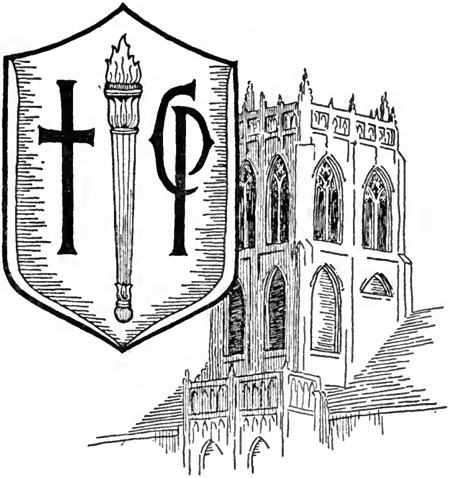

COLLEGE
OF THE PACIFIC

A SYSTEM OF PSYCHOLOGY

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BY

KNIGHT DUNLAP

ASSOCIATE PROFESSOR OF PSYCHOLOGY IN THE
JOHNS HOPKINS UNIVERSITY

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TO

ELMER ELLSWORTH BROWN

IN ACKNOWLEDGMENT OF WHAT I OWE TO HIS TEACHING AND FRIENDSHIP

PREFACE

I SHOULD not be willing to add to the large number of psychology texts already in existence did I not believe that this book, in spite of its faults of omission and commission, possesses certain good points not found in the other English texts of recent date.

My greatest effort has been to present as consistent and systematic a sketch as possible of the general field of normal human psychology, elaborating the details only when they are essential to the general survey. In a field which is in great and increasing danger of becoming unsystematized to the point of chaos, even to the trained specialist, this method of introduction is absolutely essential.

I have tried to show that the data of psychology cannot at present be definitely described except in terms of theories which are more or less "philosophical," and that the attempt to divorce the data from the theories would result in the uncritical acceptance of fragments of theories. It is important that the student should grasp this truth in the beginning, and not be taught a pseudo-final system of facts which later must crumble cataclysmically when he takes a new point of view.

I have not attempted to write a book so simple that the student might read and understand it without effort: rather, I have endeavored to write that which should demand and reward hard study. The book is not designed to be made the sole basis of a course in elementary psychology. It ought to be accompanied by lectures prepared by a competent teacher, having special reference to the difficulties and lacunæ of the text, and to its differences from the psychological theories held by the teacher. Certainly, the book cannot be used as a text from which both students and teacher may draw their information. As a main or supplementary text for semiadvanced students, it should find its greatest usefulness.

The only originality I can claim is in the way in which I have worked up materials borrowed from many places. I have not given credit for my borrowings, because in many cases the sources are too obvious to be mentioned, and in other cases what has been borrowed has been so distorted in the process that the individual to whom I am indebted might resent the ascription if credit were given.

The chief influences which have shaped my psychological constructions have come from the writings of James and from my contact, as a pupil, first with Howison, later with Stratton, and finally with Münsterberg.

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CHAPTER I

INTRODUCTION

1. The Meaning of Psychology

It is much easier to tell the beginner what psychology is *not* than it is to tell him what psychology is. Just as it would be impossible to give an intelligible definition of mathematics to a person unfamiliar with the elementary principles of number-relations, so it is impossible to make clear to the average student the nature of psychology when he is just beginning to study it. In order that one may have a definite idea of what psychology is, he must know some psychology; and a person who has not studied the subject under competent guidance is not apt to know any psychology in the strict sense. It is true, on the one hand, that there is a great deal of information which is popularly called psychological; and, on the other hand, that every person knows much that is really psychology, although the persons in question do not realize that it is such. These two species of misunderstanding contribute to the difficulty of the task when one commences to study the subject scientifically. It is clear, therefore, that what we say now in a general way concerning psychology should be brief, and that the meaning thereof will probably be clear to the student only as he reverts to it after completing the volume.

We may commence advantageously by warning the student against some of the more common misconceptions of psychology. In the first place, while on the one hand psychology is not the "study of the soul," on the other hand it is not "soulless" in the sense of doing away with a soul. It is a commonplace that *ψυχολογία* is not to be taken in its literal significance as the name of our field of labor, and that a considerable portion of the psychological discussion gets along without any mention of any sort of "soul." But in a comprehensive analysis it is not possible to avoid reference to something which may properly be called a "soul," although it is by no means the "psyche" of the Greeks and of the current popular conception, and although it is impossible really to study it.

In the second place, psychology deals very little with the so-called "occult"; with telepathy, clairvoyance, and the other charlatanisms which are often so successfully employed in separating the fool from his money. Yet if we do not affirm, neither do we deny, that there may be, at the core of some of these concretions of humbuggery, certain elements of psychological interest and importance. The investigation of such matters belongs, however, not properly to psychology, but to "psychic research."[1]

In the third place, the term "psychological" in current popular usage designates a certain delicacy or niceness of discrimination or adjustment. Thus the "psychological moment" implies an instant of time so appropriate for a certain act that a moment before would be too early, and a moment after too late. Any very precise analysis or description, of the characteristics and activities of human beings; or even a simulation of precision, is called "psychological"; and hence we find mention of "psychological" novels, and so forth. Now while psychology modestly acknowledges the pretension to

[1] The terms "psychic" and "psychical" must be distinguished carefully from "psychological." It is to be regretted that either of the first two terms is ever applied to the data which we study in the name of psychology.

exactness of analysis, she must deny any exclusive claim thereto, and cannot even pose as the only science which analyzes human activity and experience. In this popular sense of the term, physiology, logic, and ethics are, if anything, more "psychological" than is psychology.

Finally, psychology is not the study of the functions of the nervous system. In fact, all the essential points of psychology can be expounded, as they have been developed, without reference to the nervous system, or by reference to a conception thereof which is ridiculously inaccurate. Nevertheless, it is true that psychological principles and facts are more easily described and investigated when referred to the structure and probable activity of the brain and nerves, as understood by the person to whom described or by whom investigated, and we believe that the more closely the physiological conceptions approach agreement with the actual facts of structure and function, the more facile the progress of psychology.

As for a positive definition we may give the following, which will be made clear by the further discussion: psychology is the study of experience; of the reference of experience to its content; of any direct reference which it may have to a subject of experience; and of the content of experience in so far as it is directly related to experience.

2. Terminology

The terms used in this book may at first be a series of stumbling-blocks. Not only will the meaning in which many of them are used be found to differ decidedly from the meaning attached to them in every-day language, but in many cases the terms are not used in the senses in which they are used in other books which will be read by the student. This confusion is unavoidable. The terms have been used in so many different sciences (to say nothing of their unscientific uses), that they have acquired a variety of meanings, and we are obliged to select the significations which seem most appropriate. Some words, such as "mind," "intelligence," and "soul," have had, and still have, so many different meanings that they have come at last to mean practically nothing, and we hesitate to use them at all where accuracy is essential. In the choice of the signification to be given to a term we should be guided not only by predominance of present usage amongst psychologists, but also by the historical setting of words, and by popular usage; and having attached a given signification to a term we ought to endeavor to adhere to it throughout.

The term "experience" is currently used in two ways. In the first place, it means to know, apprehend, or perceive something; as when I say I experience a sound, a color, a pain, or an emotion. In the second place, it means that which is apprehended or directly known, that is, the sound which is heard, the emotion which is felt, etc., are called experiences, or kinds of experience. There has been a great deal of shifting back and forth from the one of these meanings to the other, which has introduced deplorable confusion; and, manifestly, if we wish to avoid such trouble we must adopt and cling to one meaning. We shall, therefore, use the term in the first sense given above; to designate the being aware of something, and not that of which one is aware (except in so far as one may possibly be aware of being aware, which need not concern us here and now). This first meaning is, after all, the fundamental one, and we could hardly avoid using the term in this way even if we used it also in the other.

The noun "experience" is equivalent to the word "consciousness," and we shall so use it, and shall use the verb "to be conscious of" as equivalent to "to experience." "Consciousness" meant originally "the knowing that one knows," "the experiencing that one experiences," to which we above referred parenthetically; but it has completely lost in modern psychological usage that former restriction of meaning. It is, however, used frequently in the sense which we have given as the second meaning of experience, namely: that which is apprehended or known directly. Some authors with due notice use the term in both senses, and others, we regret to say, make similar usage without notification. Outside of psychology the historical meaning is still in vogue to some extent, and the resulting misunderstanding may be readily conceived.

"Knowledge" is a wider term than "experience" or "consciousness," and our use of the former term in defining the other two must be understood with this qualification. It is only direct knowledge as distinguished from indirect, that can be identified as experience. The significance of this distinction will become clearer later.

