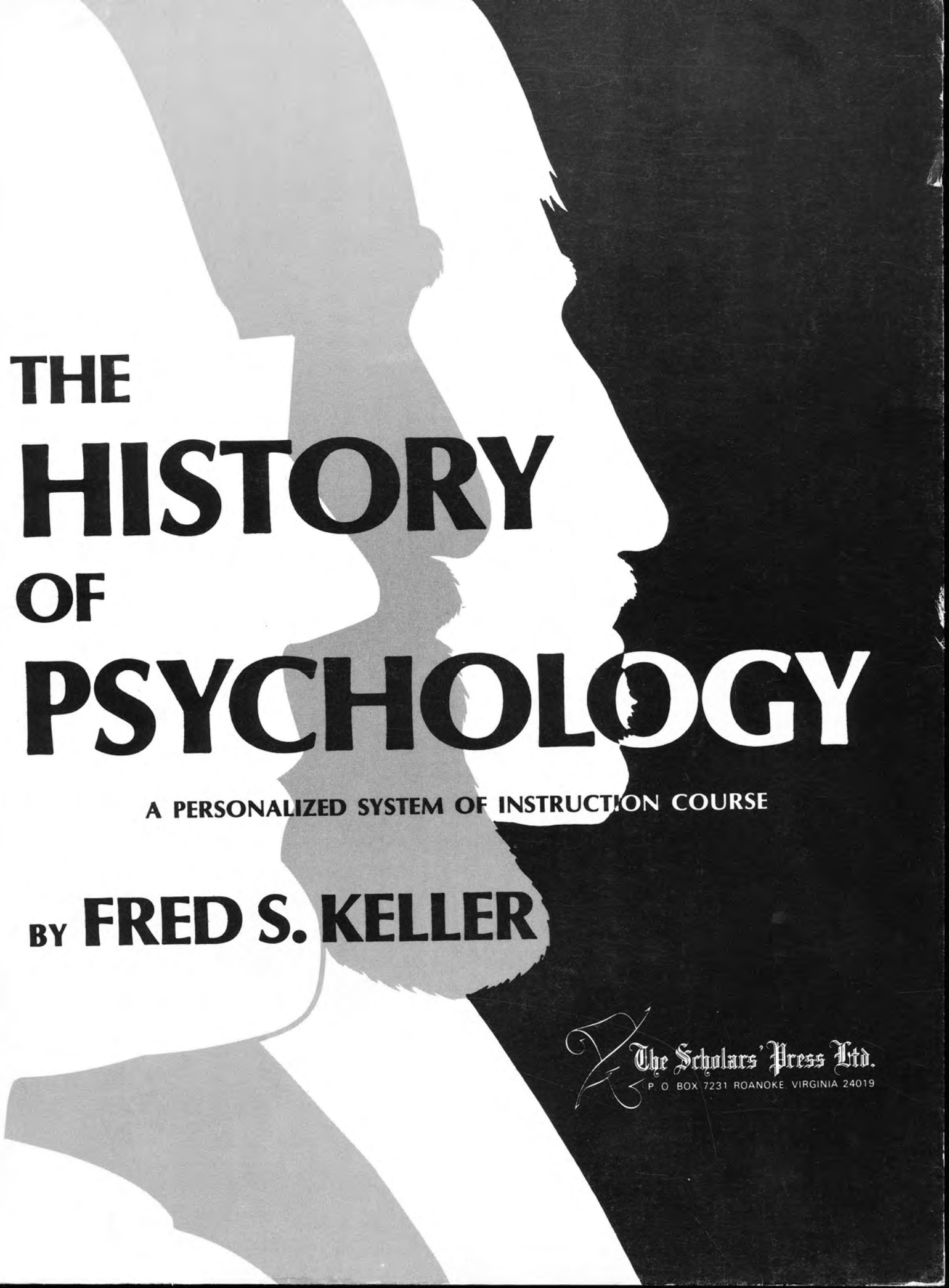

THE HISTORY OF PSYCHOLOGY

A PERSONALIZED SYSTEM OF INSTRUCTION COURSE

BY FRED S. KELLER

The Scholars' Press Ltd.
P O BOX 7231 ROANOKE, VIRGINIA 24019

History of Psychology

This course will consist of the following:

I. Required Reading Assignments

1. For classical excerpts from the history of psychology study the following 13 PSI units in Fred S. Keller's The History of Psychology:

Units	Authors
I	Rene Descartes
II	Thomas Hobbes
	John Locke
	David Hume
III	William James
IV	H. L. F. von Helmoltz
V	Edward Bradford Titchener
VI	Marshall Hall
VII	Charles Scott Sherrington
VIII	Ivan Petrovich Pavlov
IX	George John Romanes
	Conwy Lloyd Morgan
X	Jacques Loeb
	Herbert Spencer Jennings
XI	John Broadus Watson
XII	Edward Lee Thorndike
	William McDougall
XIII	Burrhus Frederick Skinner

2. It is important that you be able to fit the above readings from the original sources into perspective. For a brief overview of our history and contemporary status, read Fred S. Keller's The Definition of Psychology. It is suggested that you first read this book in a rather cursory manner (for trial 1). Then work on the 13 classical excerpts, pass your unit tests on these, and then reread very carefully The Definition of Psychology. In this way, together with the weekly class lectures, you should eventually develop a broad understanding of how we arrived at our contemporary status in psychology. In the beginning of the course you may expect that aspects of our history to which you are exposed will seem disconnected, but if you persevere along the lines planned for you, you will gain a sizeable degree of continuity by the end of the course.

II. Required class meetings once a week, to be announced. These class meetings will be devoted primarily to helping you to develop a broad perspective of the development of psychology. It is also important that you attend classes so that we can communicate about progress and problems of the course. If you miss the week's class meeting, it is your responsibility to ask for any course changes, and to educate yourself about the material covered.

III. Proctoring sessions -- to be attended at your choice. Proctoring sessions are scheduled at the following times:

_____

_____

_____

IV. Extra credit reading. Extra credit work will give you the opportunity for extra points to raise the grade on your final examination.

1. Perusal of the major works of selected men (on reserve in the psychology journal room).

2. Autobiographies of famous psychologists (from the four volumes of The History of Psychology in Autobiography, placed on reserve in the journal room).

V. Psi Chi lectures. These are real pluses for us and you will receive additional extra credit on your final examination for attending these lectures. The time for the lectures will be announced in advance.

VI. Final examination -- The final examination will sample the above sections #I, II, III, and IV.

P S I

A word about The Personalized System of Instruction (PSI): the PSI method allows you to learn at your own rate in an efficient manner. For a further description of this, see Keller's The History of Psychology, and also his "Goodbye Teacher," which is placed on reserve in the journal room for you in McGuigan's and Woods' Contemporary Studies in Psychology, Prentice Hall, 1972. If you have not previously taken a PSI course you should pay careful attention to the following course description:

1. Units: The 13 units must be mastered in succession.

2. Study Guides are provided for each unit. They will help you to learn the material upon which you will be tested.

3. Unit Tests are given by your proctor when you believe that you are prepared. Each unit must be passed with a perfect score before you may go on to the next unit. This is not as difficult as it may sound, since the study guides are comprehensive and since your proctor will answer any questions you have before you take a test. If you do not pass a test, this does not count against you, and you have as many opportunities as you need to pass each unit test. Note that the concept of failure does not enter into PSI -- you might not pass a test, but that merely means that you have the opportunity to study some more in order to increase your knowledge and do better on the next test.

4. Proctoring Sessions are scheduled _____ times a week. Make sure that you attend the proctoring sessions as they are the times that you can take unit tests. You should pace yourself to average slightly more than one unit passed per week. Plan ahead as additional proctoring sessions will not be scheduled toward the end of the semester.

5. Proctors are well qualified to help explain material on your study guides and to administer unit tests. Their main responsibility is to help you learn. Many students have reported that the proctors are the single most important part of this course, so you should get into the habit of discussing the units with your proctor. But do not expect the proctor to "teach" the course to you; real learning comes only from your accepting the responsibility for actively applying yourself. It is also better for everyone if you confine your discussions with your proctor to the units; questions on other material and general discussion of psychology should be taken up with the instructor; this can be done during class sessions, or you may make an appointment.

6. Your final grade will be computed on the basis of your final exam grade (33%) and your average on the unit tests. Assuming that you pass all 13 unit tests, 67% of your grade going into the final will be an "A." If, however, you only complete 12 units, your grade going into the final will be a "B;" 11 units completed will give you a "C," 10 units completed will give you a "D," and anything less will be an "F."

A guide to answering questions on the unit tests.

Other minor points:

1. One of the purposes of this course is to give you the opportunity to attempt to understand the thinking processes and works of some of the great men in our history, to place major writings into a good historical perspective, and to relate works with other events of the period. Hence, in answering a question, you should develop separate steps in the man's reasoning processes and form them into a logical whole. For example, suppose that a question on your unit test is: "According to Descartes, the reason that one sees a single sight with two eyes is because of the following events":

   Incompetent answers would be:

   i) "Because of the pineal gland"; or
   ii) "Because of the optic chiasma."

   A better answer would be:

   iii) "Descartes reflected that all of the parts of the brain are double, with the exception of the pineal gland, just as people have two eyes, two ears, etc. However, he noted that we have, at any given time, a single solitary thought. Descartes tried to resolve this apparent conflict as follows.

   It must be that the soul is presented with only one object. Somewhere there must be a place where the two images that come to us from the two eyes can unite before arriving at the soul. Otherwise the soul would be presented with two objects instead of one. Since, as noted above, the pineal gland is the only single organ in the brain, and since it has been reasoned that the pineal gland is the point at which the soul and body interact, the two images from the eyes might unite at this gland through the intermission of the animal spirits in the brain. By thus uniting in the pineal gland, but a single impression is presented to the soul."

You can note that the first answer above is totally incomplete, that the second answer invokes contemporary physiology which was not available to Descartes, but the third answer is a much more reasoned, complete answer presented in the spirit of Descartes' times, and with the use of his own terms. By following this example, you should be able to better answer the questions on your unit tests at the high level of scholarship of which you are capable.

2. You may take your final examination when you have completed your 13 unit tests, providing that you do this prior to _____. You should give the instructor one week's notice of when you wish to take the final examination, and report at the very start of your proctoring session for that examination. You are, however, advised that it may be to your disadvantage to take your final examination early -- some students in the past who have taken their final examination early have not done as well as those who continuously reviewed up to the regular examination period.

3. You may select questions on the unit tests by eliminating two questions from each unit (A) test. All questions selected must be answered correctly. If you do not pass a unit test, you may make an appointment with the appropriate proctor to take a second unit test. The name of the appropriate proctor can be furnished to you by any of the proctors.

If you wish to individually discuss any aspect of the course with the instructor, my office is _____; or see or call me for an appointment. Best wishes for great success in acquiring a deep understanding of how contemporary psychology arrived at where it is (and hopefully some educated guesses about where it is going).

SELECTED READINGS

IN

THE HISTORY OF PSYCHOLOGY

A PSI COMPANION

BY FRED S. KELLER

WESTERN MICHIGAN UNIVERSITY

Table of Contents

What is PSI?

The acronym, PSI, signifies a Personalized, Proctorial, or Self-Paced System of Instruction. The essential features of the system which distinguish it from conventional teaching procedures have been summarized as follows.

"(1) The go-at-your-own-pace feature, which permits a student to move through the course at a speed commensurate with his ability and other demands upon his time.

"(2) The unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded.

"(3) The use of lectures and demonstrations as vehicles of motivation, rather than sources of information.

"(4) The related stress upon written work in teacher-student communication; and, finally:

"(5) The use of proctors, which permits repeated testing, immediate scoring, ..., and a marked enhancement of the personal-social aspects of the educational process."

Thus, the student progresses through a PSI course at his or her own pace, one step at a time. Each step requires the learning of a unit of course material, and each unit must be mastered before the next can be attacked. Mastery is demonstrated by perfection on a unit test, but as many different tests may be taken on each unit as are needed to satisfy the mastery requirement. The student is not penalized for failure to pass a unit test (except for the time that must be spent in study before trying it again). The concept of failure does not enter into this method. When the student demonstrates perfect mastery of a unit of material, an A is received for that unit, regardless of the number of tests required.

The proctor is a critical figure in the PSI procedure. He, too, is a student, one who has already shown his mastery of the course material, and he helps to bridge the intellectual gap between the teacher and his pupils. Well prepared and well guided by his instructor, the proctor grades the student's tests, discusses the student's answers, and, in the case of any failure, directs the student to further study. He provides an individualized consideration that the student may never have had before.

Students say that the PSI procedure, as compared with conventional teaching methods, requires more work, but that the increased effort is more than compensated by the pleasure and degree of learning it engenders. Proctors, too, enjoy their function, deriving satisfaction from their students' progress and possibly learning more than anyone in the system. The instructor derives his reinforcement from the learning which takes place in both the students and the proctors.

A PSI "companion" (see Title page) is simply a set of study questions and related materials, prepared by the instructor for each unit of a course of study that uses PSI. It accompanies the actual subject matter of the course--the textbook, the articles to be read, or the experiments to be done, for example.

Acknowledgements

With four exceptions, the units of the course presented here were initially taken from Herrnstein and Boring's A Source Book in the History of Psychology (Harvard University Press, 1965)--a book that should be owned by every psychologist and every serious student of our science. The course itself was offered to M.A. candidates at Western Michigan University in the second semester of the 1969-70 academic year, with the aid of Kathleen Krumhus, then a graduate assistant in the Department of Psychology. Miss Krumhus not only acted as a proctor in the course, but also helped in preparing course materials and in keeping student progress records. Her help is gratefully acknowledged here. The assistance of Mary Lou Fischer is also gratefully acknowledged.

As noted herein, this course has also been used successfully with undergraduates.

Foreword to the Student

The course of study you are now beginning will make use of PSI--a personalized system of instruction, in which you travel at your own pace through 13 units of work, to be mastered in the numbered order, each one to perfection.

Study guides are provided for each unit largely in the form of study questions, the answers to which can be found in your assignment. If you can find and understand these answers, you will be ready to cope successfully with the unit tests.

Your instructor will tell you when and where you may take your unit tests. He will also give you help, or tell you where to find it, in case you do not understand some part of your assignment.

The unit tests, when taken, will be graded by a proctor. His duties are:

1) To read your answers and to grade them right or wrong;

2) To listen to any defence you wish to make of those he judges incorrect (if there aren't too many of them), to change a grade if he is convinced that you are right, or to appeal to his superior for a judgment;

3) To direct you to further study when it may be needed;

4) To grade another form of the unit test at a later time, when you have tried again to pass it; and

5) Very little more! Your proctor is not there to give you lectures, to coach you just before a test, or give you anything more than a sympathetic understanding of your efforts, and guidance in your study when it may be needed.

If you fail to pass a test, it will not be held against you, although it will delay you somewhat in your progress. (As a rule, no more than a single test is possible within a testing period, and tests in quick succession are not permitted.) On the other hand, repeated testing, after further study, may consolidate your understanding of the unit. Students, having passed one test, have been known to ask for another, in order to achieve this end.

Your periods of study for this course may be in any place you wish, but your regular classroom during specified hours is to be recommended. Difficulties that arise in connection with your reading may be ironed out there with the help of the person in charge--the instructor or his assistant--who is especially qualified to exercise this function.

One word of caution is in order as you begin your work. The most important hazard for the individual student in a self-paced course is

procrastination--specifically, the deferment of test-taking. This occurs most commonly at the outset of the course, before the student has taken a single test, and it may set him back so badly that he never completes the units. Trouble seldom arises once the student has begun. So, get started early and be safe! Take a test even though you doubt that you will pass it; by the end of the term, you will be glad you did.

Further details of the structure and the function of your course, its place of meeting, its teaching personnel, and its ground rules, will be presented by your teacher. Good luck!

STUDY UNITS

Study Guide for UNIT 1

Rene Descartes (1596-1650)

French philosopher, mathematician, and scholar, Descartes is often called the father of modern psychology. He is said to have made the first clear distinction between body and mind, thus setting the scene for a psychology that had mental events as its subject matter. But Descartes also offered a theory of the response mechanism, in which he anticipated the concepts of reflex and reflex arc, as well as the distinction between operant and respondent behavior. He had ideas about receptor function (especially the function of the eye); he had a theory of human emotions; and he held the opinion, challenged by latter philosophers and psychologists, that man is born in possession of certain ideas--innate--, requiring no experience with the outside world as their cause.

The assigned excerpts should acquaint you rather intimately with Descartes' notions of (a) the mind-body relation and (b) the operation of the human response mechanism. From them you should also get his idea of reflex action and his anticipation of operant vs. respondent. In the selection from L'Homme (1654), you will also find a description of the way eyeball movements are coordinated, in which he suggests the reciprocal innervation of muscles--a matter of concern to later physiologists. He says that animal spirits ("like wind or very subtle flame," arising from the heart and filling the "caverns" /ventricles/ of the brain) flow into one of the eye-muscles through valved channels at the same time that they flow out of the opposed muscle. As the first one is distended and made tense, the other is emptied of animal spirits and made flaccid. Unlike later theorists, Descartes saw the inhibition of one movement by another as peripheral, rather than in the nerve centers themselves.

Study Questions It may be helpful, in dealing with this assignment, to seek answers to the following questions, even to the point of writing them down. This should prepare you for test questions on all, or almost all, of the material covered. The first seven questions that follow are based on the first excerpt, the remainder on the second.

1. What functions belong to the soul (mind) and what to the body?

2. How can movements of the body be produced without the aid of the soul?

3. What is the difference between the actions and the passions of the soul? Is there an operant-respondent distinction here?

4. Where is the soul with respect to the body? Where and how do soul and body interact?

5. How can one see a single object with two eyes?

6. How does the soul recollect, imagine, or attend? How does it cause bodily movement?

7. How and why may the soul produce movement indirectly?

8. How does Descartes describe the structure of what we would now call sensory (afferent) and motor (efferent) nerves?

9. How are the nerves related to the brain?

10. How does Descartes look after the reciprocal action of opposed muscles? What happens when the muscles are "stuffed" with animal spirits?

11. How does he describe the physiological mechanism of reflex function--i.e., the reflex-arc mechanism? Can you provide your own example of its operation?

12. How does he account for the arousal of such "sensations" as those of pain, tickle, smoothness and warmth? What movements of what magnitude are involved?

N.B. Further background material may also be found in Boring's A History of Experimental Psychology--a book that you should own.

RENE DESCARTES ON THE INTERACTION OF MIND AND BRAIN.

Rene Descartes, Les Passions de l'ame (Amsterdam, 1650), pt. 1, arts. 2-4, 16, 17, 30-32, 34, 35, 41-44. Translated by E. S. Haldane and G. R. T. Ross in The Philosophical Works of Descartes (Cambridge, Eng.: University Press, 1931), I, 332-351.

ARTICLE II

That in order to understand the passions of the soul its functions must be distinguished from those of body.

Next I note also that we do not observe the existence of any subject which more immediately acts upon our soul than the body to which it is joined, and that we must consequently consider that what in the soul is a passion is in the body commonly speaking an action; so that there is no better means of arriving at a knowledge of our passions than to examine the difference which exists between soul and body in order to know to which of the two we must attribute each one of the functions which are within us.

ARTICLE III

What rule we must follow to bring about this result.

As to this we shall not find much difficulty if we realise that all that we experience as being in us, and that to observation may exist in wholly inanimate bodies, must be attributed to our body alone; and on the other hand, that all that which is in us and which we cannot in any way conceive as possibly pertaining to a body, must be attributed to our soul.

ARTICLE IV

That the heat and movement of the members proceed from the body, the thoughts from the soul.

Thus because we have no conception of the body as thinking in any way, we have reason to believe that every kind of thought which exists in us belongs to the soul; and because we do not doubt there being inanimate bodies which can move in as many as or in more diverse modes than can ours, and which have as much heat or more (experience demonstrates this to us in flame, which of itself has much more heat and movement than any of our members), we must believe that all the heat and all the movements which are in us pertain only to body, inasmuch as they do not depend on thought at all.

. . . . .

ARTICLE XVI

How all the members may be moved by the objects of the senses and by the animal spirits without the aid of the soul.

We must finally remark that the machine of our body is so formed

that all the changes undergone by the movement of the spirits may cause them to open certain pores in the brain more than others, and reciprocally that when some one of the pores is opened more or less than usual (to however small a degree it may be) by the action of the nerves which are employed by the senses, that changes something in the movement of the spirits and causes them to be conducted into the muscles which serve to move the body in the way in which it is usually moved when such an action takes place. In this way all the movements which we make without our will contributing thereto (as frequently happens when we breathe, walk, eat, and in fact perform all those actions which are common to us and to the brutes), only depend on the conformation of our members, and on the course which the spirits, excited by the heat of the heart, follow naturally in the brain, nerves, and muscles, just as the movements of a watch are produced simply by the strength of the springs and the form of the wheels.

ARTICLE XVII

What the functions of the soul are.

After having thus considered all the functions which pertain to the body alone, it is easy to recognise that there is nothing in us which we ought to attribute to our soul excepting our thoughts, which are mainly of two sorts, the one being the actions of the soul, and the other its passions. Those which I call its actions are all our desires, because we find by experience that they proceed directly from our soul, and appear to to depend on it alone: while, on the other hand, we may usually term ones passions all those kinds of perception or forms of knowledge which are found in us, because it is often not our soul which makes them what they are, and because it always receives them from the things which are represented by them.

ARTICLE XXX

That the soul is united to all the portions of the body conjointly.

But in order to understand all these things more perfectly, we must know that the soul is really joined to the whole body, and that we cannot, properly speaking, say that it exists in any one of its parts to the exclusion of the others, because it is one and in some manner indivisible, owing to the disposition of its organs, which are so related to one another that when any one of them is removed, that renders the whole body defective; and because it is of a nature which has no relation to extension, or dimensions, nor other properties of the matter of which the body is composed, but only to the whole conglomerate of its organs, as appears from the fact that we could not in any way conceive of the half or the third of a soul, nor of the space it occupies, and because it does not become smaller owing to the cutting off of some portion of the body, but separates itself from it entirely when the union of its assembled organs is dissolved.

ARTICLE XXXI

That there is a small gland in the brain in which the soul exercises

its functions more particularly than in the other parts.

It is likewise necessary to know that although the soul is joined to the whole body, there is yet in that a certain part in which it exercises its functions more particularly than in all the others; and it is usually believed that this part is the brain, or possibly the heart; the brain, because it is with it that the organs of sense are connected, and the heart because it is apparently in it that we experience the passions. But, in examining the matter with care, it seems as though I had clearly ascertained that the part of the body in which the soul exercises its functions immediately is in nowise the heart, nor the whole of the brain, but merely the most inward of all its parts, to wit, a certain very small gland which is situated in the middle of its substance and so suspended above the duct whereby the animal spirits in its anterior cavities have communication with those in the posterior, that the slightest movements which take place in it may alter very greatly the course of these spirits; and reciprocally that the smallest changes which occur in the course of the spirits may do much to change the movements of this gland.

ARTICLE XXXII

How we know that this gland is the main seat of the soul.

The reason which persuades me that the soul cannot have any other seat in all the body than this gland wherein to exercise its functions immediately is that I reflect that the other parts of our brain are all of them double, just as we have two eyes, two hands, two ears, and finally all the organs of our outside senses are double; and inasmuch as we have but one solitary and simple thought of one particular thing at one and the same moment, it must necessarily be the case that there must somewhere be a place where the two images which come to us by the two eyes, where the two other impressions which proceed from a single object by means of the double organs of the other senses, can unite before arriving at the soul, in order that they may not represent to it two objects instead of one. And it is easy to apprehend how these images or other impressions might unite in this gland by the intermission of the spirits which fill the cavities of the brain; but there is no other place in the body where they can be thus united unless they are so in this gland.

. . . . .

ARTICLE XXXIV

How the soul and the body act on one another.

Let us then conceive here that the soul has its principal seat in the little gland which exists in the middle of the brain, from whence it radiates forth through all the remainder of the body by means of the animal spirits, nerves, and even the blood, which, participating in the impressions of the spirits, can carry them by the arteries into all the members. And, recollecting what has been said above about the machine of our body, i.e., that the little filaments of our nerves are so distributed in all its parts, that on the occasion of the diverse movements

which are there excited by sensible objects, they open in diverse ways the pores of the brain, which causes the animal spirits contained in these cavities to enter in diverse ways into the muscles, by which means they can move the members in all the different ways in which they are capable of being moved; and also that all the other causes which are capable of moving the spirits in diverse ways suffice to conduct them into diverse muscles; let us here add that the small gland which is the main seat of the soul is so suspended between the cavities which contain the spirits that it can be moved by them in as many different ways as (it) may also be moved in diverse ways by the soul, whose nature is such that it receives in itself as many diverse impressions, that is to say, that it possesses as many diverse perceptions as there are diverse movements in this gland. Reciprocally, likewise, the machine of the body is so formed that from the simple fact that this gland is diversely moved by the soul, or by such other cause, whatever it is, it thrusts the spirits which surround it towards the pores of the brain, which conduct them by the nerves into the muscles, by which means it causes them to move the limbs.

ARTICLE XXXV

Example of the mode in which the impressions of the objects unite in the gland which is in the middle of the brain.

Thus, for example, if we see some animal approach us, the light reflected from its body depicts two images of it, one in each of our eyes, and these two images form two others, by means of the optic nerves, in the interior surface of the brain which faces its cavities; then from there, by means of the animal spirits with which its cavities are filled, these images so radiate towards the little gland which is surrounded by these spirits, that the movement which forms each point of one of the images tends towards the same point of the gland towards which tends the movement which forms the point of the other image, which represents the same part of this animal. By this means the two images which are in the brain form but one upon the gland, which, acting immediately upon the soul, causes it to see the form of this animal.

. . . . .

ARTICLE XLI

The power of the soul in regard to the body.

But the will is so free in its nature, that it can never be constrained; and of the two sorts of thoughts which I have distinguished in the soul (of which the first are its action, i e., its desires, the others its passions, taking this word in its most general significance, which comprises all kinds of perceptions), the former are absolutely in its power, and can only be indirectly changed by the body, while on the other hand the latter depend absolutely on the actions which govern and direct them, and they can only indirectly be altered by the soul, excepting when it is itself their cause. And the whole action of the soul consists in this, that solely because it desires something, it causes the little gland to which it is closely united to move in the way requisite to produce the effects which relates to this desire.

ARTICLE XLII

How we find in the memory the things which we desire to remember.

Thus when the soul desires to recollect something, this desire causes the gland, by inclining successively to different sides, to thrust the spirits towards different parts of the brain until they come across that part where the traces left there by the object which we wish to recollect are found; for these traces are none other than the fact that the pores of the brain, by which the spirits have formerly followed their course because of the presence of this object, have by that means acquired a greater facility than the others in being once more opened by the animal spirits which come towards them in the same way. Thus these spirits in coming in contact with these pores, enter into them more easily than into the others, by which means they excite a special movement in the gland which represents the same object to the soul, and causes it to know that it is this which it desired to remember.

ARTICLE XLIII

How the soul can imagine, be attentive, and move the body.

Thus when we desire to imagine something we have never seen, this desire has the power of causing the gland to move in the manner requisite to drive the spirits towards the pores of the brain by the opening of which pores this particular thing may be represented; thus when we wish to apply our attention for some time to the consideration of one particular object, this desire holds the gland for the time being inclined to the same side. Thus, finally, when we desire to walk or to move our body in some special way, this desire causes the gland to thrust the spirits towards the muscles which serve to bring about this result.

ARTICLE XLIV

That each desire is naturally connected with some motion of the gland, but that, by intention or habit, the will may be connected with others.

Nevertheless, it is not always the desire to excite a certain motion or other effect which causes it to be excited, for this relation varies according as nature or habit has variously united each motion of the gland to each thought. Thus, for example, if we wish to adjust our eyes to look at a very distant object, this desire causes the pupil to expand, and, if we wish to adjust our eyes so as to see an object very near, this volition makes it contract; but if we simply think of expanding the pupil, we will in vain--the pupil will not expand for that, for nature has not connected the motion of the gland, which serves to impel the (animal) spirits towards the optic nerve in the manner required for expanding or contracting the pupil, with the desire to expand or contract but instead with the desire for looking at objects distant or near. And when, in talking, we think only of the meaning of what we wish to say, that makes us move the tongue and lips much more rapidly and better than if we thought to move them in all the ways required for the utterance of the same words, inasmuch as the habit we have acquired in learning to talk has made us join the action of the mind--which, through the medium of the gland, can move the tongue and lips--with the meaning of

the words that follow these motions rather than with the motions themselves.

RENE DESCARTES ON MECHANISM IN HUMAN ACTION, 1662.

Rene Descartes, L'Homme (Paris, 1664). Originally published in Latin as De homine (Leiden, 1662). Translated for this book by Tamar March from Victor Cousin, ed., Oeuvres de Descartes, IV (Paris, 1824), 349-363.

I want to discuss first the composition of nerves and muscles, and to show how, from the very fact that the (animal) spirits that are in the brain enter into some nerves, they have at the same instant the power to move some member; then, touching briefly on the subject of respiration and on other such simple and ordinary movements, I shall discuss how exterior objects act on the organs of the senses; and after that I shall explain in detail all that is done in the cavities and the pores of the brain, how the animal spirits take their course there, and which of our functions this machine can imitate by means of these spirits: for if I were to begin with the brain, and only followed the course of the spirits, as I have done for blood, my discourse, it seems to me, would not be too clear.

Let us look, for example, at nerve A /Fig. 1/, whose exterior skin is similar to a large tube, which contains several other small tubes b, c, k, l, and so on, composed of an interior skin that is thinner; and these two skins are continuous with the (other) two, K, L, which envelop the brain MNO.

Note also /Fig. 2/ that in each of these little tubes there is a sort of a marrow composed of several very slender filaments, which come from the very substance of the brain N, and whose extremities end, on the one side, at its interior surface, which faces its cavities, and on the other at the skin and flesh against which the tube containing them ends. But since this marrow is not useful to the movement of the members, it is enough for you to know now that it does not fill the small tubes that contain it to such an extent that the animal spirits cannot flow freely from the brain into the muscles, where these small tubes, which should be considered here as so many small nerves, lead.

Then note how the tube, or small nerve bf goes into muscle D, which I assume to be one of those that move the eye; and how, once there, it divides itself into several branches, each composed of a loose skin, which can be stretched, or widened and narrowed, depending on the amount of animal spirits that enters or leaves it; its branches or fibers are so arranged that when the animal spirits enter into them they cause the entire body of the muscle to inflate and become shorter, and consequently it pulls the eye to which it is attached; likewise the opposite, when they leave it, the muscle deflates and lengthens.

Moreover, note that, besides the tube bf, there is still another one, namely, ef, through which the animal spirits can enter into muscle D, and yet another, namely dg, through which they can leave it. And that

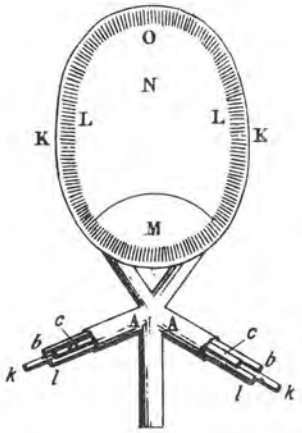

Fig. 1

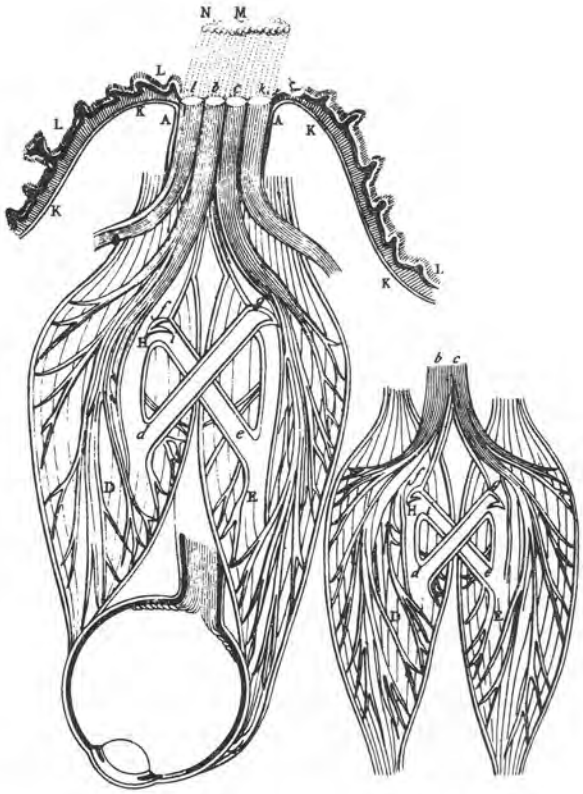

Fig. 2

similarly muscle E, which I assume serves to move the eye in the opposite way from muscle D, receives the animal spirits from the brain through tube cg, and from muscle D through dg, and sends them back to D through ef. And note that even though there is no observable passage through which the spirits contained in the two muscles D and E can leave, except to enter from one into the other, nevertheless, because their parts are very small and become incessantly even smaller by force of their movement, there are always several that escape through the skin and flesh of the muscles; but in return there are always others that come back through the two tubes bf and cg.

Finally, note that between the two tubes bf and ef there is a certain small skin Hfi, which separates these two tubes and serves as a door; it has two folds, H and i, so arranged that, when the animal spirits that tend to descend from b to H have more force than those that tend to go up from e to i, they lower and open this skin, thus enabling those in muscle E to flow very quickly with them toward D. But when those that tend to go up from e to i are stronger, or even when just as strong as the others, they raise and close this skin Hfi, and thus prevent themselves from leaving muscle E; whereas if neither has enough force to push it, it remains naturally ajar. And last, if sometimes these spirits contained in muscle D tend to leave it through dfe, or dfb, the fold H can be stretched and thus occlude its passage for them; and similarly, between the two tubes cg and dg, there is a small skin or valvule g, similar to the previous one, which remains naturally ajar and which can be closed by the spirits coming from tube dg and opened by those from cg.

Consequently it is easy to understand that, if the animal spirits in the brain do not tend, or hardly tend, to flow through tubes bf and cg, the two small skins or valvules f and g remain ajar, and thus the two muscles D and E are loose and inactive, especially since the animal spirits which they contain pass freely from one to the other, taking their course from e through f toward d, and conversely from d through g toward e. But if the spirits in the brain tend to enter with some force into the two tubes bf and cg, and if this force is equal on both sides, they immediately close the two passages g and f, and cause muscles D and E to swell as much as possible, thus making them firmly hold and stop the eye in whatever position they find it.

Then if these spirits coming from the brain tend to flow with more force through bf than through cg, they close the small skin g and open f, and this more or less, depending on whether the spirits act more or less strongly; by this means the spirits contained in muscle /E/ return to muscle D through the canal ef; and this faster or more slowly depending on whether the skin f is more or less open; so that muscle D, from which these spirits cannot come out, shortens, and E lengthens; and thus the eye is turned toward /D/. As on the contrary, if the spirits that are in the brain tend to flow with more force through cg than through bf, they close the small skin f and open g; so that the spirits from muscle D return immediately through the canal dg into muscle E, which as a result shortens and pulls the eye to its side.

For it is well known that these spirits, being like a wind or a very subtle flame, flow very quickly from one muscle into another as soon as they find some passage, although there is no other force that disposes

them to it than the sole inclination they have to continue their movement according to the laws of nature. And you know besides that even though they are very mobile and subtle they nevertheless have the force to swell and tighten the muscles within which they are enclosed just as the air in a balloon hardens it and causes the skin containing it to stretch.

Therefore it is easy to apply what I have just said about nerve A, and about the two muscles D and E, to all other muscles and nerves; and thus to understand how the machine of which I am speaking can be moved in all the same ways our bodies move, by the sole force of the animal spirits that flow from the brain into the nerves: because for each movement, and for its opposite, you may imagine two small nerves, or tubes, such as bf and cg, and two others such as dg and ef, and two small doors or valvules such as Hfi and g.

And as to the ways in which these tubes are inserted into the muscles, although these vary in a thousand ways, it is nevertheless not difficult to judge what they are by knowing what anatomy might teach concerning the exterior form and use of each muscle.

. . . . .

And it is not difficult to judge from this that the animal spirits can sometimes cause movements in the members where nerves end, even though there are several where the anatomists do not note any visible nerves, as in the pupil of the eye, the heart, liver, gall bladder, spleen, and other similar /organs/.

. . . . .

Now in order to understand how the machine can be incited by exterior objects striking the organs of its senses to move its members in a thousand different ways, imagine that the small filaments, which I have already mentioned earlier as coming from the innermost part of the brain and as composing the marrow of the nerves, are so arranged in all parts serving as the organ to some sense that can very easily be moved by the objects of the senses; and that, when they are moved somewhat strongly, they pull at the same time the parts of the brain, from whence they come, and thereby open the entrances of certain pores on the inner surface of the brain through which the animal spirits, which are in its cavities, begin immediately to take their course; the spirits go through them into the nerves and muscles, which serve to make movements in this machine very similar to those we are naturally incited to when our senses are touched in the same manner.

As, for example, if the fire A /Fig. 3/ is close to the foot B, the small parts of this fire, which move, as you know, very rapidly, have the power to move along with them the part of the skin of this foot which they touch; and by this means, pulling the small filament CC, which you see attached to it, they open at the same time the entrance of the pore de, where this small filament ends, just as, by pulling one of the ends of a cord, you cause a bell attached to the other end to ring at the same time.

Now, the entrance of the pore or small passage being thus opened, the

animal spirits of the cavity, F, enter and are carried by it, partly to the muscles that serve to withdraw the foot from the fire, partly to those that serve to turn the eyes and the head to look at it, and partly to those that serve to move the hands forward and to bend the body in order to bring relief.

But they can also be carried, by this same passage de, into several other muscles; and, before I stop to explain to you more exactly how the

Fig. 3

animal spirits follow their course through the pores of the brain and how these pores are arranged, I want to discourse here specifically on . . . the senses, such as they are found in this machine, and explain how they are related to ours.

Know, then, first, that there are a large number of small filaments similar to CC; they all begin to separate from one another at the inner surface of the brain, from whence they originate, and going from there to disperse throughout the rest of the body they serve as the organs for the sense of touch. For though ordinarily it is not they that are immediately touched by exterior objects, but the skins surrounding them, there nevertheless exists no more reason to think that it is these skins that are the organs of the sense than to think, when manipulating some object with gloved hands, that it is the gloves that serve to feel it.

. . . . .

Now I maintain that when God will unite a rational soul with this machine, as I shall assert hereafter, he will give it its principal seat in the brain, and will make it of such a nature that, according to the different ways the entrances of the pores in the interior surface of this brain will be opened by the intermission of the nerves, it will have varying sensations.

As, for example, if the small filaments that compose the marrow of these nerves are pulled with such force that they break and are separated from the part to which they were attached, so that the structure of the entire machine is somewhat less complete as a result, the movement they cause in the brain will give the soul . . . the occasion to experience the sensation of "pain."

And if they are pulled by a force almost as strong as the preceding one, but without breaking or being separated in any way from the parts to which they are attached, they will cause a movement in the brain which, giving evidence of good constitution of the other members, will give the soul the opportunity to feel a certain corporeal pleasure that is called "tickling," and which, as you can see, being very close to pain in its cause, is its opposite in effect.

If several of these small filaments are pulled together unequally, they will cause the soul to feel the surface of the body that touches the member where they end as "smooth," and they will cause it to feel it as "uneven" and "rough" if they are pulled equally.

If they are shaken just a little, independently of one another, as they continually are by the heat that the heart gives to the other members, the soul will have no sensation of it, or of any other ordinary actions; but if this movement is augmented or diminished in them by some unusual cause, its augmentation will cause the soul to have the sensation of "warmth," and its diminution that of "coldness"; and finally, according to the other diverse ways in which they will be moved, they will cause it to feel all the other qualities that belong to the sensation of touch in general, such as "humidity," "dryness," "weight," and the like.

Only it must be noted that, though they are very thin and very easy to move, they are not so to such an extent that they can bring to the brain all the smallest actions that are in nature; the smallest they do bring back to it are of the coarsest of terrestrial bodies, and there might even be some of those bodies whose parts, though quite coarse, will nonetheless slip against these small filaments so gently that they will press them or cut them completely, without their action passing to the brain; just as there are certain drugs that have the power to induce sleep or even to harm those of our members against which they are applied, without causing any sensation of it in us.

Study Guide for UNIT 2

Thomas Hobbes (1588-1679), John Locke (1632-1704), David Hume (1711-1776)

These three "mental philosophers" were empiricists and associationists. Unlike Descartes, they believed that all ideas came initially from experience, from "sensations" or "impressions," and that ideas were associated in the mind. This association doctrine is at least as old as Aristotle, it was formulated and it was carried well beyond the period which our selections represent. It contained the counterpart of several important modern conceptions--e.g., those of generalization and chaining, which you should readily perceive in the examples cited by these authors.

Study Questions

Hobbes

1. What does Hobbes mean by Consequence? How does he relate Sense to Imagination?

1. Can you discuss, using your own examples, Hobbes's distinction between "unguided" and "regulated" thought?

3. Why does Hobbes say that regulated thought is "nothing but Seeking"?

4. How would Hobbes distinguish an Imprudent man from a Prudent one?

5. On what grounds could we call Hobbes an "expectancy theorist?"

6. What does Hobbes mean by a "presumption of things Past taken from other things...past also?" Give your own example.

7. How does Hobbes relate empiricism to the idea of Infinity or of Deity?

N.B. It might be of interest to relate Hobbes's two kinds of Regulated Thought to Sets 43 and 44 of the Holland-Skinner programmed text on The Analysis of Behavior, if you have a copy of this text.

Locke

9. To what does John Lockeattribute the "association of ideas" in man--reason, egotism, madness, education? Explain, with examples.

10. What two kinds of "connexion" does Locke stress, and how are they made in man? Does he imply laws of association?

11. How are these "connexions" related to our antipathies and their origin? What is their relevance to education? Give examples.

12. Thorndike once wrote of Laws of Use and Disuse with respect to the strength of stimulus-response connections. Did Locke have counterparts of these "laws?" Explain.

13. Can you give examples of both emotional and intellectual instances of "unnatural" associations between ideas?

Hume

14. What is the difference between perception and idea, according to Hume? Is it ever lacking? Is it relevant to emotion?

15. What is included by Hume under the term Impression?

16. What does he mean by the "creative power of the Mind", and what does the analysis of our Thoughts disclose?

17. Descartes said that certain ideas were innate--e.g., the idea of God or of the axioms of geometry. What would Hume say? (The street on which Hume lived in Edinburgh was nicknamed St. David Street.)

18. Is there aught in Idea that is not derived from Impression? Explain.

19. What would Hume say about the wisdom of seeking out the referent of (exploring the S^D for) a given term? Explain.

20. What were Hume's principles of cohesion among simple ideas; which of them would you guess that he later reduced to one of the others? Give an example of each principle.

21. Why does Hume regard association as a "gentle force" and to what physical law does he relate this?

THOMAS HOBBES ON THE TRAIN OF THOUGHT, 1651.

Thomas Hobbes, Leviathan, or the Matter, Forme and Power of a Commonwealth Ecclesiasticall and Civill (London, 1651), pt. 1, chap. 3.

By Consequence, or Trayne of Thoughts, I understand that succession of one Thought to another, which is called (to distinguish it from Discourse in words) Mentall Discourse.

When a man thinketh on any thing whatsoever, His next Thought after, is not altogether so casuall as it seems to be. Not every Thought to every Thought succeeds indifferently. But as wee have no Imagination, whereof we have not formerly had Sense, in whole, or in parts; so we have no Transition from one Imagination to another, whereof we never had the like before in our Senses. The reason whereof is this. All Fancies are motions within us, reliques of those made in the Sense; And those motions that immediately succeeded one another in the sense, continue also together after Sense: In so much as the former comming again to take place, and to praedominant, the later followeth, by coherence of the matter moved, in such manner, as water upon a plain Table is drawn which way any one part of it is guided by the finger. But because in sense, to one and the same thing perceived, sometimes one thing, sometimes another succeedeth, it comes to passe in time, that in the Imagining of any thing, there is no certainty what we shall Imagine next; Onely this is certain, it shall be something that succeeded the same before, at one time or another.

This Trayne of Thoughts, or Mentall Discourse, is of two sorts. The first is Unguided, without Designe, and inconstant; Wherein there is no Passionate Thought, to govern and direct those that follow, to it self, as at the end and scope of some desire, or other passion: In which case the thoughts are said to wander, and seem impertinent one to another, as in a Dream. Such are Commonly the thoughts of men, that are not onely without company, but also without care of any thing; though even their Thoughts are as busie as at other times, but without harmony; as the sound which a Lute out of tune would yeeld to any man; or in tune, to one that could not play. And yet in this wild ranging of the mind, a man may oftimes perceive the way of it, and the dependance of one thought upon another. For in a Discourse of our present civill warre, what could seem more impertinent, than to ask (as one did) what was the value of a Roman Penny. Yet the Cohaerence to me was manifest enough. For the Thought of the warre, introduced the Thought of the delivering up the King to his enemies; The Thought of that, brought in the Thought of the delivering up of Christ; and that again the Thought of the 30 pence, which was the price of that treason: and thence easily followed that malicious question; and all this in a moment of time; for Thought is quick.

The second is more constant; as being regulated by some desire, and designe. For the impression made by such things as wee desire, or feare, is strong, and permanent, or, (if it cease for a time,) of quick return: so strong it is sometimes, as to hinder and break our sleep. From Desire, ariseth the Thought of some means we have seen produce the like of that which we ayme at; and from the thought of that, the thought of means to

that mean; and so continually, till we come to some beginning within our own power. And because the End, by the greatnesse of the impression, comes often to mind, in case our thoughts begin to wander, they are quickly again reduced into the way. . .

The Trayn of regulated Thoughts is of two kinds; One, when of an effect imagined, wee seek the causes, or means that produce it: and this is common to Man and Beast. The other is, when imagining any thing whatsoever, wee seek all the possible effects, that can by it be produced; that is to say, we imagine what we can do with it, when wee have it. Of which I have not at any time seen any signe, but in man onely; for this is a curiosity hardly incident to the nature of any living creature that has no other Passion but sensuall, such as are hunger, thirst, lust, and anger. In summe, the Discourse of the Mind, when it is governed by designe, is nothing but Seeking or the faculty of Invention; . . . a hunting out of the causes, of some effect, present or past; or of the effects, of some present or past cause. Sometimes a man seeks what he hath lost; and from that place, and time, wherein hee misses it, his mind runs back, from place to place, and time to time, to find where, and when he had it; that is to say, to find some certain, and limited time and place, in which to begin a method of seeking. Again, from thence, this thoughts run over the same place and times, to find what action, or other occasion might make him lose it. This we call Remembrance, or Calling to mind: the Latines call it Reminiscentia, as it were a Re-conning of our former actions.

Sometimes a man knows a place determinate, within the compasse whereof he is to seek; and then his thoughts run over all the parts thereof, in the same manner, as one would sweep a room, to find a jewell; or as a Spaniel ranges the field, till he find a sent; or as a man should run over the Alphabet, to start a rime.

Sometime a man desires to know the event of an action; and then he thinketh of some like action past, and the events thereof one after another; supposing like events will follow like actions. As he that foresees what wil become a Criminal, re-cons what he has seen follow on the like Crime before; having this order of thoughts, The Crime, the Officer, the Prison, the Judge, and the Gallowes. Which kind of thoughts, is called Foresight, and Prudence, or Providence; and sometimes Wisdome; though such conjecture, through the difficulty of observing all circumstances, be very fallacious. But this is certain; by how much one man has more experience of things past, than another; by so much also he is more Prudent, and his expectations the seldomer faile him. The Present onely has a being in Nature; things Past have a being in the Memory onely, but things to come have no being at all; the Future being but a fiction of the mind, applying the sequels of actions Past, to the actions that are Present; which with most certainty is done by him that has most Experience; but not with certainty enough. And though it be called Prudence, when the Event answereth our Expectation; yet in its own nature, it is but Presumption. For the foresight of things to come, which is Providence, belongs onely to him by whose will they are to come. From him onely, and supernaturally, proceeds Prophecy. The best Prophet naturally is the best guesser; and the best guesser, he that is most versed and studied in the matters he guesses at; for he hath most Signes to guesse by.

A Signe is the Event Antecedent, of the Consequent; and contrarily, the Consequent of the Antecedent, when the like Consequences have been observed, before: And the oftner they have been observed, the lesse uncertain is the Signe. And therefore he that has most experience in any kind of businesse, has most Signes, whereby to guesse at the Future time; and consequently is the most prudent: And so much more prudent than he that is new in that kind of business, as not to be equalled by any advantage of naturall and extremporary wit: though perhaps many young men think the contrary.

Neverthelesse it is not Prudence that distinguisheth man from beast. There be beasts, that a year old observe more, and pursue that which is for their good, more prudently, than a child can do at ten.

As Prudence is a Proesumtion of the Future contracted from the Experience of time Past: So there is a Praesumtion of things Past taken from other things (not future but) past also. For he that hath seen by what courses and degrees, a flourishing State hath first come into civil warre, and then to ruine; upon the sight of the ruines of any other State, will guesse, the like warre, and the like courses have been there also. But this conjecture, has the same incertainty almost with the conjecture of the Future; both being grounded onely upon Experience.

There is no other act of man's mind, that I can remember, naturally planted in him, so, as to need no other thing, to the exercise of it, but to be born a man, and live with the use of his five Senses. Those other Faculties, of which I shall speak by and by, and which seem proper to man onely, are acquired, and encreased by study and industry; and of most men learned by instruction, and discipline; and proceed all from the invention of Words, and Speech. For besides Sense, and Thoughts, and the Trayne of thoughts, the mind of man has no other motion; though by the help of Speech, and Method, the same Facultyes may be improved to such a height, as to distinguish men from all other living Creatures.

Whatsoever we imagine, is Finite. Therefore there is no Idea, or conception of any thing we call Infinite. No man can have in his mind an Image of infinite magnitude; nor conceive infinite swiftness, infinite time, or infinite force, or infinite power. When we say any thing is infinite, we signifie onely, that we are not able to conceive the ends, and bounds of the thing named; having no Conception of the thing, but of our own inability. And therefore the Name of God is used, not to make us conceive him; (for he is Incomprehensible; and his greatnesse, and power are unconceivable;) but that we may honour him. Also because whatsoever (as I said before,) we conceive, has been perceived first by sense, either all at once, or by parts; a man can have no thought, representing any thing, not subject to sense. No man therefore can conceive any thing, but he must conceive it in some place; and indued with some determinate magnitude; and which may be divided into parts; nor that any thing is all in this place, and all in another place at the same time; nor that two, or more things can be in one, and the same place at once: For none of these things ever have, or can be incident to Sense; but are absurd speeches, taken upon credit (without any signification at all,) from deceived Philosophers, and deceived, or deceiving Schoolemen.

JOHN LOCKE ON DISORDERS OF THE MIND, 1700

John Locke, An Essay concerning Humane Understanding, 4th ed. (London, 1700), bk. II, chap. 33.

1. There is scarce any one that does not observe something that seems odd to him, and is in it self really Extravagant in the Opinions, Reasonings, and Actions of other Men. The least flaw of this kind, if at all different from his own, every one is quick-sighted enough to espie in another, and will by the Authority of Reason forwardly condemn, though he be guilty of much greater Unreasonableness in his own Tenets and Conduct, which he never perceives, and will very hardly, if at all, be convinced of.

2. This proceeds not wholly from Self-love, though that has often a great hand in it. Men of fair Minds, and not given up to the over weening of Self-flattery, are frequently guilty of it; and in many Cases one with amazement hears the Arguings, and is astonish'd at the Obstinacy of a worthy Man, who yields not to the Evidence of Reason, though laid before him as clear as Day-light.

3, This sort of Unreasonableness is usually imputed to Education and Prejudice, and for the most part truly enough, though that reaches not the bottom of the Disease, nor shews distinctly enough whence it rises, or wherein it lies. Education is often rightly assigned for the Cause, and Prejudice is a good general Name for the thing it self: But yet, I think, he ought to look a little farther who would trace this sort of Madness to the root it springs from, and so explain it, as to shew whence this flaw has its Original in very sober and rational Minds, and wherein it consists.

4. I shall be pardon'd for calling it by so harsh a name as Madness, when it is considered, that opposition to Reason deserves that Name, and is really Madness; and there is scarce a Man so free from it, but that if he should always on all occasions argue or do as in some cases he constantly does, would not be thought fitter for Bedlam, than Civil Conversation. I do not here mean when he is under the power of an unruly Passion, but in the steady calm course of his Life. That which will yet more apologize for this harsh Name, and ungrateful Imputation on the greatest part of Mankind is, that enquiring a little by the bye into the Nature of Madness. . . I found it to spring from the very same Root, and to depend on the very same Cause we are here speaking of. This consideration of the thing it self, at a time when I thought not the least on the Subject which I am now treating of, suggest'd it to me. And if this be a Weakness to which all Men are so liable; if this be a Taint which so universally infects Mankind, the greater care should be taken to lay it open under its due Name, thereby to excite the greater care in its Prevention and Cure.

5. Some of our Ideas have a natural Correspondence and Connexion one with another: It is the Office and Excellency of our Reason to trace these, and hold them together in that Union and Correspondence which is founded in their peculiar Beings. Besides this there is

another Connexion of Ideas wholly owing to Chance or Custom, Ideas that in themselves are not at all of kin, come to be so united in some Mens Minds, that 'tis very hard to separate them, they always keep in company, and the one no sooner at any time comes into the Understanding but its Associate appears with it; and if they are more than two which are thus united, the whole gang always inseparable shew themselves together.

6. This strong Combination of Ideas, not ally'd by Nature, the Mind makes in it self either voluntarily, or by chance, and hence it comes in different Men to be very different, according to their different Inclinations, Educations, Interests, &c. Custom settles habits of Thinking in the Understanding, as well as of Determining in the Will, and of Motions in the Body; all which seems to be but Trains of Motion in the Animal Spirits, which once set a going continue on in the same steps they have been used to which by often treading are worn into a smooth path, and the Motion in it becomes easy and as it were Natural. As far as we can comprehend Thinking, thus Ideas seem to be produced in our Minds, or if they are not, this may serve to explain their following one another in an habitual train, when once they are put into that tract, as well as it does to explain such Motions of the Body. A Musician used to any Tune will find that let it but once begin in his Head, the Ideas of the several Notes of it will follow one another orderly in his Understanding without any care or attention, as regularly as his Fingers move orderly over the Keys of the Organ to play out the Tune he has begun, though his unattentive Thoughts be elsewhere a wandering. Whether the natural cause of these Ideas, as well as of that regular Dancing of his Fingers be the Motion of his Animal Spirits: I will not determine how probably soever by this Instance it appears to be so: But this may help us a little to conceive of Intellectual Habits, and of the tying together of Ideas.

7. That there are such Associations of them made by Custom in the Minds of most Men, I think no Body will question who has well consider'd himself or others; and to this, perhaps, might be justly attributed most of the Sympathies and Antipathies observable in Men, which work as strongly, and produce as regular Effects as if they were Natural, and are therefore called so, though they at first had no other Original but the accidental Connexion of two Ideas, which either the strength of the first Impression, or future Indulgence so united, that they always afterwards kept company together in that Man's Mind, as if they were but one Idea. I say most of the Antipathies, I do not say all, for some of them are truly natural, depend upon our original Constitution, and are born with us; but a great part of those which are counted Natural, would have been known to be from unheeded, though, perhaps, early Impressions, or wanton Phancies at first, which would have been acknowledged the Original of them if they had been warily observed. A grown Person surfeiting with Honey, no sooner hears the Name of it, but his Phancy immediately carries Sickness and Qualms to his Stomach, and he cannot bear the very Idea of it; other Ideas of Dislike and Sickness, and Vomiting presently accompany it, and he is disturb'd, but he knows from whence to date this Weakness, and can tell how he got this Indisposition: Had this happen'd to him, by an over dose of Honey, when a Child, all the same Effects would have followed, but the Cause would have been mistaken, and the Antipathy counted Natural.

8. I mention this not out of any great necessity there is in this

present Argument, to distinguish nicely between Natural and Acquired Antipathies, but I take notice of it for another purpose (viz.) that those who have Children, or the charge of their Education, would think it worth their while diligently to watch, and carefully to prevent the undue Connexion of Ideas in the Minds of young People. This is the time most susceptible of lasting Impressions, and though those relating to the Health of the Body, are by discreet People minded and fenced against, yet I am apt to doubt, that those which relate more peculiarly to the Mind, and terminate in the Understanding, or Passions, have been much less heeded than the thing deserves, nay those relating purely to the Understanding have, as I suspect, been by most Men wholly overlook'd.

9. This wrong Connexion in our Minds of Ideas in themselves, loose and independent one of another has such an influence, and is of so great force to set us awry in our Actions, as well Moral as Natural, Passions, Reasoning, and Notions themselves, that, perhaps, there is not any one thing that deserves more to be looked after.

10. The Ideas of Goblines and Sprights have really no more to do with Darkness than Light, yet let but a foolish Maid inculcate these often on the Mind of a Child, and raise them there together, possibly he shall never be able to separate them again so long as he lives, but Darkness shall ever afterwards bring with it those frightful Ideas, and they shall be so joined that he can no more bear the one than the other.

11. A Man receives a sensible Injury from another, thinks on the Man and that Action over and over, and by ruminating on them strongly, or much in his Mind so cements those two Ideas together, that he makes them almost one; never thinks on the Man, but the Pain and Displeasure he suffered comes into his Mind with it, so that he scarce distinguishes them, but has as much an aversion for the one as the other. Thus Hatreds are often begotten from slight and almost innocent Occasions, and Quarrels propagated and continued in the World.

12. A Man has suffered Pain or Sickness in any Place, he saw his Friend die in such a Room, though these have in Nature nothing to do one with another, yet when the Idea of the Place occurs to his Mind, it brings (the Impression being once made) that of the Pain and Displeasure with it, he confounds them in his Mind, and can as little bear the one as the other.

13. When this Combination is settled and whilst it lasts, it is not in the power of Reason to help us, and relieve us from the Effects of it. Ideas in our Minds, when they are there, will operate according to their Natures and Circumstances; and here we see the cause why Time cures certain Affections, which Reason, though in the right, and allow'd to be so, has not power over, nor is able against them to prevail with those who are apt to hearken to it in other cases. The Death of a Child, that was the daily delight of his Mothers Eyes, and joy of her Soul, rends from her Heart the whole comfort of her Life, and gives her all the torment imaginable; use the Consolations of Reason in this case, and you were as good preach Ease to one on the Rack, and hope to allay, by rational Discourses, the Pain of his Joints tearing asunder. Till time has by disuse separated the sense of that Enjoyment and its loss from the Idea of the Child returning to her Memory, all Representations, though never so

reasonable, are in vain; and therefore some in whom the union between these Ideas is never dissolved, spend their Lives in Mourning, and carry an incurable Sorrow to their Graves.

14. A Friend of mine knew one perfectly cured of Madness by a very harsh and offensive Operation. The Gentleman, who was thus recovered, with great sense of Gratitude and Acknowledgment, owned the Cure all his Life after, as the greatest Obligation he could have received; but whatever Gratitude and Reason suggested to him, he could never bear the sight of the Operator: That Image brought back with it the Idea of that Agony which he'd suffer'd from his Hands, which was too mighty and intolerable for him to endure.

15. Many Children imputing the Pain they endured at School to their Books they were corrected for, so joyn those Ideas together, that a Book becomes their Aversion, and they are never reconciled to the study and use of them all their Lives after; and thus Reading becomes a torment to them, which otherwise possibly they might have made the great Pleasure of their Lives. There are Rooms convenient enough, that some Men cannot Study in, and fashions of Vessels, which though never so clean and commodious they cannot Drink out of, and that by reason of some accidental Ideas which are annex'd to them, and make them offensive; and who is there that hath not observed some Man to flag at the appearance, or in the company of some certain Person not otherwise superior to him, but because having once on some occasion got the Ascendant, the Idea of Authority and Distance goes along with that of the Person, and he that has been thus subjected is not able to separate them.

16. Instances of this kind are so plentiful every where, that if I add one more, it is only for the pleasant oddness of it. It is of a young Gentleman, who having learnt to Dance, and that to great Perfection, there happened to stand an old Trunk in the Room where he learnt. The Idea of this remarkable piece of Housholdstuff, had so mixed it self with the turns and steps of all his Dances, that though in that Chamber he could Dance excellently well, yet is was only whilst that Trunk was there, nor could he perform well in any other place, unless that, or some such other Trunk had its due position in the Room. If this story shall be suspected to be dressed up with come comical Circumstances, a little beyond precise Nature; I answer for my self, that I had it some Years since from a very sober and worthy Man, upon his own knowledge, as I report it; and I dare say, there are very few inquisitive Persons, who read this, who have not met with Accounts, if not Examples of this Nature, that may parallel, or at least justify this.

17. Intellectual Habits and Defects this way contracted are not less frequent and powerful, though less observed. Let the Ideas of Being and Matter be strongly joined either by Education or much Thought, whilst these are still combined in the Mind, what Notions, what Reasonings, will there be about separate Spirits? Let custom from the very Childhood have join'd Figure and Shape to the Idea of God, and what Absurdities will that Mind be liable to about the Deity?

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18. Some such wrong and unnatural Combinations of Ideas will be

found to establish the Irreconcilable opposition between different Sects of Philosophy and Religion; for we cannot imagine every one of their Followers to impose wilfully on himself, and knowlingly refuse Truth offer'd by plain Reason. Interest though it does a great deal in the case, yet cannot be thought to work whole Societies of Men to so universal a Perverseness, as that every one of them to a Man should knowingly maintain Falshood: Some at least must be allowed to do what all pretend to, i.e., to pursue Truth sincerely; and therefore there must be something that binds their Understandings, and makes them not see the falshood of what they embrace for real Truth. That which thus captivates their Reasons, and leads Men of Sincerity blindfold from common Sence, will, when examin'd, be found to be what we are speaking of: some independent Ideas, of no alliance to one another, are by Education, Custom, and the constant din of their Party, so coupled in their Minds, that they always appear there together, and they can no more separate them in their Thoughts, than if they were but one Idea, and they operate as if they were so. This gives Sence to Jargon, Demonstration to Absurdities, and Consistency to Nonsense, and is the foundation of the greatest, I had almost said, of all the Errors in the World; or if it does not reach so far, it is at least the most dangerous one, since so far as it obtains it hinders Men from seeing and examining. When two things in themselves disjoin'd appear to the sight constantly united; if the Eye sees these things rivetted which are loose, where will you begin to rectify the mistakes that follow in two Ideas, that they have been accustom'd so to join in their Minds, as to substitute one for the other, and, as I am apt to think, often without perceiving it themselves? This, whilst they are under the deceit of it, makes them uncapable of Conviction, and they applaud themselves as zealous Champions for Truth, when indeed they are contending for Error; and the confusion of two different Ideas, which a customary connexion of them in their Minds hath to them made in effect but one, fills their Heads with false Views, and their Reasonings with false Consequences.

DAVID HUME ON A PSYCHOLOGICAL ANALOGUE OF GRAVITATION, 1739.

The first excerpt in the present selection is from David Hume, Philosophical Essays concerning Human Understanding, 2nd ed. (London, 1751), essay 2. The first edition (1748) has not been available, but presumably does not differ materially. More recent editions of this book are entitled Enquiry concerning Human Understanding. The second excerpt is from Hume's Treatise of Human Nature; being An Attempt to Introduce the experimental Method of Reasoning into Moral Subjects, vol. I (London, 1739), pt. 1, sect. 4. The later work is essentially a revision and condensation of the earlier.

/Excerpt 1/

Every one will readily allow, that there is a considerable Difference betwixt the Perceptions of the Mind, when a Man feels the Pain of excessive Heat or the Pleasure of moderate Warmth, and when he afterwards recalls to his Memory this Sensation, or anticipates it by his Imagination. These Faculties may mimick or copy the Perceptions of the Senses; but they never can reach entirely the Force and Vivacity of the

original Sentiment. The utmost we say of them, even when they operate with greatest Vigour, is, that they represent their Object in so lively a Manner, that we could almost say we feel or see it: But, except the Mind be disorder'd by Disease or Madness, they never can arrive at such a Pitch of Vivacity as to render these Perceptions altogether undistinguishable. All the Colours of Poetry, however, splendid, can never paint natural Objects in such a manner as to make the Description be taken for a real Landskip. The most lively Thought is still inferior to the dullest Sensation.

We may observe a like Distinction to run thro' all the other Perceptions of the Mind. A Man, in a Fit of Anger, is actuated in a very different Manner from one, who only thinks of that Emotion. If you tell me, that any Person is in Love, I easily understand your Meaning, and form a just Conception of his Situation; but never can mistake that Conception for the real Disorders and Agitations of the Passion. When we reflect on all our past Sentiments and Affections, our Thought is a faithful Mirror, and copies its Objects truly; but the Colours it employs are faded and dead, in comparison of those, in which our original Perceptions were cloth'd. It requires no nice Discernment nor metaphysical Head to mark the Distinction betwixt them.

Here therefore we may divide all the Perceptions of the Mind into two Classes or Species, which are distinguish'd by their different Degrees of Force and Vivacity. The less forcible and lively are commonly denominated Thoughts or Ideas. The other Species want a Name in our Language, and in most others; I suppose, because it was not requisite for any, but philosophical Purposes, to rank them under a general Term or Appellation. Let us, therefore, use a little Freedom, and call them Impressions, employing that Word in a Sense somewhat different from the usual. By the Term, Impressions, then, we mean all our more lively Perceptions, when we hear, or see, or feel, or love, or hate, or desire, or will. And Impressions are contradistinguish'd from Ideas, which are the less lively Perceptions we are conscious of, when we reflect on any of these Sensations or Movements above mention'd.

Nothing, at first View, may seem more unbounded than the Thought of Man, which not only escapes all human Power and Authority, but is not even restrain's within the Limits of Nature and Reality. To form Monsters, and join incongruous Shapes and Appearances costs it no more Trouble than to conceive the most natural and familiar Objects. And while the Body is confin'd to one Planet, along which it creeps with Pain and Difficulty; the Thought can in an Instant transport us into the most distant Regions of the Universe; or even beyond the Universe, into the unbounded Chaos, where Nature is suppos'd to lie in total Confusion. What never was seen, nor heard of may yet be conceiv'd; nor is any thing beyond the Power of Thought, except what implies an absolute Contradiction.

But tho' Thought seems to possess this unbounded Liberty, we shall find, upon a nearer Examination, that it is really confin'd within very narrow Limits, and that all this creative Power of the Mind amounts to no more than the compounding, transposing, augmenting, or diminishing the Materials afforded us by the Senses and Experience. When we think of a golden Mountain, we only join two consistent Ideas, Gold, and

Mountain, with which we were formerly acquainted. A virtuous Horse we can conceive; because, from our own Feeling, we can conceive Virtue, and this we may unite to the Figure and Shape of a Horse, which is an Animal familiar to us. In short, all the Materials of thinking are deriv'd either from our outward or inward Sentiment: The Mixture and Composition of these belongs alone to the Mind and Will. Or to express myself in philosophical Language, all our Ideas or more feeble Perceptions are Copies of our Impressions or more lively ones.

To prove this, the two following Arguments will, I hope, be sufficient. First, When we analyse our Thoughts or Ideas, however compounded or sublime, we always find, that they resolve themselves into such simple Ideas as were copy'd from a precedent Feeling or Sentiment. Even those Ideas, which, at first view, seem the most wide of this Origin, are found, upon a narrower Scrutiny, to be deriv'd from it. The Idea of God, as meaning an infinitely intelligent, wise, and good Being, arises from reflecting on the Operations of our own Mind, and augmenting those Qualities of Goodness and Wisdom, without Bound or Limit. We may prosecute this Enquiry to what Length we please, where we shall always find, that every Idea we examine is copy'd from a similar Impression. Those, who would assert, that this Position is not absolutely universal and without Exception, have only one, and that an easy Method of refuting it, by producing that idea, which, in their Opinion, is not deriv'd from this Source. It will then be incumbent on us, if we would maintain our Doctrine, to produce the Impression or lively Perception, that corresponds to it.

Secondly. If it happen, from a Defect of the Organ, that a Man is not susceptible of any Species of Sensation, we always find, that he is as little susceptible of the correspondent Ideas. A blind Man can form no Notion of Colours; a deaf Man of Sounds. Restore either of them that Sense, in which he is deficient; by opening this new Inlet for his Sensations, you also open an Inlet for the Ideas, and he finds no Difficulty of conceiving these Objects. The Case is the same if the Object, proper for exciting any Sensation, has never been apply'd to the Organ. A Laplander or Negro has no Notion of the Relish of Wine. And tho' there are few or no Instances of a like Deficiency in the Mind, where a Person has never felt or is altogether incapable of a Sentiment or Passion, that belongs to his Species; yet we find the same Observation to take place in a lesser Degree. A Man of mild Manners can form no Notion of inveterate Revenge or Cruelty; nor can a selfish Heart easily conceive the Heights of Friendship and Generosity. "Tis readily allow'd, that other Beings may possess many Senses, of which we can have no Conception; because the Ideas of them have never been introduc'd to us in the only Manner, by which an Idea can have access to the Mind, viz. by the actual Feeling and Sensation.

There is, however, one contradictory Phaenomenon, which may prove that 'tis not absolutely impossible for Ideas to go before their correspondent Impressions. I believe it will readily be allow'd, that the several distinct Ideas of Colours, which enter by the Eyes, or those of Sounds, which are convey'd by the Hearing, are really different from each other; tho', at the same time, resembling. Now if this be true of different Colours, it must be no less so, of the different Shades of the same Colour; and each Shade produces a distinct Idea, independent of the rest. For if this should be deny'd, 'tis possible, by the continual Gradation of

Shades, to run a Colour insensibly into what is most remote from it; and if you will not allow any of the Means to be different, you cannot, without Absurdity, deny the Extremes to be the same. Suppose, therefore, a Person to have enjoy'd his Sight for thirty Years, and to have become perfectly well acquainted with Colours of all kinds, excepting one particular Shade of Blue, for Instance, which it never has been his Fortune to meet with. Let all the different Shades of that Colour, except that single one, be plac'd before him, descending gradually from the deepest to the lightest; 'tis plain, that he will perceive a Blank, where that Shade is wanting, and will be sensible, that there is a greater Distance in that Place betwixt the contiguous Colours than in any other. Now I ask, whether 'tis possible for him, from his own Imagination, to supply this Deficiency, and raise up to himself the Idea of that particular Shade, tho' it had never been convey'd to him by his Senses? I believe there are few but will be of Opinion that he can; and this may serve as a Proof, that the simple Ideas are not always, in every Instance, deriv'd from the correspondent Impressions; tho' this Instance is so particular and singular, that 'tis scarce worth our observing, and does not merit, that for it alone we should alter our general Maxim.

Here, therefore, is a Proposition, which not only seems, in itself, simple and intelligible; but, if properly employ'd, might render every Dispute equally intelligible, and banish all that Jargon, which has so long taken Possession of metaphysical Reasonings, and drawn such Disgrace upon them. All Ideas, especially abstract ones, are naturally faint and obscure: The Mind has but a slender Hold on them: They are apt to be confounded with other resembling Ideas: And when we have often employ'd any Term, tho' without a distinct Meaning, we are apt to imagine it has a determinate Idea, annex'd to it. On the contrary, all Impressions, that is, all Sensations, either outward or inward, are strong and sensible: The Limits betwixt them are more exactly determin'd: Nor is it easy to fall into any Error or Mistake with Regard to them. When therefore we entertain any Suspicion, that a philosophical Term is employ'd without any Meaning or Idea (as is but too frequent) we need but enquire, from what Impression is that suppos'd Idea deriv'd? And if it be impossible to assign any, this will serve to confirm our Suspicion. By bringing Ideas into so clear a Light, we may reasonably hope to remove all Dispute, that may arise, concerning their Nature and Reality.

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/Excerpt 2/

As all simple ideas may be separated by the imagination, and may be united again in what form it pleases, nothing would be more unaccountable than the operations of that faculty, were it not guided by some universal principles, which render it, in some measure, uniform with itself in all times and places. Were ideas entirely loose and unconnected, chance alone wou'd join them; and 'tis impossible the same simple ideas should fall regularly into complex ones (as they commonly do) without some bond of union among them, some associating quality, by which one idea naturally introduces another. This uniting principle among ideas is not to be consider'd as an inseparable connexion; for that has been already excluded from the imagination: Nor yet are we to conclude, that

without it the mind cannot join two ideas; for nothing is more free than that faculty; but we are only to regard it as a gentle force, which commonly prevails, and is the cause why, among other things, languages so nearly correspond to each other; nature in a manner pointing out to every one those simple ideas, which are most proper to be united into a complex one. The qualities, from which this association arises, and by which the mind is after this manner convey'd from one idea to another, are three, viz. Resemblance, Contiguity in time or place, and Cause and Effect.

I believe it will not be very necessary to prove, that these qualities produce an association among ideas, and upon the appearance of one idea naturally introduce another. 'Tis plain, that in the course of our thinking, and in the constant revolution of our ideas, our imagination runs easily from one idea to any other that resembles it, and that this quality alone is to the fancy a sufficient bond and association. 'Tis likewise evident, that as the senses, in changing their objects, are necessitated to change them regularly, and take them as they lie contiguous to each other, the imagination must by long custom acquire the same method of thinking, and run along the parts of space and time in conceiving its objects. As to the connexion, that is made by the relation of cause and effect, we shall have occasion afterwards to examine it to the bottom, and therefore shall not at present insist upon it. 'Tis sufficient to observe, that there is no relation, which produces a stronger connexion in the fancy, and makes one idea more readily recall another, than the relation of cause and effect betwixt their objects.

That we may understand the full extent of these relations, we must consider, that two objects are connected together in the imagination, not only when the one is immediately resembling, contiguous to, or the cause of the other, but also when there is interposed betwixt them a third object, which bears to both of them any of these relations. This may be carried on to a great length; tho' at the same time we may observe, that each remove considerably weakens the relation. Cousins in the fourth degree are connected by causation, if I may be allowed to use that term; but not so closely as brothers, much less as child and parent. In general we may observe, that all the relations of blood depend upon cause and effect, and are esteemed near or remote, according to the number of connecting causes interpos'd betwixt the persons.

Of the three relations above-mention'd this of causation is the most extensive. Two objects may be consider'd as plac'd in this relation, as well when one is the cause of any of the actions or motions of the other, as when the former is the cause of the existence of the latter. For as that action or motion is nothing but the object itself, consider'd in a certain light, and as the object continues the same in all its different situations, 'tis easy to imagine how such an influence of objects upon one another may connect them in the imagination.

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These are therefore the principles of union or cohesion among our simple ideas, and in the imagination supply the place of that inseparable connexion, by which they are united in our memory. Here is a kind of Attraction, which in the mental world will be found to have as extraordinary effects as in the natural, and to shew itself in as many and as various forms. Its effects are every where conspicuous; but as to its

causes, they are mostly unknown, and must be resolv'd into original qualities of human nature, which I pretend not to explain. Nothing is more requisite for a true philosopher, than to restrain the intemperate desire of searching into causes, and having establish'd any doctrine upon a sufficient number of experiments, rest contented with that, when he sees a farther examination would lead him into obscure and uncertain speculations. In that case his enquiry wou'd be much better employ'd in examining the effects than the causes of his principle.

William James (1842-1910)

America's greatest claimant to psychological fame at the turn of the century was born in New York, received his early schooling in this country and abroad, attended Harvard College and Medical School, and was successively drawn into studies of physiology (with Helmholtz and Claude Bernard, among others), psychology, and philosophy during the remainder of his life. Especially gifted as a writer and a critic, he was quick to recognize (and lampoon) any over-simplification, pomposity, pedantry, or exaggerated claims of his contemporaries or predecessors--including such famous men as Herbert Spencer, Gustav Fechner, and Wilhelm Wundt. The clarity, color, and elegance of his literary style, as well as the breadth of his scholarship, won him an undisputed niche in the history of psychology, in spite of the fact that he contributed little of systematic importance to present-day thought. He was at his best in the role of a critic.

Study Questions

1. What are the two kinds of mental "couplings," judgments, or subject-predicate connections which James describes at the beginning of his treatment of "psychogenesis?"

2. What is the relation of these to the positions of the empiricist and the apriorist?

3. What are the two kinds of empiricism, according to James?

4. What other psychological categories than those of judgment are subject to two interpretations with respect to their origins?

5. Can you state James's own position with respect to apriorism and empiricism (nativism and geneticism)? Does it involve a belief in evolution?

6. On what point would "everyone" agree concerning the origins of mental life?

7. In what ways can the mind be related to the outside world? What does James mean by "organic mental structure"? By "experience?"

8. What value does James assign to "experience" in accounting for connections among ideas?"

9. What, according to James, did Herbert Spencer try to add to the empiricistic argument?

10. In what two ways may nature produce perceptions in the Mind? Can you give examples?

11. In what ways can an animal become a "match for its environment?" Did Spencer have names for these?

12. Can you distinguish between the "front-door" and the "back-door" manner in which the mind is assailed?

13. How would a Spencerite describe the way in which the mental categories get into our minds from the world outside? What does James object to in this? What does he agree with?

14. How does the world of "scientific reality" correspond to the world of "experience?"

15. What does James mean when he says:

> Instead of experience engendering the "inner relations," the inner relations are what engender the experiences here." Which is "back-door" knowledge; which is "front-door?"

What do you think of James's position? Is it relevant to present-day problems of psychology? Which?

WILLIAM JAMES ON THE LIMITATIONS OF ASSOCIATIONISM, 1890

William James, The Principles of Psychology (New York, 1890), vol. II, chap. 28.

In this final chapter I shall treat of what has sometimes been called psychogenesis, and try to ascertain just how far the connections of things in the outward environment can account for our tendency to think of, and to react upon, certain things in certain ways and in no others, even though personally we have had of the things in question no experience, or almost no experience at all. It is a familiar truth that some propositions are necessary. We must attach the predicate 'equal' to the subject 'opposite sides of a parallelogram' if we think those terms together at all, whereas we need not in any such way attach the predicate 'rainy,' for example, to the subject 'to-morrow.' The dubious sort of coupling of terms is universally admitted to be due to 'experience'; the certain sort is ascribed to the 'organic structure' of the mind. This structure is in turn supposed by the so-called apriorists to be of transcendental origin, or at any rate not to be explicable by experience; whilst by evolutionary empiricists it is supposed to be also due to experience, not only to the experience of the individual, but to that of his ancestors as far back as one may please to go. Our emotional and instinctive tendencies, our irrestible impulses to couple certain movements with the perception or thought of certain things, are also features of our connate mental structure, and like the necessary judgments, are interpreted by the apriorists and empiricists in the same warring ways.

I shall try in the course of the chapter to make plain three things:

1) That, taking the word experience as it is universally understood, the experience of the race can no more account for our necessary or a priori judgments than the experience of the individual can;

2) That there is no good evidence for the belief that our instinctive reactions are fruits of our ancestors' education in the midst of the same environment, transmitted to us at birth.

3) That the features of our organic mental structure cannot be explained at all by our conscious intercourse with the outer environment, but must rather be understood as congenital variations, 'accidental' in the first instance, but then transmitted as fixed features of the race.

On the whole, then, the account which the apriorists give of the facts is that which I defend; although I should contend (as will hereafter appear) for a naturalistic view of their cause.

The first thing I have to say is that all schools (however they otherwise differ) must allow that the elementary qualities of cold, heat, pleasure, pain, red, blue, sound, silence, etc., are original, innate, or a priori properties of our subjective nature, even though they should require the touch of experience to waken them into actual consciousness, and should slumber, to all eternity, without it.

This is so on either of the two hypotheses we may make concerning the relation of the feelings to the realities at whose touch they become

alive. For in the first place, if a feeling do not mirror the reality which wakens it and to which we say it corresponds, if it mirror no reality whatever outside of the mind, it of course is a purely mental product. By its very definition it can be nothing else. But in the second place, even if it do mirror the reality exactly, still it is not that reality itself, it is a duplication of it, the result of a mental reaction. And that the mind should have the power of reacting in just that duplicate way can only be stated as a harmony between its nature and the nature of the truth outside of it, a harmony whereby it follows that the qualities of both parties match.

The originality of these elements is not, then, a question for dispute. The warfare of philosophers is exclusively relative to their FORMS OF COMBINATION. The empiricist maintains that these forms can only follow the order of combination in which the elements were originally awakened by the impressions of the external world; the apriorists insist, on the contrary, that some modes of combination, at any rate, follow from the natures of the elements themselves, and that no amount of experience can modify this result.

WHAT IS MEANT BY EXPERIENCE?

The phrase 'organic mental structure' names the matter in dispute. Has the mind such a structure or not? Are its contents arranged from the start, or is the arrangement they may possess simply due to the shuffling of them by experience in an absolutely plastic bed? Now the first thing to make sure of is that when we talk of 'experience,' we attach a definite meaning to the word. Experience means experience of something foreign supposed to impress us, whether spontaneously or in consequence of our own exertions and acts. Impressions, as we well know, affect certain orders of sequence and coexistence, and the mind's habits copy the habits of the impressions, so that our images of things assume a time- and space-arrangement which resembles the time- and space-arrangements outside. To uniform outer coexistences and sequences correspond constant conjunctions of ideas, to fortuitous coexistences and sequences casual conjunctions of ideas. We are sure that fire will burn and water wet us, less sure that thunder will come after lightning, not at all sure whether a strange dog will bark at us or let us go by. In these ways experience moulds us every hour, and makes of our minds a mirror of the time- and space-connections between the things in the world. The principle of habit within us so fixes the copy at last that we find it difficult even to imagine how the outward order could possibly be different from what it is, and we continually divine from the present what the future is to be. These habits of transition, from one thought to another, are features of mental structure which were lacking in us at birth; we can see their growth under experience's moulding finger, and we can see how often experience undoes her own work, and for an earlier order substitutes a new one. 'The order of experience,' in this matter of the time- and space-conjunctions of things, is thus an indisputably vera causa of our forms of thought. It is our educator, our sovereign helper and friend; and its name, standing for something with so real and definite a use, ought to be kept sacred and encumbered with no vaguer meaning.

If all the connections among ideas in the mind could be interpreted

as so many combinations of sense-data wrought into fixity in this way from without, then experience in the common and legitimate sense of the word would be the sole fashioner of the mind.

The empirical school in psychology has in the main contended that they can be so interpreted. Before our generation, it was the experience of the individual only which was meant. But when one nowadays says that the human mind owes its present shape to experience, he means the experience of ancestors as well. Mr. Spencer's statement of this is the earliest emphatic one.

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TWO MODES OF ORIGIN OF BRAIN STRUCTURE

... The 'experience-philosophy' has from time immemorial been the opponent of theological modes of thought. The word experience has a halo of anti-supernaturalism about it; so that if anyone express dissatisfaction with any function claimed for it, he is liable to be treated as if he could only be animated by loyalty to the catechism, or in some way have the interests of obscurantism at heart. I am entirely certain that, on this ground alone, what I have erelong to say will make this a sealed chapter to many of my readers. "He denies experience!" they will exclaim, "denies science; believes the mind created by miracle, is a regular old partisan of innate ideas! That is enough! we'll listen to such antediluvian twaddle no more." Regrettable as is the loss of readers capable of such wholesale discipleship, I feel that a definite meaning for the word experience is even more important than their company. 'Experience' does not mean every natural, as opposed to every supernatural, cause. It means a particular sort of natural agency, alongside of which other more recondite natural agencies may perfectly well exist. With the scientific animus of anti-supernaturalism we ought to agree, but we ought to free ourselves from its verbal idols and bugbears.

Nature has many methods of producing the same effect. She may make a 'born' draughtsman or singer by tipping in a certain direction at an opportune moment the molecules of some human ovum; or she may bring forth a child ungifted and make him spend laborious but successful years at school. She may make our ears ring by the sound of a bell, or by a dose of quinine; make us see yellow by spreading a field of buttercups before our eyes, or by mixing a little santonine powder with our food; fill us with terror of certain surroundings by making them really dangerous, or by a blow which produces a pathological alteration of our brain. It is obvious that we need two words to designate these two modes of operating. <u>In the one case the natural agents produce perceptions which take cognizance of the agents themselves; in the other case, they produce perceptions which take cognizance of something else.</u> What is taught to the mind by the 'experience,' in the first case, is the <u>order of experience itself</u>--the 'inner relation' (in Spencer's phrase) 'corresponds' to the 'outer relation' which produced it, by remembering and knowing the latter. But in the case of the <u>other</u> sort of natural agency, what is taught to the mind has nothing to do with the agency itself, but with some different outer relation altogether. A diagram will express the alternatives. <u>B</u> stands for our human brain

in the midst of the world. All the little o's with arrows proceeding

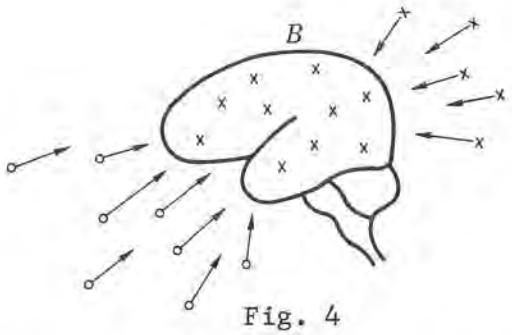

Fig. 4

from them are natural objects (like sunsets, etc.), which impress it through the senses, and in the strict sense of the word give it experience, teaching it by habit and association what is the order of their ways. All the little x's inside the brain and all the little x's outside of it are the other natural objects and processes (in the ovum, in the blood, etc.), which equally modify the brain, but mould it to no cognition of themselves. The tinnitus aurium discloses no properties of the quinine; the musical endowment teaches no embryology; the morbid dread (of solitude, perhaps) no brain-pathology; but the way in which a dirty sunset and a rainy morrow hang together in the mind copies and teaches the sequences of sunsets and rainfall in the outer world.