For that which we experience, or of which we are conscious, we have the convenient and unambiguous term "content of consciousness" or "content of experience." Frequently, however, we speak of the "objects" of consciousness or experience, or of "psychological objects." Thus, the sound which I hear is a psychological object, as distinguished from the air vibrations which cause it, which latter are physical objects, and, as we shall see, are not heard or experienced, although we may know of them.

Other terms will be defined and explained in the sections in which their comprehension can be made most easy.

3. Extrinsic Helps

The proper preparation for the study of psychology cannot be prescribed in a way that will cover the needs of diverse individuals. One student will make excellent progress while lacking certain advantages without which another sticks fast. The elements of physics and of anatomy ought to be understood, and the cell-physiology which is given in the thorough courses in elementary biology or physiology is of value. The student will get all he needs of these subjects from good lecture and demonstration courses in them, and, if after his elementary course in psychology he decides to follow it farther in some particular direction, he will then discover in which of the sciences he needs laboratory training. Perhaps the greatest need for the beginner is an adequate training in literature, which may be acquired by well-directed reading; for psychology is least of all the subject in which anything can be communicated or comprehended in a special jargon or terminology, but requires all the assistance that can be given by command of the resources of the language of the masters in letters and of the speech of the plainer men. After literary training we should rank in importance a knowledge of physics as a close second.

We have omitted the customary anatomical pictures and discussions from this book, as the result of deliberation and conviction. Cuts of the brain and nervous system are readily accessible to any student who cares to look at them, and it is better for him to be sent to good anatomies to consult a hundred pictures than to have a dozen or so chosen out and put before him. Each instructor, moreover, has his own choices of preparations, models, charts, slides, and cuts, and of methods of presentation of nervous anatomy and histology. A superficial presentation here (and none other could be given in the limits of this book) would be a positive detriment. The books and cuts suggested are merely first aid to the student working alone.

Piersol's *Human Anatomy;* Howell's *Text-Book* *of Physiology;* Quain's *Anatomy,*[1] vol. I, pt. II, and vol. II, pts. II and III; Schafer's *Text-Book of Physiology,* vol. II, and McKendrick and Snodgrass's *Physiology of the Senses* are all valuable aids in understanding the schematic anatomy of the nervous system. Excellent plates of brain, eye, and ear are given in the Sorbotta McMurrich *Atlas and Text-Book of Human Anatomy,* vol. III. We will give references chiefly to Piersol and Quain, because one of these will doubtless be accessible to the student. No specific references will be given to McKendrick and Snodgrass because the book is small, and appropriate material easy to find therein.

As for the general principles of nervous function, the best brief account is found in Howell, chaps. VI to XI, inclusive. The account of the nervous system given in Piersol, beginning on page 996, is especially valuable. For the needs of students of psychology, however, Part First of Ladd and Woodworth's *Elements of Physiological Psychology* is without doubt the best available general treatise on the structure and functions of the nervous system.

On the physical problems of light and sound, the articles by Lewis and Hallock, respectively, in

[1] The references are to the tenth edition of Quain, and third edition of Howell.

Duff's *Text-Book of Physics*, will be found elementary and useful. Zahm's *Sound and Music* is an intelligible and interesting treatise on acoustics. Unfortunately, the more commendable treatises, such as Barton's *Text-Book on Sound*, are too technical for the student who is not a specialist in physics. Tyndall's *Lectures on Sound* are still useful, and Helmholtz's *Sensations of Tone* (Ellis's translation) is the starting-point for the student interested in the psychology of audition.

CHAPTER II

PRELIMINARY ANALYSIS OF CONTENT

1. Complexity of Content and Complexity of Experience

THE content of your experience at any given moment in your life history is exceedingly complex. As you sit reading this book you have visual impressions of various forms and colors from the book and from surrounding objects; you get various sounds; odors; impressions of touch from the book and from your clothing and chair; feelings in the muscles, joints, eye-sockets, and viscera. All these things are sensed or perceived, and simultaneously something is thought of; *e. g.*, the meaning of this print is presented as a content of thought. Add to these factors the emotional complexes of interest, weariness, hunger, satisfaction, disgust, annoyance, or whatever else is giving "tone" to your content, and you begin to see the truth of the opening sentence in this paragraph.

Although the content of experience is demonstrably composed of a multitude of parts or elements in complicated organic interrelation, it does not follow that experience itself is complex. This has been a stumbling-block for modern psychology because of the frequent lack of clear distinction between consciousness and its object. It is often said that the content is not complex, but is simple and unitary; and that the elements into which we apparently resolve it by analysis are really new content brought into existence by our analysis. In stricter language, this really means that while the content which you apprehend is complex, and may be resolved into its elements, the apprehension or experience of the content is not itself a complex made up of the apprehensions of the different elements. To this dogma there is so far no reasonable objection, although it may be found ultimately that even experience is not so unitary as it appears to be; or rather, as it suits our presuppositions to think it is.

2. General Classification of Elements of Content

In the examination of content of consciousness it is important to ascertain as definitely as possible how many sorts of elementary content there are. By elementary content, or element of content, we mean that portion of content which is not itself complex; that is, which cannot in turn be analyzed into component parts. Of such elements there appear to be four groups, each including a number of sub-groups. Further investigation may show that at least one of these groups must be fundamentally revised, and perhaps eliminated, but we must give them all consideration. These four kinds of content are *sensations, relations, feelings,* and *images.* We will indicate briefly in the next paragraphs what these terms cover.

Sensations are such things as color, sound, odor, and warmth. Look at a drop of red ink on a paper before you; the color—the red—abstracted from its position on the paper, from its reference to other objects, from its familiarity, from its likeness or unlikeness to other colors; in short, from everything but the color as presented, is a sensation. So the sweet from sugar on the tongue, abstracted from all the attendant impressions in the mouth, from the fact that it is sugar, from the pleasantness, etc., is a sensation.

It is one of the commonplaces of psychology that a sensation is never presented alone to your experience. Neither is a mere group or complex of sensations ever presented alone to the adult, and probably not to the infant. Always there are other elements, such as difference, familiarity, unpleasantness, etc., joined with it. Nevertheless, we can pick out from among the mingled factors of the complex the sensation itself and consider it in detail.

Relations are easily recognized, or at least some of them are. Similarity, difference, sequence, intermediacy, possession, etc., are experienced just as directly as are sensations. Perhaps the instances given are not simple; perhaps they may be analyzable into simpler relations, but they are sufficiently good specimens.

Feelings are most easily identified in emotions or passions. Joy, sympathy, ennui, rage, hunger, pleasure, are contents which involve complexes of bodily sensations, relations, and in addition the feelings which are their most important characteristics. The total complexes named may all with fairness be called emotions, and their analysis presents probably the maximum of difficulty with which psychology has to contend. But it is reasonable to conclude for the present that they cannot be completely accounted for without taking into account elements of feeling. If it should eventually be demonstrated that these feelings are nothing but specific sensations, we will have neither done nor suffered harm by listing them as elements or quasi-elements.

Images are generally considered as being the "copies" or "revivals" of sensations and of complexes of sensations previously experienced. Having been conscious of the sensation of red under the influence of physical light-waves you may later experience an "image" which is in some respects like the sensation, and which will represent it. By the images of sound, color, touch, and of sensations from the muscles, we are enabled to "think" of content which is not present; this is practically the doctrine as Aristotle handed it down, and it is the doctrine of current psychology.

We regret the necessity of departing radically from established opinion, but feel the obligation to warn our readers at once of our conclusion that the belief in the existence of such forms of content is a delusion, flowing partly from certain peculiarities of consciousness and partly from metaphysical prejudices. We shall present the case in detail in the proper place, not slighting the current theory.

3. Terminology

In contradistinction to content *imagined,* we speak of content *intuited* or *apprehended,* and oppose *intuition* or *apprehension* to *imagination.* Thus, when light-rays fall upon my retina, I intuit a light sensation. Sometimes the sensation is said to be *present* as opposed to a sensation or other content merely imagined. *Perception* applies to intuition, and to intuition plus imagination; usually it has the latter reference. This will be clear to the reader after he has studied the chapter on perception. *Intuition* is popularly used to signify an occult or inexplicable awareness of some fact; it is needless to say that as we use the word it has no shred of that meaning, which is a perversion of the correct signification.