In zoological evolution we have two modes in which an animal race may grow to be a better match for its environment.

First, the so-called way of 'adaptation,' in which the environment may itself modify its inhabitant by exercising, hardening, and habituating him to certain sequences, and these habits may, it is often maintained, become hereditary.

Second, the way of 'accidental variation,' as Mr. Darwin termed it, in which certain young are born with peculiarities that help them and their progeny to survive. That variations of this sort tend to become hereditary, no one doubts.

The first mode is called by Mr. Spencer direct, the second indirect, equilibration. Both equilibrations must of course be natural and physical processes, but they belong to entirely different physical spheres. The direct influences are obvious and accessible things. The causes of variation in the young are, on the other hand, molecular and hidden. The direct influences are the animal's 'experiences,' in the widest sense of the term. Where what is influenced by them is the mental organism, they are conscious experiences, and become the objects as well as the causes of their effects. That is, the effect consists in a tendency of the experience itself to be remembered, or to have its elements thereafter coupled in imagination just as they were coupled in the experience. In the diagram these experiences are represented by the o's exclusively. The x's, on the other hand, stand for the indirect causes of mental modification--causes of which we are not immed-

iately conscious as such, and which are not the direct objects of the effects they produce. Some of them are molecular accidents before birth; some of them are collateral and remote combinations, unintended combinations, one might say, of more direct effects wrought in the unstable and intricate brain-tissue. Such a result is unquestionably the susceptibility to music, which some individuals possess at the present day. It has no zoological utility; it corresponds to no object in the natural environment; it is a pure incident of having a hearing organ, an incident depending on such instable and inessential conditions that one brother may have it and another brother not. Just so with the susceptibility to sea-sickness, which, so far from being engendered by long experience in its 'object' (if a heaving deck can be called its object) is erelong annulled thereby. Our higher aesthetic, moral, and intellectual life seems made up of affections of this collateral and incidental sort, which have entered the mind by the back stairs, as it were, or rather have not entered the mind at all, but got surreptitiously born in the house. No one can successfully treat psychogenesis, or the factors of mental evolution, without distinguishing between these two ways in which the mind is assailed. The way of 'experience' proper is the front door, the door of the five senses. The agents which affect the brain in this way immediately become the mind's objects. The other agents do not. It would be simply silly to say of two men with perhaps equal effective skill in drawing, one an untaught natural genius, the other a mere obstinate plodder in the studio, that both alike owe their skill to their 'experience.' The reasons of their several skills lie in wholly disparate natural cycles of causation.

I will then, with the reader's permission, restrict the word 'experience' to processes which influence the mind by the front-door-way of simple habits and association. What the back-door-effects may be will probably grow clearer as we proceed; so I will pass right on to a scrutiny of the actual mental structure which we find.

THE GENESIS OF THE ELEMENTARY MENTAL CATEGORIES

We find: 1. Elementary sorts of sensation, and feelings of personal activity;

2. Emotions; desires; instincts; ideas of worth; aesthetic ideas;

3. Ideas of time and space and number;

4. Ideas of difference and resemblance, and of their degrees.

5. Ideas of causal dependence among events; of end and means; of subject and attribute.

6. Judgments affirming, denying, doubting, supposing any of the above ideas.

7. Judgments that the former judgments logically involve, exclude, or are indifferent to, each other.

Now we may postulate at the outset that all these forms of thought have a natural origin, if we could only get at it. That assumption must be made at the outset of every scientific investigation, or there is no temptation to proceed. But the first account of their origin which we are likely to hit upon is a snare. All these mental affections are ways of knowing objects. Most psychologists nowadays believe that the objects first, in some natural way, engendered a brain from out of

their midst, and then imprinted these various cognitive affections upon it. But how? The ordinary revolutionist answer to this question is exceedingly simple-minded. The idea of most speculators seems to be that, since it suffices now for us to become acquainted with a complex object, that it should be simply present to us often enough, so it must be fair to assume universally that, with time enough given, the mere presence of the various objects and relations to be known must end by bringing about the latter's cognition, and that in this way all mental structure was from first to last evolved. Any ordinary Spencerite will tell you that just as the experience of blue objects wrought into our mind the color blue, and hard objects got it to feel hardness, so the presence of large and small objects in the world gave it the notion of size, moving objects made it aware of motion, and objective successions taught it time. Similarly in a world with different impressing things, the mind had to acquire a sense of difference, whilst the like parts of the world as they fell upon it kindled in it the perception of similarity. Outward sequences which sometimes held good, and sometimes failed, naturally engendered in it doubtful and uncertain forms of expectation, and ultimately gave rise to the disjunctive forms of judgment; whilst the hypothetic form, 'if a, then b,' was sure to ensue from sequences that were invariable in the outer world. On this view, if the outer order suddenly were to change its elements and modes, we should have no faculties to cognize the new order by. At most we should feel a sort of frustration and confusion. But little by little the new presence would work on us as the old one did; and in course of time another set of psychic categories would arise, fitted to take cognizance of the altered world.

This notion of the outer world inevitably building up a sort of mental duplicate of itself if we only give it time, is so easy and natural in its vagueness that one hardly knows how to start to criticise it. Ont thing, however, is obvious, namely that the manner in which we now become acquainted with complex objects need not in the least resemble the manner in which the original elements of our consciousness grew up. Now, it is true, a new sort of animal need only be present to me, to impress its image permanently on my mind, but this is because I am already in possession of categories for knowing each and all of its several attributes, and of a memory for retracing the order of their conjunction. I now have preformed categories for all possible objects. The objects need only awaken these from their slumber. But it is a very different matter to account for the categories themselves. I think we must admit that the origin of the various elementary feelings is a recondite history, even after some sort of neural tissue is there for the outer world to begin its work on. The mere existence of things to be known is even now not, as a rule, sufficient to bring about a knowledge of them. Our abstract and general discoveries usually come to us as lucky fancies; and it is only apres coup that we find that they correspond to some reality. What immediately produced them were previous thoughts with which, and with the brain-processes of which, that reality had naught to do.

Why may it not have been so of the original elements of consciousness, sensation, time, space, resemblance, difference, and other relations? Why may they not have come into being by the back-door method, by such physical processes as lie more in the sphere of morphological

accident, of inward summation of effects, than in that of the 'sensible presence' of objects? Why may they not, in short, be pure idiosyncrasies, spontaneous variations, fitted by good luck (those of them which have survived) to take cognizance of objects (that is, to steer us in our active dealings with them), without being in any intelligible sense immediate derivatives from them? I think we shall find this view gain more and more plausibility as we proceed.

All these elements are subjective duplicates of outer objects. They are not the outer objects. The secondary qualities among them are not supposed by any educated person even to resemble the objects. Their nature depends more on the reacting brain than on the stimuli which touch it off. This is even more palpably true of the natures of pleasure and pain, effort, desire and aversion, and of such feelings as those of cause and substance, of denial and of doubt. Here then is a native wealth of inner forms whose origin is shrouded in mystery, and which at any rate were not simply 'impressed' from without, in any intelligible sense of the verb 'to impress.'

Their time-and space-relations, however, are impressed from without--for two outer things at least the evolutionary psychologist must believe to resemble our thoughts of them, these are the time and space in which the objects lie. The time- and space-relations between things do stamp copies of themselves within. Things juxtaposed in space impress us and continue to be thought, in the relation in which they exist there. Things sequent in time, ditto. And thus, through experience in the legitimate sense of the word, there can be truly explained an immense number of our mental habitudes, many of our abstract beliefs, and all our ideas of concrete things, and of their ways of behavior. Such truths as that fire burns and water wets, that glass refracts, heat melts snow, fishes live in water and die on land, and the like, form no small part of the most refined education, and are the all-in-all of education amongst the brutes and lowest men. Here the mind is passive and tributary, a servile copy, fatally and unresistingly fashioned from without. It is the merit of the associationist school to have seen the wide scope of these effects of neighborhood in time and space; and their exaggerated applications of the principle of mere neighborhood ought not to blind us to the excellent service it has done to Psychology in their hands. As far as a large part of our thinking goes, then, it can intelligibly be formulated as a mere lot of habits impressed upon us from without. The degree of cohesion of our inner relations, is, in this part of our thinking, proportionate, in Mr. Spencer's phrase to the degree of cohesion of the outer relations; the causes and the objects of our thought are one; and we are, in so far forth, what the materialistic evolutionists would have us altogether, mere offshoots and creatures of our environment, and naught besides.

But now the plot thickens, for the images impressed upon our memory by the outer stimuli are not restricted to the mere time- and space-relations, in which they originally came, but revive in various manners (dependent on the intricacy of the brain-paths and the instability of the tissue thereof), and form secondary combinations such as the forms of judgment, which, taken per se, are not congruent either with the forms in which reality exists or in those in which experiences befall us, but which may nevertheless be explained by the way in which

experiences befall in a mind gifted with memory, expectation, and the possibility of feeling doubt, curiosity, belief, and denial. The conjunctions of experience befall more or less invariably, variably, or never. The idea of one term will then engender a fixed, a wavering, or a negative expectation of another, giving affirmative, the hypothetical, disjunctive, interrogative, and negative judgments, and judgments of actuality and possibility about certain things. The separation of attribute from subject in all judgments (which violates the way in which nature exists) may be similarly explained by the piecemeal order in which our perceptions come to us, a vague nucleus growing gradually more detailed as we attend to it more and more. These particular secondary mental forms have had ample justice done them by associationists from Hume downwards.

Associationists have also sought to account for discrimination, abstraction, and generalization by the rates of frequency in which attributes come to us conjoined. With much less success, I think . . .

THE GENESIS OF THE NATURAL SCIENCES

Our 'scientific' ways of thinking the outer reality are highly abstract ways. The essence of things for science is not to be what they seem, but to be atoms and molecules moving to and from each other according to strange laws. Nowhere does the account of inner relations produced by outer ones in proportion to the frequency with which the latter have been met, more egregiously break down than in the case of scientific conceptions. The order of scientific thought is quite incongruent either with the way in which reality exists or with the way in which it comes before us. Scientific thought goes by selection and emphasis exclusively. We break the solid plenitude of fact into separate essences, conceive generally what only exists particularly, and by our classifications leave nothing in its natural neighborhood, but separate the contiguous, and join what the poles divorce. The reality <u>exists</u> as a <u>plenum</u>. All its parts are contemporaneous, each is as real as any other, and each as essential for making the whole just what it is and nothing else. But we can neither experience nor think this <u>plenum</u>. What we experience, what comes <u>before us</u>, is a chaos of fragmentary impressions interrupting each other; what we <u>think</u> is an abstract system of hypothetical data and laws.

This sort of scientific algebra, little as it immediately resembles the reality given to us, turns out (strangely enough) applicable to it. That is, it yields expressions which, at given places and times, can be translated into real values, or interpreted as definite portions of the chaos that falls upon our sense. It becomes thus a practical guide to our expectations as well as a theoretic delight. But I do not see how any one with a sense for the facts can possibly call our systems immediate results of 'experience' in the ordinary sense. Every scientific conception is in the first instance a 'spontaneous variation' in some one's brain. For one that proves useful and applicable there are a thousand that perish through their worthlessness. Their genesis is strictly akin to that of the flashes of poetry and sallies of wit to which the instable brain-paths equally give rise. But whereas the poetry and wit (like the science of the ancients) are their 'own excuse for being,' and have to run the gauntlet of no farther test, the 'scientific'

conceptions must prove their worth by being 'verified.' This test, however, is the cause of their preservation, not that of their production; and one might as well account for the origin of Artemus Ward's jokes by the 'cohesion' of subjects with predicates in proportion to the 'persistence of the outer relations' to which they 'correspond' as to treat the genesis of scientific conceptions in the same ponderously unreal way.

The most persistent outer relations which science believes in are never matters of experience at all, but have to be disengaged from under experience by a process of elimination, that is, by ignoring conditions which are always present. The elementary laws of mechanics, physics, and chemistry are all of this sort. The principle of uniformity in nature is of this sort; it has to be sought under and in spite of the most rebellious appearances; and our conviction of its truth is far more like a religious faith than like assent to a demonstration. The only cohesions which experience in the literal sense of the word produces in our mind are, as we contended some time back, the proximate laws of nature, and habitudes of concrete things, that heat melts ice, that salt preserves meat, that fish die out of water, and the like. Such 'empirical truths' as these we admitted to form an enormous part of human wisdom. The 'scientific' truths have to harmonize with these truths, or be given up as useless; but they arise in the mind in no such passive associative way as that in which the simpler truths arise. Even those experiences which are used to prove a scientific truth are for the most part artificial experiences of the laboratory gained after the truth itself has been conjectured. Instead of experiences engendering the 'inner relations,' the inner relations are what engender the experiences here.

What happend in the brain after experience has done its utmost is what happens in every material mass which has been fashioned by an outward force,--in every pudding or mortar, for example, which I may make with my hands. The fashioning from without brings the elements into collocations which set new internal forces free to exert their effects in turn. And the random irradiations and resettlements of our ideas, which supervene upon experience, and constitute our free mental play, are due entirely to these secondary internal processes, which vary enormously from brain to brain, even though the brains be exposed to exactly the same 'outer relations.' The higher thought-processes owe their being to causes which correspond far more to the sourings and fermentations of dough, the setting of mortar, or the subsidence of sediments in mixtures, than to the manipulations by which these physical aggregates came to be compounded. Our study of similar association and reasoning taught us that the whole superiority of man depended on the facility with which in his brain the paths worn by the most frequent outer cohesions could be ruptured. The causes of the instability, the reasons why now this point and now that become in him the seat of rupture, we saw to be entirely obscure. . . The only clear thing about the peculiarity seems to be its interstitial character, and the certainty that no mere appeal to man's 'experience' suffices to explain it.

Study Guide for UNIT 4

Hermann Ludwig Ferdinand von Helmholtz (1821-1894)

Helmholtz was one of those who helped bring empiricism out of the study and into the laboratory. Although he began his career as a surgeon in the German Army, he became known primarily as a physiologist, with a strong interest in problems of physics, philosophy, and what we would now call experimental psychology. His researches on nervous-system and sense-organ functions are classical and still important for psychologists and physiologists of the world. With respect to our present concerns, he was on the side of Locke, Hume, and Hobbes, rather than Descartes or James. His empiricism or "geneticism" shows itself clearly in his treatment of perception in this excerpt.

Study Questions

1. What is the "general rule" that Helmholtz speaks of in discussing the localization of objects in the visual field. Can you give an other-than-visual example?

2. To what is a visual "illusion" due? Is the explanation in the eye?

3. What are the main features of an "unconscious conclusion" or an "unconscious inference?" Was it ever conscious?

4. When do we observe our sensations accurately? Does this come naturally or require training? Explain.

5. What is meant by "subjective" sensation? Under what conditions are they noticed? Can you give an example?

6. How would Helmholtz explain that coal is always "black" or that the plates on the table are always "round?"

7. Can you describe a simple method for getting true "sensations" from the normal surrounding visual field?

8. Differentiate between the empirical and the intuition theory. Can you find either in James or Hobbes?

9. Distinguish between idea and immediate perception; between perception and apperception. Which distinction is more difficult? Why?

10. How would you show the change from a perceptual to a memory image? To what feature of programmed instruction might this be related?

11. On what main fact would Helmholtz base his judgment that space apperceptions are the product of experience and training?

12. Which of Helmholtz's categories (perception, idea, etc.) deals most with the meaning of objects as we think of them in daily life?

HERMANN LUDWIG FERDINAND VON HELMHOLTZ ON EMPIRICISM IN PERCEPTION, 1866

H. L. F. von Helmholtz, Handbuch der physiologischen Optik, vol. III (Leipzig, 1866), sect. 26. Translated by J. P. C. Southall as Helmholtz' Treatise on Physiological Optics, vol. III (/Rochester, N. Y./: Optical Society of America, 1925).

The general rule determining the ideas of vision that are formed whenever an impression is made on the eye, with or without the aid of optical instruments, is that such objects are always imagined as being present in the field of vision as would have to be there in order to produce the same impression on the nervous mechanism, the eyes being used under ordinary normal conditions. . . . Suppose that the eyeball is mechanically stimulated at the outer corner of the eye. Then we imagine that we see an appearance of light in front of us somewhere in the direction of the bridge of the nose. Under ordinary conditions of vision, when our eyes are stimulated by light coming from outside, if the region of the retina in the outer corner of the eye is to be stimulated, the light actually has to enter the eye from the direction of the bridge of the nose. Thus, in accordance with the above rule, in a case of this kind we substitute a luminous object at the place mentioned in the field of view, although as a matter of fact the mechanical stimulus does not act on the eye from in front of the field of view nor from the nasal side of the eye, but, on the contrary, is exerted on the outer surface of the eyeball and more from behind. The general validity of the above rule will be shown by many other instances that will appear in the following pages.

In the statement of this rule mention is made of the ordinary conditions of vision, when the visual organ is stimulated by light from outside; this outside light comes from the opaque objects in its path that were the last to be encountered, and reaches the eye along rectilinear paths through an uninterrupted layer of air. This is what is meant here by the normal use of the organ of vision, and the justification for using this term is that this mode of stimulation occurs in such an enormous majority of cases that all other instances where the paths of the rays of light are altered by reflections or refractions, or in which the stimulations are not produced by external light, may be regarded as rare exceptions. This is because the retina in the fundus of the firm eyeball is almost completely protected from the actions of all other stimuli and is not easily accessible to anything but external light. When a person is in the habit of using an optical instrument and has become accustomed to is (for example, if he is used to wearing spectacles) to a certain extent he learns to interpret the visual images under these changed conditions.

Incidentally, the rule given above corresponds to a general characteristic of all sense-perceptions and not simply to the sense of sight alone. For example, the stimulation of the tactile nerves in the enormous majority of cases is the result of influences that affect the terminal extensions of these nerves in the surface of the skin. It is only under exceptional circumstances that the nerve-stems can be stimulated by more powerful agencies. In accordance with the above rule,

therefore, all stimulations of cutaneous nerves, even when they affect the stem or the nerve-centre itself, are perceived as occurring in the corresponding peripheral surface of the skin. The most remarkable and astonishing cases of illusions of this sort are those in which the peripheral area of this particular portion of the skin is actually no longer in existence, as, for example, in case of a person whose leg has been amputated. For a long time after the operation the patient frequently imagines he has vivid sensations in the foot that has been severed. He feels exactly the places that ache on one toe or the other. Of course, in a case of this sort the stimulation can affect only what is left of the stem of the nerve whose fibres formerly terminated in the amputated toes. Usually, it is the end of the nerve in the scar that is stimulated by external pressure or by contraction of the scar tissue. Sometimes at night the sensations in the missing extremity get to be so vivid that the patient has to feel the place to be sure that his limb is actually gone.

Thus it happens, that when the modes of stimulation of the organs of sense are unusual, incorrect ideas of objects are apt to be formed --which used to be described, therefore, as illusions of the senses. Obviously, in these cases there is nothing wrong with the activity of the organ of sense and its corresponding nervous mechanism which produces the illusion. Both of them have to act according to the laws that govern their activity once for all. It is rather simply an illusion in the judgment of the material presented to the senses, resulting in a false idea of it.

The psychic activities that lead us to infer that in front of us at a certain place there is a certain object of a certain character are generally not conscious activities, but unconscious ones. In their result they are equivalent to a conclusion /or inference/ to the extent that the observed action on our senses enables us to form an idea as to the possible cause of this action; although, as a matter of fact, it is invariably simply the nervous stimulations that are perceived directly, that is, the actions, but never the external objects themselves. But what seems to differentiate them from a conclusion, in the ordinary sense of that word, is that a conclusion is an act of conscious thought. An astronomer, for example, comes to real conscious conclusions of this sort, when he computes the positions of the stars in space, their distances, etc., from the perspective images he has had of them at various times and as they are seen from different parts of the orbit of the earth. His conclusions are based on a conscious knowledge of the laws of optics. In the ordinary acts of vision this knowledge of optics is lacking. Still it may be permissible to speak of the psychic acts of ordinary perception as unconscious conclusions, thereby making a distinction of some sort between them and the common so-called conscious conclusions. And while it is true that there has been, and probably always will be, a measure of doubt as to the similarity of the psychic activity in the two cases, there can be no doubt as to the similarity between the results of such unconscious conclusions and those of conscious conclusions.

These unconscious conclusions derived from sensation are equivalent in their consequences to the so-called conclusions from analogy. Inasmuch as in an overwhelming majority of cases, whenever the parts

of the retina in the outer corner of the eye are stimulated, it has been found to be due to external light coming into the eye from the direction of the bridge of the nose, the inference we make is that it is so in every new case whenever this part of the retina is stimulated; just so we assert that every single individual now living will die, because all previous experience has shown that all men who were formerly alive have died.

But, moreover, just because they are not free acts of conscious thought, these unconscious conclusions from analogy are irresistible, and the effect of them cannot be overcome by a better understanding of the real relations. It may be ever so clear how we get an idea of a luminous phenomenon in the field of vision when pressure is exerted on the eye; and yet we cannot get rid of the conviction that this appearance of light is actually there at the given place in the visual field; and we cannot seem to comprehend that there is a luminous phenomenon at the place where the retina is stimulated. It is the same way in case of all the images that we see in optical instruments.

On the other hand, there are numerous illustrations of fixed and inevitable associations of ideas due to frequent repetition, even when they have no natural connection, but are dependent merely on some conventional arrangement, as, for example, the connection between the written letters of a word and its sound and meaning. Still to many physiologists and psychologists the connection between the sensation and the conception of the object usually appears to be so rigid and obligatory that they are not much disposed to admit that, to a considerable extent at least, it depends on acquired experience, that is, on psychic activity. On the contrary, they have endeavoured to find some mechanical mode of origin for this connection through the agency of imaginary organic structures. With regard to this question, all those experiences are of much significance which show how the judgment of the senses may be modified by experience and by training derived under various circumstances, and may be adapted to the new conditions. Thus, persons may learn in some measure to utilize details of the sensation which otherwise would escape notice and not contribute to obtaining any idea of the object. On the other hand, too, this new habit may acquire such a hold that when the individual in question is back again in the old original normal state, he may be liable to illusions of the senses.

. . . . .

Another general characteristic property of our sense-perception is, that we are not in the habit of observing our sensations accurately, except as they are useful in enabling us to recognize external objects. On the contrary, we are wont to disregard all those parts of the sensations that are of no importance so far as external objects are concerned. Thus in most cases some special assistance and training are needed in order to observe these latter subjective sensations. It might seem that nothing could be easier than to be conscious of one's own sensations; and yet experience shows that for the discovery of subjective sensations some special talent is needed, such as Purkinje manifested in the highest degree; or else it is the result of accident or of theoretical speculation. For instance, the phenomena of the blind spot were discovered by Mariotte from theoretical considerations.

Similarly, in the domain of hearing, I discovered the existence of those combination tones which I have called summation tones. In the great majority of cases, doubtless it was accident that revealed this or that subjective phenomenon to observers who happened to be particularly interested in such matters. It is only when subjective phenomena are so prominent as to interfere with the perception of things, that they attract everybody's attention. Once the phenomena have been discovered, it is generally easier for others to perceive them also, provided the proper precautions are taken for observing them, and the attention is concentrated on them. In many cases, however--for example, in the phenomena of the blind spot, or in the separation of the overtones and combination tones from the fundamental tones of musical sounds, etc. --such an intense concentration of attention is required that, even with the help of convenient external appliances, many persons are unable to perform the experiments. Even the after-images of bright objects are not perceived by most persons at first except under particularly favourable external conditions. It takes much more practice to see the fainter kinds of after-images. A common experience, illustrative of this sort of thing, is for a person who has some ocular trouble that impairs his vision to become suddenly aware of the so-called mouches volantes in his visual field, although the causes of this phenomenon have been there in the vitreous humor all his life. Yet now he will be firmly persuaded that these corpuscles have developed as the result of his ocular ailment, although the truth simply is that, owing to his ailment, the patient has been paying more attention to visual phenomena. No doubt, also, there are cases where one eye has gradually become blind, and yet the patient has continued to go about for an indefinite time without noticing it, until he happened one day to close the good eye without closing the other, and so noticed the blindness of that eye.

When a person's attention is directed for the first time to the double images in binocular vision, he is usually greatly astonished to think that he had never noticed them before, especially when he reflects that the only objects he has ever seen single were those few that happened at the moment to be about as far from his eyes as the point of fixation. The great majority of objects, comprising all those that were farther or nearer than this point, were all seen double.

Accordingly, the first thing we have to learn is to pay heed to our individual sensations. Ordinarily we do so merely in case of those sensations that enable us to find out about the world around us. In the ordinary affairs of life the sensations have no other importance for us. Subjective sensations are of interest chiefly for scientific investigations only. If they happen to be noticed in the ordinary activity of the senses, they merely distract the attention. Thus while we may attain an extraordinary degree of delicacy and precision in objective observation, we not only fail to do so in subjective observations, but indeed we acquire the faculty in large measure of overlooking them and of forming our opinions of objects independently of them, even when they are so pronounced that they might easily be noticed.

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The same difficulty that we have in observing subjective sensations,

that is, sensations aroused by internal causes, occurs also in trying to analyze the compound sensations, invariably excited in the same connection by any simple object, and to resolve them into their separate components. In such cases experience shows us how to recognize a compound aggregate of sensations as being the sign of a simple object. Accustomed to consider the sensation-complex as a connected whole, generally we are not able to perceive the separate parts of it without external help and support . . . For instance the perception of the apparant direction of an object from the eye depends on the combination of those sensations by which we estimate the adjustment of the eye, and on being able to distinguish those parts of the retina where light falls from those parts where it does not fall. The perception of the solid form of an object of three dimensions is the result of the combination of two different perspective views in the two eyes. The gloss of a surface, which is apparently a simple effect, is due to differences of colouring or brightness in the images of it in the two eyes. These facts were ascertained by theory and may be verified by suitable experiments. But usually it is very difficult, if not impossible, to discover them by direct observation and analysis of the sensations alone. Even with sensations that are much more involved and always associated with frequently recurring complex objects, the oftener the same combination recurs, and the more used we have become to regarding the sensation as the normal sign of the real nature of the object, the more difficult it will be to analyze the sensation by observation alone. By way of illustration, it is a familiar experience that the colours of a landscape come out much more brilliantly and definitely by looking at them with the head on one side or upside down than they do when the head is in the ordinary upright position. In the usual mode of observation all we try to do is to judge correctly the objects as such. We know that at a certain distance green surfaces appear a little different in hue. We get in the habit of overlooking this difference, and learn to identify the altered green of distant meadows and trees with the corresponding colour of nearer objects. In the case of very distant objects like distant ranges of mountains, little of the colour of the body is left to be seen, because it is mainly shrouded in the colour of the illuminated air. This vague blue-grey colour, bordered above by the clear blue of the sky or the red-yellow of the sunset glow, and below by the vivid green of meadows and forests, is very subject to variations by contrast. To us it is the vague and variable colour of distance. The difference in it may, perhaps, be more noticeable sometimes and with some illuminations than at other times. But we do not determine its true nature, because it is not ascribed to any definite object. We are simply aware of its variable nature. But the instant we take an unusual position, and look at the landscape with the head under one arm, let us say, or between the legs, it all appears like a flat picture; partly on account of the strange position of the image in the eye, and partly because, as we shall see presently, the binolular judgment of distance becomes less accurate. It may even happen that with the head upside down the clouds have the correct perspective, whereas the objects on the earth appear like a painting on a vertical surface, as the clouds in the sky usually do. At the same time the colours lose their associations also with near or far objects, and confront us now purely in their own peculiar differences. Then we have no difficulty in recognizing that the vague blue-grey of the far distance may indeed be a fairly saturated violet, and that the green of

the vegetation blends imperceptibly through blue-green and blue into this violet, etc. This whole difference seems to me to be due to the fact that the colours have ceased to be distinctive signs of objects for us, and are considered merely as being different sensations. Consequently, we take in better their peculiar distinctions without being distracted by other considerations.

The connection between the sensations and external objects may interfere very much with the perception of their simplest relations. A good illustration of this is the difficulty about perceiving the double images of binocular vision when they can be regarded as being images of one and the same external object.

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It is likewise true with respect to the perception of space-relations. For example, the spectacle of a person in the act of walking is a familiar sight. We think of this motion as a connected whole, possibly taking note of some of its most conspicuous singularities. But it requires minute attention and a special choice of the point of view to distinguish the upward and lateral movements of the body in a person's gait. We have to pick out points or lines of reference in the background with which we can compare the position of his head. But look through an astronomical telescope at a crowd of people in motion far away. Their images are upside down, but what a curious jerking and swaying of the body is produced by those who are walking about! Then there is no trouble whatever in noticing the peculiar motions of the body and many other singularities of gait; and especially differences between individuals and the reasons for them, simply because this is not the everyday sight to which we are accustomed. On the other hand, when the image is inverted in this way, it is not so easy to tell whether the gait is light or awkward, dignified or graceful, as it was when the image was erect.

Consequently, it may often be rather hard to say how much of our apperceptions (Anschauungen) as derived by the sense of sight is due directly to sensation, and how much of them, on the other hand, is due to experience and training. The main point of controversy between various investigators in this territory is connected also with this difficulty. Some are disposed to concede to the influence of experience as much scope as possible, and to derive from it especially all notion of space. This view may be called the empirical theory (empiristische Theorie). Others, of course, are obliged to admit the influence of experience in the case of certain classes of perceptions; still with respect to certain elementary apperceptions that occur uniformly in the case of all observers, they believe it is necessary to assume a system of innate appreceptions that are not based on experience, especially with respect to space-relations. In contradistinction to the former view, this may perhaps be called the intuition theory (nativistische Theorie) of the sense-perceptions.

In my opinion the following fundamental principles should be kept in mind in this discussion.

Let us restrict the word idea (Vorstellung) to mean the image of

visual objects as retained in the memory, without being accompanied by any present sense-impressions; and use the term apperception (Anschauung) to mean a perception (Wahrnehmung) when it is accompanied by the sense-impressions in question. The term immediate perception (Perzeption) may then be employed to denote an apperception of this nature in which there is no element whatever that is not the result of direct sensations, that is, an apperception such as might be derived without any recollection of the previous experience. Obviously, therefore, one and the same apperception may be accompanied by the corresponding sensations in very different measure. Thus idea and immediate perception may be combined in the apperception in the most different proportions.

A person in a familiar room which is brightly lighted by the sun gets an apperception that is abundantly accompanied by very vivid sensations. In the same room in the evening twilight he will not be able to recognize any objects except the brighter ones, especially the windows. But whatever he does actually recognize will be so intermingled with his recollections of the furniture that he can still move about in the room with safety and locate articles he is trying to find, even when they are only dimly visible. These images would be utterly insufficient to enable him to recognize the objects without some previous acquaintance with them. Finally, he may be in the same room in complete darkness, and still be able to find his way about in it without making mistakes, by virtue of the visual impressions formerly obtained. Thus, by continually reducing the material that appeals to the senses, the perceptual-image (Anschauungsbild) can ultimately be traced back to the pure memory-image (Vorstellungsbild) and may gradually pass into it. In proportion as there is less and less material appeal to the senses, a person's movements will, of course, become more and more uncertain, and his apperception less and less accurate. Still there will be no peculiar abrupt transition, but sensation and memory will continually supplement each other, only in varying degrees.

But even when we look around a room of this sort flooded with sunshine, a little reflection shows us that under these conditions too a large part of our perceptual-image may be due to factors of memory and experience. The fact that we are accustomed to the perspective distortions of pictures of parallelopipeds and to the form of the shadows they cast has much to do with the estimation of the shape and dimensions of the room, as will be seen hereafter. Looking at the room with one eye shut, we think we see it just as distinctly and definitely as with both eyes. And yet we should get exactly the same view in case every point in the room were shifted arbitrarily to a different distance from the eye, provided they all remained on the same lines of sight.

Thus in a case like this we are really considering an extremely multiplex phenomenon of sense; but still we ascribe a perfectly definite explanation to it, and it is by no means easy to realize that the monocular image of such a familiar object necessarily means a much more meagre perception than would be obtained with both eyes. Thus too it is often hard to tell whether or not untrained observers inspecting stereoscopic views really notice the peculiar illusion produced by the instrument.

We see, therefore, how in a case of this kind reminiscences of

previous experiences act in conjunction with present sensations to produce a perceptual image (Anschauungsbild) which imposes itself on our faculty of perception with overwhelming power, without our being conscious of how much of it is due to memory and how much to present perception.

Still more remarkable is the influence of the comprehension of the sensations in certain cases, especially with dim illumination, in which a visual impression may be misunderstood at first, by not knowing how to attribute the correct depth-dimensions; as when a distant light, for example, is taken for a near one, or vice versa. Suddenly it dawns on us what it is, and immediately, under the influence of the correct comprehension, the correct perceptual image also is developed in its full intensity. Then we are unable to revert to the previous imperfect apperception.

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Hence, at all events it must be conceded that, even in what appears to the adult as being direct apperception of the senses, possibly a number of single factors may be involved which are really the product of experience, although at the time it is difficult to draw the line between them.

Now in my opinion we are justified by our previous experiences in stating that no indubitable present sensation can be abolished and overcome by an act of the intellect; and no matter how clearly we recognize that it has been produced in some anomalous way, still the illusion does not disappear by comprehending the process. The attention may be diverted from sensations, particularly if they are feeble and habitual; but in noting those relations in the external world, that are associated with these sensations, we are obliged to observe the sensations themselves. Thus we may be unmindful of the temperature-sensation of our skin when it is not very keen, or of the contact-sensation produced by our clothing, as long as we are occupied with entirely different matters. But just as soon as we stop to think whether it is warm or cold, we are not in the position to convert the feeling of warmth into that of coldness; maybe because we know that it is due to strenuous exertion and not to the temperature of the surrounding air. In the same way the apparition of light when pressure is exerted on the eyeball cannot be made to vanish simply by comprehending better the nature of the process, supposing the attention is directed to the field of vision and not, say, to the ear or the skin.

On the other hand, it may also be that we are not in the position to isolate an impression of sensation, because it involves the composite sense-symbol of an external object. However, in this case the correct comprehension of the object shows that the sensation in question has been perceived and used by the consciousness.

My conclusion is, that nothing in our sense-perception can be recognized as sensation which can be overcome in the perceptual image and converted into its opposite by factors that are demonstrably due to experience.

Whatever, therefore, can be overcome by factors of experience, we must consider as being itself the product of experience and training. By observing this rule, we shall find that it is merely the qualities of the sensation that are to be considered as real, pure sensation; the great majority of space-apperceptions, however, being the product of experience and training.

Study Guide for UNIT 5

Edward Bradford Titchener (1867-1927)

Titchener, an Englishman, who studied in Germany with Wundt and spent his active academic life in this country, is best known today as the leader of Structuralistic, (Introspective, Existential) Psychology in the United States during the period from 1892 to 1927, at Cornell University. A scholar, an influential teacher and instigator of research, as well as a clear and incisive writer on systematic matters, T (as his pupils called him) was the dominant figure in American psychology for many years. In these two excerpts from his many writings, we get his basic position and one of his best-known theories--the context theory of meaning. Although a subjectivist in psychology, T was not naively so. If one looks closely enough, he will find the beginnings of a behavioral approach, even in these selections. Certainly the problems dealt with here are among the more subtle ones to be encountered in the area of stimulus control and private events within a science of behavior.

Study Questions

1. How does T define perception?

2. What kind of "context" is the equivalent of logical meaning?

3. "It takes at least two sensations to make a meaning." Explain.

4. Can meaning be unconscious? Is T's answer a concession to behaviorism?

5. What sort of principle looks after "accrual" of context to core?

6. In what way are all sciences alike, according to T?

7. With what does each science deal initially?

8. How does attitude or viewpoint differentiate the sciences?

9. What distinguishes psychology from physics?

10. What are the basic factors in Inspection and Introspection? Is there anticipation of a behavioral psychology in either?

11. How does T use the concepts of time, space, and mass in distinguishing between psychology and physics?

12. How does T view the mind-body relation? Compare his view with that of Descartes.

13. Define mind a la T. Can a psychologist study other than his own mind? Can he study the mind of animals? Explain.

Even if one knows French, he may find little context for the following perceptual core: PAS DE LEUR RHONE QUE NOUS. See if you can add context to the core by saying this aloud.

ERNEST BRADFORD TITCHENER
THE CONTEXT THEORY OF MEANING, 1910

E. B.Titchener, A Text-Book of Psychology (New York: Macmillan, 1910) pp. 367-371, 274-275. The theory was first formulated in 1909 in Lectures on the Experimental Psychology of the Thought-Processes (New York: Macmillan, 1909), pp. 174-194, but the reference of 1910 is clearer and more concise, and quotes the earlier one repeatedly.

103. Meaning.--Perceptions are selected groups of sensations, in which images are incorporated as an integral part of the whole process. But that is not all: the essential thing about them has still to be named: and it is this,--that perceptions have meaning. No sensation means; a sensation simply goes on in various attributive ways, intensively, clearly, spatially, and so forth. All perceptions mean; they go on, also, in various attributive ways; but they go on meaningly. What then, psychologically, is meaning?

Meaning, psychologically, is always context; one mental process is the meaning of another mental process if it is that other's context. And context, in this sense, is simply the mental process which accrues to the given process through the situation in which the organism finds itself. Originally, the situation is physical, external, and originally, meaning is kinaethesis; the organism faces the situation by some bodily attitude, and the characteristic sensations which the attitude arouses give meaning to the process which stands at the conscious focus, are psychologically the meaning of that process. For ourselves, the situation may be either external or internal, either physical or mental, either a group of adequate stimuli or a constellation of ideas; image has now supervened upon sensation, and meaning can be carried in imaginal terms. For us, therefore, meaning may be mainly a matter of sensations of the special senses, or of images, or of kinaesthetic or other organic sensations, as the nature of the situation demands.

Of all its possible forms, however, two appear to be of especial importance: kinaesthesis and verbal images. We are locomotor organisms, and change of bodily attitude is of constant occurrence in our experience; so that typical kinaesthetic patterns become, so to say, ingrained in our consciousness. And words themselves, let us remember, were at first bodily attitudes, gestures, kinaesthetic contexts: complicated, of course, by sound, but still essentially akin to the gross bodily attitudes of which we have been speaking. The fact that words are thus originally contextual, and the fact that they nevertheless as sound, and later as sight, possess and acquire a content-character,--these facts render language preeminently available as the vehicle of meaning. The words that we read are both perception and context of perception; the auditory-kinaesthetic idea is the meaning of the visual symbols. And it is obvious that all sorts of sensory and imaginal complexes receive their meaning from some mode of verbal representation: we understand a thing, place a thing, as soon as we have named it.

Hence, in minds of a certain constitution, it may well be that all

conscious meaning is carried by total kinaesthetic attitude or by words. As a matter of fact, however, mental constitution is widely varied, and meaning is carried by all sorts of sensory and imaginal processes.

The gist of this account is that it takes at least two sensations to make a meaning. If an animal has a sensation of light, and nothing more, there is no meaning in consciousness. If the sensation of light is accompanied by a strain, it becomes forthwith a perception of light, with meaning; it is now 'that bright something'; and it owes the 'that something' to its strain-context. Simple enough!--only be clear that account is not genetic, but analytic. We have no reason to believe that mind began with meaningless sensations, and progressed to meaningful perceptions. On the contrary, we must suppose that mind was meaningful from the very outset. We find, by our analysis, that sensation does not mean; and we find, in synthesis, that the context which accrues from the situation, however simple or however complex the context may be, makes it mean, is its meaning.

What, then, precisely, is a situation? The physical or external situation is the whole external world as an organism, at any given moment, takes it; it consists of those stimuli to which the organism, by virtue of its inherited organisation and its present disposition, is responsive,--which it selects, unifies, focalises, supplements, and, if need be, acts upon. The mental or internal situation is, in like manner, some imaginative or memorial complex which is fitted, under the conditions obtaining in the nervous system, to dominate consciousness, to maintain itself in the focus of attention, to serve as the starting-point for further ideas or for action. To put the definition in a word, a situation is the meaningful experience of a conscious present.

But is meaning always conscious meaning? Surely not: meaning may be carried in purely physiological terms. In rapid reading, the skimming of pages in quick succession; in the rendering of a musical composition, without hesitation or reflection, in a particular key; in shifting from one language to another as you turn to your right- or left-hand neighbour at a dinner-table: in these and similar cases meaning has, time and time again, no discoverable representation in consciousness. The course and connection of ideas may be determined beforehand and from without; a word, an expression of face, an inflection of the voice, a bodily attitude, presses the nervous button, and consciousness is switched, automatically, into new channels. We find here an illustration of an universal law of mind, of which we shall have more to say when we come to deal with Action: the law that all conscious formations, as the life of the organism proceeds, show like phenomena of rise and fall, increase and decrease in complexity, expansion and reduction; so that, in the extreme case, what was originally a focal experience may presently lapse altogether. We learned our French and German with pains and labour; the conscious context that gave meaning to words and sentences was elaborate; but now all this context has disappeared, and a certain set of the nervous system, itself not accompanied by consciousness, gives the sounds that fall upon our ears a French-meaning, or changes us into German-speakers.

This predetermination of consciousness by influences that, during the course of consciousness, are not themselves conscious, is a fact

of extreme psychological importance, and the reader should verify it from his own experience. It has a threefold bearing upon the psychological system. First, it reminds us that consciousness is a temporal affair, to be studied in longitudinal as well as in transverse section. It is part of the direct business of psychology to trace the fate of meaning from its full and complete conscious representation, through all stages of its degeneration, to its final disappearance. Secondly, our psychology is to be explanatory, and our explanations are to be physiological. To explain the way in which consciousness runs, the definite line that it takes, we must have recourse to physiological organisation; and the tracing of the stages of mental decay helps us to follow and understand the organising process. Thirdly, if we lose sight of nervous predisposition, we shall make grave mistakes in our psychological analysis; we shall read into mental processes characters that, in fact, they do not possess . . . A simple instance is given /below/. Here we must either say that the meaning of the experiment, after the week's work, is carried for the observer in purely physiological, non-conscious terms; or we must say that his observation is untrustworthy, that there is a mental context which he has overlooked. But if we take this latter alternative, we shall be constructing mind as the naturalist in the story constructed the camel; we shall be inventing, not describing.