CHAPTER III

SENSATION IN GENERAL

1. Sensation, Physical Stimulus, and Physiological Process

SENSATION—that which is experienced through the senses, or through sense—must be distinguished rigidly from the physical stimulus, on the one hand, and the nervous activity which is caused by this stimulus, on the other hand. The normal stimulus is some activity of what we call "matter," usually outside of, but acting on, the body of the individual. Thus, the oscillation of the air particles which act on the inner organs of the ear and produce sound; the vibration of the ether which stimulates the retina of the eye and occasions the experience of light; the chemical activity of substances, which produces odor; these are instances of stimuli. There is little difficulty in distinguishing stimuli from sensations, even for the beginner, for a little reflection convinces us that these physical facts are not experienced, but only inferred. When, for instance, I hear a tone, I am not conscious of the back-and-forth movement of the air particles; and when I see a color I am not experiencing the undulations of the ether. In the latter case the stimulus is so far from being experienced that it has required great labor to discover its real nature (assuming that we do know it now) by inferences from observations, and it took years for those who held the present theory to convince of error those who drew different conclusions from the observations. Even to-day physicists do not profess to have a complete understanding of the actual behavior of the ether and some of them doubt its existence. Yet an ignorant man, who has never heard of ether, and whose views on the transmission of light are amusing, may experience light and color sensations which are as highly developed as those of any one. The smell of a volatile substance depends doubtless on the arrangement of the atoms in the molecules (or on some such physico-chemical factor), but smell itself gives no direct information as to this arrangement. So it is throughout. What you experience through the senses is not a material object, or any part of a material object, although we have learned all we know concerning material objects from a study of the behavior of sensations. We have discovered during the last ten centuries a great deal about the physical activities corresponding to most of our sensations, and the general principles of their behavior; which helps to create in the unreflective the belief that we experience directly the physical activities themselves.

The difference between the sensation and the nervous process, especially that in the brain, is harder to grasp than is the difference between sensation and stimulus. This difficulty is at once exemplified and increased by the fact that many physiologists seem to teach that there is no difference.

The psycho-physiological confusion is rendered well-nigh hopeless by the ambiguity of the term "nervous process," and though the ambiguity is not dangerous in physiology, it is productive of much trouble when physiology is brought into relation with other studies. The terms "brain," "nerve," etc., may mean the actually experiencible; that is, visible and tangible objects; and "nervous process," accordingly, may signify changes which may actually be watched, or which might be observed if sufficiently delicate instruments were available. On the other hand, the terms may signify the matter and material changes which are supposed to be at the basis of these observable things or changes, and which, of course, we infer, but do not experience. If, for example, someone could lay bare your brain and with proper instruments observe the operations of that mechanism, his sensations would be, loosely speaking, brain processes; at least, the brain processes observed would be partly composed of his sensations. But this is not what the physiologists mean; they mean that *your* sensations, while you observe anything whatsoever, are identical with *your* brain processes. This meaning does not refer to the brain processes in the first sense mentioned, although often taken in that way, for no thoughtful person would be guilty of supposing that while, for instance, you are watching an indigo blue light, that shade of blue could be discovered by observation of your brain cells. In general, if you could watch the light (or other object), and at the same time watch through some instrument all the changes observable in the brain and nerve cells, you would find practically nothing in common in the two objects.

The brain processes the physiologists mean when they say that a sensation is a brain process are the material facts and transformations which are not observable directly as brain facts, but which we can infer; in short, the things represented by the symbols of chemistry. What you see, when you examine a nerve, are only sensations of light and color;

what you feel are touch sensations; you do not see or feel the matter of the nerve. The sensations you experience and which you may suppose to be the nerve under examination are really transformations in your own material nerves, which cannot be experienced by anybody or anything except your own "mind," or perhaps can only experience themselves. Thus, the sensation, when followed relentlessly back in the physiological system of events, is apparently found to have disappeared completely, and to have been replaced by something else.

The vulgar way of accounting for this vanishing of sensations under scientific scrutiny is to suppose that the "mind" experiences these brain changes and experiences them (wrongly, indeed,) as sensations. This is merely an unintelligent reversion to an older and more respectable theory—that the processes in the brain *produce* the sensations in the "mind,"—which theory does not identify the process with the sensation. A more modern way is to say that the brain process experiences itself. Thus, we do away with the concept of "mind," except as a name for a certain activity of brain cells and arrive at a point of view which is apparently quite simple. But this little subterfuge saves us only for a moment, and either method of explanation, if consistently adopted and carried out, lands us either in the conclusions of the Hindu Vedantists, that the world which we seem to experience is not real but only illusion; or in idealism, which holds Mind to be the only reality. If we wish to hold to the theory that there is a real world to experience, we must hold that sensation is not brain state nor brain activity.

The student will probably ask himself—very likely has asked while reading this chapter—"Where is sensation?" The commonplace answer, "It is in the brain," seems to commit one to the doctrine of sensation as a brain state; and yet, where else can the sensation be? The sensation is not in the brain unless the whole body is in the brain. Suppose you have before you a red surface and ask yourself, "Where is the red?" Put your finger on the surface, and the evident answer is, that it is where the finger is; that is, "out there," in space. Of course, there is a possibility that you are deluded in both cases, and that neither the color nor the finger are "there," but are both in the brain; or rather, since the brain itself is in the same class with the finger, the whole outfit is "in the mind." Thus, if you begin by assuming that the sensations are in the "mind," as opposed to a "real world," you will conclude in the end that the whole knowable universe is in the "mind," unless you are too busy, too lazy, or too dull, to carry the process you have started to its logical conclusion. If you are satisfied, and call this mental universe "real," you have reached idealism. If you are dissatisfied, and think this does not give you reality enough, you have reached the Hindu view of the world as Maya, or illusion.[1]

We do not feel either of these conclusions to be satisfactory, and, therefore, are forced to assume that sensations are not in the brain, but are where they are experienced as being, or are so in many cases. In some instances they may be at some other point of space, and, hence, wrongly "located"; and there may indeed be in all cases a certain amount of error in location; but error is possible here, as elsewhere, only if there is a basis of correctness.

If it should be proven that what we call "out there" is really in the mind, then our analysis is still true, for the sensation is "out there" in so far as there is any "out there." This whole matter is

[1] If sensations are brain states, or "in the mind," so are all other experiencible elements and complexes; and we experience nothing which is outside the brain (or mind).

subject to many sophistical difficulties which it requires clear philosophy to dispel, but for the present the student need not abjure his naïve common-sense view, which will not in any event vitiate his analysis, whereas the opposite view certainly would be risky. The illusion theory and the idealistic hypothesis, are not necessary for science or psychology.

2. Matter and Psycho-Physical Causation

Understanding that sensation is not the same thing as the stimulus which may physically cause it, and is not the same thing as the brain and nerve processes which may also be said to cause it, we still find it useful and necessary to treat of sensation and other mental processes in relation to both of these. The question of the ultimate relation of the mental to the material, with its more or less definite answers of "parallelism," "interactionism," "materialism," etc., will be of interest and importance to the student as he goes deeper into psychology, but are so far from being essential at the start that a considerable knowledge of psychology is necessary before he can take up these matters intelligently. It is at present no business of ours to decide whether matter actually exists as substance, or whether it is only a convenient fiction, or whether it exists in the Huxleyan sense as the universally valid law of the content of experience. We must hold the concept of matter as scientifically indispensable,[1] at least for the present, and take it into consideration when dealing with the facts of experience. The author is personally convinced of the correctness of Huxley's theory, which has the weight of centuries of philosophy behind it; but nothing in the present volume should be any the less harmonious with your postulates if you hold that matter is an actual thing or substance, or hold some other view; because none of our psychological analyses depends on any such assumption.

On the other question, which is frequently confused with the one as to the nature of matter and its relation to experiencible things;[2] on the question, that is, of the relation between the experience and its content and the brain activities which accompany this experience, and which may themselves be made the content of experience, we must take the common-sense view that the relation is one

[1] By "matter" is meant either the atoms and ether, or whatever physical science replaces these with. "Energy" must also be included, or else assumed in addition.

[2] This confusion furnishes practically the whole substance of the time-honored dispute between the "interactionists" and the "parallelists."

of cause and effect, although we know very little about the real nature of causation, here or elsewhere, and are moreover unable to find out just how the causal sequences occur in these cases. If any one is prejudiced the other way, and is determined to believe that there is no causal relation between brain and experience, he will probably find few instances herein in which our supposition makes less acceptable for him our exposition of facts and principles.

3. The Lag of Sensation

The sensation may or may not begin simultaneously with the process in the cerebral cortex; there is no direct evidence on this point. Between the initial action of the stimulus on the end-organ, and the beginning of the sensation, there is an interval which we suppose to be due primarily to the time required to set in action the end-organ, the nervous path of conduction, and the cerebral apparatus successively. When the stimulus ceases to act on the end-organ, the sensation does not cease at once, but continues for a brief time; this persistence we suppose to be due to the fact that the neural apparatus continues in action after the discontinuance of the stimulus.

With a given strength of stimulus, the time required for the sensation to reach its maximal intensity after the beginning of the stimulus is less than the time required for the sensation to disappear after the cessation of the stimulus. The time required to raise the sensation to any point of intensity lower than the maximal is less than the time the sensation will last after it reaches that same intensity in the dying-out process.

The delay in the rise of the sensation to a maximum, or to a definite point below the maximum, we designate as the *initial lag* of the sensation. The time required for the dying out of the sensation, from the point at which the stimulus ceases, is called the *terminal lag*. The terminal lag is greater than the initial lag, however the initial lag is defined in a particular case.

We take practical advantage of the excess of the terminal lag over the initial lag in the mixing of colors by means of revolving discs. If the disc revolves so fast that the retinal processes excited by a sector in any retinal area do not diminish appreciably in intensity before the sector again stimulates the same area, the effect is exactly the same as that of a constant stimulus, and, therefore, the sensation is steady. The initial lag operates in this case to effect a reduction of the intensity of the sensation below that which would obtain if the stimulus acted continuously. The passage of the sector across the point in the visual field occupies so brief a time (if the colors blend well) that before the physiological process has been raised to its full intensity the sector has gone by. The intensity of the sensation produced by the intermittent stimulation is about the same as the intensity produced by the constant action of a stimulus bearing the same intensity ratio to the intermittent stimulus as the length of time the intermittent stimulus is present bears to the total time.[1] This generalization is known as the Talbot-Plateau law. Possibly there are limitations to be made, but none are yet established.

The other modes of sense are theoretically subject to lag, and its occurrence may be demonstrated in the cases of audition and the dermal senses. Where the intermittence of a tone is rapid enough, the sensation becomes continuous and steady. And

[1] For example: A light stimulus which is so intermitted by means of rotating sectors, or otherwise, that the half-phase from disappearance to reappearance is exactly as long as the half-phase from reappearance to disappearance, will appear as bright as a stimulus of half the intensity continuously present. The frequency of intermittence necessary to produce a "smooth" mixture, *i. e.*, to avoid flicker, is in many cases over sixty per second; with dimmer lights a slower rate will succeed. This rate gives us no idea of the actual magnitude of either initial or terminal lag, but throws some light on the relation of the two.

a rapid succession of taps on the finger will fuse into a steady sensation.

Intermittence of a stimulus modifies in an essential way the resulting sensation or sensations. This modification is in some circumstances noticeable in light as a variation in quality, but is still more marked in the case of tones, because a large part of the range of the rates of sound vibration is within the range of intermittences which can be employed. The practical effect of intermitting a tone stimulus is to add to the sensation another tone having a pitch corresponding to the rate of intermittence, provided the said rate is faster than *circa* thirty per second. Below thirty, the result is merely the production of beats. It is sometimes said that the beats "fuse into a tone" when they become sufficiently rapid; there is no reasonable objection to that form of statement for the present. The new, or secondary, tone arises when two sources of sound differ by more than thirty vibrations per second, as well as when a single tone is mechanically intermittent; the tone in the one case mentioned is accordingly called a *difference tone*, and in the other an *intermittence tone*. There are difference tones of the first and second orders, corresponding to the two orders of beats.

The production of a tone by a sound-wave is itself sometimes spoken of as the fusion of the processes aroused by intermittent stimulation, the sound-wave being considered as an intermittent affair. This is an error, for the sound-wave, when rapid enough to produce a tone sensation, is strictly a continuous stimulus.

4. Secondary Sensations

In many cases the sensation aroused by a given stimulus is followed by a secondary sensational content, after the cessation of the stimulus in question, and without further essential stimulation. The secondary sensation follows its primary sensation after an interval varying from a fraction of a second to several seconds. It may be of the same quality as the primary, or it may be of some other quality of the same mode.

The secondary sensation is commonly called an "after-image," and is said to be "negative" when complementary in color, or opposite in temperature, to the primary sensation, and "positive" when of the quality of the primary. It is unfortunate that we have not a better terminology for these phenomena, for it is important that the secondary sensations be distinguished from the negative after-images described in the chapter on sensation quality.[1] The true negative after-image is produced by a stimulation which may be called secondary, since it follows the stimulus which conditions the preceding sensation, and its operation depends on the results of that stimulus; but as a sensation, it is just as primary as the preceding sensation.

Secondary visual sensations develop best after a brief stimulation by a strong light. Gaze for a moment at a gas flame, or electric light filament, and then turn out the light, having the room otherwise completely darkened. In a few moments an "image of the light" will appear, perhaps in its normal color, perhaps in some other; it may seem minute in size, and located in the eye itself; by a little practice you can succeed in projecting it to a distance, when it will seem correspondingly large. A very slight movement of the eye will cause the secondary sensation to disappear temporarily.

5. The Characters of Sensation

If we consider a single sensation, *e. g.*, a certain red, and compare it with others, *e. g.*, sweet or blue, we find that, although the sensation cannot be analyzed or resolved into simpler objects, and, there-

[1] Chap. IV, § 8.

fore, is properly called elementary, yet it is not so simple that it has not several different aspects, or points of difference from other sensations. These aspects, or points of difference, are usually called *characters*, and a proper understanding of these characters is the indispensable foundation of the study of sensation.

In the first place, a certain red differs from sweet and blue in a way in which it does not differ from other reds. This difference we call one of *quality*. It is a difference in *kind* of sensation. Next, there is a difference between certain reds of the same quality, as well as between reds and any other sensations, which we call *intensity*. We may increase the brightness of red without bringing any other color or sensation, so far as is observable. (In most cases, however, changing the intensity of a color involves the changing of the quality also, to some extent.) A spoonful of sugar in a glass of water will give a taste which is weaker (less intense) than two spoonfuls; and though we commonly say it is less sweet, we do not mean that the quality is different, but that the intensity is less.[1] The weak

[1] The same language in regard to other sensations may mean a difference of quality, rather than of intensity. Thus, to say a light is less red than another usually means that it contains more of some other color.

sweet is no more like bitter or blue in quality than is the more intense sweet.

A third character of sensation is volume or *extensity.* A large patch of light differs from a small one even if of the same color and intensity. So a large touch on the skin differs from a small one. Similar differences may be found in muscular and auditory sensations, but that they may be found in all kinds cannot be said definitely. Smell sensations do not seem to have this character at all, and its presence is an open question with regard to taste. Extensity is sometimes confused with extension, or perceived space; but in the latter the former is only one factor, as will be shown in the proper place. Extension is a function of a complex content, but extensity is just as original an aspect of those sensations which possess it at all as are quality and intensity.

The fourth aspect is duration, or *protensity.* Just as most sensations have extensity or inchoate bigness, which forms the beginning of our knowledge of space, so all have a magnitude of another sort which forms the basis of our perception of time. No sensation can be conceived which has not this temporal or enduring character. It may be roughly indicated by saying that a sensation which lasts no time at all does not exist. This, however, gives a slightly false implication, since the protensity of a perception does not imply the perception of time as such.[1]

Some sensations possess the important character of *local significance.* This is an aspect which cannot be directly demonstrated, but which can, nevertheless, be conclusively proved to exist. It is the character of a sensation by which, independently of its other aspects, we are able to determine the part of the body in which the neural process originates, or the direction in space from which the stimulus comes. The sensation from each part of the skin and retina has its peculiar local sign.

Any sensation may be pleasant or unpleasant. By considering the neutral condition, in which there is neither positive pleasantness nor unpleasantness, as simply the transitional point between the two, we may consider the triad as an aspect of sensation which is usually called feeling-tone. This so-called character is not strictly on a par with the ones previously enumerated, because, in the

[1] Protensity is not quite the same as duration, in the common acceptation of the term. This will be made clear in the section on time-perception.

first place, it can be considered as an *accompaniment* of sensation, which the others cannot, and in the second place it is equally attached to other features of the content of experience besides sensations, in which cases it seems still more clearly to be an accompanying factor rather than an aspect.

The characters just named seem to exhaust the list. We find no other aspects under which sensation must be viewed in and for itself, although of course we find it functioning in definite ways in the total content, and entering into different relations to consciousness. The catalogue stands then: quality, intensity, protensity, extensity, local significance, with possibly feeling-tone.

In an advanced study of the psychology of sensation it is advisable to take up each group of sensations by itself, and to give it exhaustive treatment from all sides. In an elementary study, where the general principles are more important than the minute details, and in particular where sensation is studied in its connection with other content and with experience rather than for its own interest, the systematic treatment under the different aspects or characters is more useful. We shall, therefore, treat sensation first under its qualitative aspect, and then under the other aspects in order. Such a programme cannot be adhered to absolutely, and there will necessarily be some overlapping.

CHAPTER IV

SENSATION QUALITY

1. General Classification

THE various qualities of sensation are commonly divided into groups, each of which is said to "belong to" a definite *sense*. Red, green, and blue, for example, belong to the sense of vision and are called visual sensations. Bitter and sweet belong to the sense of taste, or gustation, and are called gustatory sensations.