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The guiding influence of nervous bias is not a matter of inference, still less a matter of speculation; it can be demonstrated in the psychological laboratory. Suppose that we are measuring the time required to reply to a spoken word by another word of the same class or kind: to associate dog to cat, table to chair, and so on. The experimenter prepares a long list of words: cat, chair, and so forth. Then he explains to the observer the precise nature of the experiment: I shall call out certain words, he says, and you are to reply, as quickly as you can, with words of the same class; if I say horse, you will mention some other animal, and if I say pen, you will mention something else that has to do with writing. The observer understands, and the experiment begins. Suppose, further, that the experiments have been continued for some days. The experimenter has no need to repeat his explanation at every sitting; the observer takes it for granted that he is still to reply with a coordinate word. And suppose, finally, that some day, after a week's work, the experimenter interrupts the series, and asks: Are you thinking about what I told you to do? The observer, fearing that he has made some error, and feeling very repentant, will say: No! to tell the truth I had absolutely forgotten all about it; it had gone altogether out of my mind; have I done anything wrong? He had not done anything wrong; but his answer shows that a certain tendency, impressed upon his nervous system by the experimenter's original explanation, has been effective to direct the course of his ideas long after its conscious correlate has disappeared. And what happens here, in the laboratory, happens every day of our lives in the wider experience outside the laboratory.

E. B. Titchener, A Text-Book of Psychology (New York: Macmillan, 1910), pp. 2-8, 13, 16, 19-27.

First of all, then, it is plain that all the sciences have the same sort of subject-matter; they all deal with some phase or aspect of the world of human experience. If we take a mere fragment of this world,--say, our own experience during a single day,--we find it a rather hopeless mixture. Our lawn-sprinkler obeys the third law of motion, while our pleasure in possessing it is a fact for psychology; the preparation of our food is an applied chemistry, its adulteration depends upon economic conditions, and its effect upon health is a matter of physiology; our manner of speech is governed by phonetic laws, while the things we say reflect the moral standards of the time: in a word, one science seems to run into another science as chance may decide, without order or distinction. If, however, we look over the world as a whole, or examine historically any long period of human existence, the survey is less bewildering. The world of nature breaks up at once, as we inspect it, into living objects, the objects that change by growth, and non-living objects, the objects that change only by decay. And living objects divide, again, into objects that grow in one place, the plants, and objects that move about as they grow, the animals. Here, almost at the first glance, we have distinguished the raw materials of three different sciences; geology, botany, zoology. Now let us turn to some stage of human evolution: we may choose the social life of mankind before the dawn of civilisation. Primitive man was required, by the necessities of his case, to make himself weapons; to hunt animals for food; to protect himself by clothing and shelter, and to avoid eating or drinking from poisonous or tainted sources. If he ventured upon the water, he must steer his course by the stars; if he banded with his fellows, he must hold to the code of honour of the tribe. He dreamed, and told his dreams; when he was glad, or angry, or afraid, he showed his feeling in gesture or by the expression of his face. Doubtless, his daily experience, if he ever thought about it, seemed to him as chaotic as our own has just appeared to us. But we, who have a larger vision of that experience, can see that it contained the natural germs of many sciences: mechanics, zoology and physiology,--astronomy, ethics and psychology.

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Experience, we have seen, presents itself under different aspects. The differences are roughly outlined, but are definite enough to serve as a starting-point. These different aspects engage the attention of different men. Division of labour is necessary, if the whole of experience is to be brought within the sphere of science; and men's interests are so various that every aspect of experience is sure, in the long run, to find a student. As scientific investigation proceeds, and as the number of scientific men increases, more and more aspects of experience are revealed, and the sciences multiply. They do not exist independently, side by side, as accounts of separate portions of the world or of separate regions of experience; they overlap and coincide, describing one and the same world of experience as it appears from their special standpoints. They are not like blocks of knowledge, which when cut to the proper size and properly fitted together will give

us a map of the universe; they are rather like the successive chapters of a book which discusses a large topic from every possible point of view. Some chapters are long, and some are short; some are general; and some are special: this depends upon the sort of attitude which a given science takes towards experience. But all the chapters, or sciences, deal with the same world under its various aspects.

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. . . If it is true that all the sciences have the same sort of subject-matter, there can be no essential difference between the raw materials of physics and the raw materials of psychology. Matter and mind, as we call them, must be fundamentally the same thing. Let us find out, now, whether this statement is really as paradoxical as at first thought it appears.

All human knowledge is derived from human experience; there is no other source of knowledge. But human experience, as we have seen, may be considered from different points of view. Suppose that we take two points of view, as far as possible apart, and discover for ourselves what experience looks like in the two cases. First, we will regard experience as altogether independent of any particular person; we will assume that it goes on whether or not anyone is there to have it. Secondly, we will regard experience as altogether dependent upon the particular person; we will assume that it goes on only when someone is there to have it. We shall hardly find standpoints more diverse. What are the differences in experience, as viewed from them?

Take, to begin with, the three things that you first learn about in physics; space, time and mass. Physical space, which is the space of geometry and astronomy and geology, is constant, always and everywhere the same. Its unit is 1 cm., and the cm. has precisely the same value wherever and whenever it is applied. Physical time is similarly constant; and its constant unit is the 1 sec. Physical mass is constant; its unit, the 1 gr., is always and everywhere the same. Here we have experience of space, time and mass considered as independent of the person who experiences them. Change, then, to the point of view which brings the experiencing person into account. The two /horizontal/ lines in Fig. 1 are physically equal; they measure alike in units of 1 cm. To you, who see them, they are not equal. The hour that you spend in the waiting-room of a village station and the hour that you spend in watching an amusing play are physically equal; they measure alike in units of 1 sec. To you, the one hour goes slowly, the other quickly; they are not equal. Take two circular cardboard boxes of different diameter (say, 2 cm. and 8 cm.), and pour sand into them until they both weigh, say, 50 gr. The two masses are physically equal; placed on the pans of a balance, they will hold the beam level. To you, as you lift them in your two hands, or raise them in turn by the same

hand, the box of smaller diameter is considerably the heavier. Here we have experience of space, time and mass considered as dependent upon the experiencing person. It is the same experience that we were discussing just now. But our first point of view gives us facts and laws of physics; our second gives us facts and laws of psychology.

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Common sense says that we cry because we are sorry, laugh because we are amused, run because we are frightened; that we feel gloomy and morose because we do not digest our food, go insane from softening of the brain, lost consciousness because we have inhaled ether. Mind influences body, and body influences mind. Our own position has been that mind and body, the subject-matter of psychology and the subject-matter of physiology, are simply two aspects of the same world of experience. They cannot influence each other, because they are not separate and independent things. For the same reason, however, wherever the two aspects appear, any change that occurs in the one will be accompanied by a corresponding change in the other. Your view of a town from the east cannot influence your view of the same town from the west; but as your view from the east differs in sunlight and moonlight, so correspondingly will your view from the west differ. This doctrine of the relation of mind to body is known as the doctrine of psychophysical parallelism: the common-sense doctrine is that of interaction.

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We have defined mind as the sum-total of human experience considered as dependent upon the experiencing person. We have said, further, that the phrase 'experiencing person' means the living body, the organized individual; and we have hinted that, for psychological purposes, the living body may be reduced to the nervous system and its attachments. Mind thus becomes the sum-total of human experience considered as dependent upon a nervous system. And since human experience is always process, occurrence, and the dependent aspect of human experience is its mental aspect, we may say, more shortly, that mind is the sum-total of mental processes. All these words are significant. 'Sum-total' implies that we are concerned with the whole world of experience, not with a limited portion of it; 'mental' implies that we are concerned with experience under its dependent aspect, as conditioned by a nervous system; and 'processes' implies that our subject-matter is a stream, a perpetual flux, and not a collection of unchanging objects.

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...Scientific method may be summed up in the single word 'observation'; the only way to work in science is to observe those phenomena which form the subject-matter of science. And observation implies two things: attention to the phenomena, and record of the phenomena; that is, clear and vivid experience, and an account of the experience in words or formulas.

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The method of psychology, then, is observation. To distinguish it from the observation of physical science, which is inspection, a looking-at, psychological observation has been termed introspection, a looking-within. But this difference of name must not blind us to the essential likeness of the methods.

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In principle, then, introspection is very like inspection. The objects of observation are different; they are objects of dependent, not of independent experience; they are likely to be transient, elusive, slippery. Sometimes they refuse to be observed while they are in passage; they must be preserved in memory, as a delicate tissue is preserved in hardening fluid, before they can be examined. And the standpoint of the observer is different; it is the standpoint of human life and of human interest, not of detachment and aloofness. But, in general, the method of psychology is much the same as the method of physics.

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. . . If mind is the sum-total of human experience considered as dependent upon the experiencing person, it follows that each one of us can have direct acquaintance only with a single mind, namely, with his own. We are concerned in psychology with the whole world of human experience; but we are concerned with it solely under its dependent aspect, as conditioned by a nervous system; and a nervous system is a particular thing, possessed by a particular individual. In strictness, therefore, it is only his own mind, the experience dependent upon his own nervous system, that each of us knows at first-hand; it is only to this limited and individual subject-matter that the method of experimental introspection can be directly applied. How, then, is a scientific psychology possible? How can psychology be anything more than a body of personal beliefs and individual opinions?

The difficulty is more apparent than real. We have every reason to believe, not only in general that our neighbours have minds like our own, that is, are able like ourselves to view experience in its dependent aspect, but also in detail that human minds resemble one another precisely as human bodies do. Within a given race there is much apparent diversity of outward form: differences in height and figure, in colour of hair and eyes, in shape of nose and mouth. We notice these differences, because we are obliged in everyday life to distinguish the persons with whom we come in contact. But the resemblances are more fundamental than the differences. If we have recourse to exact measurements, we find that there is in every case a certain standard of type to which the individual more or less closely conforms and about which all the individuals are more or less closely grouped. And even without measurement we have evidence to the same effect: strangers see family likenesses which the members of the family cannot themselves detect, and the units in a crowd of aliens, Chinese or Negroes, look bewilderingly alike.

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If, however, we attribute minds to other human beings, we have no right to deny them to the higher animals. These animals are provided with a nervous system of the same pattern as ours, and their conduct or behaviour, under circumstances that would arouse certain feelings in us, often seems to express, quite definitely, similar feelings in them. Surely we must grant that the highest vertebrates, mammals and birds, have minds. But the lower vertebrates, fishes and reptiles and amphibia, possess a nervous system of the same order, although of simpler construction. And many of the invertebrates, insects and spiders and crustaceans, show a fairly high degree of nervous development. Indeed, it is difficult to limit mind to the animals that possess even a rudimentary nervous system, for the creatures that rank still lower in the scale of life manage to do, without a nervous system, practically everything that their superiors do by its assistance. The range of mind thus appears to be as wide as the range of animal life.

Study Guide for UNIT 6

Marshall Hall (1790-1857)

It took 200 years for students of natural science to check out the opinions of Descartes concerning the mechanism of response, and to place the study of the reflex on a solid basis of observable fact. During this period, men like Francis Glisson (1597-1677) and Jan Swammerdam (1637-1680) tested the theory of "muscle stuffing" and found it wanted; Albrecht von Haller (1708-1777) hypothesized a vis insita--the power of the isolated muscle to contract; Robert Whytt (1714-1766) showed that the stimuli applied to a nerve might cause a contraction of the muscle at its end; George Prochaska (1749-1820) extended the reach of the stimulus-response relation to an even greater distance and talked about vis nervosa or nervous excitability--our modern nerve impulse; and the great physician-philosopher-psychologist, David Hartley (1705-1757), made a list of "automatic motions" in the human being--we would say reflexes.

At the end of this period, the name of Marshall Hall emerges as especially important. With him, it can be said, the field of reflex physiology was definitely established, with operated animals as experimental subjects. From then on, research upon this problem was accelerated throughout the scientific world. These two small excerpts from his work convey something of the method, the results, and the theory of these early studies--as well as the excitement.

Study Questions

1. What special functions of the response mechanism are assigned by Hall to the "true spinal system?" How does this system differ from the "peristaltic?"

2. How does the "diastaltic" system differ from the "true spinal?" What is the purest diastaltic function? What are the various -odic courses of action?

3. What was Hall's basic surgical operation? Can you list the important effects of stimuli in an operated animal? Which would be called reflex today? Are they diffuse or specific in their action?

4. What is his position on the vis nervosa; what new evidence does he give?

5. Over what functions is diastaltic function seen to reign?

6. What does Hall say about reflex compounding? Loci of maximal excitability? Combined reflex and voluntary action?

7. What does he say about the relative excitability of different parts of the nervous system to different forms of stimulation? What does he mean by the "dynamic force" and "static equilibrium" of the spinal "marrow?"

8. What are some of the factors that augment (or diminish) the excitability of spinal marrow tissue? On what observations does Hall build his case.

9. What is the relation of irritability of muscle tissue to the brain and spinal marrow? (Notice where <u>volition</u> is said to reside.)

MARSHALL HALL ON THE SPINAL NERVOUS SYSTEM, 1843, 1850

The first excerpt is from Marshall Hall, New Memoir on the Nervous System (London, 1843), sect. 3, pp. 51-52. The second excerpt is from Marshall Hall, Synopsis of the Diastaltic Nervous System (London, 1850), sect. 1, pp. 4-11, 13, and sect. 2, pp. 17-20.

/EXCERPT 1/

SECTION III

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190. The first physiological remark I would offer, relates to the complete distinction between the functions of the cerebral, the true spinal, and ganglionic portions of the several nervous systems. Whilst the cerebral system places us in relation with the external world mentally, the true spinal appropriates some of its materials in the mass, and the ganglionic performs the same office still more intimately in regard to its atoms.

191. Every act of ingestion, of retention, of expulsion, or of exclusion, is a reflex act, an excito-motor act, an act of the true spinal system, performed through its incident nerves, its central organ (the true spinal marrow), and its reflex motor nerves; an act of the special power seated in this system. I have always wondered that such an extensive generalization did not excite more admiration of Nature's works.

192. If we wish, then, to know what are the special acts of the true spinal system, we have only to ask--what are the acts by means of which masses of matter are ingurgitated into and expelled from the animal oeconomy?

193. These acts are found to preside over two important classes of functions,--those of the preservation of the individual and the propagation of the species. The designs of Nature in the functions of the true spinal system are, therefore, obvious.

194. These views will be made conspicuous by a careful examination of the following Table of

The Physiology of the True Spinal System

I. The Excited Actions--
   1. Of the Iris;--of the Eye-lids
   2. Of the Orifices)1. The Larynx
)2. The Pharynx
   3. Of the Ingestion
      1. Of the Food,
         1. In Suction;
         2. In Deglutition.
      2. Of the Air, or Respiration.
      3. Of the Semen, or Conception.

4. Of Exclusion.
5. Of the Expulsors, or of Egestion
   1. Of the Foeces;
   2. Of the Urine
   3. Of the Perspiration;
   4. Of the Semen;
   5. Of the Foetus, or Parturition.
6. Of the Sphincters.
   1. The Cardia.
   2. The Valvula Coli?
   3. The Sphincter Ani.
   4. The Sphincter Vesicoe.

II. The Direct Action or Influence--
   I. In the Tone,) of the Muscular System.
   II. In the Irritability,)

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/EXCERPT 2/

SECTION 1

II. New Terms Proposed

15. On analysing the facts which have been detailed, I observed that the following anatomical relations are essential:

1. A nerve leading from the point or part irritated, to and into the spinal marrow;
2. The spinal marrow itself; and
3. A nerve, or nerves, passing out of or from the spinal marrow, --all in essential relation or connection with each other.

16. On these anatomical facts I have ventured to institute a new nomenclature, descriptive of what I have hitherto designated The Spinal System, and expressive of these essential points. The term peristaltic... is familiar to us all. It may be justly extended to all the movements of the interior organs, as the heart, the stomach, the large and small intestines, the uterus, &c. These movements, it is well known, are independent of the spinal marrow. But it has been shown that a series of experimental phenomena, and it will be shown hereafter that a series of important functions, are effected by means of the series of nerves in essential connection with the spinal marrow, to which I have adverted. The action or act is performed through the spinal marrow as its essential centre. I propose to designate the phenomena by the term diastaltic.

17. The spinal system may henceforth be designated--The Diastaltic Nervous System, a designation which will have the advantage of including this system in the invertebrate as well as the vertebrate tribes of animals. This system embraces a peculiar anatomy, physiology, pathology, and therapeutics.

18. Perhaps the only purely diastaltic function is Respiration;

and this is variously modified by volition and influenced by emotion. But there are many other functions which partake of both the diastaltic and peristaltic character. Such are the functions of the immediate conduits of ingestion and of egestion;--the oesophagus, the rectum, the uterus. These functions are dia- and peri- staltic.

19. How much there is in these terms calculated to excite new and accurate inquiry! How much to refute injurious and calumnious criticism! I have hitherto spoken of the mode and course of the diastaltic actions and functions. But I shall immediately proceed to show that the Principle of action in the diastaltic nervous system is as special and peculiar as its direction. This principle I long ago demonstrated to be the vis nervosa of Haller, the 'excitabilite' of M. Flourens, acting in newly discovered diastaltic, forms. Now, the term 'reflex' may have been vaguely used by Prochaska; but the full and distinct idea of a diastaltic action of the vis nervosa had occurred to no one.

20. We are much in need of other terms still, to aid us in this investigation. The terms incident excitor and reflex motor have been used to designate those nerves whose influence proceeds to and from the spinal marrow. But they have never appeared to me satisfactory, and I have long wished for others more expressive and explicit. The following compounds of odos, a way, have appeared to competent judges very appropriate to our subject: esodic. . . will express the action into; exodic. . . the action out of; anodic . . . will express the ascending, cathodic . . . the descending, course of action; pollodic . . . and panthodic . . . will express the facts, on which I shall shortly have to dwell at considerable length, of the action of the vis nervosa from each one point of the diastaltic system, in many or even all directions, to every other.

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III. Subsequent Experiments

I may now proceed with my detail:

23. If, in the severed head of the frog, the toad, the eft, the snake,--the kitten, the puppy, the young rabbit, &c. we touch the eye-lid, the eye-lash, or the conjunctiva, the eye is immediately closed. The same event occurs in the horse stunned to insensibility by the blow of the pole-axe.

24. If, in the decapitated trunk of these animals, we irritate a toe or other part of the foot of the anterior or posterior extremity, this extremity is immediately withdrawn; if we irritate the tail, or the integuments near the sphincter ani, still greater movements are produced.

25. If the brain merely be removed, in a very young animal, all these phenomena are still observed.

26. The same effects are produced by irritating the dura mater within the cranium, and other interior membranes and tissues--a fact which throws a beam of light on some pathological events.

27. By any of these irritations, an act of inspiration, if respiration were previously suspended, is especially apt to be induced.

28. Each irritation of a cutaneous or mucous surface appears to induce a peculiar, special, and definite movement. If in the very young kitten, deprived of cerebrum and cerebellum, the foot be irritated, it is retracted; if a finger be introduced between the lips, an act of suction is excited; if a soft substance, as milk, be inserted into the pharynx, an act of deglutition is attempted; if the border of the rectum be irritated, the sphincter is contracted. The eye-lash, the meatus of the ear, and the tufts of hair between the toes, are peculiarly excitor.

29. Similar phenomena are observed in the anencephalous foetus, in the early stage of asphyxia in young animals, in the anaesthesia induced by chloroform.

30. In the case of perfect paraplegia in the human subject, when sensibility is absolutely extinct, and voluntary movements totally abolished, diastaltic actions are excited on the application of appropriate irritants, such as tickling, a puncture, a pinch, or sudden heat or cold; of all which the patient is unconscious.

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V. The Vis Nervosa of Haller: Its Catastaltic Law of Action

36. The Vis Nervosa, that power in the spinal marrow and muscular nerves, by means of which, if their tissues be irritated, muscular contraction follows, was supposed by Haller, by Bichat, by Prof. J. Müller, and, I believe, by all physiologists, to act in one direction only, from downwards. Its action was supposed to be cata-staltic only.

37. As long as this view prevailed, this motor power had, and could have, no application to physiology. It was presented to us as a mere experimental fact, or, at the utmost, in its relation to pathology.

38. It was . . . sterile and without utility. Now the existence of a distinct and energetic motor power in the animal frame, without utility in the animal oeconomy, would be a perfect incongruity, and contrary to every thing observed in creation.

39. By a series of oft-repeated experiments, I have demonstrated other Laws of action of the vis nervosa, and especially one which may be designated dia-staltic.

40. By this discovery, I have been enabled to prove the identity of the motor power in these experiments of Haller and in the experiments of Redi and of Whytt, and, disentangling the maze, to show that that double series of experiments is not without its application in physiology; that the latter have, in fact, their prototypes in all the acts of ingestion and of egestion in the animal oeconomy, and in some instances of pathological and therapeutic actions; and the former, in certain cases of pathology. It is the first real step in the philosophy of involuntary motions.

VI. The Diastaltic Law of Action of the Vis Nervosa: Its Demonstration

41. If the spinal marrow, in the decapitated tortoise or turtle, be denuded and irritated by the point of a needle, or the galvanic current, both anterior and posterior extremities are moved. The same irritation, applied to one and the same point of this nervous centre, produces all these movements.

42. If, instead of irritating a point of the spinal marrow itself, we denude and irritate a lateral spinal nerve,--the same results, the same movements of both pairs of extremities are observed.

43. In the first experiment, it is the vis nervosa of Haller which acts on the posterior extremities. This is the general view. Are the similar and synchronous movement of the anterior extremities, and the similar movements of both anterior and posterior extremities in the second experiment, of different origin? But if the integument be irritated, the same movements still take place; and this is one of the cases of reflex or diastaltic action.

44. Lastly, if we so irritate the border of the eye-lid, the eyelids close; or if we touch the border of the larynx, or of the sphincter ani, these orifices are closed. But these are Functions.

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48. Such I believe to be the Demonstration of the diastaltic action, and such the application to physiology, of the vis nervosa of Haller. Previously a sterile experimental fact, this principle of action has now taken its place as the dynamic force presiding over the large Class of the functions of ingestion and of egestion in the animal oeconomy.

49. It appears to me that the anastaltic and the diastaltic actions, in these experiments, are slower and more combined than the merely catastaltic. There is a similar difference between physiological acts, which are all diastaltic, and those pathological movements which are catastaltic.

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VIII. Diastaltic Actions Special, Resembling Design

56. Diastaltic actions are sometimes so combined, and, as it were, concatinated, as nearly to resemble acts of volition.

57. If a toe of the posterior extremity in the frog be irritated, the limb is flexed at the first, second, and third articulations, and drawn close to the body of the animal, by those combined movements.

58. But frequently, besides these movements of flexion, sudden movements of extension take place; sometimes of one extremity, but sometimes also of both. These concatenated movements may issue in a jump or leap even. It is only by observing that, when these movements

have ceased, no further movements--no spontaneous movements--occur, and by a certain peculiarity, readily detectible by those who have performed a lengthened series of experiments, that their real nature is detected.

59. Movements in all directions from any one point of the system, continued movements, and concatinated movements, are observed under other circumstances.

60. Exp.--If a kitten be reduced to a state of asphyxia, and the nostril, the ear, a toe of the anterior or posterior extremity, the tail, or the sphincter ani, be irritated, an act of inspiration is excited.

61. If, under various circumstances, we dash cold water in the face of the human patient, an act of inspiration, or of deglutition, or an act of contraction and expulsion in the rectum, the bladder, or the uterus, may be excited.

62. Each and every part of the spinal system is bound in a bond of action with each and every other part of that system.

63. The modes of action hitherto described have been induced by excitants applied to the cutaneous surface. And, indeed, as I long ago observed. . .it is the fine origins of the incident or esodic nerves, spread on the cutaneous or membranous tissues, which are the most excitable.

64. Some parts of the cutaneous surface are more excitable than the rest. This extraordinary excitability is especially observed in the toes and near the sphincter ani, in the frog; and within the ear, in the eye-lid, in the sole of the foot, in the young kitten and puppy. If the integument near the sphincter ani, in the frog, be irritated, a movement of the posterior extremities, apparently designed to remove that irritation, occurs.

65. The final cause of all this is obvious. If an object be placed in the hand of a sleeping infant, it is grasped pretty firmly, by a mere diastaltic action. Such action appears designed to strengthen and aid, and to cooperate with, volition. If it were otherwise, each act of volition would be opposed and thwarted by diastaltic actions, and the objects of volition might be frustrated.

66. The act of inspiration presents us with the most marked example of combined action, including that of the nostril, the larynx, the intercostal muscles, and the diaphragm. This act also includes a concatenated action; for the act of inspiration is essentially linked with the act of expiration. This is most obvious in the case of sneezing. But it is not less so, to the attentive observer, in ordinary respiration, in which there is a sort of continued equilibrium of action. To this point I shall have to revert hereafter.

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SECTION II

I. Condition of the Vis Nersova: Static and Dynamic

78. The cerebrum and cerebellum are insensible and in-excitor or a-staltic, on being punctured or lacerated, whilst their principle of action. . .is spontaneous in its motor influences.

79. The spinal marrow, on the contrary, is essentially excitor, requiring the application and repetition of a stimulus for the development of each and every movement.

80. The natural condition of the spinal marrow is one of inaction, or of static equilibrium. It is by appropriate and successive stimuli that its dynamic force is made effective and manifest.

81. This statement is true in every condition of the spinal marrow. Even when its excitability is extreme, under the influence of strychnine, freedom from stimulus if freedom from all motor action.

82. Still more is this the case in the state of diminished excitability from shock, from chloroform, &c.

83. After the application of a stimulus and the phenomena of dynamic force, the spinal marrow again resumes its condition of static equilibrium, but with reduced excitability. The action of each stimulus is followed by this effect, and each second stimulus is accordingly less effective than the former one. The excitability is, on the other hand, restored by repose. And thus the static equilibrium and the dynamic force bear a certain relation to each other.

84. A frog, affected by shock, or placed under the influence of chloroform, may be deprived of voluntary movement, respiratory movements, and reflex actions, the circulation being also almost extinct. If it be now left at rest, respiratory movements return. If it be excited, they again cease. And thus repeatedly. The same observation applies to all other movements. Quiet is the restorer, excitement the exhauster, of the motor energies.

II. The Spinal Marrow Susceptible of Augmented Excitability.

85. The degree of Excitability of the spinal marrow is, in general terms, (like Irritability of the muscular fibre), inversely as the degree of Activity or of Stimulus.

86. Augmented or restored during sleep, it is diminished during each day, by every act of volition, every act of the respiration, and by each meal.

87. But the excitability of the spinal marrow admits of intense augmentation and extreme diminution by therapeutic agents. That of the nerve admits of no such augmentation.

88. Exp.--The tenth part of a grain of the acetate of strychnine

dissolved in distilled water, and applied over the cutaneous surface of the frog, induces the most extreme excitability, or hypererethism. The slightest stimulus induces violent tetanoid spasm. Meantime, the circulation, in the intervals of such spasms, remains unimpaired.

89. Exp.--On the other hand, if ten drops of chloroform be dropped on a bit of sponge and attached to the upper part of a tumbler, and this be inverted on a plate of glass, so as to enclose a frog, this animal first ceases from voluntary movements, then loses its excitability, and lastly, its circulation.

90. Undue excitability is the usual effect of teething, of irritated esodic nerves in general, and especially in the case of a wounded nerve, as in tetanus.

91. The usual immediate effect of a convulsive seizure is augmented excitability; and therefore one seizure frequently succeeds to another. The remoter effect is diminished excitability, and the patient is frequently secure from other attacks until the excitability is slowly restored.

92. Indolence allows the excitability to become morbidly great; activity diminishes its degree or intensity. Hence the importance, in such cases, of restraining the excitability by daily exercise, limited only by approaching fatigue.

III. Relation of Irritability to the Cerebrum and Spinal Marrow

93. We are naturally led, by the consideration given in the last section, to the subject of the present one. Every act of an organ is followed by diminished energy or power. This is not only true of the nervous tissue, but of the muscular fibre. Each contraction of a muscle is followed by a diminution of the irritability of the muscular fibre. If, on the contrary, all stimulus be removed, the irritability exists in its maximum degree.

94. But, for the perfect state of the muscular irritability, it is essential that the muscle should have remained in connection, through the nerves, with the spinal marrow. The spinal marrow is, so far, the source of muscular irritability.

95. If, in experiment or disease, the influence of the brain, that is, of volition, be withdrawn from a muscle, its irritability becomes greater, comparatively, than that of the similar muscles. In cerebral paralysis, or that paralysis in which the influence of the cerebrum is removed from a limb, the muscles of that limb are more irritable, tested by the mildest galvanic influence which will produce an obvious effect, than those of the other limb.

96. But if the connection between the spinal marrow and the muscle be severed, either in an experiment or by disease, the irritability of the muscles of the paralysed limb (and the excitability of the severed portion of nerve) is less than that of the healthy limb.

97. These conclusions are founded upon a vast number of experiments, most carefully made and observed.

98. The fact affords a Diagnosis between cerebral and spinal paralysis, or between the cases of paralysis in which the influence of the cerebrum or of the spinal marrow, is severed, respectively--a diagnosis frequently of great importance.

Charles Scott Sherrington (1857-1952)

Sir Charles Sherrington was born in the same year that Marshall Hall died, but there were sixty-odd years between their bestknown contributions to science, and in that period enormous progress was made in the field of reflex physiology. There are 314 references in Sherrington's Integrative Action..., and most of them are to studies that succeeded those of Marshall Hall--not a few to those of Sherrington himself. Many new research techniques had been developed and perfected, and countless aspects of reflex function had been investigated, with animals of many species and especially the dog. Reflex actions of all kinds (scratch, flexion, crossed extension, etc.) were evoked by various kinds and intensities of stimuli, almost always with a spinal, decerebrate, or other laboratory "preparation," and many laws of action were well-established. Although the observable data were often in the form of change in stimulus and response, the focus of interest continued to be, as it was in the time of Descartes, on the mechanism of response. This is very clear in Sherrington's theory of synaptic function, with which he attempts to explain the observable differences between reflex-arc and nerve-trunk conduction.

Study Questions (This unit's study questions will be more general than usual, but you will be expected to show detailed knowledge on your unit test.)

1. What are the three points of view from which nervous reactions may be treated?

2. What kinds of integration may be distinguished in organismic function? Examples?

3. What is "reflex action?" What does not qualify as such? What structures are involved?

4. Define: a "reflex arc"; an "afferent arc"; a "simple reflex"; "reflex coordination" and "compounding."

5. What is the major function of receptors"

6. What are the differences between reflex-arc and nerve-trunk conduction?

7. What explanations of these differences does Sherrington reject?

8. What is a "synapse," according to Sherrington; what is its function--what does it account for?

CHARLES SCOTT SHERRINGTON ON THE INTEGRATIVE ACTION OF THE NERVOUS SYSTEM, 1906.

Chas. S. Sherrington, The Integrative Action of the Nervous System (New Haven: Yale University Press, 1906), pp. 2-4, 5-8, 13-14, 15-16, 18.

The physiology of nervous reactions can be studied from three main points of view.

In the first place, nerve cells, like all other cells, lead individual lives,---they breathe, they assimilate, they dispense their own stores of energy, they repair their own substantial waste; each is, in short, a living unit, with its nutrition more or less centered in itself. . .

Secondly, nervous cells present a feature so characteristically developed in them as to be specially theirs. They have in exceptional measure the power to spatially transmit (conduct) states of excitement (nerve impulses) generated within them. Since this seems the eminent functional feature of nerve-cells wherever they exist, its intimate nature is a problem co-extensive with the existence of nerve-cells, and enters into every question regarding the specific reactions of the nervous system. This field of study may be termed that of nerve-cell conduction.

But a third aspect which nervous reactions offer to the physiologist is the integrative. In the multicellular animal, especially for those higher reactions which constitute its behavior as a social unit in the natural economy, it is nervous reaction which par excellence integrates it, welds it together from its components, and constitutes it from a mere collection of organs an animal individual. This integrative action in virtue of which the nervous system unifies from separate organs an animal possessing solidarity, an individual, is the problem before us in these lectures. Though much in need of data derived from the two previously mentioned lines of study, it must in the meantime be carried forward of itself and for its own sake.

The integration of the animal organism is obviously not the result solely of any single agency at work within it, but of several. Thus, there is the mechanical combination of the unit cells of the individual into a single mass. This is effected by fibrous stromata, capsules of organs, connective tissue in general, e.g., of the liver, and indeed the fibrous layer of the skin encapsulating the whole body. In muscles this mechanical integration of the organ may arrive at providing a single cord tendon by which the tensile stress of a myriad contractile cells can be additively concentrated upon a single place of application.

Integration also results from chemical agency. Thus, reproductive organs, remote from one another, are given solidarity as a system of communication that is of chemical quality; lactation supervenes post partum in all the mammary glands of a bitch subsequent to thoracic transaction of the spinal cord severing all nervous communication between the pectoral and the inguinal mammae (Goltz). In digestive

organs we find chemical agency co-ordinating the action of separate glands, and thus contributing to the solidarity of function of the digestive glands as a whole. The products of salivary digestion on reaching the pyloric region of the stomach, and the gastric secretion on reaching the mucosa of the duodenum, make there substances which absorbed duly excite heightened secretion of gastric and of pancreatic juice respectively suited to continue the digestion of the substances initiating the reaction (Bayliss and Starling, Edkins). Again, there is the integrating action effected by the circulation of the blood. The gaseous exchanges at one limited surface of the body are made serviceable for the life of every living unit in the body. By the blood the excess of heat produced in one set of organs is brought to redress the loss of heat in others; and so on.

But the integrative action of the nervous system is different from these, in that its agent is not mere intercellular material, as in connective tissue, nor the transference of material in mass, as by the circulation; it works through living lines of stationary cells along which it despatches waves of physicochemical disturbance, and these act as releasing forces in distant organs where they finally impinge. Hence it is not surprising that nervous integration has the feature of relatively high speed, a feature peculiarly distinctive of integrative correlation in animals as contrasted with that of plants, the latter having no nervous system in the ordinary sense of the word.

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It is in view of this interconnecting function of the nervous system that the field of study of nervous reactions which was called at the outset the third or integrative, assumes its due importance. The due activity of the interconnection resolves itself into the co-ordination of the parts of the animal mechanism by reflex action.

It is necessary to be clear as to what we understand by the expression "reflex" action.

In plants and animals occur a number of actions the initiation of which is traceable to events in their environment. The event in the environment is some change which acts on the organism as an exciting stimulus. The energy which is imparted to the organism by the stimulus is often far less in quantity than the energy which the organism itself sets free in the movement or other effect which it exhibits in consequence of the application of the stimulus. This excess of energy must be referred to energy potential in the organism itself. The change in the environment evidently acts as a releasing force upon the living machinery of the organism. The source of energy set free is traced to chemical compounds in the organism. These are of high potential value, and in immediate or mediate consequence of the stimulus decompose partly, and so liberate external from internal energy. It is perfectly conceivable, and in many undifferentiated organisms, especially in unicellular, e.g., amoeba, is actually the case, that one and the same living structure not only undergoes this physico-chemical change at the point of that change from particle to particle along it, so that there then ensue in it changes of form, movement. In such a case the initial reaction or reception of the stimulus, the spatial transmission or

conduction of the reaction, and the motor or other end-effect, are all processes that occur in one and the same living structure. But in many organisms these separable parts of the reaction are exhibited by separate and specific structures. Suppose an animal turn its head in response to a sudden light. Large fields of its body take part in the reaction, but also large fields of it do not. Some of its musculature contracts, particularly certain pieces of its skeletal musculature. The external stimulus is, so to say, led to them by certain nerves in the altered form of a nervous impulse. If the neck nerves are severed the end-effect is cut out of part of the field; and the nerves themselves cannot exhibit movement on the application of the stimulus. The optic nerve itself is unable to enter into a heightened phase of its own specific activity on the application of light. Initiation of nervous activity by light is the exclusive (in this instance) function of cells in the retina, retinal receptors. In such cases there exist three separable structures for the three processes--initiation, conduction, and end-effect.

These reactions, in which there follows on an initiating reaction and end-effect reached through the mediation of a conductor, itself incapable either of the end-effect, or under natural conditions, of the inception of the reaction, are "reflexes." The conductors are nerve. Usually the spaces and times bridged across by the conductors are quite large, and easily capable of measurement. Now there occur cases, especially within the unicellular organism and the unicellular organ, where the spaces and times bridged are minute. In them spread of response may involve "conduction" (Poteriodendron, Vorticella) in some degree specific. Yet to cases where neither histologically nor physiologically a specific conductor can be detected, it seems better not to apply the term "reflex." It seems better to reserve that expression for reactions employing specifically recognizable nerve-processes and morphologically differentiated nerve-cells; the more so because the process of conduction in nerve is probably a specialized one, in which the qualities of speed and freedom from inertia of reaction have been attained to a degree not reached elsewhere since not elsewhere demanded.

The conception of a reflex therefore embraces that of at least three separable structures,--an effector organ, e.g., gland cells or muscle cells; a conducting nervous path or conductor leading to that organ; and an initiating organ or receptor whence the reaction starts. The conductor consists, in the reactions which we have to study, of at least two nerve-cells,--one connected with the receptor, the other with the effector. For our purpose the receptor is best included as a part of the nervous system, and so it is convenient to speak of the whole chain of structures--receptor, conductor, and effector--as a reflex-arc. All that part of the chain which leads up to but does not include the effector and the nerve-cell attached to this latter, is conveniently distinguished as the afferent-arc.

The reflex-arc is the unit mechanism of the nervous system when that system is regarded in its integrative function. The unit reaction in nervous integration is the reflex, because every reflex is an integrative reaction and no nervous action short of a reflex is a complete act of integration. The nervous synthesis of an individual from what without it were a mere aggregation of commensal organs resolves itself

into co-ordination by reflex action. But though the unit reaction in the integration is a reflex, not every reflex is a unit reaction, since some reflexes are compounded of simpler reflexes. Co-ordination, therefore, is in part the compounding of reflexes. In this co-ordination there are obviously two grades.

The simple reflex. There is the coordination which a reflex action introduces when it makes an effector organ responsive to excitement of a receptor, all other parts of the organism being supposed indifferent to and indifferent for that reaction. In this grade of co-ordination the reflex is taken apart, as if separable from all other reflex actions. This is the simple reflex. A simple reflex is probably a purely abstract conception, because all parts of the nervous system are connected together and no part of it is probably ever capable of reaction without affecting and being affected by various other parts, and it is a system certainly never absolutely at rest. But the simple reflex is a convenient, if not a probable, fiction. Reflexes are of various degrees of complexity, and it is helpful in analyzing complex reflexes to separate from them reflex components which we may consider apart and therefore treat as though they were simple reflexes.

In the simple reflex there is exhibited the first grade of co-ordination. But it is obvious that if the integration of the animal mechanism is due to co-ordination by reflex action, reflex actions must themselves be co-ordinated one with another; for co-ordinations to be reflex action there must be co-ordination of reflex actions. This latter is the second grade of co-ordination. The outcome of the normal reflex action of the organism is an orderly coadjustment and sequence of reactions. This is very patently expressed by the skeletal musculature. The co-ordination involves orderly coadjustment of a number of simple reflexes occurring simultaneously, i.e., a reflex pattern, figure, or "complication," if one may warp a psychological term /used by Wundt to describe the simultaneous association of conscious elements from different senses, as in the sight-sound-touch perception of a violin/ for this use; orderly succession involves due supercession of one reflex by another, or of one group of reflexes by another group, i.e., orderly change from one reflex pattern or figure to another. For this succession to occur in an orderly manner no component of the previous reflex may remain which would be out of harmony with the new reflex that sets in. When the change from one reflex to another occurs it is therefore usually a far-reaching change spread over a wide range of nervous arcs.

This compounding of reflexes with orderliness of coadjustment and of sequence constitute co-ordination, and want of it, inco-ordination. We may therefore in regard to co-ordination distinguish co-ordination of reflexes simultaneously proceeding, and co-ordination of reflexes successively proceeding. The main secret of nervous co-ordination lies evidently in the compounding of reflexes.

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We infer...that the main contribution made to the mechanism of the reflex-arc by that part of it which constitutes the receptor is selective excitability. It thus contributes to co-ordination, for it

renders its arc prone to reply to certain stimuli, while other arcs not having that kind of receptor do not reply, and it renders its arc unlikely to reply to certain other stimuli to which other arcs are likely to respond. It will thus, while providing increase of responsiveness on the part of the organism to the environment, tend to prevent confusion of reactions (inco-ordination) by limiting to particular stimuli a particular reaction.

On the whole, we may regard the receptor as being concerned with the mode of excitation rather than with the features of conduction of the reflex-arc, and may now return to that conduction, which itself has important co-ordinative characters.

Nervous conduction has been studied chiefly in nerve-trunks. Conduction in reflexes is of course for its spatially greater part conduction along nerve-trunks, yet reflex conduction in toto differs widely from nerve-trunk conduction.

Conduction in reflex-arcs exhibits (1) slower speed as measured by the latent period between application of stimulus and appearance of end-effect, this difference being greater for weak stimuli than for strong; (2) less close correspondence between the moment of cessation of stimulus and the moment of cessation of end-effect, i.e., there is a marked "after-discharge;" (3) less close correspondence between rhythm of stimulus and rhythm of end-effect; (4) less close correspondence between the grading of intensity of the stimulus and the grading of intensity of the end-effect; (5) considerable resistance to passage of a single nerve-impulse, but a resistance easily forced by a succession of impulses (temporal summation); (6) irreversibility of direction instead of reversibility as in nerve-trunks; (7) fatigability in contrast with the comparative unfatigability of nerve-trunks; (8) much greater variability of the threshold value of stimulus than in nerve-trunks; (9) refractory period, "bahnung," inhibition, and shock, in degrees unknown for nerve-trunks; (10) much greater dependence on blood-circulation, oxygen (Verworn, Winterstein, v. Baeyer, etc.); (11) much greater susceptibility to various drugs--anaesthetics.

These differences between conduction in reflex-arcs and nerve-trunks respectively appear referable to that part of the arc which lies in gray matter. The constituents of gray matter over and above those which exist also in nerve-trunks are the nerve-cell bodies (perikarya), the fine nerve-cell branches (dendritic and axonic nerve-fibres), and neuroglia.

Neuroglia exists in white matter as well as in gray, and there is no good ground for attributing the above characteristics of conduction in reflex-arcs to that part of the arcs which consist of white matter. It is improbable, therefore, on that ground that the features of conduction are due to neuroglia. In deed there is no good evidence that neuroglia is concerned directly in nervous conduction at all...As to perikarya (nerve-cell bodies) the experiment of Bethe...the observation by Langley.../and/ the experiements of Exner, and of Moore and Reynolds...withdraw from the perikaryon the responsibility...