It is sometimes said that there are five senses, but as a matter of fact we discriminate several more than that number. There is much confusion in regard to the names applied to several of the senses and to the sensations which appertain to them, and still more confusion in the names applied to the sensibility or insensibility to certain sorts of sensation. The terms given in the following table represent the most justifiable usage, although not in all cases the most common:

THE TERMINOLOGY OF SENSATION

I	II	III	IV	V
SENSE		ADJECTIVES		ANÆSTHESIA
Taste.	Gustation.	Gustatory.	Geusic.	Ageusia.
Smell.	Olfaction.	Olfactory.	Osmic.	Anosmia.
Sight.	Vision.	Visual.	Opsic.	Anopsia.
Hearing.	Audition.	Auditory.	Acusic.	Anacusia.
Touch.	Taction.	Tactual.	Haphic.	Anaphia.
Warmth-sense.	......	......	Thalpotic.	Athalposia.
Cold-sense.	......	......	Rhigotic.	Arrhigosia.
Tickle-sense.	Titilliation.	Titilliatory.	Gargalæsthetic.	Gargalanæsthesia.
Muscle-sense.	......	......	Kinæsthetic.	Akinæsthesia.
Joint-sense.	......	......		
Body-sense.	......	......	Cœnæsthetic.	......
Pain-sense.	......	......	Algetic.	Analgesia.
Hair-sense.	......	......	Trichoæsthetic.	Trichoanæsthesia.
Vibration-sense.	......	......	Palmæsthetic.	Palmanæsthesia.

The first column contains the names for the senses, derived from various languages. In the second column are the corresponding words of Latin derivation. The third column gives the adjectives applying to the sensations. In a case where there is no specific adjective, the usual English sense name is used adjectively; *e. g.*, pain sensation, cold sensation. The adjectives from the Greek, given in the fourth column, indicate the sensibility, and should not be used to indicate either the sense or the sensation.

The prefixes *par-* (*para-*), *pseud-*, (*pseudo-*), *hyp-* (*hypo-*), and *hyper-* are also used with the Greek words (with the *ia* termination) to indicate specific aberrations of sensibility; as, for example, *paropsia, pseudosmia, hypokinæsthesia.* The prefix *orth-* (*ortho-*) is used to indicate the normal condition of the sensibility, as for example *orthacusia.* The suffix *-meter* is added to indicate the instrument for measuring the sensibility; for example, *acumeter, haptometer, algesimeter.* Certain sense realms have also special prefixes to indicate peculiarities of sensibility found in these realms. *Chromopsia,* for example, indicates sensitivity to color; *achromopsia* indicates color-blindness; and for various aberrations of color sensitivity we have the terms *parachromopsia, dichromopsia,* etc.[1]

Each sense has its own end-organ or organs; that is, some mechanism for receiving physical stimulation and transmitting excitation to the brain; this is true both anatomically and histologically. But the sense cannot be defined by reference simply to the organ in either meaning. Some organs (grossly speaking) are vehicles for more than one

[1] The system of terminology for sense-psychology given above is the logical one, and is in common use, except for the terms for temperature sensations. This system, however, is not exclusively used, there being the most deplorable confusion in regard to terms for almost all of the senses. Certain terms are used by different authors in exactly opposite senses, and for some cases we have a variety of terms in use.

sense. The eye gives visual, muscular, and temperature sensations; the ear auditory and organic as well as tactual; the tongue gustatory, tactual, and cold and warm sensations; the nose also gives tactual and cold and warmth as well as olfactory sensations; the skin gives several sorts of sensations.

We might use the term organ in a narrower sense and say that the retina is the organ of vision, the cochlea the organ of hearing, etc., but this would be inaccurate; because the whole ball of the eye and its muscles are functionally concerned in vision, and form the organ; and so likewise the bones, membranes, and muscles, of the ear-drum are entitled to be specified as parts of the organ of hearing, since they participate normally in the production of the nervous process which conditions the experience of sound.

If we wish to associate the visual sensation with its specific nervous terminals, excluding the accessory parts of the organ, we should have to take, not the retina as a whole, but the minute rods and cones therein, into consideration. In the same way we should consider only the hair-cells in the basilar membrane of the inner ear in connection with auditory sensations. We might, therefore, with accuracy specify visual sensations as those presented through the activity of the nerve endings in the retina of the eye, and so on; and to this method of speech there can be no reasonable objection; but it gives no information about the sensations themselves beyond the connection explicitly designated. It neither defines nor specifies the sensations, but presupposes their identification.

The term "sense" is used very loosely. Sometimes it indicates the group of sensations, sometimes the abstract possibility of experiencing these, and sometimes the entire physiological mechanism for the experience, including the histological organ. Accordingly, psychologists are accustomed to use the term "mode of sensation" to convey with precision the first of these meanings. The visual sensations taken as a group are said to constitute the visual mode of sensation; the olfactory sensations the olfactory mode, and so on.[1] Modality is one step above quality in the logical classification of sensations.

[1] Helmholtz defined a mode as a group of sensations related so closely that it is possible to pass from one to the other by a gradation so minute as to be practically continuous. (*Handbuch der physiologischen Optik,* 1894, § 584.) This will be illustrated in section 6 of this chapter, in the case of visual sensations. The definition is not useful, since it gives no criterion for distinguishing a transition between two sensations of the same mode from a transition between two sensations of different modes; hence the modality has always

2. Sensation and Brain Process

Each sensation quality depends on a specific kind of nervous process in the cortex of the brain, and each mode of sense seems to be dependent upon the functioning of a definite part of the cortex, which is called the "cortical centre," for that mode. Each mode, and perhaps in some modes each quality, is represented by certain peripheral nervous structures called "end-organs," and these are connected by sensory nerves with the corresponding centres.[1]

The cells of the sensory cortex are specialized to respond to the excitations poured in upon them by the end-organs with which they are connected. Whether they would (in the case of an adult) respond to a different kind of stimulation, is a matter for doubt. In the plastic condition of the developing cortex (of the infant) it seems to be a fact that

to be distinguished on other grounds. A continuously graded transition from heat to bitter, for instance, is perfectly possible, and there would be no objection to considering it a transition within a mode, if we had not decided, on grounds having no reference to the question of gradations, that bitter belongs to one mode, and heat to another. The final decision on a question of modality of elementary sensations must rest on the likeness and unlikeness of the sensations involved.

[1] See Howell, figs. 96–100, and pp. 198–228. Piersol, figs. 102 and 1043; also figs. 1041, 1044, 909, 910, 987, 988. Schäfer, figs. 330, 338, 340 and 351.

if certain cells which would normally respond to a definite sort of stimulation, *e. g.*, visual, be destroyed, other cells, either in the cortex or in the lower centres, may become so adapted as to respond to that sort of stimulus. In any case, it is the kind of stimulus furnished to the brain cell by the end-organ which determines its response. Direct irritation of the cells of the cortex by electrical currents, or by pinching or burning, produces no sensation. The character of the process in the end-organ is the thing of prime importance in determining the sensory function of the brain cell.

3. Sensation of Taste

Gustatory sensations are dependent on the stimulation of certain nerve endings, almost all of which are on the tongue. These nerve endings are in the "taste-buds," which are the peripheral organs of taste. They are found on the tongue in the walls of the circumvallate papillæ and in the fungiform papillæ, and also occur in the epithelium of the mucus membrane where there are no papillæ.[1] In the cases of infants and some adults a few taste-buds are found on the soft palate, gums, cheek-linings and even on the tonsils and hard palate.

[1] Piersol, figs. 1193, 1194, 1195, 1196, 1197; Quain, III, pt. III, figs. 167, 168, 170, 172.

The cortical centres for taste, or gustatory centres, are on the inner sides of the hemispheres, probably in the hippocampal lobes. The course of the nerve-fibres from tongue to cortex is extremely complicated. One bundle runs through the tympanum (ear-drum), and is hence called for that portion of its course the "chorda tympani." [1]

Substances which are gustable (sapid substances) must be dissolved in water (or in some aqueous liquid; saliva is, of course, the common solvent), and so either enter the outer part of the taste-bud, or perhaps come in contact with the hair-like fibres of the gustatory cells projecting into the orifice leading to the bud. Substances insoluble in water are tasteless; but soluble substances are not always gustable.