As to the nerve-cell branches. . . It seems...scarcely justifiable

to suppose that conduction along nerve-fibres assumes in the gray matter characters so widely different from those it possesses elsewhere as to account for the dissimilarity between reflex-arc conduction and nerve-trunk conduction respectively.

In this difficulty there rises forcibly to mind that not the least fruitful of the facts which the cell-theory rests upon and brings together is the existence at the confines of the cells composing the organism of "surfaces of separation" between the adjacent cells. In certain cyncytial cases such surfaces are not apparent, but with most of the cells in the organism their existence is indisputed, and they play an important role in a great number of physiological processes. Now in addition to the structural elements of gray matter specified above, there is one other which certainly in many cases exists. The gray matter is the field of nexus between neurone and neurone. Except in sympathetic ganglia, the place of nexus between neurone and neurone lies nowhere else than in gray matter. We know of no reflex-arc composed of one single neurone only. In other words, every reflex-arc must contain a nexus between one neurone and another. The reflex-arc must, therefore, on the cell-theory, be expected to include not only intracellular conduction but intercellular conduction. But on the current view of the structure of the nerve-fibres of nerve-trunks the conduction observed in nerve-trunks is entirely and only intracellular conduction. Perhaps, therefore, the difference between the reflex-arc conduction and nerve-trunk conduction is related to an additional element in the former, namely intercellular conduction. If there exists any surface or /sic/ separation at the nexus between neurone and neurone, much of what is characteristic of the conduction exhibited by the reflex-arc might be more easily explicable. At the nexus between cells if there be not actual confluence there must be a surface of separation. At the nexus between efferent neurone and the muscle-cell, electrical organ, etc., which it innervates, it is generally admitted that there is not actual confluence of the two cells together, but that a surface separates them; and a surface of separation is physically a membrane. As regards a number of the features enumerated above as distinguishing reflex-arc conduction from nerve-trunk conduction, there is evidence that similar features, though not usually in such marked extent, characterize conduction from efferent nerve-fibre to efferent organ...Here change in conduction is not due to perikarya (nerve-cell bodies), for such are not present. The change may well be referable to the surface of separation admittedly existent between efferent neurone and effector cell.

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...It seems therefore likely that the nexus between neurone and neurone in the reflex-arc, at least in the spinal arc of the vertebrate, involves a surface of separation between neurone and neurone; and this as a transverse membrane across the conductor must be an important element in intercellular conduction. The characters distinguishing reflex-arc conduction from nerve-trunk conduction may therefore be largely due to intercellular barriers, delicate transverse membranes, in the former.

In view, therefore, of the probable importance physiologically of this mode of nexus between neurone and neurone it is convenient to have a term for it. The term introduced /by Foster and Sherrington/ has been synapse.

Ivan Petrovich Pavlov (1849-1936)

The Pavlovian story is so well-known today that no remarks are needed here about his work. Two comments, however, may not be out of place concerning his relation to earlier and later developments in the study of behavior. First, his work may be said to represent a stage of reflex physiology in which the intact organism became an object of experimental study. Rather than reduce the laboratory organism to a spinal, decerabrate, or other preparation, as had Sherrington and his predecessors, Pavlov increased the control of experimental conditions--application of stimuli, removal of distractions, acclimatization of animals to the situation, and so forth.

Secondly, he gave us the basic outline of a system of behavior. In showing how conditioning and extinction were related to generalization, discriminination, and the like, he provided an integration of behavioral data which went well beyond that of Sherrington and his predecessors. By virtue of his experimental findings, and independently of his physiological theory, Pavlov set the stage for a self-supporting and non-mentalistic science of psychology...which was probably the last thing that he had in mind.

Study Questions

1. From his studies of the gastric glands, what does Pavlov say that he learned about the stimuli for salivation? Where his studies "physiological?"

2. What did Pavlov learn, in these studies, about conditioning, extinction, spontaneous recovery, and inhibition?

3. What was the difference between conditioned and unconditioned reflexes of salivation?

4. What are the signals of which Pavlov speaks?

5. What explains conditioning?

6. What is the "merchanism" of our "psychical experience?"

7. Why should we study the cerebral hemispheres?

8. What is the current state of such study, and why does it exist?

9. What does Pavlov think of the contributions of Descartes, Sherrington, Sechenov, Richet, Loeb, Jennings, Thorndyke (sic) and the "behaviorists" to such research?

10. What is Pavlov's point of departure?

11. What is the role of the reflex; what kinds of reflex are there;

and how do reflexes differ from instincts?

12. What are some of the "fundamental reflexes?" What is the "freedom" reflex; the "investigatory" reflex; the reflex of "self defence? Is the listing of reflexes important?

13. What are the effects of decerebration upon reflex behavior?

14. With what basic observations did Pavlov's work begin?

15. What is the "most general function of the hemispheres?"

Pavlov, I. P. Conditioned Reflexes (Trans. by G. V. Anrep) London, Oxford Univ. Press, xv, 1927, pp. 1-15.

LECTURE I.

The development of the objective method in investigating the physiological activities of the cerebral hemispheres. -- Concept of Reflexes.-- Signal-reflexes, the most fundamental physiological characteristic of the hemispheres.

The cerebral hemispheres stand out as the crowning achievement in the nervous development of the animal kingdom. These structures in the higher animals are of considerable dimensions and exceedingly complex, being made up in man of millions upon millions of cells--centres of foci of nervous activity--varying in size, shape and arrangement, and connected with each other by countless branchings and from their individual processes. Such complexity of structure naturally suggests a like complexity of function, which in fact is obvious in the higher animal and in man. Consider the dog, which has been for so many countless ages the servant of man. Think how he may be trained to perform various duties, watching, hunting, etc. We know that this complex behaviour of the animal, undoubtedly involving the highest nervous activity, is mainly associated with the cerebral hemispheres. If we remove the hemispheres in the dog /Goltz[1] and others[2]/, the animal becomes not only incapable of performing these duties but also incapable even of looking after itself. It becomes in fact a helpless invalid, and cannot long survive unless it be carefully tended.

In man also the highest nervous activity is dependent upon the structural and functional integrity of the cerebral hemispheres. As soon as these structures become damaged and their functions impaired in any way, so man also becomes an invalid. He can no longer proceed with his normal duties, but has to be kept out of the working world of his fellow men.

In astounding contrast with the unbounded activity of the cerebral hemispheres stands the meagre content of present-day physiological knowledge concerning them. Up to the year 1870, in fact, there was no physiology of the hemispheres; they seemed to be out of reach of the physiologist. In that year the common physiological methods of stimulation and extirpation were first applied to them /Fritsch and Hitzig[3]/. It was found by these workers that stimulation of certain

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[1]F. Goltz, "Der Hund ohne Grosshirn," Pflüger's Archiv, V. 1i. p. 570, 1892.

[2]M. Rothmann, "Der Hund ohne Grosshirn." Neurologisches Centralblatt, V. xxviii, p. 1045, 1909.
A.P.

[3]Fritsch und E. Hitzig, "Ueber die elektrische Erregbarkeit des Grosshirns." Archiv für (Anatomie und) Physiologie, p. 300, 1870.

parts of the cortex of the hemispheres (motor cortex) regularly evoked contractions in definite groups of skeletal muscles: extirpation of these parts of the cortex led to disturbances in the normal functioning of the same groups of muscles. Shortly afterwards it was demonstrated /Ferrier,[1] H. Munk[2]/ that other areas of the cortex which do not evoke any motor activity in response to stimulation are also functionally differentiated. Extirpation of these areas leads to definite defects in the nervous activity associated with certain receptor organs, such as the retina of the eye, the organ of Corti, and the sensory nerve-endings in the skin. Searching investigations have been made, and still are being made, by numerous workers on this question of localization of function in the cortex. Our knowledge has been increased in precision and filled out in detail, especially as regards the motor area, and has even found useful application in medicine. These investigations, however, did not proceed fundamentally beyond the position established by Fritsch and Hitzig. The important question of the physiological mechanism of the whole higher and complex behaviour of the animal which is--as Goltz showed --dependent upon the cerebral hemispheres, was not touched in any of these investigations and formed no part of the current physiological knowledge.

When therefore we ask the questions: What do those facts which have up to the present been at the disposal of the physiologist explain with regard to the behaviour of the higher animals? What general scheme of the highest nervous activity can they give? of what general rules governing this activity can they help us to formulate? --the modern physiologist finds himself at a loss and can give no satisfactory reply. The problem of the mechanism of this complex structure which is so rich in function has got hidden away in a corner, and this unlimited field, so fertile in possibilities for research, has never been adequately explored.

The reason for this is quite simple and clear. These nervous activities have never been regarded from the same point of view as those of other organs, or even other parts of the central nervous system. The activities of the hemispheres have been talked about as some kind of special activity, whose working we feel and apprehend in ourselves, and by analogy suppose to exist in animals. This is an anomaly which has placed the physiologist in an extremely difficult position. On the one hand it would seem that the study of the activities of the cerebral hemispheres, as of the activities of any other part of the organism, should be within the compass of physiology, but on the other hand it happens to have been annexed to the special field of another science--psychology.

What attitude then should the physiologist adopt? Perhaps he should first of all study the methods of this science of psychology, and only afterwards hope to study the physiological mechanism of the

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[1]D. Ferrier, Functions of the Brain, London, 1876.

[2]H. Munk, Ueber die Functionen der Grosshirnrinde, Berlin, 1890 and 1909.

hemispheres? This involves a serious difficulty. It is logical that in its analysis of the various activities of living matter physiology should base itself on the more advanced and more exact sciences--physics and chemistry. But if we attempt an approach from this science of psychology to the problem confronting us we shall be building our superstructure on a science which has no claim to exactness as compared even with physiology. In fact it is still open to discussion whether psychology is a natural science, or whether it can be regarded as a science at all.

It is not possible here for me to enter deeply into this question, but I will stay to give one fact which strikes me very forcibly, viz. that even the advocates of psychology do not look upon their science as being in any sense exact. The eminent American psychologist, William James, has in recent years referred to psychology not as a science but as a hope of science. Another striking illustration is provided by Wundt, the celebrated philosopher and psychologist, founder of the so-called experimental method in psychology and himself formerly a physiologist. Just before the War (1913), on the occasion of a discussion in Germany as to the advisability of making separate Chairs of Philosophy and Psychology, Wundt opposed the separation, one of his arguments being the impossibility of fixing a common examination schedule in psychology, since every professor had his own special ideas as to what psychology really was. Such testimony seems to show clearly that psychology cannot yet claim the status of an exact science.

If this be the case there is no need for the physiologist to have recourse to psychology. It would be more natural that experimental investigation of the physiological activities of the hemispheres should lay a solid foundation for a future true science of psychology; such a course is more likely to lead to the advancement of this branch of natural science.

The physiologist must thus take his own path, where a trail has already been blazed for him. Three hundred years ago Descartes evolved the idea of the reflex. Starting from the assumption that animals behaved simply as machines, he regarded every activity of the organism as a necessary reaction to some external stimulus, the connection between the stimulus and the response being made through a definite nervous path: and this connection, he stated, was a fundamental purpose of the nervous structures in the animal body. This was the basis on which the study of the nervous system was firmly established. In the eighteenth, nineteenth and twentieth centuries the conception of the reflex was used to the full by physiologists. Working at first only on the lower parts of the central nervous system, they came gradually to study more highly developed parts, until quite recently Magnus,[1] continuing the classical investigations of Sherrington[2] upon the spinal reflexes, has succeeded in demonstrating the reflex nature of all the elementary motor activities of the animal organism. Descartes' conception of the reflex was constantly

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[1]R. Magnus, Körperstellung, Berlin, 1924.

[2]C. S. Sherrington, The Integrative Action of the Nervous System, 1906.

and fruitfully applied in these studies, but its application has stopped short of the cerebral cortex.

It may be hoped that some of the more complex activities of the body, which are made up by a grouping together of the elementary locomotor activities, and which enter into the states referred to in psychological phraseology as "playfulness," "fear," "anger," and so forth, will soon be demonstrated as reflex activities of the sub-cortical parts of the brain. A bold attempt to apply the idea of the reflex to the activities of the hemispheres was made by the Russian physiologist, I. M. Sechenov, on the basis of the knowledge available in his day of the physiology of the central nervous system. In a pamphlet entitled "Reflexes of the Brain," published in Russian in 1863, he attempted to represent the activities of the cerebral hemispheres as reflex--that is to say, as determined. Thoughts he regarded as reflexes in which the effector path was inhibited, while great outbursts of passion he regarded as exaggerated reflexes with a wide irradiation of excitation. A similar attempt was made more recently by Ch. Richet,[1] who introduced the conception of the psychic reflex, in which the response following on a given stimulus is supposed to be determined by the association of this stimulus with the traces left in the hemispheres by past stimuli. And generally speaking, recent physiology shows a tendency to regard the highest activities of the hemispheres as an association of the new excitations at any given time with traces left by old ones (associative memory, training, education by experience).

All this, however, was mere conjecture. The time was ripe for a transition to the experimental analysis of the subject--an analysis which must be as objective as the analysis in any other branch of natural science. An impetus was given to this transition by the rapidly developing science of comparative physiology, which itself sprang up as a direct result of the Theory of Evolution. In dealing with the lower members of the animal kingdom physiologists were, of necessity, compelled to reject anthropomorphic preconceptions, and to direct all their effort towards the elucidation of the connections between the external stimulus and the resulting response, whether locomotor or other reaction. This led to the development of Loeb's doctrine of Animal Tropisms;[2] to the introduction of a new objective terminology to describe animal reactions /Beer, Bethe and Uexküll[3]/; and finally, it led to the investigation by zoologists, using purely objective methods, of the behaviour of the lower members of the animal kingdom in response to external stimuli--as for example in the classical researches of Jennings.[4]

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[1]Ch. Richet, Reflexes Psychiques. Reflexes Conditionels. Automatisme Mental. Pavlov's Jubilee Volume, Petrograd, 1925.

[2]J. Loeb, Studies in General Physiology, Chicago, 1905.

[3]Beer, Bethe und Uexküll, "Vorschläge zu einer objectivirenden Nomenklatur in der Physiologie des Nervensystems," Biologisches Centralblatt, V. xix, p. 517, 1899.

[4]H.S. Jennings, The Behavior of Lower Organisms, New York, 1906.

Under the influence of these new tendencies in biology, which appealed to the practical bent of the American mind, the American School of Psychologists--already interested in the comparative study of psychology--evinced a disposition to subject the highest nervous activities of animals to experimental analysis under various specially devised conditions. We may fairly regard the treatise by Thorndyke, The Animal Intelligence (1898),[1] as the starting point for systematic investigations of this kind. In these investigations the animal was kept in a box, and food was placed outside the box so that it was visible to the animal. In order to get the food the animal had to open a door, which was fastened by various suitable contrivances in the different experiments. Tables and charts were made showing how quickly and in what manner the animal solved the problems set it. The whole process was understood as being the formation of an association between the visual and tactile stimuli on the one hand and the locomotor apparatus on the other. This method, with its modifications, was subsequently applied by numerous authors to the study of questions relating to the associative ability of various animals.

At about the same time as Thorndyke was engaged on this work, I myself (being then quite ignorant of his researches) was also led to the objective study of the hemispheres, by the following circumstance: In the course of the detailed investigation into the activities of the digestive glands I had to inquire into the so-called psychic secretion of some of the glands, a task which I attempted in conjunction with a collaborator. As a result of this investigation in unqualified conviction of the futility of subjective methods of inquiry was firmly stamped upon my mind. It became clear that the only satisfactory solution of the problem lay in an experimental investigation by strictly objective methods. For this purpose I started to record all the external stimuli falling on the animal at the time its reflex reaction was manifested (in this particular case the secretion of saliva), at the same time recording all changes in the reaction of the animal.

This was the beginning of these investigations, which have gone on now for twenty-five years--years in which numerous fellow-workers on whom I now look back with tender affection have united with mine in this work their hearts and hands. We have of course passed through many stages, and only gradually has the subject been opened up and the difficulties overcome. At first only a few scattered facts were available, but today sufficient material has been gathered together to warrant an attempt to present it in a more or less systematized form. At the present time I am in a position to present you with a physiological interpretation of the activities of the cerebral hemispheres which is, at any rate, more in keeping with the structural and functional complexity of this organ than is the collection of fragmentary, though very important facts which up to the present have represented all the

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[1] E. L. Thorndyke, The Animal Intelligence, An Experimental Study of the Associative Processes in Animals, New York, 1898.

knowledge of this subject. Work on the lines of purely objective investigation into the highest nervous activities has been conducted in the main in the laboratories under my control, and over a hundred collaborators have taken part. Work on somewhat similar lines to our has been done by the American psychologists. Up to the present, however, there has been one essential point of difference between the American School and ourselves. Being psychologists, their mode of experimentation, in spite of the fact that they are studying these activities on their external aspect, is mostly psychological--at any rate so far as the arrangement of problems and their analysis and the formulation of results are concerned. Therefore--with the exception of a small group of "behaviourists"--their work cannot be regarded as purely physiological in character. We, having started from physiology, continue to adhere strictly to the physiological point of view, investigating and systematizing the whole subject by physiological methods alone. As regards other physiological laboratories a few only have directed their attention to this subject, and that recently; nor have their investigations extended beyond the limits of a preliminary inquiry.

I shall now turn to the description of our material, first giving as a preliminary an account of the general conception of the reflex, of specific physiological reflexes, and of the so-called "instincts." Our starting point has been Descartes' idea of the nervous reflex. This is a genuine scientific conception, since it implies necessity. It may be summed up as follows: An external or internal stimulus falls on some one or other nervous receptor and gives rise to a nervous impulse; this nervous impulse is transmitted along nerve fibres to the central nervous system, and here, on account of existing nervous connections, it gives rise to a fresh impulse which passes along outgoing nerve fibres to the active organ, where it excites a special activity of the cellular structures. Thus a stimulus appears to be connected of necessity with a definite response, as cause with effect. It seems obvious that the whole activity of the organism should conform to definite laws. If the animal were not in exact correspondence with its environment it would, sooner or later, cease to exist. To give a biological example: if, instead of being attracted to food, the animal were repelled by it, or if, instead of running from fire the animal threw itself into the fire, then it would quickly perish. The animal must respond to changes in the environment in such a manner that its responsive activity is directed towards the preservation of its existence. This conclusion holds also if we consider the living organism in terms of physical and chemical science. Every material system can exist as an entity only so long as its internal forces, attraction, cohesion, etc., balance the external forces acting upon it. This is true for an ordinary stone just as much as for the most complex chemical substances; and its truth should be recognized also for the animal organism. Being a definite circumscribed material system, it can only continue to exist so long as it is in continuous equilibrium with the forces external to it: so soon as this equilibrium is seriously disturbed the organism will cease to exist as the entity it was. Reflexes are the elemental units in the mechanism of perpetual equilibration. Physiologists have studied and are studying at the present time these numerous machine-like, inevitable reactions of the organism--reflexes existing from the very birth of the animal, and due therefore to the inherent organization of the nervous system.

Reflexes, like the driving-belts of machines of human design, may be of two kinds--positive and negative, excitatory and inhibitory. Although the investigation of these reflexes by physiologists has been going on now for a long time, it is as yet not nearly finished. Fresh reflexes are continually being discovered. We are ignorant of the properties of those receptor organs for which the effective stimulus arises inside the organism, and the internal reflexes themselves remain a field unexplored. The paths by which nervous impulses are conducted in the central nervous system are for the most part little known, or not ascertained at all. The mechanism of inhibitions confined within the central nervous system remains quite obscure: we know something only of those inhibitory reflexes which manifest themselves along the inhibitory efferent nerves. Furthermore, the combination and interaction of different reflexes are as yet insufficiently understood. Nevertheless physiologists are succeeding more and more in unravelling the mechanism of these machine-like activities of the organism, and may reasonably be expected to elucidate and control it in the end.

To those reflexes which have long been the subject of physiological investigation, and which concern chiefly the activities of separate organs and tissues, there should be added another group of inborn reflexes. These also take place in the nervous system, and they are the inevitable reactions to perfectly definite stimuli. They have to do with reactions of the organism as a whole, and comprise that general behaviour of the animal which has been termed "instinctive." Since complete agreement as regards the essential affinity of these reactions to the reflex has not yet been attained, we must discuss this question more fully. We owe to the English philosopher, Herbert Spencer, the suggestion that instinctive reactions are reflexes. Ample evidence was later advanced by zoologists, physiologists, and students of comparative psychology in support of this. I propose here to bring together the various arguments in favour of this view. Between the simplest reflex and the instinct we can find numerous stages of transition, and among these we are puzzled to find any line of demarcation. To exemplify this we may take the newly hatched chick. This little creature reacts by pecking to any stimulus that catches the eye, whether it be a real object or only a stain in the surface it is walking upon. In what way shall we say that this differs from the inclining of the head, the closing of the lids, when something flicks past its eyes? We should call this last a defensive reflex, but the first has been termed a feeding instinct: although in pecking nothing but an inclination of the head and a movement of the beak occurs.

It has also been maintained that instincts are more complex than reflexes. There are, however, exceedingly complex reflexes which nobody would term instincts. We may take vomiting as an example. This is very complex and involves the co-ordination of a large number of muscles (both striped and plain) spread over a large area and usually employed in quite different functions of the organism. It involves also a secretory activity on the part of certain glands which is usually evoked for quite a different purpose.

Again, it has been assumed that the long train of actions involved in certain instinctive activities affords a distinctive point of contrast with the reflex, which is regarded as always being built on a simple scale. By way of example, we may take the building of a nest, or

of dwellings in general, by animals. A chain of incidents is linked together: material is gathered and carried to the site chosen; there it is built up and strengthened. To look upon this as reflex we must assume that one reflex initiates the next following--or, in other words, we must regard it as a chain-reflex. But this linking up of activities is not peculiar to instincts alone. We are familiar with numerous reflexes which most certainly fuse into chains. Thus, for example, if we stimulate an afferent nerve, e.g., the sciatic nerve, a reflex rise of blood pressure occurs; the high pressure in the left ventricle of the heart, and first part of the aorta, serves as the effective stimulus to a second reflex, this time a depressor reflex which has a moderating influence on the first. Again, we may take one of the chain reflexes recently established by Magnus. A cat, even when deprived of its cerebral hemispheres, will in most cases land on its feet when thrown from a height. How is this managed? When the position of the otolithic organ in space is altered a definite reflex is evoked which brings about a contraction of the muscles in the neck, restoring the animal's head to the normal position. This is the first reflex. With the righting of the head a fresh reflex is evoked, and certain muscles of the trunk and limbs are brought into play, restoring the animal to the standing posture. This is the second reflex.

Some, again, object to the identification of instincts with reflexes on this ground: instincts, they say, frequently depend upon the internal state of an organism. For instance, a bird only builds its nest in the mating season. Or, to take a simpler case, when an animal is satiated with eating, then food has no longer any attraction and the animal leaves off eating. Again, the same is true of the sexual impulse. This depends on the age of the organism, and on the state of the reproductive glands; and a considerable influence is exerted by hormones (the products of the glands of internal secretion). But this dependence cannot be claimed as a peculiar property of "instincts." The intensity of any reflex, indeed its very presence, is dependent on the irritability of the centres, which in turn depends constantly on the physical and chemical properties of the blood (automatic stimulation of centres) and on the interaction of reflexes.

Last of all, it is sometimes held that whereas reflexes determine only the activities of single organs and tissues, instincts involve the activity of the organism as a whole. We now know, however, from the recent investigations of Magnus and de Kleijn, that standing, walking and the maintenance of postural balance in general, are all nothing but reflexes.

It follows from all this that instincts and reflexes are alike the inevitable responses of the organism to internal and external stimuli, and therefore we have no need to call them by two different terms. Reflex has the better claim of the two, in that it has been used from the very beginning with a strictly scientific connotation.

The aggregate of reflexes constitutes the foundation of the nervous activities both of men and of animals. It is therefore of great importance to study in detail all the fundamental reflexes of the organism. Up to the present, unfortunately, this is far from being accomplished, especially, as I have mentioned before, in the case of those reflexes

which have been known vaguely as "instincts." Our knowledge of these latter is very limited and fragmentary. Their classification under such headings as "alimentary," "defensive," "sexual," "parental" and "social" instincts, is thoroughly inadequate. Under each of these heads is assembled often a large number of individual reflexes. Some of these are quite unidentified; some are confused with others; and many are still only partially appreciated. I can demonstrate from my own experience to what extent the subject remains inchoate and full of gaps. In the course of the researches which I shall presently explain, we were completely at a loss on one occasion to find any cause for the peculiar behaviour of an animal. It was evidently a very tractable dog, which soon became very friendly with us. We started off with a very simple experiment. The dog was placed in a stand with loose loops round its legs, but so as to be quite comfortable and free to move a pace or two. Nothing more was done except to present the animal repeatedly with food at intervals of some minutes. It stood quietly enough at first, and ate quite readily, but as time went on it became excited and struggled to get out of the stand, scratching at the floor, gnawing the supports, and so on. This ceaseless muscular exertion was accompanied by breathlessness and continuous salivation, which persisted at every experiment during several weeks, the animal getting worse and worse until it was no longer fitted for our researches. For a long time we remained puzzled over the unusual behaviour of this animal. We tried out experimentally numerous possible interpretations, but though we had had long experience with a great number of dogs in our laboratories we could not work out a satisfactory solution of the strange behavious, until it occurred to us at last that it might be the expression of a special freedom reflex, and that the dog simply could not remain quiet when it was constrained in the stand. This reflex was overcome by setting off another against it --the reflex for food. We began to give the dog the whole of its food in the stand. At first the animal ate but little, and lost considerably in weight, but gradually it got to eat more, until at last the whole ration was consumed. At the same time the animal grew quieter during the course of the experiments: the freedom reflex was being inhibited. It is clear that the freedom reflex is one of the most important reflexes, or, if we use a more general term, reactions, of living beings. This reflex has even yet to find its final recognition. In James's writings it is not even enumerated among the special human "instincts." But it is clear that if the animal were not provided with a reflex of protest against boundaries set to its freedom, the smallest obstacle in its path would interfere with the proper fulfilment of its natural functions. Some animals as we all know have this freedom reflex to such a degree that when placed in captivity they refuse all food, sicken and die.

As another example of a reflex which is very much neglected we may refer to what may be called the investigatory reflex. I call it the "What-is-it?" reflex. It is this reflex which brings about the immediate response in man and animals to the slightest changes in the world around them, so that they immediately orientate their appropriate receptor organ in accordance with the perceptible quality in the agent bringing about the change, making full investigation of it. This biological significance of this reflex is obvious. If the animal were not provided with such a reflex its life would hang at every moment by a thread. In man this reflex has been greatly developed with far-

reaching results, being represented in its highest form by inquisitiveness--the parent of that scientific method through which we may hope one day to come to a true orientation in knowledge of the world around us.

Still less has been done towards the elucidation of the class of negative or inhibitory reflexes (instincts) which are often evoked by any strong stimulus or even by weak stimuli, if unusual. Animal hypnotism, so-called, belongs to this category.

As fundamental nervous reactions both of men and of animals are inborn in the form of definite reflexes, I must again emphasize how important it is to compile a complete list comprising all these reflexes with their adequate classification. For, as will be shown later on, all the remaining nervous functions of the animal organism are based upon these reflexes. Now, although the possession of such reflexes as those just described constitutes the fundamental condition for the natural survival of the animal, they are not in themselves sufficient to ensure a prolonged, stable and normal existence. This can be shown in dogs in which the cerebral hemispheres have been removed. Leaving out of account the internal reflexes, such a dog still retains the fundamental external reflexes. It is attracted by food; it is repelled by nocuous stimuli; it exhibits the investigatory reflex, raising its head and pricking up its ears to sound. In addition it exhibits the freedom reflex, offering a powerful resistance to any restraint. Nevertheless it is wholly incapable of looking after itself, and if left to itself will very soon die. Evidently something important is missing in its present nervous make-up. What nervous activities can it have lost? It is easily seen that, in this dog, the number of stimuli evoking reflex reaction is considerably diminished; those remaining are of an elemental, generalized nature, and act at a very short range. Consequently the dynamic equilibrium between the inner forces of the animal system and the external forces in its environment has become elemental as compared with the exquisite adaptability of the normal animal, and the simpler balance is obviously inadequate to life.

Let us return now to the simplest reflex from which our investigations started. If food or some rejectable substance finds its way into the mouth, a secretaion of saliva is produced. The purpose of this secretaion is in the case of food to alter it chemically, in the case of a rejectable substance to dilute and wash it out of the mouth. This is an example of a reflex due to the physical and chemical properties of a substance when it comes into contact with the mucous membrane of the mouth or tongue. But, in addition to this, a similar reflex secretion is evoked when these substances are placed at a distance from the dog and the receptor organs affected are only those of smell and sight. Even the vessel from which the food has been given is sufficient to evoke an alimentary reflex complete in all its details; and, further, the secretion may be provoked even by the sight of the person who brought the vessel, or by the sound of his footsteps. All these innumerable stimuli falling upon the several finely discriminating distance receptors lose their power for ever as soon as the hemispheres are taken from the animal, and those only which have a direct effect on mouth and tongue still retain their power. The great advantage to the organism of a capacity to react to the former stimuli is evident, for it is in virtue of their

action that food finding its way into the mouth immediately encounters plenty of moistening saliva, and rejectable substances, often nocuous to the mucous membrane, find a layer of protective saliva already in the mouth which rapidly dilutes and washes them out. Even greater is their importance when they evoke the motor component of the complex reflex of nutrition, i.e., when they act as stimuli to the reflex of seeking food.

Here is another example--the reflex of self-defence. The strong carnivorous animal preys on weaker animals, and these if they waited to defend themselves until the teeth of the foe were in their flesh would speedily be exterminated. The case takes on a different aspect when the defence reflex is called into play by the sights and sounds of the enemy's approach. Then the prey has a chance to save itself by hiding or by flight.

How can we describe, in general, this difference in the dynamic balance of life between the normal and the decorticated animal? What is the general mechanism and law of this distinction? It is pretty evident that under natural conditions the normal animal must respond not only to stimuli which themselves bring immediate benefit or harm, but also to other physical or chemical agencies--waves or sound, light, and the like --which in themselves only signal the approach of these stimuli; though it is not the sight and sound of the beast of prey which is in itself harmful to the smaller animal, but its teeth and claws.

Now although the signalling stimuli do play a part in those comparatively simple reflexes we have given as examples, yet this is not the most important point. The essential feature of the highest activity of the central nervous system, with which we are concerned and which in the higher animals most probably belongs entirely to the hemispheres, consists not in the fact that innumerable signalling stimuli do initiate reflex reactions in the animal, but in the fact that under different conditions these same stimuli may initiate quite different reflex reactions; and conversely the same reaction may be initiated by different stimuli.

In the above-mentioned example of the salivary reflex, the signal at one time is one particular vessel, at another time another; under certain conditions one man, under different conditions another--strictly depending upon which vessel had been used in feeding and which man had brought the vessel and given food to the dog. This evidently makes the machine-like responsive activities of the organism still more precise, and adds to it qualities of yet higher perfection. So infinitely complex, so continuously in flux, are the conditions in the world around, that that complex animal system which is itself in living flux, and that system only, has a chance to establish dynamic equilibrium with the environment. Thus we see that the fundamental and the most general function of the hemispheres is that of reacting to signals presented by innumerable stimuli of interchangeable signification.

Study Guide for UNIT 9

George John Romanes 1848-1894); Conwy Lloyd Morgan (1852-1936)

We have already approached modern psychology by way of two intellectual streams, each stemming from Descartes. One was by way of British empiricism and German physiology; the other was through reflex physiology, From Marshall Hall to Sherrington and Pavlov. The present approach is via Darwinism. Although we do not deal with Darwin himself, or his statement of mental evolution, we do consider two of the most illustrious of his followers, George Romanes and C. Lloyd Morgan, who tried to clarify the reasons for assuming mind in animals (which Descartes had denied). Curiously, in so doing, they paved the way for a psychology that had no place for mind at all.

Study Questions

1. What two "different things" does Romanes mean by "Mind?" What two kinds of "cognizance" and analysis?

2. What kind of activity suggests the presence of consciousness and choice in other organisms?

3. What is the difference between "adaptive movements due to reflex actions" and those due to "mental perceptions?"

4. What is Romanes's criterion of mind? What qualifications does he suggest in the application of this criterion? (Do you think that Romanes would accept conditioning as a criterion? Would Titchener agree with Romanes?)

5. What does Romanes have to say about mental states at different phylogenetic levels? (Do you think that this leads him beyond the restrictions he has already imposed upon his basic criterion?)

6. Can you explain Lloyd Morgan's "doubly inductive process?" What are the steps involved? Did Romanes have the same point of view?

7. What is Morgan's "basal principle" or canon of interpretation? How does Morgan answer the three objections to this canon?

8. What are the three methods of gauging "psychical level" in an animal? Which does Morgan prefer, and why? Which is the least anthropomorphic? Which seems to call for the evolution of higher faculties?

GEORGE JOHN ROMANES ON COMPARATIVE PSYCHOLOGY, 1882

G. J. Romanes, Animal Intelligence (London, 1882), pp. 1-10.

Before we begin to consider the phenomena of mind throughout the animal kingdom it is desirable that we should understand, as far as possible, what it is that we exactly mean by mind. Now, by mind we may mean two very different things, according as we contemplate it in our own individual selves, or in other organisms. For if we contemplate our own mind, we have an immediate cognizance of a certain flow of thoughts or feelings, which are the most ultimate things, and indeed the only things, of which we are cognisant. But if we contemplate mind in other persons or organisms, we have no such immediate cognizance of thoughts or feelings. In such cases we can only infer the existence and the nature of thoughts and feelings from the activities of the organisms which appear to exhibit them. Thus it is that we may have a subjective analysis of mind and an objective analysis of mind--the difference between the two consisting in this, that in our subjective analysis we are restricted to the limits of a single isolated mind which we call our own, and within the territory of which we have immediate cognizance of all the processes that are going on, or at any rate of all the processes that fall within the scope of our introspection. But in our objective analysis of other or foreign minds we have no such immediate cognizance; all our knowledge of their operations is derived, as it were, through the medium of ambassadors--these ambassadors being the activities of the organism. Hence it is evident that in our study of animal intelligence we are wholy restricted to the objective method. Starting from what I know subjectively of the operations of my own individual mind, and the activities which in my own organism they prompt, I proceed by analogy to infer from the observable activities of other organisms what are the mental operations that underlie them.

Now, in this mode of procedure what is the kind of activities which may be regarded as indicative of mind? I certainly do not so regard the flowing of a river or the blowing of the wind. Why? First, because the objects are too remote in kind from my own organism to admit of my drawing any reasonable analogy between them and it; and, secondly, because the activities which they present are of invariably the same kind under the same circumstances; they afford no evidence of feeling or purpose. In other words, two conditions require to be satisfied before we even begin to imagine that observable activities are indicative of mind: first, the activities must be displayed by a living organism; and secondly, they must be of a kind to suggest the presence of two elements which we recognise as the distinctive characteristics of mind as such--consciousness and choice.

So far, then the case seems simple enough. Wherever we see a living organism apparently exerting intentional choice, we might infer that it is conscious choice, and therefore that the organism has a mind. But further reflection shows us that this is just what we cannot do; for although it is true that there is no mind without the power of conscious choice, it is not true that all apparent choice is

due to mind. In our own organisms, for instance, we find a great many adaptive movements performed without choice or even consciousness coming into play at all--such, for instance, as in the beating of our hearts. And not only so, but physiological experiments and pathological lesions prove that in our own and in other organisms the mechanism of the nervous system is sufficient, without the intervention of consciousness, to produce muscular movements of a highly co-ordinate and apparently intentional character. Thus, for instance, if a man has his back broken in such a way as to sever the nervous connection between his brain and lower extremities, on pinching or tickling his feet they are drawn suddenly away from the irritation, although the man is quite unconscious of the adaptive movement of his muscles; the lower nerve-centres of the spinal cord are competent to bring about this movement of adaptive response without requiring to be directed by the brain. This non-mental operation of the lower nerve-centres in the production of apparently intentional movements is called Reflex Action, and the cases of its occurrence, even within the limits of our own organism, are literally numberless. Therefore, in view of such non-mental nervous adjustment, leading to movements which are only in appearance intentional, it clearly becomes a matter of great difficulty to say in the case of the lower animals whether any action which appears to indicate intelligent choice is not really action of the reflex kind.

On this whole subject of mind-like and yet not truly mental action I shall have much to say in my subsequent treatise, where I shall be concerned among other things with tracing the probable genesis of mind from non-mental antecedents. But here it is sufficient merely to make this general statement of the fact, that even within the experience supplied by our own organisms adaptive movements of a highly complex and therefore apparently purposive character may be performed without any real purpose, or even consciousness of their performance. It thus becomes evident that before we can predicate the bare existence of mind in the lower animals, we need some yet more definite criterion of mind than that which is supplied by the adaptive actions of a living organism, howsoever apparently intentional such actions may be. Such a criterion I have now to lay down, and I think it is one that is as practically adequate as it is theoretically legitimate.

Objectively considered, the only distinction between adaptive movements due to reflex action and adaptive movements due to mental perception, consists in the former depending on inherited mechanisms within the nervous system being so constructed as to effect <u>particular</u> adaptive movements in response to <u>particular</u> stimulations, while the latter are independent of any such inherited adjustment of special mechanisms to the exigencies of special circumstances. Reflex actions under the influence of their appropriate stimuli may be compared to the actions of a machine under the manipulations of an operator; when certain springs of action are touched by certain stimuli, the whole machine is thrown into appropriate movement; there is no room for choice, there is no room for uncertainty; but as surely as any of these inherited mechanisms are affected by the stimulus with reference to which it has been constructed to act, so surely will it act in precisely the same way as it always has acted. But the case with conscious mental adjustment is quite different. For, without at present going into the

question concerning the relation of body and mind, or waiting to ask whether cases of mental adjustment are not really quite as mechanical in the sense of being the necessary result or correlative of a chain of physical sequences due to a physical stimulation, it is enough to point to the variable and incalculable character of mental adjustments. All, in fact, that in an objective sense we can mean by a mental adjustment is an adjustment of a kind that has not been definitely fixed by heredity as the only adjustment possible in the given circumstances of stimulation. For were there no alternative of adjustment, the case, in an animal at least, would be indistinguishable from one of reflex action.

It is, then, adaptive action by a living organism in cases where the inherited machinery of the nervous system does not furnish data for our prevision of what the adaptive action must necessarily be--it is only here that we recognise the objective evidence of mind. The criterion of mind, therefore, which I propose, and to which I shall adhere throughout the present volume, is as follows:--Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience? If it does so, the fact cannot be due merely to reflex action in the sense above described, for it is impossible that heredity can have provided in advance for innovations upon, or alterations of, its machinery during the lifetime of a particular individual.

...I may here explain that in my use of this criterion I shall always regard it as fixing only the upper limit of non-mental action; I shall never regard it as fixing the lower limit of mental action. For it is clear that long before mind has advanced sufficiently far in the scale of development to become amenable to the test in question, it had probably begun to dawn as nascent subjectivity. In other words, because a lowly organised animal does not learn by its own individual experience, we may not therefore conclude that in performing its natural or ancestral adaptations to appropriate stimuli consciousness, or the mind-element, is wholly absent; we can only say that this element, if present, reveals no evidence of the fact. But, on the other hand, if a lowly organised animal does learn by its own individual experience, we are in possession of the best available evidence of conscious memory leading to intentional adaptation. Therefore our criterion applies to the upper limit of non-mental action, not to the lower limit of mental.

Of course to the sceptic this criterion may appear unsatisfactory, since it depends, not on direct knowledge, but on inference. Here, however, it seems enough to point out, as already observed, that it is the best criterion available; and further, that scepticism of this kind is logically bound to deny evidence of mind, not only in the case of the lower animals, but also in that of the higher, and even in that of men other than the sceptic himself. For all objections which could apply to the use of this criterion of mind in the animal kingdom would apply with equal force to the evidence of any mind other than that of the individual objector. This is obvious, because, as I have already observed, the only evidence we can have of objective mind is that which is furnished by objective activities; and as the subjective mind can never become assimilated with the objective so as to learn by direct

feeling the mental processes which there accompany the objective activities, it is clearly impossible to satisfy any one who may choose to doubt the validity of inference, that in any case other than his own mental processes ever do accompany objective activities. Thus it is that philosophy can supply no demonstrative refutation of idealism, even of the most extravagant form. Common sense, however, universally feels that analogy is here a safer guide to truth than the sceptical demand for impossible evidence; so that if the objective existence of other organisms and their activities is granted--without which postulate comparative psychology, like all other sciences, would be an unsubstantial dream--common sense will always and without question conclude that the activities of organisms other than our own, when analogous to those activities of our own which we know to be accompanied by certain mental states, are in them accompanied by analogous mental states.

The theory of animal automatism, therefore, which is usually attributed to Descartes (although it is not quite clear how far this great philosopher really entertained the theory), can never be accepted by common sense; and even as a philosophical speculation it will be seen, from what has just been said, that by no feat of logic is it possible to make the theory apply to animals to the exclusion of man. The expression of fear or affection by a dog involves quite as distinctive and complex a series of neuro-muscular actions as does the expression of similar emotions by a human being; and therefore, if the evidence of corresponding mental states is held to be inadequate in the one case, it must in consistency be held similarly inadequate in the other. And likewise, of course, with all other exhibitions of mental life.

It is quite true, however, that since the days of Descartes--or rather, we might say, since the days of Joule--the question of animal automatism has assumed a new or more defined aspect, seeing that it now runs straight into the most profound and insoluble problem that has ever been presented to human thought--viz. the relation of body to mind in view of the doctrine of the conservation of energy. . . Here I desire only to make it plain that the mind of animals must be placed in the same category, with reference to this problem, as the mind of man; and that we cannot without gross inconsistency ignore or question the evidence of mind in the former, while we accept precisely the same kind of evidence as sufficient proof of mind in the latter.

And this proof, as I have endeavoured to show, is in all cases and in its last analysis the fact of a living organism showing itself able to learn by its own individual experience. Wherever we find an animal able to do this, we have the same right to predicate mind as existing in such an animal that we have to predicate it as existing in any human being other than ourselves. For instance, a dog has always been accustomed to eat a piece of meat when his organism requires nourishment, and when his olfactory nerves respond to the particular stimulus occasioned by the proximity of the food. So far, it may be said, there is no evidence of mind; the whole series of events comprised in the stimulations and muscular movements may be due to reflex action alone. But now suppose that by a number of lessons the dog has been taught not to eat the meat when he is hungry until he receives a certain verbal signal: then we have exactly the same kind of evidence

that the dog's actions are prompted by mind as we have that the actions of a man are so prompted. Now we find that the lower down we go in the animal kingdom, the more we observe reflex action, or non-mental adjustment, to predominate over volitional action, or mental adjustment. That is to say, the lower down we go in the animal kingdom, the less capacity do we find for changing adjustive movements in correspondence with changed conditions; it becomes more and more hopeless to <u>teach</u> animals--that is, to establish association of ideas; and the reason of this, of course is that ideas or mental units become fewer and less definite the lower we descend through the structure of mind.

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The terms sensation, perception, emotion, and volition need not here be considered. I shall use them in their ordinary psychological significations; and although I shall subsequently have to analyse each of the organic or mental states which they respectively denote, there will be no occasion in the present volume to enter upon this subject. I may, however, point out one general consideration to which I shall throughout adhere. Taking it for granted that the external indications of mental processes which we observe in animals are trustworthy, so that we are justified in inferring particular mental states from particular bodily actions, it follows that in consistency we must everywhere apply the same criteria.

For instance, if we find a dog or a monkey exhibiting marked expressions of affection, sympathy, jealousy, rage, &c., few persons are sceptical enough to doubt that the complete analogy which these expressions afford with those which are manifested by man, sufficiently prove the existence of mental states analogous to those in man of which these expressions are the outward and visible signs. But when we find an ant or a bee apparently exhibiting by its actions these same emotions, few persons are sufficiently non-sceptical not to doubt whether the outward and visible signs are here trustworthy as evidence of analogous or corresponding inward and mental states. The whole organisation of such a creature is so different from that of a man that it becomes questionable how far analogy drawn from the activities of the insect is a safe guide to the inferring of mental states--particularly in view of the fact that in many respects, such as in the great preponderance of 'instinct' over 'reason,' the psychology of an insect is demonstrably a widely different thing from that of a man. Now it is, of course, perfectly true that the less the resemblance the less is the value of any analogy built upon the resemblance, and therefore that the inference of an ant or a bee feeling sympathy or rage is not so valid as is the similar inference in the case of a dog or a monkey. Still it <u>is</u> an inference, and, so far as it goes, a valid one--being, in fact, the only inference available. That is to say, if we observe an ant or a bee apparently exhibiting sympathy or rage, we must either conclude that some psychological state resembling that of sympathy or rage is present, or else refuse to think about the subject at all; from the observable facts there is no other inference open. Therefore, having full regard to the progressive weakening of the analogy from human to brute psychology as we recede through the animal kingdom downwards from man, still, as it is the only analogy available, I shall follow it throughout the animal series.

It may not, however, be superfluous to point out that if we have full regard to this progressive weakening of the analogy, we must feel less and less certain of the real similarity of the mental states compared; so that when we get down as low as the insects, I think the most we can confidently assert is that the known facts of human psychology furnish the best available pattern of the probable facts of insect psychology. Just as the theologians tell us--and logically enough--that if there is a Divine Mind, the best, and indeed only, conception we can form of it is that which is formed on the analogy, however imperfect, supplied by the human mind; so with 'inverted anthropomorphism' we must apply a similar consideration with a similar conclusion to the animal mind. The mental states of an insect may be widely different from those of a man, and yet most probably the nearest conception that we can form of their true nature is that which we form by assimilating them to the pattern of the only mental states with which we are actually acquainted. And this consideration, it is needless to point out, has a special validity to the evolutionist, inasmuch as upon his theory there must be a psychological, no less than a physiological, continuity extending throughout the length and breadth of the animal kingdom.

CONWY LLOYD MORGAN ON LLOYD MORGAN'S CANON, 1894

C. Lloyd Morgan, An Introduction to Comparative Psychology (London, 1894), pp. 47-59.

We are now in a position to see clearly what is the distinctive peculiarity of the study of mind in beings other than our own individual selves. Its conclusions are reached not by a singly inductive process, as in Chemistry or Physics, in Astronomy, Geology, Biology, or other purely objective science, but by a double inductive process. Inductions reached through the objective study of certain physical manifestations have to be interpreted in terms of inductions reached through the introspective study of mental processes. By induction I mean the observation of facts, the framing of hypotheses to comprise the facts, and the verification of the hypotheses by constant reversion to the touchstone of fact. Our conclusions concerning the mental processes of beings other than our own individual selves are, I repeat, based on a two-fold induction. First the psychologist has to reach, through induction, the laws of mind as revealed to him in his own conscious experience. Here the facts to be studied are facts of consciousness, known at first-hand to him alone among mortals; the hypotheses may logically suggest themselves, in which case they are original so far as the observer himself is concerned, or they may be derived,--that is to say, suggested to the observer by other observers; the verification of the hypotheses is again purely subjective, original or derived theories being submitted to the touchstone of individual experience. This is the one inductive process. The other is more objective. The facts to be observed are external phenomena, physical occurrences in the objective world; the hypotheses again may be either original or derived; the verification is objective, original or derived theories being submitted to the touchstone of observable phenomena. Both inductions, subjective and objective, are necessary. Neither can be omitted without renouncing the scientific method. And then finally the objective manifestations in conduct and activity have to be interpreted in terms of subjective experience. The inductions reached by the one method have to be explained in the light of inductions reached by the other method.

I am anxious to make this matter quite clear, and I will therefore endeavour to illustrate it diagrammatically. In the first diagram (Fig. 5) the line ab represents the conduct, activities, and other objective phenomena exhibited by other beings or organisms than the individual psychologist, while cd represents the states of consciousness of which he alone has direct knowledge.

Then the diagram is intended to show how the psychologist must combine both objective induction and subjective induction, that he may reach a subjective interpretation of ab in terms of cd.

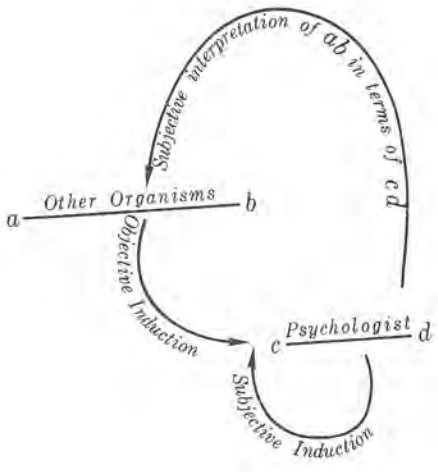

Fig. 5

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Now it is idle to assert that one set of inductions is more important than the other, since both are essential. But there can be no question that the subjective inductions are in some respect more subtle and difficult and delicate than the inductions concerning objective phenomena. There can be no question that false assumptions and vague generalizations more commonly pass muster with regard to mental processes than with regard to their physical manifestations. And there can be no question that in the systematic training of the comparative psychologist the subjective aspect is not less important than the objective aspect.

The question now arises whether in passing from human to animal psychology any other method of interpretation is possible than that which holds good for the former. Can the zoological psychologist afford to dispense with that systematic training in introspective or subjective analysis and induction which is absolutely essential for the student of human psychology? I venture to contend that he cannot. The scheme of interpretation exhibited diagrammatically in Fig. 5 holds good I maintain as well for animal psychology as for the psychology of man.

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Unfortunately, many able men who are eminently fitted to make and record exact observations on the habits and activities of animals have not undergone the training necessary to enable them to deal with the psychological aspect of the question. The skilled naturalist or biologist is seldom also skilled in psychological analysis. Notwithstanding therefore the admirable and invaluable observations of our great naturalists, we cannot help feeling that their psychological conclusions are hardly on the same level as that reached by their conclusions in

the purely biological field.

For in the study of animal psychology as a branch of scientific inquiry, it is necessary that accurate observation, and a sound knowledge of the biological relationships of animals, should go hand in hand with a thorough appreciation of the methods and results of modern psychology. The only fruitful method of procedure is the interpretation of facts observed with due care in the light of sound psychological principles.

What some of these principles are we have considered, or shall consider, in this work. There is one basal principle, however, the brief exposition of which may fitly bring to a close this chapter. It may be thus stated:--In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale.

To this principle several objections, none of them however of any real weight, may be raised. First there is the sentimental objection that it is ungenerous to the animal. In dealing with one's fellow-man it is ungenerous to impute to him lower motives for his actions when they may have been dictated by higher motives. Why should we adopt a different course with the poor dumb animal from that which we should adopt with our human neighbour? In the first place, it may be replied, this objection starts by assuming the very point to be proved. The scientific problem is to ascertain the limits of animal psychology. To assume that a given action may be the outcome of the exercise of either a higher or a lower faculty, and that it is more generous to adopt the former alternative, is to assume the existence of the higher faculty, which has to be proved. In the case of our neighbours we have good grounds for knowing that such and such a deed may have been dictated by either a higher or a lower motive. If we had equally good grounds for knowing that the animal was possessed of both higher and lower faculties, the scientific problem would have been solved; and the attribution of the one or the other, in any particular case, would be a purely individual matter of comparatively little general moment. In the second place, this generosity, though eminently desirable in the relations of practical social life, is not precisely the attitude which a critical scientific inquiry demands. Moreover, an ungenerous interpretation of one's neighbour's actions may lead one to express an unjust estimate of his moral character and thus to do him grave social wrong; but an ungenerous interpretation of the faculties of animals can hardly be said to be open to like practical consequences.

A second objection is, that by adopting the principle in question we may be shutting our eyes to the simplest explanation of the phenomena. Is it not simpler to explain the higher activities of animals as the direct outcome of reason or intellectual thought, than to explain them as the complex results of mere intelligence of practical sense-experience? Undoubtedly it may in many cases seem simpler. It is the apparent simplicity of the explanation that leads many people naively to adopt it. But surely the simplicity of an explanation is no necessary criterion of its truth. The explanation of the genesis of the organic world by direct creative fiat, is far simpler than the

explanation of its genesis through the indirect method of evolution. The explanation of instinct and early phases of intelligence as due to inherited habit, individually acquired, is undoubtedly simpler than the explanation which Dr. Weismann would substitute for it. The formation of the cañon of the Colorado by a sudden rift in the earth's crust, similar to those which opened during the Calabrian earthquakes, is simpler than its formation by the fretting of the stream during long ages under varying meteorological conditions. In these cases and in many others the simplest explanation is not the one accepted by science. Moreover, the simplicity of the explanation of the phenomena of animal activity as the result of intellectual processes, can only be adopted on the assumption of a correlative complexity in the mental nature of the animal as agent. And to assume this complexity of mental nature on grounds other than those of sound induction, is to depart from the methods of scientific procedure.

But what, it may be asked, is the logical basis upon which this principle is founded? If it be true that the animal mind can only be interpreted in the light of our knowledge of human mind, why should we not use this method of interpretation freely, frankly, and fully? Is there not some contradiction in refusing to do so? For, first, it is contended that we must use the human mind as a key by which to read the brute mind, and then it is contended that this key must be applied with a difference. If we apply the key at all, should we not apply it without reservation?

This criticism might be valid if we were considering the question apart from evolution. Here evolution is postulated. The problem is this: (1) Given a number of divergently ascending grades of organisms, with divergently increasing complexity of organic structure and correlated activities: (2) granted that associated with the increasing organic complexity there is increasing mental or psychical complexity: (3) granted that in man the organic complexity, the complexity of correlated activities, and the associated mental or psychical complexity, has reached the maximum as yet attained: (4) to gauge the psychical level to which any organism has been evolved. As we have already seen, we are forced, as men, to gauge the psychical level of the animal in terms of the only mind of which we have first-hand knowledge, namely the human mind. But how are we to apply the gauge?

There would appear to be three possible methods, which are exemplified in Fig. 6. Let a represent the psychical stature of man, and 1, 2, 3, ascending faculties or stadia in mental development. Let bc represent two animals the psychical stature of each of which is to be gauged. It may be gauged first by the "method of levels," according to which the faculties or stadia are of constant value. In the diagram, b has not quite reached the level of the beginning of the third or highest faculty, while c has only just entered upon the second stadium. Secondly, it may be gauged by the "method of uniform reduction." In both b and c we have all three faculties represented in the same ratio as in a, but all uniformly reduced. And thirdly, it may be gauged by the "method of variation," according to which any one of the faculties 1, 2, or 3, may in b and c be either increased or reduced relatively to its development in a. Let us suppose, for

example, that b represents the psychical stature of the dog. Then, according to the interpretation on the method of levels, he possesses the lowest faculty (1) in the same degree as man; in the faculty (2) he somewhat falls short of man; while in the highest faculty (3) he is altogether wanting. According to the interpretation on the mothod of uniform reduction he possesses all the faculties of man but in a reduced degree. And according to the interpretation on the method of variation he excels man in the lowest faculty, while the other two faculties are both reduced but in different degrees. The three "faculties" 1, 2, 3, are not here intended to serve any other purpose than merely to illustrate the three methods of interpretation.

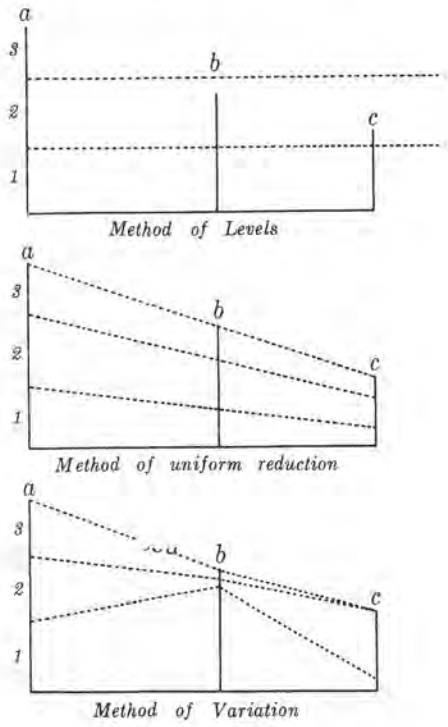

Fig. 6

On the principles of evolution we should unquestionably expect that those mental faculties which could give decisive advantage in the struggle for existence would be developed in strict accordance with the divergent conditions of life. Hence it is the third method, which I have termed the method of variation, which we should expect a priora to accord most nearly with observed facts. And so far as we can judge from objective observation (the only observation open to us) this would appear to be the case. Presumably there are few observers of animal habit and intelligence who would hesitate in adopting the method of variation as the most probably mode of interpretation. But note that while it is the most probable it is also the most difficult mode of interpretation. According to the method of levels the dog is just like me, without my higher faculties. According to the method of uniform

reduction he is just like me, only nowise so highly developed. But according to the method of variation there are many possibilities of error in estimating the amount of such variation. Of the three methods that of variation is the least anthropomorphic, and therefore the most difficult.

In the diagram by which the method of variation is illustrated, the highest faculty 3 is in c reduced to zero,--in other words, is absent. It may, however, be objected that this is contrary to the principles of evolution, since the presence of any faculty in higher types involves the germ of this faculty in lower types. This criticism only holds good, however, on the assumption that the evolution of higher faculties out of lower faculties is impossible. Those evolutionists who accept this assumption as valid are logically bound to believe either (1) that all forms of animal life from the amoeba upwards have all the faculties of man, only reduced in degree and range, and to interpret all animal psychology on a method of reduction (though not necessarily uniform reduction), or (2) that in the higher forms of life the introduction of the higher faculties has been effected by some means other than that of natural evolution. I am not prepared to accept the assumption as valid; and it will be part of my task in future chapters to consider how the transition from certain lower to certain higher phases of mental development may have been effected.

If this be so it is clear that any animal may be at a stage where certain higher faculties have not yet been evolved from their lower precursors; and hence we are logically bound not to assume the existence of these higher faculties until good reasons shall have been shown for such existence. In other words, we are bound to accept the principle above enunciated: that in no case is an animal activity to be interpreted as the outcome of the exercise of a higher psychical faculty, if it can be fairly interpreted as the outcome of the exercise of one which stands lower in the psychological scale.

Study Guide for UNIT 10

Jacques Loeb (1859-1924); Herbert Spencer Jennings (1868-1947)

Animal conduct is known to many through the romantic tales of popularizers, through the descriptive work of biological observers, or through the attempts of vitalists to show the inadequacy of physical laws for the explanation of life. Since none of these contributions are based upon quantitative experiments, they have led only to speculations, which are generally of an anthropomorphic or of a purely verbalistic character.

(From the Author's Preface to Loeb's Forced Movements, Tropisms, and Animal Conduct, 1918.)

Study Questions

1. What does Loeb mean by "associative memory?" With whose earlier teachings on this point do Loeb's resemble most closely?

2. What does Loeb have to say about Ernst Mach's conception of "self?" What determines this conception?

3. What are Loeb's three processes in "volition?" What would Hemholtz have found of interest in this view?

4. What would Loeb say about the mind-body relation?

5. What is the difference between "memory" as found in plants and moths and as found when Loeb speaks of "associative memory?"

6. A dog comes when its name is called. What would Loeb conclude from this observation?

7. Is "associative memory" mental or physiological?

Assertions regarding consciousness in animals, whether affirmative or negative, are not susceptible of verification. This does not deprive the subject of consciousness of its interest, but renders it expedient to separate carefully this matter from those which can be controlled by observation and experiment. For those primarily in the conscious aspects of behavior, a presentation of the objective facts is a necessary preliminary to an intelligent discussion of the matter.

(From the Preface to Jennings's Behavior of the Lower Organisms, 1923)

Study Questions

8. What did Jennings think about the dangers of 'reasoning by analogy' as a way of knowing about the consciousness of other organisms?

9. On what objective phenomena do we commonly depend, according to Jennings, when we judge that an animal has 'perception,' 'discrimination,' and 'choice?'

10. What does 'attention; amount to in higher animals? Do lower animals show it? What is the basic requirement?

11. Even though the stimuli are the same, says Jennings, organisms may behave differently. What is his explanation? Can you give examples of such behavior?

12. What are the accompaniments of pleasure, pain, fear, and hope, according to Jennings/ Essentially what are Jennings's "representative" stimuli?

13. What is memory or habit in higher animals, for Jennings, and how are they related to the resolution of physiological states?

14. What is Jennings's difference between "memory" and "associative memory?"

15. What suggests "intelligence," and how low in the animal scale is it to be found?

16. How is "differentiation" related to the animal scale?

17. Are there objective phenomena that suggest consciousness in lower organisms? Can its existence be proved?

18. What can one say about the consciousness of <u>paramecium</u> and <u>amoeba</u>?

From the two excerpts above, from Loeb and Jennings, what would you think would be the next logical step for students of psychology to take?

JACQUES LOEB ON ASSOCIATIVE MEMORY, 1899

Jacques Loeb, Einleitung in die vergleichende Gehirnphysiologie und vergleichende Psychologie mit besonderer Berücksichtigung der wirbellosen Thiere (Leipzig, 1899), chap. 15. The English translation, Comparative Physiology of the Brain and Comparative Psychology (New York: Putnam, 1900), was made by Anne Leonard Loeb and incorporated extensive changes by the author.

1. The most important problem in the physiology of the central nervous system is the analysis of the mechanisms which give rise to the so-called psychic phenomena. The latter appear, invariably, as a function of an elementary process, namely, the activity of the associative memory. By associative memory I mean the two following peculiarities of our central nervous system: First, that processes which occur there leave an impression or trace by which they can be reproduced even under different circumstances than those under which they originated. This peculiarity can be imitated by machines like the phonograph. Of course, we have no right to assume that the traces of processes in the central nervous system are analogous to those in the phonograph. The second peculiarity is, that two processes which occur simultaneously or in quick succession will leave traces which fuse together, so that if later one of the processes is repeated, the other will necessarily be repeated also. The odour of a rose will at the same time reproduce its visual image in our memory, or, even more than that, it will reproduce the recollection of scenes or persons who were present when the same odour made its first strong impression on us. By associative memory we mean, therefore, that mechanism by means of which a stimulus produces not only the effects which correspond to its nature and the specific structure of the stimulated organ, but which produces, in addition, such effects of other causes as at some former time may have attacked the organism almost or quite simultaneously with the given stimulus . . . The chief problem of the physiology of the brain is, then, evidently this: What is the physical character of the mechanism of associative memory? As we said. . . the answer to this question will probably be found in the field of physical chemistry.

I think it can be shown that what the metaphysician calls consciousness are phenomena determined by the mechanism of associative memory. Mach has pointed out that the consciousness of self or the ego is simply a phrase for the fact that certain constituents of memory are constantly or more frequently produced than others. . . The complex of these elements of memory is the "ego" or the "soul," or the personality of the metaphysicians. To a certain extent we are able so far as it lies in the field of vision, certain sensations of touch which are repeated very frequently, the sound of our own voice, certain interests and cares, a certain feeling of comfort or discomfort according to temperament or state of health, etc. . .

An inventory of all the memory-constituents of the ego-complex of different persons would show that the consciousness of self is not a definite unit, but, as Mach maintains, merely an artificial separation

of those constituents of memory which occur most frequently in our perceptions. These will necessarily be subject to considerable variations in the same person in the different periods of life.

If we speak of loss or an interruption of consciousness, we mean a loss or an interruption of the activity of associative memory. If a faint is caused directly by lack of oxygen or indirectly by a disturbance in the circulatory system, the activity of associative memory ceases. This was proved by Speck's experiments on the effects of low pressure of oxygen. When he breathed air with less than eight per cent. of oxygen, he soon fainted. In these experiments, he had to count the number of respirations. Before he fainted, he became confused in his counting and forgot what happened. When this disturbance in counting began to appear, he knew it was time to discontinue the experiment. When a loss of consciousness is produced by narcotics or anaesthetics, we have again to deal with an interruption in the activity of the associative memory. It is the same in the case of a deep sleep.

The metaphysician speaks of conscious sensations and conscious will. That the will is only a function of the mechanism of the associative memory can be proved. We speak of conscious volition if an idea of the resulting final complex of sensations is present before the movements causing it have taken place or have ceased. In volition three processes occur. The one is an innervation of some kind which may be caused directly or indirectly by an external stimulus. This process of innervation produces two kinds of effects. The <u>one</u> effect is the activity of the associative memory which produces the sensations that in former cases accompanied or followed the same innervation. The <u>second</u> effect is a coordinated muscular activity. It happens that in such cases the reaction-time for the memory-effect of the innervation is shorter than the time for the muscular effect. When some internal process causes us to open the window, the activity of the associative memory produces the idea of sensations which will follow or accompany the opening of the window sooner than the act of opening really occurs. As we do not realise this any more than we realize the inverted character of the retina-image, we consider the memory-effect of the innervation as the cause of the muscular effect. The common cause of both effects, the innervating process, escapes our immediate observation as our senses do not perceive it. The will of the metaphysicians is then clearly the outcome of an illusion due to the necessary incompleteness of self-observation. . . I think that we are justified in substituting the term activity of associative memory for the phrase consciousness used by the metaphysicians.

2. We have spoken of <u>associative</u> memory because the word <u>memory</u> is often applied in quite a different sense scientifically, namely, to signify any after-effect to external circumstances. For instance, the term memory has been used to account for the fact that a plant which had been cultivated in the tropics will often not endure low temperatures so well as a plant of the same species which was raised in the north. It is true in this case the preceding conditions influence the ability of the plant to react, but the process differs from the one which we have called associative memory in the lack of associative processes. No definite stimulus produces in a plant, in addition to its own effects, those of another entirely different stimulus which at some former time occurred simultaneously

with the given stimulus. It is probable that the tropical plant is somewhat different chemically from the plant raised in the north. This would account for its smaller power of resistance. Further illustrations of a different use of the word memory can easily be given.

Many moths sleep during the day and wake in the evening when it becomes dark. If kept for days in a dark room, they will continue at first to do the same thing. The same is true of certain plants. One might also say in this case that the moth or the plant "remembers" the difference between day and night. It is probable, however, that internal changes take place in the organism, corresponding to the periodic change of day and night, and that these changes continue for a time in the same periodicity, when the animal is kept in the dark.

3. We will then consider the extent of associative memory in the animal kingdom instead of the extent of consciousness among animals. How can we determine whether an animal possesses the mechanism necessary for associative memory? The criteria for the existence of associative memory must form the basis of a future comparative psychology. It will require more observations than we have made at present to give absolutely unequivocal criteria. For the present, we can say that if an animal can learn, that is, if it can be trained to react in a desired way upon certain stimuli (signs), it must possess associative memory. The only fault with this criterion lies in the fact that an animal may be able to remember (and to associate) and yet may not yield to our attempts to train it. In this case other experiments must be substituted which will prove that the animal does associate or remember.

We may conclude that associative memory is present when an animal responds upon hearing its name called, or when it can be trained upon hearing a certain sound to go to the place where it is usually fed. The optical stimulus of the place where the food is to be found and the sensations of hunger and satiety are not qualitatively the same, but they occur simultaneously in the animal. The fusion or growing together of heterogeneous but by chance simultaneous processes is a sure criterion for the existence of associative memory.

Associative memory probably exists in most mammals. The dog which comes when its name is called, which runs away from the whip, which welcomes its master joyfully, has associative memory. In birds, it is likewise present. The parrot learns to talk; the dove finds its way home. In lower Vertebrates, memory is also occasionally found. Tree-frogs, for example, can be trained, upon hearing a sound, to go to a certain place for food. In other frogs, Rana esculenta, for instance, no reaction is as yet known which proves the existence of associative memory. Some fishes evidently possess memory; in sharks, however, its existence is doubtful. With regard to the Invertebrates, the question is difficult to determine. The statements of enthusiasts who discover consciousness and resemblance to man on every side should not be too readily accepted.

HERBERT SPENCER JENNINGS ON THE CONTINUITY OF PSYCHOLOGICAL PROCESSES, 1906

H. S. Jennings, Behavior of the Lower Organisms (New York: Columbia University Press, 1906), chap. 20.

In describing the behavior of lower organisms we have used in the present work, so far as possible, objective terms--those having no implication of psychic or subjective qualities. We have looked at organisms as masses of matter, and have attempted to determine the laws of their movements. In ourselves we find movements and reactions resembling in some respects those of the lower organisms. We draw away from heat and cold and injurious chemicals, just as Paramecium does. Our behavior depends on physiological states, as does that of Stentor. But in ourselves there is the very interesting additional fact that these movements, reactions, and physiological states are often accompanied by subjective states,--states of consciousness. Different states of consciousness are as varied as the different possibilities of reaction; indeed, more varied. In speaking of behavior in ourselves, and as a rule in higher animals, we use terms based on these subjective states, as pleasure and pain, sensation, memory, fear, anger, reason, and the like.

The peculiarity of subjective states is that they can be perceived only by the one person directly experiencing them,--by the subject. Each of us knows directly states of consciousness only in himself. We cannot by observation and experiment detect such states in organisms outside of ourselves. But observation and experiment are the only direct means of studying behavior in the lower organisms. We can reason concerning their behavior, and through reasoning by analogy we may perhaps conclude that they also have conscious states. But reasoning by analogy, when it is afterward tested by observation and experiment, has often shown itself fallacious, so that where it cannot be tested, we must distrust its conclusiveness. Moreover, in different men it leads to different conclusions, so that it does not result in admitted certainty. Hence it seems important to keep the results of observation and experiment distinct from those of reasoning by analogy, so that we may know what is really established. On this account it is customary among most physiologists not to use, in discussing the behavior of the lower organisms, psychic terms, or those implying subjective states. This has the additional ground that the ideal of most scientific men is to explain behavior in terms of matter and energy, so that the introduction of psychic implications is considered superfluous.

While this exclusive use of objective terms has great advantages, it has one possible disadvantage. It seems to make an absolute gulf between the behavior of the lower organisms on the one hand, and that of man and higher animals on the other. From a discussion of the behavior of the lower organisms in objective terms, compared with a discussion of the behavior of man in subjective terms, we get the impression of complete discontinuity between the two.

Does such a gulf actually exist, or does it lie only in our manner of speech? We can best get evidence on this question by comparing the objective features of behavior in lower and in higher organisms. In any animal outside of man, and even in man outside of the self, the existence of perception, choice, desire, memory, emotion, intelligence, reasoning, etc., is judged from certain objective facts--certain things which the organisms do. Do we find in the lower organisms objective phenomena of a similar character, so that the same psychic names would be applied to them if found in higher organisms? Do the objective factors in the behavior of lower organisms follow laws that are similar to the laws of psychic states? Only by comparing the objective factors can we determine whether there is continuity or a gulf between the behavior of lower and higher organisms (including man), for it is only these factors that we know.

Let us then examine some of the concepts employed in discussions of the behavior of higher animals and man, determining whether there exist any corresponding phenomena in lower organisms. We shall not attempt to take into consideration the scholastic definitions of the terms used, but shall judge of them merely from the objective phenomena on which they are based.

When we say that an animal perceives something, or that it shows perception of something, we base this statement on the observation that it reacts in some way to this thing. On the same basis we could make the statement that Amoeba perceives all classes of stimuli which we ourselves perceive, save sound (which is, however, essentially one form of mechanical stimulation). Perception as judged from our subjective experiences means much more: how much of this may be present in animals outside the self we cannot know.

Discrimination is a term based, so far as objective evidence goes, upon the observed fact that organisms react differently to different stimuli. In this sense Paramecium, as we have seen, discriminates acids from alkalies; Amoeba discriminates a Euglena cyst from a grain of sand, and in general all lower organisms show discrimination in many phases of their behavior.

Choice is a term based objectively on the fact that the organism accepts or reacts positively to some things, while it rejects or reacts negatively or not at all to others. In this sense all lower organisms show choice, and at this we need not be surprised, for inorganic substances show a similar selectiveness. The distinctive thing about the choice of organisms is that it is regulatory; organisms on the whole choose those things which aid their normal life processes and reject those that do not. This is what justifies the use of the term "choice," as contrasted with the mere selectiveness of inorganic reactions. Choice in this regulatory sense is shown by lower organisms, as we have seen in detail in previous chapters. Choice is not perfect, from this point of view, in either lower or higher organisms. Paramecium at times accepts things that are useless or harmful to it, but perhaps on the whole less often than does man.

. . . . .

Is not what we call attention in higher organisms, when considered objectively, the same phenomenon that we have called the interference of one stimulus with the reaction to another? At the basis of attention lies objectively the phenomenon that the organism may react to only one stimulus even though other stimuli are present which would, if acting alone, likewise produce a response. The organism is then said to attend to the particular stimulus to which it responds. The fundamental phenomenon is clearly present in unicellular organisms. Stentor and Paramecium when reacting to contact with a solid "pay no attention" to a degree of heat or a chemical or an electric current that would produce an immediate reaction in a free individual. On the other hand, individuals reacting to heat or a chemical may not respond to contact with a mass of bacteria, to which they would under other conditions react positively. In our chapter on reaction under two or more stimuli in the infusoria, many examples of this character are given.

Indeed, attention in this objective sense seems a logical necessity for the behavior of any organism having at its command more than a single action. The characteristic responses to two present stimuli may be incompatible with each other. The organism must then react to one or the other, since it cannot react to both; it thus attends (objectively) to one, and not to the other. Only in case there is no reaction at all in the presence of two stimuli, or in case its reaction is precisely intermediate between those required by the two, could the basis of attention be considered lacking. An organism behaving in this way would be quickly destroyed as a result of its indecisive and ineffective behavior.

In higher animals and man we distinguish certain different conditions,--"states of feeling," "emotions," "appetites," "desires," and the like. In all cases except the self, these various states are distinguished through the fact that the organism behaves differently in the different conditions, even though the external stimuli may be the same. We find a parallel condition of affairs in the lower organisms. Here, as we have seen, the behavior under given external conditions depends largely on the physiological condition of the individual. Many illustrations of this fact are given in preceding chapters, so that we need not dwell upon it here.

In the lower organisms we can even distinguish a number of states that are parallel, so far as observation can show, with those distinguished and named in higher animals and man. To begin with some of the simpler ones, the objective correlate of hunger can be distinguished at least as low in the scale as Hydra and the sea anemone. These animals, as we have seen, take food only when hungry, and if very hungry, will take substances as food which they otherwise reject. Doubtless hunger could be detected in still lower organisms by proper experiments. A resting condition comparable to sleep is found, as we have seen, in the flatworm . . . while there seems to be no indication of such a state in the infusoria . . . Fatigue can of course be distinguished in all living things, including separated muscles.

Correlative with hunger, there exists a state which corresponds so far as objective evidence goes with what we should call in higher animals a desire for food. Hydra when hungry opens its mouth widely when immersed in a nutritive liquid. In the flatworm, we can distinguish

a certain physiological condition in which the animal moves about in an eager, searching way, as if hunting for food. Even in Amoeba we find a pertinacity in the pursuit of food. . . such as we would attribute in a higher animal to a desire for it.

All the way up the scale, from Amoeba and bacteria to man, we find that organisms react negatively to powerful and injurious agents. In man and higher animals such reactions are usually said to be due to pain. In the lower organisms the objective facts are parallel, and naturally lead to the assumption of a physiological state similar to what we have in the higher forms. As to subjective accompaniments of such a state we of course know nothing in animals other than ourselves. The essential cause of the states corresponding to pain is interference with any of the processes of which the organism is the seat, and the correlate in action of these states is a change in movement. . .

A similar basis exists for distinguishing throughout the organic series a physiological state corresponding to that accompanying pleasure in man. This is correlated with a relief from interference with the life processes, or with the uninterrupted progression of these processes.

In man and higher animals we often find a negative reaction to that which is not in itself injurious, but which is usually followed by something injurious. The sight of a wild beast is not injurious, considered by itself, but as preceding actual and injurious contact with this beast, it leads to powerful negative reactions. Such reactions are said to be due to fear. In fear there is then a negative reaction to a representative stimulus--one that stands for a really injurious stimulation. In lower organisms we find the objective indications of a parallel state of affairs. The infusoria react negatively to solutions of chemicals that are not, so far as we can determine, injurious, though they would naturally, under ordinary circumstances, be immediately followed by a solution so strong as to be injurious. Euglena reacts negatively when darkness affects only its colorless anterior end, though we have reason to believe that it is only the green part of the body which requires the light for the proper discharge of its functions. A much clearer case is seen in the sea urchin, which reacts by defensive movements when a shadow falls upon it, though shade is favorable to its normal functions. Objectively, fear has as its basis the fact that a negative reaction may be produced by a stimulus which is not in itself injurious, provided it leads to an injurious stimulation; this basis we find throughout organisms.

Sometimes higher animals and man are thrown into a "state of fear" such that they react negatively to all sorts of stimuli, that under ordinary circumstances would not cause such a reaction. A similar condition of affairs we have seen in Stentor and the flatworm. After repeated stimulation, they react negatively to all stimuli to which they react at all.

The general fact of which the reactions through fear are only a special example is the following: Organisms react appropriately to representative stimuli. That is, they react, not merely to stimuli that are in themselves beneficial or injurious, but to stimuli which

lead to beheficial or injurious conditions. This is as true of positive as of negative reactions. It is true of Amoeba when it moves toward a solid body that will give it an opportunity to creep about and obtain food. It is true of Paramecium when it settles against solids (even bits of filter paper), because usually such solids furnish a supply of bacteria. It is true of the colorless flagellate Chytridium and the white Hydra, when they move toward a source of light and thus come into the region where their prey congregate. There seems to be no general name for this positive reaction to a representative stimulus. In man we call various subjective aspects of it by different names,--foresight, anticipation, prudence, hope, etc.

The fact that lower as well as higher organisms thus react to representative stimuli is of the greatest significance. It provides the chief condition for the advance of behavior to higher planes. At the basis of reaction of this character lies the simple fact that a change, even though neutral in its effect, may cause reaction . . .

Related to these reactions to representative stimuli are certain other characteristics distinguished in the behavior of man and higher animals. The objective side of memory and what is called habit is shown when the behavior of an organism is modified in accordance with past stimuli received or past reactions given. If the behavior is merely changed in a way that is not regulatory, as by fatigue, we do not call this memory. In memory the reaction is modified in such a way that it is now more adequate to the conditions to be met. Habit and memory in this objective sense are clearly seen in the Crustacea, and in the low acoelous flatworm Convoluta . . . Something of a similar character is seen even in the protozoan Stentor. After reacting to a weak stimulus which does not lead to an injurious one it ceases to react when this stimulus is repeated, while if the weak stimulus does lead to an injurious one, the animal changes its behavior so as to react next time in a more effective way; and it repeats this more effective reaction at the next incidence of the stimulus. Habit and memory, objectively considered, are based on the law of the resolution of physiological states . . . which may be set forth in application to the present subject as follows: If a given physiological state, induced by a stimulus, is repeatedly resolved into a succeeding state, this resolution becomes easier, and may take place spontaneously, so that the reaction induced is that due primarily to the second physiological state reached. Wherever we find this law in operation, we have the ultimate basis from which habit and memory (objectively considered) are developed.

From memory in the general sense it is customary to distinguish associative memory. This is characterized objectively by the fact that the response at first given to one stimulus comes, after a time, to be transferred to another one. Examples of associative memory are seen in the experiments of Yerkes and Spaulding on crustaceans . . . It may be pointed out that the essential basis for associative memory is the same law of the resolution of physiological states which we have set forth in the last paragraph as underlying ordinary memory . . . There seems to be no difference in kind, therefore, between associative memory and other sorts; they are based on the same fundamental law. The existence of associative memory has often been considered a criterion of the existence of consciousness, but it is clear that the process underlying it is as readily conceivable in terms of matter and energy as are

other physiological processes. Even in inorganic colloids, as we have seen, . . . the properties depend on the past history of the colloid, and the way in which it has reached the condition in which it is now found. If this is conceivable in terms of matter and energy, it is difficult to see why the law of the readier resolution of physiological states is not equally so.

Intelligence is commonly held to consist essentially in the modification of behavior in accordance with experience. If an organism reacts in a certain way under certain conditions, and continues this reaction no matter how disastrous the effects, we say that its behavior is unintelligent. If on the other hand it modifies its behavior in such a way as to make it more adequate, we consider the behavior as in so far intelligent. It is the "correlation of experiences and actions" that constitutes, as Hobhouse (1901) has put it, "the precise work of intelligence."

It appears clear that we find the beginnings of such adaptive changes of behavior even in the Protozoa. They are brought about through the law in accordance with which the resolution of one physiological state into another takes place more readily after repetition,--in connection with the other principle that interference with the life processes causes a change of behavior. These laws apparently form the fundamental basis of intelligent action. This fundamental basis then clearly exists even in the Protozoa; it is apparently coextensive with life. It is difficult if not impossible to draw a line separating the regulatory behavior of lower organisms from the so-called intelligent behavior of higher ones; the one grades insensibly into the other. From the lowest organisms up to man behavior is essentially regulatory in character, and what we call intelligence in higher animals is a direct outgrowth of the same laws that give behavior its regulatory character in the Protozoa.

Thus is seems possible to trace back to the lowest organisms some of the phenomena which we know, from objective evidence, to exist in the behavior of man and the higher animals, and which have received special names. It would doubtless be possible to extend this to many other phenomena. Many conditions which we can clearly distinguish in man must be followed back to a single common condition in the lower organism. But this is what we should expect. Differentiation takes place as we pass upward in the scale in these matters as in others. Because we can trace these phenomena back to conditions found in unicellular forms, it does not follow that the behavior of these organisms has as many factors and is as complex as that of higher animals. The facts are precisely parallel with what we find to be true for other functions. Amoeba shows respiration, and all the essential features of respiration in man can be traced back to the condition in such an organism. Yet in man respiration is an enormously complex operation, while in Amoeba it is of the simplest character possible--apparently little more than a mere interdiffusion of gases. In the case of behavior there is the same possibility of tracing all essential features back to the lower organisms, with the same great simplification as we go back.

. . . . .

All that we have said thus far in the present chapter is independent of the question whether there exist in the lower organisms such subjective accompaniments of behavior as we find in ourselves, and which we call consciousness. We have asked merely whether there exixt in the lower organisms objective phenomena of a character similar to what we find in the behavior of man. To this question we have been compelled to give an affirmative answer. So far as objective evidence goes, there is no difference in kind, but a complete continuity between the behavior of lower and of higher organisms.

Has this any bearing on the question of the existence of consciousness in lower animals? It is clear that objective evidence cannot give a demonstration either of the existence or of the non-existence of consciousness, for consciousness is precisely that which cannot be perceived objectively. No statement concerning consciousness in animals is open to verification or refutation by observation and experiment. There are no processes in the behavior of organisms that are not as readily conceivable without supposing them to be accompanied by consciousness as with it.

But the question is sometimes proposed: Is the behavior of lower organisms of the character which we should "naturally" expect and appreciate if they did have conscious states, of undifferentiated character, and acted under similar conscious states in a parallel way to man? Or is their behavior of such a character that it does not suggest to the observer the existence of consciousness?

If one thinks these questions through for such an organism as Paramecium, with all its limitations of sensitiveness and movement, it appears to the writer that an affirmative answer must be given to the first of the above questions, and a negative one to the second. Suppose that this animal <u>were</u> conscious to such an extent as its limitations seem to permit. Suppose that it could feel a certain degree of pain when injured; that it received certain sensations from alkali, others from acids, others from solid bodies, etc.,--would it not be natural for it to act as it does? That is, can we not, through our consciousness, <u>appreciate</u> its drawing away from things that hurt it, its trial of the environment when the conditions are bad, its attempting to move forward in various directions, till it finds one where the conditions are not bad, and the like? To the writer it seems that we can; that Paramecium in this behavior makes such an impression that one involuntarily recognizes it as a little subject acting in ways analogous to our own. Still stronger, perhaps, is this impression when observing an Amoeba obtaining food . . . The writer is thoroughly convinced, after long study of the behavior of this organism, that if Amoeba were a large animal, so as to come within the everyday experience of human beings, its behavior would at once call forth the attribution to it of states of pleasure and pain, of hunger, desire, and the like, on precisely the same basis as we attribute these things to the dog. . .

Of a character somewhat similar to that last mentioned is another test that has been proposed as a basis for deciding as to the consciousness of animals. This is the satisfactoriness or usefulness of the

concept of consciousness in the given case. We do not usually attribute consciousness to a stone, because this would not assist us in understanding or controlling the behavior of the stone. Practically indeed it would lead us much astray in dealing with such an object. On the other hand, we usually do attribute consciousness to the dog, because this is useful; it enables us practically to appreciate, foresee, and control its actions much more readily than we could otherwise do so. If Amoeba were so large as to come within our everyday ken, I believe it beyond question that we should find similar attribution to it of certain states of consciousness a practical assistance in foreseeing and controlling its behavior. Amoeba is a beast of prey, and gives the impression of being controlled by the same elemental impulses as higher beasts of prey. If it were as large as a whale, it is quite conceivable that occasions might arise when the attribution to it of the elemental states of consciousness might save the unsophisticated human being from the destruction that would result from the lack of such attribution. In such a case, then, the attribution of consciousness would be satisfactory and useful. In a small way this is still true for the investigator who wishes to appreciate and predict the behavior of Amoeba under his microscope.