Although the number of "flavors" detectable in substances introduced into the mouth is indefinitely large, there are probably but four distinct elementary taste qualities. These are: sweet, salty, bitter, and sour ("acid"). These are the only sensations (except possibly "metallic" and another to be noted later) referable to the taste-buds, and are the only ones to be called tastes. The so-called "alkali" taste is probably a combination of weak salty

[1] Piersol, figs. 1075 and 1079; Howell, fig. 119.

with weaker bitter. "Hot" tastes, as of pepper, are due to the excitation of non-gustatory end-organs on the tongue and in other parts of the mouth, and are genuine warmth sensations, like those obtainable from the skin of the hand or arm. The tongue is also sensitive to cold, and to touch; peppermint excites indirectly sensations of the former, and "astringent" substances, as alum and strong tea, excite those of the latter. But the characteristic thing about what we call flavor in foods and drink is given through the sense of smell, as may be demonstrated in many ways. Every one has noticed the comparative tastelessness of food during the course of a severe cold; this is the result of the interference of the catarrhal inflammation with the function of the organs of smell. Conclusive results may be obtained readily by stopping up the outer opening of the nostrils (anterior nares) and the inner opening (posterior nares).[1] The patient then breathes through the mouth and no aroma can possibly ascend to the nostrils. The patient in the condition described is temporarily anosmic. If his eyes are

[1] The posterior nares, of course, should not be meddled with except by a physician. But one can obtain fairly good results by stopping the anterior nares alone (with pieces of cotton) provided the patient breathes gently. Vigorous breathing increases the diffusion of odorous substances into the nose through the posterior nares.

shut, he can distinguish substances put into his mouth only in so far as they differ in regard to the five qualities we have mentioned, or in regard to their "feel" (touch), or temperature. A few instances will illustrate. Tea, weak coffee, and a solution of quinine cannot be told apart if the strength of each is properly chosen. If the tea is very strong, the quinine solution may require a drop of alum water to be added to it to make it taste like the tea. Plain sugar and water cannot be distinguished from molasses or almost any fruit syrup, properly diluted. Suitable mixtures of grain alcohol and water, with sugar, and a few drops of alum water and vinegar (or acid-solution), as necessary, will counterfeit vinous or distilled liquors. These experiments may be extended indefinitely, and not only demonstrate the fewness of taste qualities, but will also show how very sensitive the tongue is to touch and to temperature, and how much our discrimination depends on these. It is well not to let the patient taste the solutions before his nostrils are stopped, or slight differences in viscosity, or strength of any element, may cause him to remember and distinguish them later, with no intention of trickery on his part.

The functions of individual taste-buds have not been satisfactorily examined, but experiments which have been made on single papillæ (fungiform) show that some of them are sensitive to two qualities only, some to three, and some to only one, although there is some doubt whether there are papillæ sensitive to bitter only. Seldom are papillæ sensitive to all four qualities. Whether a single taste-bud can produce the nervous excitation of more than one taste quality is for the present an open question.

The circumvallate papillæ, and others near the base of the tongue, are especially sensitive to bitter. Papillæ sensitive to sweet are grouped more numerously toward the tip of the tongue, and those sensitive to salt and sour on or near the edges. Sensitive papillæ are few in the central area of the tongue, which some experimentors have reported as completely ageusic; but, in general, all parts of the upper surface of the tongue possess some of the papillæ sensitive to each of the gustatory qualities, although the details of distribution differ with the individuals, and some persons are, through disease, rendered totally ageusic.

There is one content of experience which is commonly called a "taste" which merits special attention, since it is not included in any of the conditions we have here described. This sensation, or complex, which every one, no matter how temperate, has doubtless experienced, is commonly known by the picturesque name of the "dark-brown taste." It certainly is not salt, sweet, or sour, and the bitter, metallic or astringent components, if present, are not the main thing. Although due to visceral conditions, it is probably produced through stimulation of the nerves in the mouth, and so may have a certain claim to be classed as a taste sensation. But there are other reasons why it may be classed with the organic sensations (cœnæsthesia), and we shall discuss it further under that head.

4. Sensations of Smell

If the student looks on the nose as the organ of smell, with no further idea of the exact part of the nose which is sensitive, he will be somewhat surprised upon examining the nasal structure. The interior of the nose is a complicated cavern, or rather two caverns, communicating not only with the outer air and with the pharynx, but with cavities in the bones of the face. The peripheral nervous apparatus of smell occupies only a very small area in the membrane covering a part of the superior turbinal bone and of the adjacent portion of the nasal septum. This region is known as the olfactory region, and this portion of the membrane as the olfactory membrane. The cells which receive the terminations of the nerve fibres are much like the gustatory cells of the taste-buds.[1]

The fibres of the olfactory nerve penetrate directly through the skull to the olfactory lobes of the brain, and pass thence to the hippocampal lobe, especially the distal portion thereof, called the gyrus uncinatus. This is, therefore, the cortical centre for smell—the olfactory centre.

In order that it may be smelled, a substance must be in a gaseous state, and must be brought into direct contact with the olfactory membrane. However fine may be the particles of a substance, if they remain mere particles, not becoming vaporized, they are without odor. Formerly it was thought that substances dissolved in water could be smelled if brought in contact with the membrane, but now it is known that such is not the case. Substances that are odorous also fulfil a definite chemical condition; the molecules which constitute them must

[1] On nose and peripheral terminations see Piersol, figs. 1174, 1175, 1176, 1178, 1179, 1180; Quain, III, pt. III, figs. 154, 156, 157, 158, 159, 160; Schäfer, figs. 446, 447. On the neural connections, Piersol, figs. 1042, 1043, 1047, 1048, 1049; Howell, fig. 95; Schäfer, figs. 351, 349.

possess or exceed a certain minimum weight. This minimum is for most persons the weight of prussic acid (hydrocyanic acid), which substance is odorless for these individuals. Other persons, whose osmic sensitivity extends slightly lower, find that prussic acid has a distinct odor.

Constant presence may render any substance odorless; that is, an odor continuously present, finally disappears. Water vapor and carbon dioxide, although gaseous and of sufficient molecular weight, are odorless because always in the air. This is probably an instance of what is best designated as protective adaptation. A sensory organ acted upon by a stimulus which it is functionally fitted to receive becomes by the action of the stimulus less responsive to it. This is not fatigue, which of course may produce a similar result; it is an antagonistic reaction by which the organ becomes protected against the action of the stimulus, just as the soles of the feet become protected by thickening of the skin when no shoes are worn. The quickness and completeness with which one becomes insensitive to an osmic stimulation is a matter of common observation. The air in the room becomes fetid from one of a number of causes, and you do not notice it until you return after being out of the room some moments. People are, in general, immune to the odor of their own perspiration.

The number of elementary olfactory qualities is at present unknown. We are obliged to treat them as if they were indefinitely numerous, and yet there may be really only a few, which by combination in endlessly different ways give rise to the riotous profusion of odors which constitute our olfactory world. The suggestive similarities which run criss-cross through this world point to this theory, but so far we have not been able to make any scientific use of those similarities. Classification by qualitative affinity has been attempted; a great many naturalists since Aristotle have tinkered with the problem; the most laudable attempt being made by the botanist Linnæus, to whose catalogue Zwaardemaker has added two more titles. The result of all these efforts has been of slight value theoretically or practically. The classes of Linnæus are nicely exemplified by certain odors, but when you attempt to classify a large number of odors according to the scheme, you find that many belong equally well under two or more headings, and others refuse to fit anywhere. The types selected evidently do not represent anything fundamental.

LINNÆUS' OLFACTORY CATEGORIES. EXAMPLES

1.	Aromatic	Turpentine; lavendar; camphor; spices; butyric ether.
2.	Fragrant	Flowers; vanilla; benzoin.
3.	Ambrosiac	Musk; ambergris.
4.	Alliaceous	Garlic; assafœtida; Cl.; Br; CS^2.
5.	Hircine	Cheese; sweat; rancid oil; lactic acid.
6.	Repulsive, or Virulent	Opium; nightshade family.
7.	Nauseous	Decaying animal matter.

ZWAARDEMAKER'S ADDITIONS

a.	Ethereal	Fruits; some essential oils and ethers.
b.	Empyrheumatic	Toast; tobacco smoke; tar; coffee; gasolene; creosote.

Although the attempt at classification has been a failure, some hope has been aroused by the discovery, by Sir William Ramsay and others, that certain substances with similar molecular structure have similar odors, and that in a group of substances of similar structure (as the alcohols) the pungency of the odor increases with the molecular weight. Although there are exceptions enough to make the connections merely interesting and suggestive, it seems certain that in sensations of smell we come closer, so to speak, to the unexperiencible matter than in sensations of any other mode.

Individuals differ in their sensitiveness to odors even more than they do in regard to taste. Some persons are osmically as keen as the lower animals;

others are very obtuse to odor, and some are completely anosmic from birth. Catarrh, or other disease, may largely or completely rob the victim of his sense of smell. Other details of osmic sensitiveness will be mentioned under intensity.