But such impressions and suggestions of course do not demonstrate the existence of consciousness in lower organisms. Any belief on this matter can be held without conflict with the objective facts. All that experiment and observation can do is to show us whether the behavior of lower organisms is objectively similar to the behavior that in man is accompanied by consciousness. If this question is answered in the affirmative, as the facts seem to require, and if we further hold, as is commonly held, that man and the lower organisms are subdivisions of the same substance, then it may perhaps be said that objective investigation is as favorable to the view of the general distribution of consciousness throughout animals as it could well be. But the problem as to the actual existence of consciousness outside of the self is an indeterminate one; no increase of objective knowledge can ever solve it. Opinions on this subject must then be largely dominated by general philosophical considerations, drawn from other fields.

John Broadus Watson (1878-1958)

"This emphasis upon analogy in psychology has led the behaviorist somewhat afield. Not being willing to throw off the yoke of consciousness he feels impelled to make a place in the scheme of behavior where the rise of consciousness can be determined. This point has been a shifting one. A few years ago certain animals were supposed to possess "associative memory," while certain others were supposed to lack it. One meets this search for the origin of consciousness under a good many guises. Some of our texts state that consciousness arises at the moment when reflex and instinctive activities fail properly to conserve the organism. A perfectly adjusted organism would be lacking in consciousness. On the other hand, whenever we find the presence of diffuse activity which results in habit formation, we are justified in assuming consciousness...Many of us are still viewing behavior problems with something like this in mind, as is evidenced by the fact that more than one student of behavior has attempted to frame criteria of the psychic--to devise a set of objective, structural, and functional criteria which...will enable him to decide whether such and such responses are positively conscious, merely indicative of consciousness, or...are purely 'physiological.' Such problems as these can no longer satisfy behavior men...One can assume either the presence or absence of consciousness anywhere in the phylogenetic scale without affecting the problems of behavior by one jot or tittle; and without influencing in any way the mode of experimental attack upon them..."

(From Chapter One of Watson's Behavior--An Introduction to Comparative Psychology -- 1914)

Neither the above quotation nor your H. & B. assignment takes much account of an important feature of Watsonian behaviorism--its concern with conditioned reflexes and habit formation. In 1924, in his Psychology from the Standpoint of a Behaviorist, he treated habit essentially as a chain of reflexes, differing only from instinct in the fact that the chain was acquired rather than learned. A little later, in his Behaviorism, he minimized the role of instinct in human behavior and argued, with respect to habit, that when such a "complicated, integrated, spaced and timed" response was analyzed, its elemental components were conditioned reflexes.

The study questions that follow deal only with the relation of Watson's thinking to that of other men considered in this course. No questions will be provided for the Watson material in itself. You should be able to construct your own!

Study Questions

1. What can you discover in Romanes, Morgan, Loeb, and Jennings with which Watson might agree? With which he might disagree?

2. What objections might Watson have raised to the teachings of Descartes, Marshall Hall, and William James?

3. How does Watson's use of reinfordement match with its use in modern psychology?

4. Can you detect the influence of Sherrington and Pavlov in Watson's treatment of habit formation?

5. Can you find similarity between Watson's verbal-report and Titchener's introspective method? Explain.

JOHN BROADUS WATSON ON BEHAVIORISM, 1913

J. B. Watson, "Psychology as the behaviorist views it," Psychological Review 20, 158-177 (1913).

Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. The behaviorist, in his efforts to get a unitary scheme of animal response, recognizes no dividing line between man and brute. The behavior of man, with all of its refinement and complexity, forms only a part of the behaviorist's total scheme of investigation.

It has been maintained by its followers generally that psychology is a study of the science of the phenomena of consciousness. It has taken as its problem, on the one hand, the analysis of complex mental states (or processes) into simple elementary constituents, and on the other the construction of complex states when the elementary constituents are given. The world of physical objects (stimuli, including here anything which may excite activity in a receptor), which forms the total phenomena of the natural scientist, is looked upon merely as means to an end. That end is the production of mental states that may be 'inspected' or 'observed.' The psychological object of observation in the case of an emotion, for example, is the mental state itself. The problem in emotion is the determination of the number and kind of elementary constituents present, their loci, intensity, order of appearance, etc. It is agreed that introspection is the method par excellence by means of which mental states may be manipulated for purposes of psychology. On this assumption, behavior data (including under this term everything which goes under the name of comparative psychology) have no value per se. They possess significance only in so far as they may throw light upon conscious states. Such data must have at least an analogical or indirect reference to belong to the realm of psychology.

Indeed, at times, one finds psychologists who are sceptical of even this analogical reference. Such scepticism is often shown by the question which is put to the student of behavior, "what is the bearing of animal work upon human psychology?" I used to have to study over this question. Indeed it always embarrassed me somewhat. I was interested in my own work and felt that it was important, and yet I could not trace any close connection between it and psychology as my questioner understood psychology. I hope that such a confession will clear the atmosphere to such an extent that we will no longer have to work under false pretences. We must frankly admit that the facts so important to us which we have been able to glean from extended work upon the senses of animals by the behavior method have contributed only in a fragmentary way to the general theory of human sense organ processes, nor have they suggested new points of experimental attack. The enormous number of

experiments which we have carried out upon learning have likewise contributed little to human psychology. It seems reasonably clear that some kind of compromise must be effected: either psychology must change its viewpoint so as to take in facts of behavior, whether or not they have bearings upon the problems of 'consciousness'; or else behavior must stand alone as a wholly separate and independent science. Should human psychologists fail to look with favor upon our overtures and refuse to modify their position, the behaviorists will be driven to using human beings as subjects and to employ methods of investigation which are exactly comparable to those now employed in the animal work.

Any other hypothesis than that which admits the independent value of behavior material, regardless of any bearing such material may have upon consciousness, will inevitably force us to the absurd position of attempting to construct the conscious content of the animal whose behavior we have been studying. On this view, after having determined our animal's ability to learn, the simplicity or complexity of its methods of learning, the effect of past habit upon present response, the range of stimuli to which it ordinarily responds, the widened range to which it can respond under experimental conditions,--in more general terms, its various problems and its various ways of solving them,--we should still feel that the task is unfinished and that the results are worthless, until we can interpret them by analogy in the light of consciousness. Although we have solved our problem we feel uneasy and unrestful because of our definition of psychology: we feel forced to say something about the possible mental processes of our animal. We say that, having no eyes, its stream of consciousness cannot contain brightness and color sensations as we know them,--having no taste buds this stream can contain no sensations of sweet, sour, salt and bitter. But on the other hand, since it does respond to thermal, tactual and organic stimuli, its conscious content must be made up largely of these sensations; and we usually add, to protect ourselves against the reproach of being anthropomorphic, "if it has any consciousness." Surely this doctrine which calls for an analogical interpretation of all behavior data may be shown to be false: the position that the standing of an observation upon behavior is determined by its fruitfulness in yielding results which are interpretable only in the narrow realm of (really human) consciousness.

This emphasis upon analogy in psychology has led the behaviorist somewhat afield. Not being willing to throw off the yoke of consciousness he feels impelled to make a place in the scheme of behavior where the rise of consciousness can be determined. This point has been a shifting one. A few years ago certain animals were supposed to possess 'associative memory,' while certain others were supposed to lack it. One meets this search for the origin of consciousness under a good many disguises. Some of our texts state that consciousness arises at the moment when reflex and instinctive activities fail properly to conserve the organism. A perfectly adjusted organism would be lacking in consciousness. On the other hand whenever we find the presence of diffuse activity which results in habit formation, we are justified in assuming consciousness. I must confess that these arguments had weight with me when I began the study of behavior. I fear that a good many of us are still viewing behavior problems with something like this in mind. More than one student in behavior has attempted to frame

criteria of the psychic--to devise a set of objective, structural and functional criteria which, when applied in the particular instance, will enable us to decide whether such and such responses are positively conscious, merely indicative of consciousness, or whether they are purely 'physiological.' Such problems as these can no longer satisfy behavior men. It would be better to give up the province altogether and admit frankly that the study of the behavior of animals has no justification, than to admit that our search is of such a 'will o' the wisp' character. One can assume either the presence or the absence of consciousness anywhere in the phylogenetic scale without affecting the problems of behavior by one jot or one tittle; and without influencing in any way the mode of experimental attack upon them. On the other hand, I cannot for one moment assume that the paramecium responds to light; that the rat learns a problem more quickly by working at the task five times a day than once a day, or that the human child exhibits plateaux in his learning curves. These are questions which vitally concern behavior and which must be decided by direct observation under experimental conditions.

This attempt to reason by analogy from human conscious processes to the conscious processes in animals, and vice versa: to make consciousness, as the human being knows it, the center of reference of all behavior, forces us into a situation similar to that which existed in biology in Darwin's time. The whole Darwinian movement was judged by the bearing it had upon the origin and development of the human race. Expeditions were undertaken to collect material which would establish the position that the rise of the human race was a perfectly natural phenomenon and not an act of special creation. Variations were carefully sought along with the evidence for the heaping up effect and the weeding out effect of selection; for in these and the other Darwinian mechanisms were to be found factors sufficiently complex to account for the origin and race differentiation of man. The wealth of material collected at this time was considered valuable largely in so far as it tended to develop the concept of evolution in man. It is strange that this situation should have remained the dominant one in biology for so many years. The moment zoology undertook the experimental study of evolution and descent, the situation immediately changed. Man ceased to be the center of reference. I doubt if any experimental biologist today, unless actually engaged in the problem of race differentiation in man, tries to interpret his findings in terms of human evolution, or ever refers to it in his thinking. He gathers his data from the study of many species of plants and animals and tries to work out the laws of inheritance in the particular type upon which he is conducting experiments. Naturally, he follows the progress of the work upon race differentiation in man and in the descent of man, but he looks upon these as special topics, equal in importance with his own yet ones in which his interests will never be vitally engaged. It is not fair to say that all of his work is directed toward human evolution or that it must be interpreted in terms of human evolution. He does not have to dismiss certain of his facts on the inheritance of coat color in mice because, forsooth, they have little bearing upon the differentiation of the genus homo into separate races, or upon the descent of the genus homo from some more primitive stock.

In psychology we are still in that stage of development where we feel that we must select our material. We have a general place of

discard for processes, which we anathematize so far as their value for psychology is concerned by saying, "this is a reflex"; "that is a purely physiological fact which has nothing to do with psychology." We are not interested (as psychologists) in getting all of the processes of adjustment which the animal as a whole employs, and in finding how these various responses are associated, and how they fall apart, thus working out a systematic scheme for the prediction and control of response in general. Unless our observed facts are indicative of consciousness, we have no use for them, and unless our apparatus and method are designed to throw such facts into relief, they are thought of in just as disparaging a way. I shall always remember the remark one distinguished psychologist made as he looked over the color apparatus designed for testing the responses of animals to monochromatic light in the attic at Johns Hopkins. It was this: "And they call this psychology!"

I do not wish unduly to criticize psychology. It has failed signally. I believe, during the fifty-odd years of its existence as an experimental discipline to make its place in the world as an undisputed natural science. Psychology, as it is generally thought of, has something esoteric in its methods. If you fail to reproduce any findings, it is not due to some fault in your apparatus or in the control of your stimulus, but it is due to the fact that your introspection is untrained. The attack is made upon the observer and not upon the experimental setting. In physics and in chemistry the attack is made upon the experimental conditions. The apparatus was not sensitive enough, impure chemicals were used, etc. In these sciences a better technique will give reproducible results. Psychology is otherwise. If you can't observe 3-9 states of clearness in attention, your introspection is poor. If, on the other hand, a feeling seems reasonably clear to you, your introspection is again faulty. You are seeing too much. Feelings are never clear.

The time seems to have come when psychology must discard all reference to consciousness; when it need no longer delude itself into thinking that it is making mental states the object of observation. We have become so enmeshed in speculative questions concerning the elements of mind, the nature of conscious content . . . that I, as an experimental student, feel that something is wrong with our premises and the types of problems which develop from them. There is no longer any guarantee that we all mean the same thing when we use the terms now current in psychology. Take the case of sensation. A sensation is defined in terms of its attributes. One psychologist will state with readiness that the attributes of a visual sensation are quality, extension, duration, and intensity. Another will add clearness. Still another that of order. I doubt if any one psychologist can draw up a set of statements describing what he means by sensation which will be agreed to by three other psychologists of different training. Turn for a moment to the question of the number of isolable sensations. Is there an extremely large number of color sensations--or only four, red, green, yellow and blue? Again, yellow, while psychologically simple, can be obtained by superimposing red and green spectral rays upon the sane diffusing surface! If, on the other hand, we say that every just noticeable difference in the spectrum is a simple sensation, and that every just noticeable increase in the white value of a given color

gives simple sensation, we are forced to admit that the number is so large and the conditions for obtaining them so complex that the concept of sensation is unusable, either for the purpose of analysis or that of synthesis. Titchener, who has fought the most valiant fight in this country for a psychology based upon introspection, feels that these differences of opinion as to the number of sensations and their attributes; as to whether there are relations (in the sense of elements) and on the many others which seem to be fundamental in every attempt at analysis, are perfectly natural in the present undeveloped state of psychology. While it is admitted that every growing science is full of unanswered questions, surely only those who are wedded to the system as we not have it, who have fought and suffered for it, can confidently believe that there will ever be any greater uniformity than there is now in the answers we have to such questions. I firmly believe that two hundred years from now, unless the introspective method is discarded, psychology will still be divided on the question as to whether auditory sensations have the quality of 'extension,' whether intensity is an attribute which can be applied to color, whether there is a difference in 'texture' between image and sensation and upon many hundreds of others of like character.

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My psychological quarrel is not with the systematic and structural psychologist alone. The last fifteen years have seen the growth of what is called functional psychology. This type of psychology decries the use of elements in the static sense of the structuralists. It throws emphasis upon the biological significance of conscious processes instead of upon the analysis of conscious states into introspectively isolable elements. I have done my best to understand the difference between functional psychology and structural psychology. Instead of clarity, confusion grows upon me. The terms sensation, perception, affection, emotion, volition are used as much by the functionalist as by the structuralist. The addition of the word 'process' ('mental act as a whole,' and like terms are frequently met) after each serves in some way to remove the corpse of 'content' and leave 'function' in its stead. Surely if these concepts are elusive when looked at from a content standpoint, they are still more deceptive when viewed from the angle of function, and especially so when function is obtained by the introspection method. It is rather interesting that no functional psychologist has carefully distinguished between 'perception' (and this is true of the other psychological terms as well) as employed by the systematist, and 'perceptual process' as used in functional psychology. It seems illogical and hardly fair to criticize the psychology which the systematist gives us, and then utilize his terms without carefully showing the changes in meaning which are to be attached to them. . .

One of the difficulties in the way of a consistent functional psychology is the parallelistic hypothesis. If the functionalist attempts to express his formulations in terms which make mental states really appear to function, to play some active role in the world of adjustment, he almost imevitably lapses into terms which are not connatative of interaction. When taxed with this he replies that it is more convenient to do so and that he does it to avoid the circumlocution and clumsiness which are inherent in any thoroughgoing

parallelism. As a matter of fact I believe the functionalist actually thinks in terms of interaction and resorts to parallelism only when forced to give expression to his views. I feel that behaviorism is the only consistent and logical functionalism. In it one avoids both the Scylla of parallelism and the Charybdis of interaction. Those time-honored relics of philosophical speculation need trouble the student of behavior as little as they trouble the student of physics. The consideration of the mind-body problem affects neither the type of problem selected nor the formulation of the solution of that problem. I can state my position here no better than by saying that I should like to bring my students up in the same ignorance of such hypotheses as one finds among the students of other branches of science.

This leads me to the point where I should like to make the argument constructive. I believe we can write a psychology. . . and. . . never use the terms consciousness, mental states, mind, content, introspectively verifiable, imagery, and the like. I believe that we can do it in a few years without running into the absurd terminology of Beer, Bethe, Von Uexkull, Nuel, and that of the so-called objective schools generally. It can be done in terms of stimulus and response, in terms of habit formation, habit integrations and the like. Furthermore, I believe that it is really worth while to make this attempt now.

The psychology which I should attempt to build up would take as a starting point, first, the observable fact that organisms, man and animal alike, do adjust themselves to their environment by means of hereditary and habit equipments. These adjustments may be very adequate or they may be so inadequate that the organism barely maintains its existence; secondly, that certain stimuli lead the organisms to make the responses. In a system of psychology completely worked out, given the response the stimuli can be predicted; given the stimuli the response can be predicted. Such a set of statements is crass and raw in the extreme, as all such generalizations must be. Yet they are hardly more raw and less realizable than the ones which appear in the psychology texts of the day. I possibly might illustrate my point better by choosing an everyday problem which anyone is likely to meet in the course of his work. Some time ago I was called upon to make a study of certain species of birds. Until I went to Tortugas I had never seen these birds alive. When I reached there I found the animals doing certain things: some of the acts seemed to work peculiarly well in such an environment, while others seemed to be unsuited to their type of life. I first studied the responses of the group as a whole and later those of individuals. In order to understand more thoroughly the relation between what was habit and what was hereditary in these responses, I took the young birds and reared them. In this way I was able to study the order of appearance of hereditary adjustments and their complexity, and later the beginnings of habit formation. My efforts in determining the stimuli which called forth such adjustments were crude indeed. Consequently my attempts to control behavior and to produce responses at will did not meet with much success. Their food and water, sex and other social relationships, light and temperature conditions were all beyond control in a field study. I did find it possible to control their reactions in a measure by using the nest and egg (or young) as stimuli. It is not necessary in this paper to develop further how

such a study should be carried out and how work of this kind must be supplemented by carefully controlled laboratory experiments. Had I been called upon to examine the natives of some of the Australian tribes, I should have gone about my task in the same way. I should have found the problem more difficult; the types of responses called forth by physical stimuli would have been more varied, and the number of effective stimuli larger. I should have had to determine the social setting of their lives in a far more careful way. These savages would be more influenced by the responses of each other than was the case with the birds. Furthermore, habits would have been more complex and the influences of past habits upon the present responses would have appeared more clearly. Finally, if I had been called upon to work out the psychology of the educated European, my problem would have required several lifetimes. But in the one I have at my disposal I should have followed the same general line of attack. In the main, my desire in all such work is to gain an accurate knowledge of adjustments and the stimuli calling them forth. My final reason for this is to learn general and particular methods by which I may control behavior.

John B. Watson, Psychology From the Standpoint of a Behaviorist, Philadelphia: Lippincott, 1919.

III. Verbal Report Methods.

Introduction. -- The methods so far discussed have dealt with the integrated motor and glandular behavior of individuals other than ourselves. The methods have been largely developed by and have come into prominence through the study of animal behavior and infant human subjects. Indeed, in these fields we must depend largely upon such methods, since the observation of the happenings in our own bodies and the verbal reports of the same are impossible in the case of animals, or very imperfect in the case of abnormal individuals. Man is above all an animal which reacts most often and most complexly with speech reactions. The notion has somehow gained ground that objective psychology does not deal with speech reactions. This, of course, is a mistake. It would be foolish and one-sided to an absurd degree to neglect man's vocal behavior. Often the sole observable reaction in man is speech. In other words, his adjustments to situations are made more frequently by speech than through action of the remaining motor mechanisms. We shall in a later chapter develop our notion of the implicit and explicit language adjustments. We wish here mainly to show the use of speech reactions as a part of general psychological methods. As an illustration of the use of the verbal report method in an actual experiment we may glance for a moment at the tests on sensitivity to warmth and cold on a given area of the skin. We first mark off a small area and go over it with a warm and a cold cylinder: we say to the subject, "Tell us each time the cold cylinder is applied and each time the warm cylinder is applied." If the area touched is sensitive to cold he responds with the word "cold," and similarly when the warm cylinder is applied with the word "warm." The verbal report or response is put down in our records of the results of the experiment and is used exactly as the conditioned reflex responses would be used had we adopted that form of experimentation in our test.

Is There a Verbal Report Method Distinct From Other Observable Methods? -- Up to the present time psychologists have employed the verbal report method in a somewhat different sense from that used here. Without entering into this bitterly contested and controversial field, we can briefly outline the position of this text in regard to it. The question: Can I make the same observations upon myself that I make on other individuals? brings home the difficulties. The answer is, of course, "yes," but it will be remembered that on page 13 we stated that all we can observe in another individual is his behavior, and we defined behavior as the integrated responses of muscles and glands. The question now becomes simpler: Can I observe the movements of my own muscles and glands and their integration? For example, that I am writing, that my face is flushed, etc.? Who would deny it?

At this point we diverge for a moment to correct a misconception which has arisen with reference to objective psychology. The misconception lies in the fact that a good many psychologists have misunderstood the behaviorist's position. They insist that he is only observing the individual movements of the muscles and glands;

that he is interested in the muscles and glands in exactly the same way the physiologist is interested in them. This is not the whole statement. The behaviorist is interested in integrations and total activities of the individual. At one moment we ask the question: What is the individual doing? We observe that he is typewriting, searching for a lost pocketbook or "reacting" to an emotional stimulus. If the latter happens to be true and we are interested in the way his emotional life as a whole hangs together, we may go on to show why the individual reacts in an emotional way to this particular stimulus. We may show how his fear reactions to certain situations arose in his infancy and how they have affected his whole personality and more highly organized habit activities. To illustrate this we may give a hypothetical example: Through some injury (or other emotional happening) in youth, occasioned by a rapidly moving mechanical toy, the individual cannot be induced to enter an automobile or motor boat or to ride in a train if it can possibly be avoided. In the occupations and activities of individuals we do not stop as a rule to reduce the total activity to muscle twitches. We can do it if necessary and we do do it at times when it becomes necessary to study the various part reactions. Surely objective psychology can study brick-laying, house building, playing games, marriage, or emotional activity without being accused of reducing everything to muscle twitch or the secretion of a gland. It is just as fair to accuse the behaviorist, or indeed the conventional psychologist as far as that goes, of reducing everything to the ionic constitution of matter. All of us believe that matter is constituted as the physicists would have us believe, but his formulation does not help us very much in specific psychological problems. On the psychological side, we can describe a man's behavior in selecting and marrying a wife. We can show how that event has influenced his whole life after marriage. In detail, how the increased responsibility stabilized certain emotional maladjustments, how the added financial burden led him to work longer hours and to study the details of his profession so that his salary would be increased and his number of business connections enlarged. It would not help us very much in the present state of science to be able to trace the molecular changes in cell constitution--they certainly exist, but are aside from our problem. Our problem is the effect of marriage upon the general behavior of this one individual.

In the psychological laboratory we do find it necessary often to study the details of the total activity we see in daily life. When it becomes necessary to make such observations we find it extremely difficult to observe the part or individual reactions of our own bodies. We pointed out above that observation is often impossible without the use of instrumentation and the control of the experimental setting. Hence the movements which we would have to make in the manipulation of the instruments and the setting would interfere always with the movements we are trying to observe in ourselves. It is perfectly possible for a subject to make observations by the use of his eyes of the number of drops coming from the salivary glands after someone has attached the apparatus for him; but in reaching for acids, water to wash out the mouth, etc., certain variable factors are introduced which disturb the purity and the scientific character of the observation. Physiology has to answer this same question; but who doubts that the physiologist can make observations of a kind upon his own heart, respiration, and movements of the food particles in the

intestines? But if the physiologist limited himself to what he could learn from observing and experimenting upon his own organs, he would long ago have given up the science. But now and then the physiologist and the physician, like other human beings, observe that something goes wrong with one of their organs. They immediately put themselves into the hands of a skilled observer who brings all of the technic of modern science to bear upon the observation he is about to make. His report may be that there are adhesions, mitral leaks, or an enlarged spleen. In other words, in physiology and in medicine self-observation is crude and inexact and is discarded just as soon as other methods can be brought to bear. We suffer in psychology today greatly because methods for observing what goes on in another individual's internal mechanisms are lacking. For this reason we have to depend in part at least upon his own report of what is taking place. We are gradually breaking away from this inexact method; we shall break away very rapidly when the need is more generally recognized. Suppose we have a subject in the laboratory. We record his arm and finger responses to a given experimental situation. During the course of the experiment we may also want to know whether there is an increased tension in the leg muscles. We ask the subject: When you move your hands in this experiment do your leg muscles contract? He may say "yes" or "no" and he may be right. But if we want a scientific answer to depend upon, we immediately attach an instrument which will record any change in the tension of the leg muscles. We discard crude self-observation and turn to instrumentation wherever it is necessary or possible.

But in many spheres of psychology and especially in psychiatry, self-observation, which is usually expressed in words by the subject, is the only kind of observation at our immediate disposal. The patient comes to the psychiatrist and says: "I feel 'sad' and 'gloomy'"; or "Doctor, I am under a terrible strain--I fear I am going to kill my wife and children." This is a psychological situation which the physician must meet. The physician then by a series of skillful questions begins to take the word responses of the patient. These responses, however, are from the physician's standpoint as objective as would be a moving-picture photograph of the subject's activity in weaving a rug or basket. The responses are a part of the record of the subject's way of adjusting to his world. These responses the physician can in virtue of his past training connect with the remote and immediate situations in the life of the patient which have produced the mal-adjustment. The physician has found that when speech reactions of such and such types are made by the patient, they are to be associated with disturbances of the remaining action systems--the individual's action systems are no longer integrated and no longer function as a unit, as is necessarily the case when the patient is well.

HABIT FIXATION -- At the present time there is no satisfactory way of giving an account of the formation of a habit in terms of cause and effect. A good many monographs and special chapters have been devoted to its explanations, but although we know a great deal about the factors which influence the formation of habits, as we shall see later, we cannot state in detail what the course of events is in the inception of any individual habit. Habits start, as we have seen, with the so-called random movements (if the object fails to arouse either positive or negative reaction tendencies no habit can be formed). Among those

random movements is one group or combination which completes the adjustment, the "successful" one. All others, from a superficial standpoint, seem to be unnecessary. But it must be remembered that the organism cannot respond in any other way than his equipment allows him to. When put in front of a problem the solution to which cannot be effected by an immediate instinctive act or by one belonging to his past habit acquisitions, the whole organism begins to work in each and every part but without working together. Not only are the arms, legs and trunk active but the heart, stomach, lungs and glands as well. We know that when the new habit is formed the organism as a whole acts smoothly, each part reaction hangs together with every other part reaction, all tending to facilitate and make possible the smooth working of the group of acts effecting the final adjustment. The formation of the simplest habit is an enormously complicated affair. We are prone to think that the successful act is only a small group of movements involving, for example, only the hands and the fingers. This is not true. Even so apparently simple a thing as firing a rifle successfully requires many facilitating part adjustments all over the body. As the right hand picks up the rifle the body parts begin to fall into line--a certain stance is taken so as to brace the body, the back muscles take on a greater tone, the left hand and arm begin to take on the position of grasping the end of the barrel, the shoulder muscles contract, finally the instant before firing respiration is blocked and as the trigger is pulled the body gets ready to withstand the recoil.

The production of such a close-fitting and well-timed group of activities all working together, the end result being the hitting of the bull's-eye or the felling of the deer, requires in the beginning naturally the display of a large number of "useless" movements. But probably on each succeeding attempt to hit the bull's-eye some of these part reactions fall together in such a way as to facilitate succeeding moements. The whole learning stage is thus an active one and something is gained each time the individual goes through the process. Hence the so-called useless movements are useless only when looked at from the standpoint of the completed habit. They are all necessary in view of the fact that the successful movements could not have appeared in any given trial unless they had been preceded by just those acts which did precede.

Some attempted causal explanations of the process of fixation are as follows: (1) In most cases where random activity finally leads to success the successful group of acts is always the last one to appear; hence when the next trial is given the last group active in the preceding test (the successful one) is thus the one most recently exercised, therefore, other things being equal, it will be the one most likely to occur first or at least early in the second trial. (2) In view of the fact that the random acts are infinitely varied the successful act is the only one performed each time the stimulus is presented. It, therefore, becomes the most frequently performed movement. (3) By reason of the fact that the final group of acts always brings food, water, removes an irritating object, lessens emotional tension, etc., the new state (attained by the result of the action of the final group) brings heightened metabolism. It is conceivable that those neuro-muscular elements which have just been active, in completing the

adjustment have a slightly dilated system of blood-vessels, consequently they share more generously than the group functioning earlier in the increased and bettered blood supply. (4) It is possible that when the final group of movements functions and the adjustment is completed, the situation as a whole becomes an emotion-producing one; internal glandular secretions are set free which serve as reinforcers. It is possible to suppose, due to the increased dilation of the blood-vessels in the elements which have just functioned, that they receive a slightly greater "reinforcement" (possibly increase in metabolic rate as a result of the increased blood flow to the parts in active use) from the autocoid agencies than the groups which functioned earlier. One pictures here, of course, the possible action of adrenin in neutralizing fatigue products. It should again be emphasized that these are little more than mere speculations. The fact, however, that we must confess to no ready-made explanation of this problem should detract in no way from our zeal in studying the other factors involved in habit formation.

William McDougall (1871-1938); Edward Lee Thorndike (1874-1949)

William McDougall is our only representative here of a tradition, that of act psychology, which began with Aristotle, reached "school" proportions in the work of Franz Pzentano (1838-1917), and came down to McDougall through the teachings of his countrymen, James Ward and George Frederick Stout. Known as a "hormic" psychologist, McDougall was an admirer of James, a defender of purposivism, Lamarckianism, interactionism, and other unpopular causes. He struggled vainly to offset the influence of Watsonian behaviorism in his time, distinguishing between "real" and "reflex" behavior as the subject-matter of psychology. In this distinction, the reader will find a crude anticipation of our modern operant and respondent.

E. L. Thorndike, one of America's most imaginative, productive, and influential psychologists of this century, is hard to place within any single historical trend. An early student of James, his theorizing reflects the teachings of Darwin, Spencer, Bain, and Lloyd Morgan, among others. In his famous Law of Effect, he brings pleasure-pain doctrine to bear upon voluntary or trial-and-error behavior, somewhat in the manner of Spencer and Bain, but on the basis of experimental observations designed to throw light upon the intelligence of animals.

Study Questions

1. What is the research area that Thorndike proposes to enter in his studies? What is the general aim? What is the purpose of comparative psychology and why are we interested?

2. What is the difference between Thorndike's method and interest and those of his predecessors? What defects in research does he propose to correct?

3. What was his experimental method? What subjects were used, and in what state at the time of the experimentation? What advantages does the method have?

4. In Thorndike's explanation of behavior, what elements were associated?

5. What were the motivating factors for Thorndike's subjects?

6. What did Thorndike mean by instinct, impulse, motive, and act?

7. What were the "marks" of true behavior for McDougall? Of these, which is:
   a) the surest criterion of mental life;
   b) lease reflex-like;
   c) most like Sherrington's "after-discharge";
   d) Thorndike's learning
   e) least suggestive of stereotypy;
   f) suggestive of the importance of motives;
   g) most suggestive of Pavlovian conditioning?

EDWARD LEE THORNDIKE ON ANIMAL LEARNING, 1898

E. L. Thorndike, "Animal intelligence: an experimental study of the associative processes in animals," The Psychological Review Monograph Supplements 2, no. 4 (whole no. 8), 1-8, 13-18, 73-74 (1898)

This monograph is an attempt at an explanation of the nature of the process of association in the animal mind. Inasmuch as there have been no extended researches of a character similar to the present one either in subject-matter or experimental method, it is necessary to explain briefly its standpoint.

Our knowledge of the mental life of animals equals in the main our knowledge of their sense-powers, of their instincts or reactions performed without experience, and of their reactions which are built up by experience. Confining our attention to the latter we find it the opinion of the better observers and analysts that these reactions can all be explained by the ordinary associative processes without aid from abstract, conceptual, inferential thinking. These associative processes then, as present in animals' minds and as displayed in their acts, are my subject-matter. Any one familiar in even a general way with the literature of comparative psychology will recall that this part of the field has received faulty and unsuccessful treatment. The careful, minute, and solid knowledge of the sense-organs of animals finds no counterpart in the realm of associations and habits. We do not know how delicate or how complex or how permanent are the possible associations of any given group of animals. And although one would be rash who said that our present equipment of facts about instincts was sufficient or that our theories about it were surely sound, yet our notion of what occurs when a chick grabs a worm are luminous and infallible compared to our notion of what happens when a kitten runs into the house at the familiar call. The reason that they have satisfied us as well as they have is just that they are so vague. We say that the kitten associates the sound 'kitty kitty' with the experience of nice milk to drink, which does very well for a common-sense answer. It also suffices as a rebuke to those who would have the kitten ratiocinate about the matter, but it fails to tell what real mental content is present. Does the kitten feel "sound of call, memory-image of milk in a saucer in the kitchen, thought of running into the house, a feeling, finally, of 'I will run in'?" Does he perhaps feel only the sound of the bell and an impulse to run in, similar in quality to the impulses which make a tennis player run to and fro when playing? The word association may cover a multitude of essentially different processes, and when a writer attributes anything that an animal may do to association his statement has only the negative value of eliminating reasoning on the one hand and instinct on the other. His position is like that of a zoölogist who should today class an animal among the 'worms.' To give to the word a positive value and several definite possibilities of meaning is one aim of this investigation.

The importance to comparative psychology in general of a more scientific account of the association-process in animals is evident.

Apart from the desirability of knowing all the facts we can, of whatever sort, there is the especial consideration that these associations and consequent habits have an immediate import for biological science. In the higher animals the bodily life and preservative acts are largely directed by these associations. They, and not instinct, make the animal use the best feeding grounds, sleep in the same lair, avoid new dangers and profit by new changes in nature. Their higher development in mammals is a chief factor in the supremacy of that group. This, however, is a minor consideration. The main purpose of the study of the animal mind is to learn the development of mental life down through the phylum, to trace in particular the origin of human faculty. In relation to this chief purpose of comparative psychology the associative processes assume a role predominant over that of sense-powers or instinct, for in a study of the associative processes lies the solution of the problem. Sense-powers and instincts have changed by addition and supersedence, but the cognitive side of consciousness has changed not only in quantity but also in quality. Somehow out of these associative processes have arisen human consciousnesses with their sciences and arts and religions. The association of ideas proper, imagination, memory, abstraction, generalization, judgment, inference, have here their source. And in the metamorphosis the instincts, impulses, emotions and sense-impressions have been transformed out of their old natures. For the origin and development of human faculty we must look to these processes of association in lower animals. Not only then does this department need treatment more, but promises to repay the worker better.

Although no work done in this field is enough like the present investigation to require an account of its results, the <u>method</u> hitherto in use invites comparison by its contrast and, as I believe, by its faults. In the first place, most of the books do not give us a psychology, but rather a <u>eulogy</u> of animals. They have all been about animal <u>intelligence</u>, never about animal <u>stupidity</u>. Though a writer derides the notion that animals have reason, he hastens to add that they have marvellous capacity of forming associations, and is likely to refer to the fact that human beings only rarely reason anything out, that their trains of ideas are ruled mostly by association, as if, in this latter, animals were on a par with them. The history of books on animals' minds thus furnishes an illustration of the well-nigh universal tendency in human nature to find the marvelous wherever it can. We wonder that the stars are so big and so far apart, that the microbes are so small and so thick together, and for much the same reason wonder at the things animals do. They used to be wonderful because of the mysterious, God-given faculty of instinct, which could almost remove mountains. More lately they have been wondered at because of their marvellous mental powers in profiting by experience. Now imagine an astronomer tremendously eager to prove the stars as big as possible, or a bacteriologist whose great scientific desire is to demonstrate the microbes to be very, very little! Yet there has been a similar eagerness on the part of many recent writers on animal psychology to praise the abilities of animals. It cannot help leading to partiality in deductions from facts and more especially in the choice of facts for investigation. How can scientists who write like lawyers, defending animals against the charge of having no power of rationality, be at

the same time impartial judges on the bench? Unfortunately the real work in this field has been done in this spirit. The level-headed thinkers who might have won valuable results have contented themselves with arguing against the theories of the eulogists. They have not made investigations of their own.

In the second place the facts have generally been derived from anecdotes. Now quite apart from such pedantry as insists that a man's word about a scientific fact is worthless unless he is a trained scientist, there are really in this field special objections to the acceptance of the testimony about animals' intelligent acts which one gets from anecdotes. Such testimony is by no means on a par with testimony about the size of a fish or the migration of birds, etc. For here one has to deal not merely with ignorant or inaccurate testimony, but also with prejudiced testimony. Human folk are as a matter of fact eager to find intelligence in animals. They like to. And when the animal observed is a pet belonging to them or their friends, or when the story is one that has been told as a story to entertain, further complications are introduced. Nor is this all. Besides commonly misstating what facts they report, they report only such facts as show the animal at his best. Dogs get lost hundreds of times and no one ever notices it or sends an account of it to a scientific magazine. But let one find his way from Brooklyn to Yonkers and the fact immediately becomes a circulating anecdote. Thousands of cats on thousands of occasions sit helplessly yowling, and no one takes thought of it or writes to his friend, the professor; but let one cat claw at the knob of a door supposedly as a signal to be let out, and straightway this cat becomes the representative of the cat-mind in all the books. The unconscious distortion of the facts is almost harmless compared to the unconscious neglect of an animal's mental life until it verges on the unusual and marvelous. It is as if some denizen of a planet where communication was by thought-transference, who was surveying humankind and reporting their psychology, should be oblivious to all our intercommunication save such as the psychical-research society has noted. If he should further misinterpret the cases of mere coincidence of thoughts as facts comparable to telepathic communication, he would not be more wrong than some of the animal psychologists. In short, the anecdotes give really the <u>abnormal</u> or <u>super-normal</u> psychology of animals.

Further, it must be confessed that these vices have been only ameliorated, not obliterated, when the observation is first hand, is made by the psychologist himself. For as men of the utmost scientific skill have failed to prove good observers in the field of spiritualistic phenomena, so biologists and psychologists before the pet terrier or hunted fox often become like Samson shorn. They, too, have looked for the intelligent and unusual and neglected the stupid and normal.

Finally, in all cases, whether of direct observation or report by good observers or bad, there have been three other defects. Only a single case is studied, and so the results are not necessarily true of the type; the observation is not repeated, nor are the conditions perfectly regulated; the previous history of the animal in question is not known. Such observations may tell us, if the observer is perfectly

reliable, that a certain thing takes place, but they cannot assure us that it will take place universally among the animals of that species, or universally with the same animal. Nor can the influence of previous experience be estimated. All this refers to means getting knowledge about what animals do. The next question is, "What do they feel?" Previous work has not furnished an answer or the material for an answer to this more important question. Nothing but carefully designed, crucial experiments can. In abandoning the old method one ought to seek above all to replace it by one which will not only tell more accurately what they do, and give the much-needed information how they do it, but also inform us what they feel while they act.

To remedy these defects experiment must be substituted for observation and the collection of anecdotes. Thus you immediately get rid of several of them. You can repeat the conditions at will, so as to see whether or not the animal's behavior is due to mere coincidence. A number of animals can be subjected to the same test, so as to attain typical results. The animal may be put in situations where its conduct is especially instructive. After considerable preliminary observation of animals' behavior under various conditions, I chose for my general method one which, simple as it is, possesses several other marked advantages besides those which accompany experiment of any sort. It was merely to put animals when hungry in enclosures from which they could escape by some simple act, such as pulling at a loop of cord, pressing a lever, or stepping on a platform. (A detailed description of these boxes and pens will be given later.) The animal was put in the enclosure, food was left outside in sight, and his actions observed. Besides recording his general behavior, special notice was taken of how he succeeded in doing the necessary act (in case he did succeed), and a record was kept of the time that he was in the box before performing the successful pull, or clawing, or bite. This was repeated until the animal had formed a perfect association between the sense-impression of the interior of that box and the impulse leading to the successful movement. When the association was thus perfect, the time taken to escape was, of course, practically constant and very short.

If, on the other hand, after a certain time the animal did not succeed, he was taken out, but not fed. If, after a sufficient number of trials, he failed to get out, the case was recorded as one of complete failure. Enough different sorts of methods of escape were tried to make it fairly sure that association in general, not association of a particular sort of impulse, was being studied. Enough animals were taken with each box or pen to make it sure that the results were not due to individual peculiarities. None of the animals used had any previous acquaintance with any of the mechanical contrivances by which the doors were opened. So far as possible the animals were kept in a uniform state of hunger, which was practically utter hunger. That is, no cat or dog was experimented on when the experiment involved any important question of fact or theory, unless I was sure that his motive was of the standard strength. With chicks this is not practicable, on account of their delicacy. But with them dislike of loneliness acts as a uniform motive to get back to the other chicks. Cats (or rather kittens), dogs and chicks were the subjects of the experiments. All were apparently in excellent health, save an occasional chick.

By this method of experimentation the animals are put in situations which call into activity their mental functions and permit them to be carefully observed. One may, by following it, observe personally more intelligent acts than are included in any anecdotal collection. And this actual vision of the animals in the act of using their minds is far more fruitful than any amount of histories of what animals have done without the history of how they did it. But besides affording this opportunity for purposeful and systematic observation, our method is valuable because it frees the animal from any influence of the observer. The animal's behavior is quite independent of any factors save its own hunger, the mechanism of the box it is in, the food outside, and such general matters as fatigue, indisposition, etc. Therefore the work done by one investigator may be repeated and verified or modified by another. No personal factor is present save in the observation and interpretation. Again, our method gives some very important results which are quite uninfluenced by <u>any</u> personal factor in any way. The curves showing the progress of the formation of associations, which are obtained from the records of the times taken by the animal in successive trials, are facts which may be obtained by any observer who can tell time. They are absolute, and whatever can be deduced from them is sure. So also the question of whether an animal does or does not form a certain association requires for an answer no higher qualification in the observer than a pair of eyes. The literature of animal psychology shows so uniformly and often so sadly the influence of the personal equation that any method which can partially eliminate it deserves a trial.

Furthermore, although the associations formed are such as could not have been previously experienced or provided for by heredity, they are still not too remote from the animal's ordinary course of life. They mean simply the connection of a certain act with a certain situation and resultant pleasure, and this general type of association is found throughout the animal's life normally. The muscular movements required are all such as might often be required of the animal. And yet it will be noted that the acts required are nearly enough like the acts of the anecdotes to enable one to compare the results of experiment by this method with the work of the anecdote school.

. . . . .

The starting point for the formation of any association in these cases, then, is the set of instinctive activities which are aroused when a cat feels discomfort in the box either because of confinement or a desire for food. This discomfort, plus the sense-impression of a surrounding, confining wall, expresses itself prior to any experience, in squeezings, clawings, bitings, etc. From among these movements one is selected by success. But this is the starting point only in the case of the first box experienced. After that the cat has associated with the feeling of confinement certain impulses which have led to success more than others and are thereby strengthened. A cat that has learned to escape from <u>A</u> by clawing has when put into <u>C</u> or <u>G</u> a greater tendency to claw at things than it instinctively had at the start, and a less tendency to squeeze through holes. A very pleasant form of this decrease in instinctive impulses was noticed in the

gradual cessation of howling and mewing. However, the useless instinctive impulses die out slowly, and often play an important part even after the cat has had experience with six or eight boxes. And what is important in our previous statement, namely, that the activity of an animal when first put into a new box is not directed by any appreciation of that box's character, but by certain general impulses to acts, is not affected by this modification. Most of this activity is determined by heredity; some of it, by previous experience.