5. Visual Sensations

The nerve endings which condition the production of visual sensations—the *rods* and *cones*—are in the retina, the lining of the eyeball. The other parts of the eye are important as means for the bringing of the rays of light to bear properly on those endings.[1]

The fibres of the optic nerve pass from the rods and cones through the midbrain beneath the hemisphere to the occipital lobes, the rearmost portions of the hemispheres; and these, with the addition of certain contiguous areas, constitute the visual centres.[2]

Opposite to the pupil of the eye there is a little depression in the retina, about two and one-half square millimetres in area, called the *fovea*. While not so sensitive to light as are the surrounding areas,

[1] Piersol, figs. 1202, 1203, 1214, 1218, 1220, 1221, 1222, 1223; Quain, figs. 45, 48, 52.

[2] Piersol, fig. 1050; Howell, figs. 91, 92.

it is capable of finer discriminations; or, as we say, the visual acuity is greatest here; hence, the eye is commonly moved so that the image of whatever we are attending to, or the most important part of that image, falls on the fovea. Only after considerable practice can one attend to a definite part of the field of vision without automatically turning the eye toward it so that its image falls on the fovea. The fovea contains no rods, but only cones, and they are here covered by a thinner layer of nervous tissue than elsewhere, so that the light reaching them is less dispersed, *i. e.*, is brought to a sharper focus here than elsewhere on the retina.

A short distance from the fovea is the spot at which the optic nerve enters the eyeball. This spot is insensitive to light because there are here neither rods nor cones, and is hence called the *blind-spot.* The blind-spot does not inconvenience us in ordinary vision because it is so situated in the retina that the portion of the image which falls on the blind-spot of one eye does not fall on the blind-spot of the other.

We can discuss color only by reference to the solar spectrum, and the student should, if possible, examine the spectrum, either projected on a screen or viewed through a spectroscope. Failing the actual spectrum, colored charts of it may be used. Several such charts are published but are not chromatically true.

The prism of the spectroscope spreads out the light-waves coming through a narrow slit into a diverging beam at one side of which there are long waves and at the other short waves, the wave length in the intermediate portions varying accordingly. If now this beam of light falls on the retina through proper lenses, or after being intercepted by a screen, a band of colors—the "spectrum"—is formed, ranging from the red produced by the least frequent (longest) waves, through the orange, yellow, green, blue, to the violet of the most frequent (shortest) rays; and as the wave length decreases continuously from one end of the spectrum to the other, so the red merges smoothly into the orange, the orange into the yellow, and so on, through the intermediate hues of orange-red, red-orange, yellow-orange, orange-yellow, etc. Here we have an excellent example of a sensation-continuum; a series of sensations passing one into the other without discrete gradations; that is, without break.

Although there are a great number of hues in the spectrum, there are only a few elementary color sensations, and the other hues are composed of these in different proportions. That such uniform gradations can be produced by mixture is clearly shown by mixing the light-rays from the ends of the spectrum, in which case a continuous gradation of purples is obtained, ranging from the spectral red to the spectral violet: a series which is not in the spectrum, but which, with the spectral hues, makes the total of colors within our experience.

Inspection shows that the orange is a composite color involving red and yellow; that the hues between green and blue are really only blendings of green and blue; and so the sensation-continuum here is not different in kind from the series of blendings of bitter and sweet, sweet and sour, etc., although it is more readily displayed. We are justified, therefore, in assuming that there are a few fundamental colors, just as there are a few tastes, and that the combination of these produces all the hues with which we are familiar.[1] In seeking for these fundamental colors we reject the orange, the

[1] It is sometimes said that a "mixed" color, *e. g.*, orange, does not contain other colors (red and yellow, in case of orange), but merely is like them, being really as simple as they are. On this postulate a psychology of color has been built up, but has so far not justified itself. We think it much more rational to proceed on the simpler postulate, on which all advance in the knowledge of color theory is actually founded.

blue-greens and green-blues, the yellow-greens and green-yellows, and the extreme violet as being apparent mixtures. We have left as presumably fundamental colors: red, yellow, green, and blue or violet-blue; and these, or certain specific portions of them in the spectrum, seem to be truly elementary. But in the consideration of them two peculiar circumstances are at once discovered, which merit careful attention.

In the first place, there is no direct qualitative transition between the red and the green, and none between blue and yellow. That is to say: while you may arrange between red and blue a continuum involving only these two colors (the red-blues or purples); and between blue and green a similar continuum of green-blues and blue-greens; and between green and yellow a continuum of green-yellows and yellow-greens; and between yellow and red a continuum of yellow-orange, orange, etc., the yellow-blues and the red-greens are lacking. The transition in either case involves one of the other supposedly elementary colors, or else white (gray). We can, for example, pass from red through orange and yellow, or through purple and blue, or through pale red (pink), gray, and pale green; but never through red-greens. Yet, if red and green are elementary colors we surely ought to be able to combine them as well as any other pair. This at once suggests that the four colors are not on the same plane.

In the second place, the combination of green rays and red rays in diverse proportions (as regards intensities) gives the transition colors through yellow, while analogous combinations of yellow and blue rays produce the transition colors through white (gray).

These relationships lead to the conclusion (first formulated as a scientific theory by Thomas Young), that yellow is not an elementary color, but is really red-green, and that gray is the composite of the three elementary colors, red, green, and blue (or indigo). This is the so-called "Three-Color Theory," or "Young Theory"—often called the "Young-Helmholtz Theory." According to it, the three colors are supposed to depend each on a specific process in the retina and in the brain (chromoptic process) the nature of which is unassigned; and each of these three processes is supposed to be excited by light from all parts of the solar spectrum, but most strongly from one particular region (see fig. 5). The yellow portion of the spectrum is so colored because the rays from that portion excite both the red and green processes rather strongly; while the rays from the blue-green portion excite both the blue and the green processes strongly.

This theory, as it has been developed by Helmholtz and others, succeeds in referring to one logical scheme all the facts of visual sensation yet discovered; but in its looser statement it has encountered one serious criticism. This criticism is that yellow cannot be introspectively analyzed into red and green, and gray into red, green, and blue. Examine pure yellow as intently as you may, and you cannot find any red or green in it, and gray, if it is pure, is *ipso facto* neither reddish, greenish, nor bluish. This consideration has led many physiologists and psychologists to hold to the theory of Hering, or to variants of his theory. They hold that there are four colors—and four retinal processes, with an additional process for white. They even assert that black is an elementary sensation, and assign a sixth retinal process to it. These six processes are in pairs, the members of each pair opposing each other. We cannot go into the details of this theory, or the many objections to it. It is a noteworthy fact that the practical working out of the theory obliged its adherents to abandon the very psychological grounds on which they started, by assuming as a fundamental color either blue-green or reddish-purple.[1]

The three-color theory, as first proposed, implied the composite nature of the sensations of white and gray, and assumed that a "color-blind" (see below) person lacked one or two of the three processes. As a matter of fact, the first point is not essential to the theory; for all that is necessarily assumed is that when the "red" process and the "green" process are active together at certain relative intensities, the sense-content yellow arises. So, the theory need not insist on white as a complex, but may allow the alternative opinion. That is to say; the three-color theory is not necessarily a three-sensation theory.

In behalf of the three-sensation theory, however, it must be said that the fact that a content of experience cannot be directly analyzed does not prove it to be simple. Of course we may assume such to be the case, and a certain sort of psychology does make that assumption to cover certain convenient cases. If the assumption were applied in a thorough-going way it would make psychological analy-

[1] For further details of the Hering theory see *Rivers*, (Schäfer), pp. 1112–1121. On the Young theory, *idem*, 1106–1112.

sis impertinent, to say the least, and experimental psychology is based on the denial of this assumption.

As for color-blindness, whatever the earlier adherents of the theory may have held, the present adherents hold that in the common cases of color abnormality the three processes are present, but have an unusual range of excitability, as will be explained later, although it may be that in some cases there may be one or more of the processes lacking.[1]

6. The Schematic Representation of Visual Qualities

The whole range of color hues may be represented (as they might actually be presented) in the following way. Suppose three circular patches of light partially superposed as in fig. 1. Let one patch of light be of each of the three fundamental colors, and let the intensity of each patch be maximal at its centre, falling off gradually to zero at the edge. We have then in the triangle of which N is the centre (leaving now out of account all the un-

[1]The three-color theory in the five-sensation form has been given an evolutionary setting by Mrs. Franklin, who assumes that gray is the primitive color phylogenetically; that in the second stage of development yellow and blue arise by a differentiation of the "gray-process" into two new processes, and that in the third stage red and green arise by a differentiation of the "yellow-process."

superposed and two-ply parts) all the colors, ranging from the full hues along the boundaries, through paler tints, to neutral gray or white near the centre.