My use of the words instinctive and impulse may cause some misunderstanding unless explained here. Let us, throughout this book, understand by instinct any reaction which an animal makes to a situation without experience. It thus includes unconscious as well as conscious acts. Any reaction, then, to totally new phenomena, when first experienced, will be called instinctive. Any impulse then felt will be called an instinctive impulse. Instincts include whatever the nervous system of an animal, as far as inherited, is capable of. My use of the word will, I hope, everywhere make clear what fact I mean. If the reader gets the fact meant in mind it does not in the least matter whether he would himself call such a fact instinct or not. Any one who objects to the word may substitute 'hocus-pocus' for it wherever it occurs. The definition here made will not be used to prove or disprove any theory, but simply as a signal for the reader to imagine a certain sort of fact.

The word impulse is used against the writer's will, but there is no better. Its meaning will probably become clear as the reader finds it in actual use, but to avoid misconception at any time I will state now that impulse means the consciousness accompanying a muscular innervation apart from that feeling of the act which comes from seeing oneself move, from feeling one's body in a different position, etc. It is the direct feeling of the doing as distinguished from the idea of the act done gained through eye, etc. For this reason I say 'impulse and act' instead of simply 'act.' Above all, it must be borne in mind that by impulse I never mean the motive to the act. In popular speech you may say that hunger is the impulse which makes the cat claw. That will never be the use here. The word motive will always denote that sort of consciousness. Any one who thinks that the act ought not to be thus subdivided into impulse and deed may feel free to use the word act for impulse or impulse and act throughout, if he will remember that the act in this aspect of being felt as to be done or as doing is in animals the important thing, is the thing which gets associated, while the act is done, as viewed from outside, is a secondary affair. I prefer to have a separate word, impulse, for the former, and keep the word act for the latter, which it commonly means.

Starting, then, with its store of instinctive impulses, the cat hits upon the successful movement, and gradually associates it with the sense-impression of the interior of the box until the connection is perfect, so that it performs the act as soon as confronted with the sense-impression. The formation of each association may be represented graphically by a time-curve. In these curves lengths of one millimeter along the abcissa represent successive experiences in the box, and heights of one millimeter above it each represent ten seconds of time. The curve is formed by joining the tops of perpendiculars

erected along the abscissa 1 mm. apart (the first perpendicular coinciding with the y line), each perpendicular representing the time the cat was in the box before escaping. Thus, in Fig. 7. . . the curve marked 12 in A shows that in 24 experiences or trials in box A, cat 12

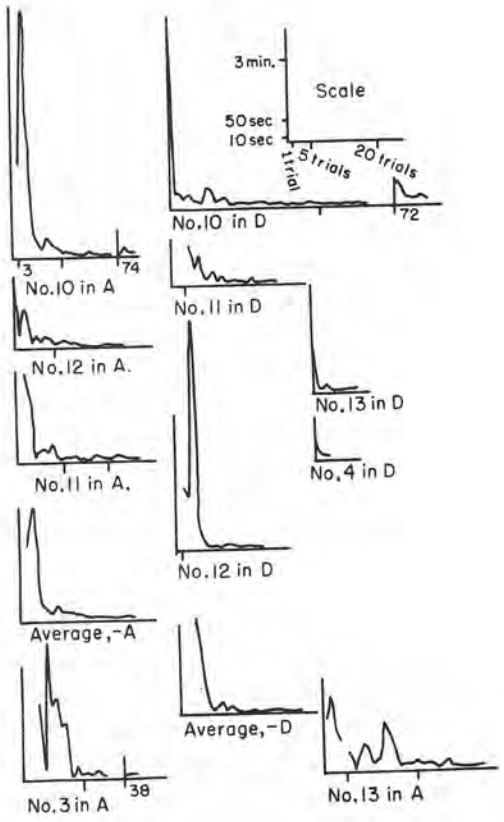

Fig. 7

took the following times to perform the act, 160 sec., 30 sec., 90 sec., 60, 15, 28, 20, 30, 22, 11, 15, 20, 12, 10, 14, 10, 8, 8, 5, 10, 8, 6, 6, 7. A short vertical line below the abscissa denotes that an interval of approximately 24 hours elapsed before the next trial. Where the interval was longer it is designated by a figure 2 for two days, 3 for three days, etc. If the interval was shorter the number of hours is specified by 1 hr., 2 hrs., etc. In many cases the animal failed in some trial to perform the act in ten or fifteen minutes and was then taken out by me. Such failures are denoted by a break in the curve either at its start or along its course. In some cases there are short curves after the main ones. These, as shown by the figures beneath, represent the animal's mastery of the association after a very long interval of time, and may be called memory curves. . .

The time-curve is obviously a fair representation of the progress of the formation of the association, for the two essential factors in the latter are the disappearance of all activity save the particular sort which brings success with it, and perfection of that particular sort of act so that it is done precisely and at will. Of these the second is, on deeper analysis, found to be part of the first; any clawing at a loop except the particular claw which depresses it is theoretically a useless activity. If we stick to the looser phraseology, however, no harm will be done. The combination of these two factors is inversely proportional to the time taken, provided the animal surely wants to get out at once. This was rendered almost certain by the degree of hunger. Theoretically a perfect association is formed when both factors are perfect,--when the animal, for example, does nothing but claw at the loop, and claws at it in the most useful way for the purpose. In some cases. . . neither factor ever gets perfected in a great many trials. In some cases the first factor does but the second does not, and the cat goes at the thing not always in the desirable way. In all cases there is a fraction of the time which represents getting oneself together after being dropped in the box, and realizing where one is. But for our purpose all these matters count little, and we may take the general slope of the curve as representing very fairly the progress of the association. The slope of any particular part of it may be due to accident. Thus, very often the second experience may have a higher time-point than the first, because the first few successes may all be entirely due to accidentally hitting the loop, or whatever it is, and whether the accident will happen sooner in one trial than another is then a matter of chance. Considering the general slope, it is, of course, apparent that a gradual descent--say, from initial times of 300 sec. to a constant time of 6 or 8 sec. in the course of 20 to 30 trials--represents a difficult association, while an abrupt descent, say in 5 trials, from a similar initial height, represents a very easy association.

Presumably the reader has already seen budding out of this dogma a new possibility, a further simplification of our theories about animal consciousness. The possibility is that animals may have no images or memories at all, no ideas to associate. Perhaps the entire fact of association in animals is the presence of sense-impressions with which are associated, by resultant pleasure, certain impulses, and that therefore, and therefore only, a certain situation brings forth a certain act. Returning to our analysis of the association, this theory would say that . . . the sense-impression gave rise, when accompanied by the feeling of discomfort, to the impulse. . . directly, without the intervention of any representations of the taste of the food, or the experience of being outside, or the sight of oneself doing the act. This theory might be modified so as to allow that the representations could be there, but to deny that they were necessary, were inevitably present, that the impulse was connected to the sense-impression through them. It would then claim that the effective part of the association was a direct bond between the situation and the impulse, but would not cut off the possibility of there being an aura of memories along with the process. It then becomes a minor question of interpretation which will doubtless sooner or later demand an answer. I shall not try to answer it now. The more radical question, the question of the utter exclusion of representative trains

of thought, of any genuine association of ideas from the mental life of animals, is worth serious consideration. I confess that, although certain authentic anecdotes and certain experiments to be described soon, lead me to reject this exclusion, there are many qualities in animals' behavior which seem to back it up. If one takes his stand by a rigid application of the law of parsimony, he will find justification for this view which no experiments of mine can overthrow.

Of one thing I am sure, and that is that it is worth while to state the question and how to solve it, for although the point of view involved is far removed from that of our leading psychologists today, it cannot long remain so. I am sorry that I cannot pretend to give a final decision.

WILLIAM McDOUGALL

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Each of us has no direct or immediate acquaintance with minds other than his own. Each one of us experiences pain and pleasure and various emotions, thinks and strives, remembers and expects and resolves. And it is generally agreed that all such experiences are manifestations of his mind or mental capacities. By reflection upon such experiences a man may form some notion of what his mind does and can do. And, by comparing notes with other men, he learns that they have similar experiences upon similar occasions, and infers that they have minds not unlike his own. Such observation of the varieties of one's own experience is called introspection. . . /which/ has for a long time been a well-recognized method; it has in fact often been declared to be the sole practical method of psychological study, the only legitimate and effective method of obtaining knowledge of the mind.

. . . . .

The introspective method has . . . peculiar difficulties and limitations; yet, in spite of these, it is possible for it to achieve a generalized description of types of experience. It could and did achieve in this way a certain stage of psychological science, namely, the descriptive classificatory stage, which is but the first stage of the development of a science. But even this could be achieved only by taking note of the conditions under which we enjoy the experiences that we more or less successfully describe in words. . . Some of these conditions are facts of the outer world, some are facts of experience; and by noting systematically such occasions or conditions of various types of experience, it is possible to establish a certain number of empirical rules which raise to the explanatory stage the purely descriptive psychology attainable by introspection alone . . .

A third great type of observation enables us to carry yet further our understanding of our experience, and at the same time raises another group of problems. This is the observation of conduct or behavior, both our own and that of other persons.

. . . . .

By "behavior" we commonly mean the action or actions of some living thing, /for/ behavior. . . it peculiar to living things. When an animal is dead, its corpse does not "behave"; it has become inert, the sport of forces that play upon it from without. This indicates one of the marks of behavior, namely, a certain spontaneity of movement. In behaving, an animal is not simply pushed or pulled by forces external to itself; but if it actively resists the push or pull, it is behaving. It is true that the behavior of an animal often appears to be a response or reaction to some sense-impression, a sound, or a touch, or a ray of light. And some of the mechanists dogmatically lay down the law that every movement is a response to some such impression . . . Whether this assumption is well founded we cannot at present say. But, even if it be true that

every instance of behavior is initiated by a "stimulus," it is evident that the movement or train of behavior, once initiated, often continues independently of the initiating stimulus. A momentary noise, such as the snapping of a twig, may send a rabbit scurrying to his burrow, put to flight a flock of birds, and throw the timid deer into the attitude and motions of alert watchfulness. . . This is the second mark of behavior; namely the persistence of activity independently of the continuance of the impression which may have initiated it.

An inanimate object, when set in motion, continues to move in the same direction, if not acted upon by any forces which deflect or arrest it. . . Its movements and changes are in principle strictly predictable according to physical laws . . . But, when an animal persists in the movements initiated by sense-impression, its movements are not predictable in detail . . . When, for example, /an animal/, like a rabbit, belongs to some timid species which normally shelters itself in holes in the earth, we may predict that, if it is set running by a sudden noise, it will continue to run until it finds such shelter, and that, if the course, it first takes, leads to no such shelter, it will dodge hither and thither until such shelter is found. Such variation of direction of persistent movements is a third mark of behavior.

The movements of an animal are commonly continued, with more or less variation of direction, until they bring about that kind of change in its situation which, as we have noted, is predictable in general terms from a knowledge of the species; and when that new situation is achieved, the train of activity commonly ceases, perhaps giving place to some activity of an altogether different kind. . . This coming to an end of the animal's movements as soon as they have brought about a particular kind of change in its situation is a fourth mark of behavior.

Again, we may often observe that, while the animal's movements are maintained, they seem to show in some degree preparation for, or anticipation of, the new situation which will bring them to an end, or will give rise to a new and very different train of movements. . . The cat, aroused by the squeak of the mouse behind the wainscot, stealthily approaches the hole and there lies in wait in the attitude of preparation for the spring upon the prey. Such preparation for the new situation toward the production of which the action contributes is a fifth mark of behavior.

. . . . .

A sixth mark of behavior, which is less easy to observe, has been very commonly accepted as the most trustworthy indication of mental life; namely, some degree of improvement in the effectiveness of behavior, when it is repeated by the animal under similar circumstances . . . No doubt, when such improvement may be observed, it provides the surest criterion; but, without this sixth mark, we may infer mental activity from the other five. And it is to be noted that this sixth mark implies the others; if the train of movements did not represent those characters, we should not be able to infer Mind from the sixth alone.

. . . . .

In contrasting reflex action with purposive action or behavior, we must take notice of yet another distinction of great importance, which perhaps deserves to rank as seventh objective mark of behavior, namely, a reflex action is always a partial reaction, but a purposive action is a total reaction of the organism. . .

In purposive action . . . the whole organism is commonly involved; the processes of all its parts are subordinated and adjusted in such a way as to promote the better pursuit of the natural goal of the action. If, while you amuse yourself by repeatedly exciting the scratch-reflex in your dog, some sound excites him to behavior, then, even though the behavior consists in nothing more than assuming an alert attitude with eyes and ears directed toward the disturbing object, your stimulation of his flank becomes ineffective. . . If the sound is followed by the appearance of a stranger (dog or man) your dog springs to his feet with every muscle and organ at work in preparation for attack. . . That is the type of the total reaction.

Burrhus Frederic Skinner (1904-)

Pavlov's contributions to psychology began with studies of digestive activity in dogs. Skinner's researches took off in a similar fashion from an investigation of the eating behavior of white rats. Each man went on to develop a new method of research, a new body of experimental data, and a system of behavior. Using a "repeating problem box" and rate of response as his measure, Skinner did for voluntary behavior what Pavlov had done for reflex, at the same time giving new life to Thorndike's Law of Effect and opening up a field of pure and applied research that has not yet reached its peak of productivity. In the present situation, from The Behavior of Organisms (1938) you will find signs of Skinner's indebtedness to earlier men--to Sherrington, Pavlov, and, to a lesser degree, Thorndike, Morgan, and Darwin. You will also find references, sometimes veiled, to the teachings of Watson, Köhler, and Freud; and you will discover certain themes that were later to be expanded--such as the relation of physiology to psychology and the role of hypothesis in the study of behavior. Most of all, however, you will sample the systematic thought of the leading psychological thinker of our time, in his first important book. Welcome to the B. of O.!

Study Questions

1. What stages does Skinner find in the development of behavior systems? What does he say about current "explanations" of behavior?

2. How did behavior come to be investigated for its own sake?

3. How does Skinner define behavior? Should we analyze behavior? What is "narration?" What is wrong with "narration?"

4. How are stimulus and response defined? How does his notion of reflex differ from Sherrington's? Criticize reflex "cataloguing."

5. How do "static" differ from "dynamic" laws? Have you met these laws before?

6. How does Skinner's position differ from Sherrington's? From Pavlov's?

7. What are respondents? Operants? How are they measured?

8. Which "laws" remind you most of Hobbes? Thorndike? Pavlov? Which suggest "successive associations"; "similarity"; Jenning's discrimination?

9. With which of the men that you have considered in this course does Skinner have most in common? Why?

Skinner, B. F. The Behavior of Organisms, An Experimental Analysis. New York: Appleton-Century-Crofts, Inc. 1938.

Chapter One
A SYSTEM OF BEHAVIOR
Behavior as a Scientific Datum

Although the kind of datum to which a science of behavior addresses itself is one of the commonest in human experience, it has only recently come to be regarded without reservation as a valid scientific subject matter. It is not that man has never talked about behavior nor tried to systematize and describe it, but that he has constantly done so by indirection. Behavior has that kind of complexity or intricacy which discourages simple description and in which magical explanatory concepts flourish abundantly. Primitive systems of behavior first set the pattern by placing the behavior of man under the direction of entities beyond man himself. The determination of behavior as a subject of scientific inquiry was thus efficiently disposed of, since the directing forces to which appeal was made were by hypothesis inscrutable or at least called only faintly for explanation. In more advanced systems of behavior, the ultimate direction and control have been assigned to entities placed within the organism and called psychic or mental. Nothing is gained by this stratagem because most, if not all, of the determinative properties of the original behavior must be assigned to the inner entity, which becomes, as it were, an organism in its own right. However, from this starting point three courses are possible. The inner organism may in resignation be called free, as in the case of 'free will,' when no further investigation is held to be possible. Or, it may be so vaguely defined as to disturb the curiosity of no one, as when the man in the street readily explains his behavior by appeal to a directing 'self' but does not ask nor feel it necessary to explain why the self behaves as it does. Or, it may become in turn the subject matter of a science. Some conceptions of the 'mind' and its faculties, and more recently the 'ego,' 'super-ego,' and 'id,' are examples of inner agents or organisms, designed to account for behavior, which have remained the subject of scientific investigation.

The important advance from this level of explanation that is made by turning to the nervous system as a controlling entity has unfortunately had a similar effect in discouraging a direct descriptive attack upon behavior. The change is an advance because the new entity beyond behavior to which appeal is made has a definite physical status of its own and is susceptible to scientific investigation. Its chief function with regard to a science of behavior, however, is again to divert attention away from behavior as a subject matter. The use of the nervous system as a fictional explanation of behavior was a common practice even before Descartes, and it is now much more widely current than is generally realized. At a popular level a man is said to be capable (a fact about his behavior) because he has brains (a fact about his nervous system). Whether or not such a statement has any meaning for the person who makes it is scarcely important; in either case it exemplifies the practice of explaining an obvious (if unorganized) fact by appeal to something about which little is known. The more sophisticated neurological views generally agree with the popular view in

contending that behavior is in itself incomprehensible but may be reduced to law if it can be shown to be controlled by an internal system susceptible to scientific treatment. Facts about behavior are not treated in their own right, but are regarded as something to be explained or even explained away by the prior facts of the nervous system. (I am not attempting to discount the importance of a science of neurology but am referring simply to the primitive use of the nervous system as an explanatory principle in avoiding a direct description of behavior.)

The investigation of behavior as a scientific datum in its own right came about through a reformation of psychic rather than neurological fictions. Historically, it required three interesting steps, which have often been described and may be briefly summed up in the following way. Darwin, insisting upon the continuity of mind, attributed mental faculties to some subhuman species. Lloyd Morgan, with his law of parsimony, dispensed with them there in a reasonably successful attempt to account for characteristic animal behavior without them. Watson used the same technique to account for human behavior and to reestablish Darwin's desired continuity without hypothesizing mind anywhere. Thus was a science of behavior born, but under circumstances which can scarcely be said to have been auspicious. The science appeared in the form of a remodeled psychology with ill-concealed evidences of its earlier frame. It accepted an organization of data based upon ancient concepts which were not an essential part of its own structure. It inherited a language so infused with metaphor and implication that it was frequently impossible merely to talk about behavior without raising the ghosts of dead systems. Worst of all, it carried on the practice of seeking a solution for the problems of behavior elsewhere than in behavior itself. When a science of behavior had once rid itself of psychic fictions, it faced these alternatives: either it might leave their places empty and proceed to deal with its data directly, or it might make replacements. The whole weight of habit and tradition lay on the side of replacement. The altogether too obvious alternative to a mental science was a neural science, and that was the choice made by a non-mentalistic psychology. The possibility of a directly descriptive science of behavior and its peculiar advantages have received little attention.

The need for a science of behavior should be clear to anyone who looks about him at the role of behavior in human affairs. Indeed, the need is so obvious and so great that it has acted to discourage rather than to stimulate the establishment of such a science. It is largely because of its tremendous consequences that a rigorous treatment of behavior is still regarded in many quarters as impossible. The goal has seemed wholly inaccessible. What the eventual success of such a science might be, probably no one is now prepared to say; but the preliminary problems at least are not beyond the reach of existing scientific methods and practices, and they open up one of the most interesting prospects in modern science.

The two questions which immediately present themselves are: What will be the structure of a science of behavior? and How valid can its laws be made? These questions represent sufficiently well the double field of the present book. I am interested, first, in setting up a system of behavior in terms of which the facts of a science may be

stated and, second, in testing the system experimentally at some of its more important points. In the present chapter I shall sketch what seems to me the most convenient formulation of the data at the present time, and in later chapters I shall consider some factual material fitting into this scheme. If the reader is primarily interested in facts and experimental methods, he may go directly to Chapter Two, using the index here and there to clarify the terms defined in what follows. If he is interested in the structure of a science of behavior and wishes to understand why the experiments to be reported were performed the theoretical treatment in the rest of this chapter is indispensable.

A DEFINITION OF BEHAVIOR

It is necessary to begin with a definition. Behavior is only part of the total activity of an organism, and some formal delimitation is called for. The field might be defined historically by appeal to an established interest. As distinct from the other activities of the organism, the phenomena of behavior are held together by a common conspicuousness. Behavior is what an organism is doing--or more accurately what it is observed by another organism to be doing. But to say that a given sample of activity falls within the field of behavior simply because it normally comes under observation would misrepresent the significance of this property. It is more to the point to say that behavior is that part of the functioning of an organism which is engaged in acting upon or having commerce with the outside world. The peculiar properties which make behavior a unitary and unique subject matter follow from this definition. It is only because the receptors of other organisms are the most sensitive parts of the outside world that the appeal to an established interest in what an organism is doing is successful.

By behavior, then, I mean simply the movement of an organism or of its parts in a frame of reference provided by the organism itself or by various external objects or fields of force. It is convenient to speak of this as the action of the organism upon the outside world, and it is often desirable to deal with an effect rather than with the movement itself, as in the case of the production of sounds.

NARRATION AND THE REFLEX

Once in possession of a set of terms we may proceed to a kind of description of behavior by giving a running account of a sample of behavior as it unfolds itself in some frame of reference. This is a typical method in natural history and is employed extensively in current work--for example, in child and infant behavior. It may be described as narration. It presents no special problem. If there is an objection to the use of a verbal description, the investigator may resort to sound-films and multiply them at will; and the completeness of the transcription will be limited only by any eventual unwillingness to increase the number of recording devices any further. From data obtained in this way it is possible to classify different kinds of behavior and to determine relative frequencies of occurrence. But although this is, properly speaking, a description of behavior, it is not a science in the accepted sense. We need to go beyond mere observation to a study of functional relationships. We need to establish laws by virtue of which we may predict behavior, and we may do this only by finding variables of which

behavior is a function.

One kind of variable entering into the description of behavior is to be found among the external forces acting upon the organism. It is presumably not possible to show that behavior as a whole is a function of the stimulating environment as a whole. A relation between terms as complex as these does not easily submit to analysis and may perhaps never be demonstrated. The environment enters into a description of behavior when it can be shown that a given part of behavior may be induced at will (or according to certain laws) by a modification in part of the forces affecting the organism. Such a part, or modification of a part, of the environment is traditionally called a stimulus and the correlated part of the behavior a response. Neither term may be defined as to its essential properties without the other. For the observed relation between them I shall use the term reflex, for reasons which, I hope, will become clear as we proceed. Only one property of the relation is usually invoked in the use of the term--the close coincidence of occurrence of stimulus and response--but there are other important properties to be noted shortly.

The difference between the demonstration of a reflex and mere narration is, not that part of the environment may not be mentioned in the narration, but that no lawful relation between it and the behavior is asserted. In the narrative form, for example, it may be said that 'at such and such a moment the ape picked up a stick.' Here there is no reference to other instances of the same behavior either past or future. It is not asserted that all apes pick up sticks. The story is told simply of something that has once happened. The isolation of a reflex, on the other hand, is the demonstration of a predictable uniformity in behavior. Another name may be used, and the degree of rigor in the demonstration of lawfulness may fall short of that required in the case of the reflex, but the same fundamental activity must go on whenever anything of a scientific nature is to be said about behavior that is not mere narration. Current objections to the reflex on the ground that in the analysis of behavior we destroy the very thing we are trying to understand, scarcely call for an answer. We always analyze. It is only good sense to make the act explicit--to analyze as overtly and as rigorously as possible.

So defined a reflex is not, of course, a theory. It is a fact. It is an analytical unit, which makes an investigation of behavior possible. It is by no means so simple a device as this brief account would suggest, and I shall return later to certain questions concerning its proper use. Many traditional difficulties are avoided by holding the definition at an operational level. I do not go beyond the observation of a correlation of stimulus and response. The omission of any reference to neural events may confuse the reader who is accustomed to the traditional use of the term in neurology. The issue will, I think, be clarified in Chapter Twelve, but it may be well to anticipate that discussion by noting that the concept is not used here as a 'neurological explanation' of behavior. It is a purely descriptive term.

That the reflex as a correlation of stimulus and response is not the only unit to be dealt with in a description of behavior will appear later when another kind of response that is 'emitted' rather than 'elicited' will be defined. The following argument is confined largely

to elicited behavior.

THE COLLECTION OF REFLEXES

One step in the description of behavior is the demonstration of the relationships that are called reflexes. It leads to considerable power of prediction and control, but this is not, as has often been claimed, the aim and end of the study of behavior. Watson, for example, defined the goal of psychological study as "the ascertaining of such data and laws that, given the stimulus, psychology can predict what the response will be; or, given the response, it can specify the nature of the effective stimulus /(75), p. 10./." But a little reflection will show that this is an impracticable program. In the field of behavior a science must contend with an extraordinary richness of experimental material. The number of stimuli to which a typical organism may respond originally is very great. The number of stimuli to which it may come to respond through a process to be described below is indefinitely large, and to each of them it may be made to respond in many ways. It follows that the number of possible reflexes is for all practical purposes infinite and that what one might call the botanizing of reflexes will be a thankless task.

Nevertheless, there is no way of reaching the goal set by this quotation, taken literally, except to botanize. The sort of prediction that it proposes would require the compilation of an exhaustive catalogue of reflexes, by reference to which predictions could be made. The catalogue would be peculiar to a single organism and would require continual revision as long as the organism lived. It is obviously unpractical. Quite aside from any question of completeness, it could not reach any degree of usefulness before becoming unmanageable from its sheer bulk. No one has seriously attempted to construct a catalogue for this purpose, and I have probably misconstrued the quotation. Those who regard wholesale prediction as the essence of the description of behavior have usually supposed it to be possible to reduce the size of the field and to reach detailed predictions by a shorter route. But no method has ever been demonstrated that would make this possible. Generally the attempt is made to reduce the total number of required terms by making each term more comprehensive (as by resorting to classes of reflexes). But the more comprehensive the term the less complete and less accurate the descriptive reference upon any given occasion when it is used. I shall show later that the level of analysis of the reflex is uniquely determined with respect to its usefulness as an analytical instrument and that it cannot be altered for the sake of reducing the number of terms to be taken into account.

We have no reason to expect, either from theoretical considerations or from a survey of what has already been done experimentally, that any wholesale prediction of response or identification of stimulus will become possible through the discovery of principles that circumvent the routing of listing reflexes. Confronted with the sheer expansiveness of the topography of behavior, we must concede the impossibility of any wholesale prediction of stimulus or response that could be called exact. The number of items to be dealt with is very great and does not seem likely to be reduced, and there is at present no reason to believe that a new order may some day be discovered to resolve

the difficulty. This view may appear somber to those who believe that the study of behavior is concerned primarily with the topographical prediction of stimulus and response. But this is a mistaken, and fatal, characterization of its aim. Actually there may be little interest in the continued demonstration of reflex relationships. The discovery of a reflex was historically an important event at a time when the field of behavior was encroached upon by many other (usually metaphysical) descriptive concepts. It may still conceivably be of importance whenever there seems to be a special reason for questioning the 'reflex nature' of a given bit of behavior. But when a large number of reflexes have once been identified and especially when it has been postulated that all behavior is reflex, the mere listing of reflexes has no further theoretical interest and remains important only for special investigations (as, for example, the analysis of posture). No interest in the description of behavior itself will prompt us to press the botanizing of reflexes any further.

THE STATIC LAWS OF THE REFLEX

I have restricted the preceding paragraphs to the topographical prediction of behavior in order to allow for another kind of prediction to which a science of behavior must devote itself--the prediction of the quantitative properties of representative reflexes. In limiting the concept of the reflex to the coincidence of occurrence of a stimulus and a response a considerable simplification is introduced; and the supposition that the relation so described is invariable involves another. It is only by virtue of these simplifications that the mere collection of reflexes may be shown to possess any predictive value whatsoever, and the argument against collection as the aim of a science of behavior might have been greatly strengthened by considering how reduced in value a catalogue would become after these simplifying assumptions had been lifted.

The quantitative properties arise because both stimulus and response have intensive and temporal dimensions in addition to their topography and because there is a correlation between the values assumed in the two cases. Given a stimulus over which we have quantitative control and a measure of the magnitude of the response, we are in a position to demonstrate the following laws.

THE LAW OF THRESHOLD. The intensity of the stimulus must reach or exceed a certain critical value (called the threshold) in order to elicit a response. A threshold follows from the necessarily limited capacity of the organism to be affected by slight external forces. The values obtained in typical reflexes of this sort are usually considerably above values for the basic receptive capacity of the organism determined in other ways (e.g., in the 'discrimination' of Chapter Five).

THE LAW OF LATENCY. An interval of time (called the latency) elapses between the beginning of the stimulus and the beginning of the response. A latency is to be expected from the usual spatial separation of receptor and effector and from the difference in form of energy of stimulus and response. The values obtained vary greatly between

reflexes, following to some slight extent a classification of receptors (cf. visual and thermal reflexes) and of effectors (cf. the responses of skeletal muscle and smooth muscle or gland). No measure of the magnitude of stimulus or response is needed to determine the latency, provided these magnitudes may be held constant, and it is therefore a useful measure when the dimensions of either term are in doubt. One important property of latency is that it is usually a function of the intensity of the stimulus, as Sherrington originally showed /(68), pp. 18 ff./. The stronger the stimulus the shorter the latency.

THE LAW OF THE MAGNITUDE OF RESPONSE. The magnitude of the response is a function of the intensity of the stimulus. Although there are exceptional cases which show an apparently all-or-none character, the magnitude of the response is in general graded, and there is a corresponding gradation in the intensity of the stimulus. The two magnitudes are measured on separate scales appropriate to the form of each term, but this does not interfere with the demonstration of a relation. The ratio of the magnitudes will be referred to hereafter as the R/S ratio.[1]

THE LAW OF AFTER-DISCHARGE. The response may persist for some time after the cessation of the stimulus. The term after-discharge is usually not applied to the time alone but to the total amount of activity taking place during it. In general the after-discharge increases with the intensity of the stimulus. In measuring the difference between the times of cessation the latency may be subtracted as a minor refinement.

The preceding statements regard the intensity of the stimulus as the only property of which the response is a function, but the duration must not be ignored. The laws are subject to the folowing elaboration:

THE LAW OF TEMPORAL SUMMATION. Prolongation of a stimulus or repetitive presentation within certain limiting rates has the same effect as increasing the intensity. Summation is often restricted to near-threshold values of the stimulus, when the effect is to obtain a response that is not elicited without summation, but the law applies to the magnitude of response, its latency, and so on, as well as to its mere occurrence. Thus, a sub-threshold value of a stimulus may elicit a response if it is prolonged or repeated within a certain time or at a

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[1]An increase in the intensity of the stimulus may result not only in an increase in the magnitude of the response but in an apparent change of topography. Thus, a mild shock to the foot may bring about simple flexion, while a stronger shock will lead to vigorous postural and progressive responses. These effects may be treated by dealing with each response separately and noting that the thresholds differ. A single stimulus is correlated with all of them but elicits any given one only when it is above its particular threshold value.

certain rate, and the magnitude of the response and the after-discharge are functions of the duration of the stimulus as well as the intensity. The latency is frequently too short to be affected by prolongation of the stimulus, but at near-threshold values of the stimulus an effect may be felt. With repetitive presentation of a weak stimulus, the latency is a function of the frequency of presentation.[2]

The properties of latency, threshold, after-discharge and the R/S ratio are detected by presenting a stimulus at various intensities and durations and observing the time of occurrence, duration, and magnitude of the response. They may be called the static properties of a reflex. They supplement a topographical description in an important way and cannot be omitted from any adequate account. They are to be distinguished from a more extensive group of laws which concern changes in the state of the static properties. Changes begin to be observed when we repeat the elicitation of a reflex, as we cannot help doing if we are to check our measurements or if we are to give a description of behavior over any considerable period of time. The values of the static properties of a reflex are seldom, if ever, exactly confirmed upon successive elicitations. Important changes take place either in time or as a function of certain operations performed upon the organism. They are described by invoking another kind of law which I shall distinguish from the preceding by calling it dynamic.

. . . . .

(The next selection from Skinner starts on the following page)

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[2]The summated stimulus may appear to bring about topographical changes similar to those following an increase in the intensity of the stimulus. Iff the pinna of a sleeping dog is touched, the ear may be flicked; if it is repeatedly touched the dog may stir and change its position. What has happened may be treated as in the case of increased intensity. The reflex of changing position has a higher threshold than the pinna reflex and may be exhibited only with a stronger stimulus or through the summation of stimuli.

In the course of this book I shall attempt to show that a large body of material not usually considered in this light may be expressed with dynamic laws which differ from the classical examples only in the nature of the operations. The most important instances are conditioning and extinction (with their subsidiary processes of discrimination), drive, and emotion, which I propose to formulate in terms of changes in reflex strength. One type of conditioning and its corresponding extinction may be described here.

THE LAW OF CONDITIONING OF TYPE S. The approximately simultaneous presentation of two stimuli, one of which (the 'reinforcing' stimulus) belongs to a reflex existing at the moment at some strength, may produce an increase in the strength of a third reflex composed of the response of the reinforcing reflex and the other stimulus.

THE LAW OF EXTINCTION OF TYPE S. If the reflex strengthened through conditioning of Type S is elicited without presentation of the reinforcing stimulus, its strength decreases.

These laws refer to the Pavlovian type of conditioned reflex, which will be discussed in detail in Chapter Three. I wish to point out here simply that the observed data are merely changes in the strength of a reflex. As such they have no dimensions which distinguish them from changes in strength taking place during fatigue facilitation, inhibition, or, as I shall show later, changes in drive, emotion, and so on. The process of conditioning is distinguished by what is done to the organism to induce the change; in other words, it is defined by the operation of the simultaneous presentation of the reinforcing stimulus and another stimulus. The type is called Type S to distinguish it from conditioning of Type R (see below) in which the reinforcing stimulus is contingent upon a response.

Before indicating how other divisions of the field of behavior may be formulated in terms of reflex strength, it will be necessary to consider another kind of behavior, which I have not yet mentioned. The remaining dynamic laws will then be taken up in connection with both kinds at once.

Operant Behavior

With the discovery of the stimulus and the collection of a large number of specific relationships of stimulus and response, it came to be assumed by many writers that all behavior would be accounted for in this way as soon as the appropriate stimuli could be identified. Many elaborate attempts have been made to establish the plausibility of this assumption, but they have not, I believe, proved convincing. There is a large body of behavior that does not seem to be elicited, in the sense in which a cinder in the eye elicits closure of the lid, although it may eventually stand in a different kind of relation to external stimuli. The original 'spontaneous' activity of the organism is chiefly of this sort, as is the greater part of the conditioned behavior of the adult organism, as I hope to show later. Merely to assert that there must be eliciting stimuli is an unsatisfactory appeal to ignorance. The brightest hope of establishing the generality of the eliciting stimulus was

provided by Pavlov's demonstration that part of the behavior of the adult organism could be shown to be under the control of stimuli which had acquired their power to elicit. But a formulation of this process will show that in every case the response to the conditioned stimulus must first be elicited by an unconditioned stimulus. I do not believe that the 'stimulus' leading to the elaborate responses of singing a song or of painting a picture can be regarded as the mere substitute for a stimulus or a group of stimuli which originally elicited these responses or their component parts.

Most of the pressure behind the search for eliciting stimuli has been derived from a fear of 'spontaneity' and its implication of freedom. When spontaneity cannot be avoided, the attempt is made to define it in terms of unknown stimuli. Thus, Bethe (28) says that the term 'has long been used to describe behavior for which the stimuli are not known and I see no reason why the word should be stricken from a scientific vocabulary.' But an event may occur without any observed antecedent event and still be dealt with adequately in a descriptive science. I do not mean that there are no originating forces in spontaneous behavior but simply that they are not located in the environment. We are not in a position to see them, and we have no need to. This kind of behavior might be said to be emitted by the organism, and there are appropriate techniques for dealing with it in that form. One important independent variable is time. In making use of it I am simply recognizing that the observed datum is the appearance of a given identifiable sample of behavior at some more or less orderly rate. The use of a rate is perhaps the outstanding characteristic of the general method to be outlined in the following pages, where we shall be concerned very largely with behavior of this sort.

The attempt to force behavior into the simple stimulus-response formula has delayed the adequate treatment of that large part of behavior which cannot be shown to be under the control of eliciting stimuli. It will be highly important to recognize the existence of this separate field in the present work. Differences between the two kinds of behavior will accumulate throughout the book, and I shall not argue the distinction here at any length. The kind of behavior that is correlated with specific eliciting stimuli may be called respondent behavior and a given correlation a respondent. The term is intended to carry the sense of a relation to a prior event. Such behavior as is not under this kind of control I shall call operant and any specific example an operant. The term refers to a posterior event, to be noted shortly. The term reflex will be used to include both respondent and operant even though in its original meaning it applied to respondents only. A single term for both is convenient because both are topographical units of behavior and because an operant may and usually does acquire a relation to prior stimulation. In general, the notion of a reflex is to be emptied of any connotation of the active 'push' of the stimulus. The terms refer here to correlated entities, and to nothing more. All implications of dynamism and all metaphorical and figurative definitions should be avoided as far as possible.

An operant is an identifiable part of behavior of which it may be said, not that no stimulus can be found that will elicit it (there may

be a respondent the response of which has the same topography), but that no correlated stimulus can be detected upon occasions when it is observed to occur. It is studied as an event appearing spontaneously with a given frequency. It has no static laws comparable with those of a respondent since in the absence of a stimulus the concepts of threshold, latency, after-discharge, and the R/S ratio are meaningless. Instead, appeal must be made to frequency of occurrence in order to establish the notion of strength. The strength of an operant is proportional to its frequency of occurrence, and the dynamic laws describe the changes in the rate of occurrence that are brought about by various operations performed upon the organism.

OTHER DYNAMIC LAWS

Three of the operations already described in relation to respondent behavior involve the elicitation of the reflex and hence are inapplicable to operants. They are the refractory phase, fatigue, and conditioning of Type S. The refractory phase has a curious parallel in the rate itself, as I shall note later, and a phenomenon comparable with fatigue may also appear in an operant. The conditioning of an operant differs from that of a respondent by involving the correlation of a reinforcing stimulus with a response. For this reason the process may be referred to as of Type R. Its two laws are as follows:

THE LAW OF CONDITIONING OF TYPE R. If the occurrence of an operant is followed by presentation of a reinforcing stimulus, the strength is increased.

THE LAW OF EXTINCTION OF TYPE R. If the occurrence of an operant already strengthened through conditioning is not followed by the reinforcing stimulus, the strength is decreased.

The conditioning is here again a matter of a change in strength. The strength cannot begin at zero since at least one unconditioned response must occur to permit establishment of the relation with a reinforcing stimulus. Unlike conditioning of Type S the process has the effect of determining the form of the response, which is provided for in advance by the conditions of the correlation with a reinforcing stimulus or by the way in which the response must operate upon the environment to produce a reinforcement (see Chapter Three).

It is only rarely possible to define an operant topographically (so that successive instances may be counted) without the sharper delineation of properties that is given by the act of conditioning. This dependence upon the posterior reinforcing stimulus gives the term operant its significance. In a respondent the response is the result of something previously done to the organism. This is true even for conditioned respondents because the operation of the simultaneous presentation of two stimuli precedes, or at least is independent of, the occurrence of the response. The operant, on the other hand, becomes significant for behavior and takes on an identifiable form when it acts upon the environment in such a way that a reinforcing stimulus is produced. The operant-respondent distinction goes beyond that

between Types S and R because it applies to unconditioned behavior as well; but where both apply, they coincide exactly. Conditioning of Type R is impossible in a respondent because the correlation of the reinforcing stimulus with a response implies a correlation with its eliciting stimulus. It has already been noted that conditioning of Type S is impossible in operant behavior because of the absence of an eliciting stimulus.

An operant may come to have a relation to a stimulus which seems to resemble the relation between the stimulus and response in a respondent. The case arises when prior stimulation is correlated with the reinforcement of the operant. The stimulus may be said to set the occasion upon which a response will be reinforced, and therefore (through establishment of a discrimination) upon which it will occur; but it does not elicit the response. The distinction will be emphasized later.

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Two other laws which come under the broad heading of interaction have a slightly different status, but may be listed here.

THE LAW OF CHAINING. The response of one reflex may constitute or produce the eliciting or discriminative stimulus of another. The stimuli may be proprioceptive (as in the serial reaction of throwing a ball) or produced externally by a change in the position of receptors (as when the organism looks to the right and then responds to a resulting visual stimulus or reaches out and then seizes the object which touches its hand). The Law of Chaining is considered again in the following chapter.

THE LAW OF INDUCTION. A dynamic change in the strength of a reflex may be accompanied by a similar but not so extensive change in a related reflex, where the relation is due to the possession of common properties of stimulus or response. The dynamic changes are limited to those which affect the reserve. An example of induction is the fatigue of a flexion reflex from one locus of stimulation through repeated elicitation of a reflex from another locus. This is not the meaning of induction given by Sherrington or Pavlov. In Sherrington's usage the term refers both to summation from adjacent stimuli (immediate induction) and to the 'post-inhibitory' strengthening of a related reflex (successive induction). The latter is, as Sherrington points out, in several ways the reverse of the former, and the use of a single term is misleading. Pavlov adopts the term from Sherrington but uses only the second meaning. Neither case matches the present definition, for a fuller explanation of which Chapter Five should be consulted.

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THE LAW OF THE DISCRIMINATION OF THE STIMULUS IN TYPE S. A reflex strengthened by induction from the reinforcement of a reflex possessing a similar but not identical stimulus may be separately extinguished if the difference in stimuli is supraliminal for the organism. This is an incomplete statement, since it ignores the reciprocal effect of the extinction upon the directly conditioned reflex and the need for repeated alternate conditioning and extinction in order to obtain any

considerable difference in strength. But since the degree to which the difference is carried is arbitrary and can apparently never be complete, the statement will suffice. The law follows from the Law of Induction, and, as its present statement implies, does not represent a new kind of dynamic process. The changes taking place in discrimination are conditioning and extinction. Nevertheless, the process is interesting in its own right and of considerable importance in the behavior of the organism since by far the greater part of conditioned behavior is discriminative.

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A formal expression of the process of discrimination may be given as follows:

THE LAW OF THE DISCRIMINATION OF THE STIMULUS IN TYPE R. The strength acquired by an operant through reinforcement is not independent of the stimuli affecting the organism at the moment, and two operants having the same form of response may be given widely different strengths through differential reinforcement with respect to such stimuli.