This representation introduces us at once to a characteristic of color sensations which is designated *saturation*. A color is said to be *saturated* in

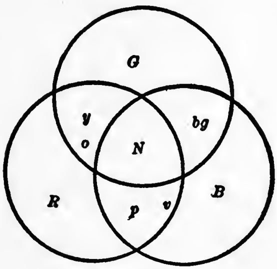


FIG. 1.

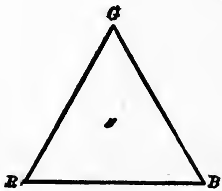


FIG. 2.

proportion as it does not contain white or gray; the more gray the color contains (that is, the paler it is), the less the saturation is said to be.

If we suppose the three fundamental colors to be taken in their maximal saturation, we can represent all visible hues in every possible saturation by such a triangle as that in fig. 1, in which the pure fundamentals stand at the vertices. For convenience we draw the sides of the triangle straight, as in fig. 2; but it must be understood that the exact form of the triangle is insignificant—the fact that we have drawn it isosceles does not imply that the difference between R and G is equal to that between R and B, etc., for these differences are incommensurable. We might, indeed, use a circle in place of a triangle, locating the fundamental colors thereon at appropriate points;. and this "color circle" is frequently employed in preference to the "color triangle."

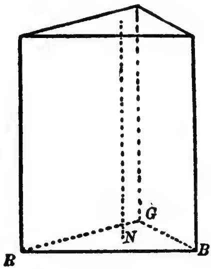


Fig. 3.

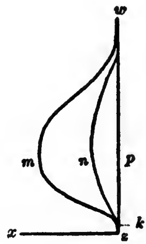


Fig. 4.

Now, we may wish to represent different intensities of color; this we may do in the dimension at right angles to the plane of the "color triangle." If we wish to represent another complete series of hues at an intensity uniformly higher than those just supposed to be represented by the triangle, we do it by a second triangle above and parallel to the first, as in fig. 3. In this connection we find the peculiar fact that if we start with that intensity of a pure spectral light which gives the maximal saturation, and steadily increase the intensity, the saturation of the sensation soon begins to decrease, and at a certain high intensity of the stimulus the color becomes white. Schematically, this would mean that the triangles must be drawn smaller and smaller, as we go up, until they become points. In decreasing the intensity the same phenomenon is met; all colors becoming gray (red is possibly an exception) before being extinguished; the saturation-decrease being more sudden at this end.

The qualitative changes perceived as a light stimulus of practically homogeneous wave length is progressively increased from zero to a maximum, are shown schematically in fig. 4. The line $w\,p\,z$ is the series of grays, or neutral sensations, and is, therefore, conceived as perpendicular to the color triangle (or color circle) at the centre.

The interval $z\,k$, in which the stimulus arouses only the sensation of gray; the interval, therefore, between the light-threshold and the color-threshold, is called the *photochromatic interval.* Logically, there is an upper photochromatic interval also, but it is not susceptible of measurement because of the incident damage to the eye.

Since the rate and the magnitude of change are represented here purely schematically, we may represent any hue by a curve of the same form. Ranging them all around the common gray-axis, we derive (*i. e.*, by rotating fig. 4 on the axis *w p z*) an onion-like figure, which, taken as a solid, contains schematically all possible visual sensations.[1] Linear distance parallel with the axis represents intensity-change; linear distance perpendicular to the axis represents saturation change; and angular distance about the axis represents change of hue.

Since white (gray) is equivalent to a certain proportion of red, green, and blue, it is evident from the color triangle that, for any color, we can find another color which when mixed with it will produce gray, provided the intensities of the two are properly chosen; for all points on the triangle (except the vertices) represent combinations of two of the fundamental colors: and to any combination of two it is possible to add one of them and the third in such proportions that the proportions of the three shall be whatever is desired. And practically the conditions are quite easy of fulfilment. Colors which combine thus in pairs to produce gray are called *complementary*. Examples of complementary colors are: red and a certain blue-green; or-

[1] This is the tri-dimensional figure on the basis of the color circle. It might be constructed on the basis of the triangle, only the description of the generation is a little more difficult. Commonly, the line *z m w*, of fig. 4, is made a semicircle or else two straight lines, from *m* to *w* and *m* to *z*. The solid figures become then a sphere or a double pyramid or a double cone.

ange and greenish-blue: yellow and indigo-blue; green and reddish-purple.

We have used the terms white and gray interchangeably. White is a relative term denoting the brightest gray. Any piece of paper which looks "white" may, if placed on a still whiter one be made to be a dull gray; and the new "white" may be literally put in the shade by a still brighter. "Black," too, is purely relative. The blackest paper obtainable looks dark gray against a black velvet. Black and white are contents of consciousness, but not sensations simply; they are complex sensations of gray perceived in certain relations. The difference between the various neutral grays is one of brightness only, that is, they form an intensive series of identical quality (whether we consider it a simple quality, or a mixture of three).

7. Achromopsia and Parachromopsia

Individuals differ in the sensitiveness of their color processes to the action of light of various wave lengths, and in the cases of some persons the variation from the normal is so considerable that these persons are called *color-blind.* In extreme cases the patient can see no color at all, everything appearing to him gray; so that the landscape which shows to us a wealth of hues presents itself to him as a black and white sketch. Yet the color-blind man may not realize that his vision is different from yours, and if you ask him the color of the grass he will say "green," for he has always heard it called so, and has no way of knowing that "green" does not mean to you the same particular shade of gray it does for him. Such a person is said to be *totally color-blind*, or *achromopsic*.

More numerous than the "achromopes" are persons who see colors, but not as we see them; they are called *partially color-blind*, or *parachromopsic; parachromopes*. The commonest case is that in which only blue and yellow are seen (in addition to gray), the normal red and green of the spectrum appearing yellow and a certain part of the blue-green appearing gray, as does also a certain purple (not in the spectrum, of course, but mixed from blue and red), which is to the normal eye complimentary to this blue-green. This is a typical sort of *dichromopsia* (two-color vision). Other persons see some green in addition to the gray, yellow, and blue; others probably see gray, red, and one other color; and still others see only gray and one color, which is probably green in some cases.

How large the list of color abnormalities in vision

—*parachromopsias*—may be, we cannot even guess, as yet, but enough is known to assure us that it is not small. The detection of these abnormalities is of great importance for railroad and nautical purposes, but is difficult, and possible only by skilfully arranged tests. Exact work can be done with spectral light and elaborate apparatus, but rough tests can be made with colored worsteds or silks. A few cases have been found in which the patient had one eye achromopsic, or parachromopsic, and the other normal, or nearly so, so that he could tell just what colors were seen with the defective eye; and these cases have given indispensible assistance in diagnosing the color defects of others.

We must distinguish between true parachromopsia and mere lack of memory for hues, or inability to name them properly, or awkwardness in sorting them. While it is true that a genuine defect may escape detection sometimes, it is also true that a person may fail miserably in a color test, and yet be chromopsically normal, just as a nervous patient may, by confused reports on the oculist's tests, be convicted of serious astigmatism, and yet not be astigmatic at all. It is said that there are more color-defective men than women, but this may be doubted. Women are much more apt to escape detection, even by themselves, because of more practice in handling colors.

The totally color-blind person is apt to be able to see in a dim light better than a normal person, and

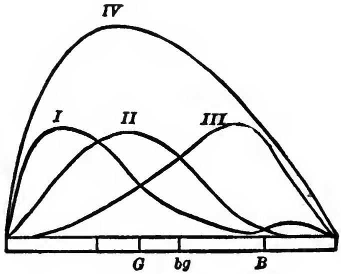


FIG. 5.

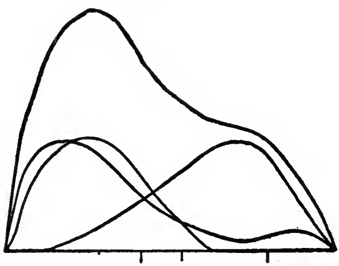


FIG. 6.

to find unbearable a light which is for the normal person reasonably strong. This suggests at once the possibility that all three color-processes are present in his eye, and that they are alike excitable by rays of light of any wave length included in the spectrum. This hypothesis is also necessitated by the fact that in cases of monocular achromopsia gray is seen alike by both eyes. This condition is represented by the curves in fig. 8, where the achro-

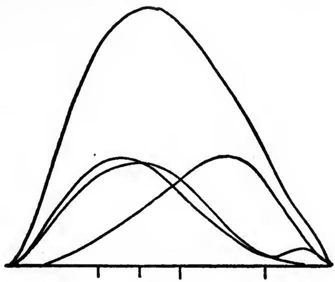


Fig. 7.

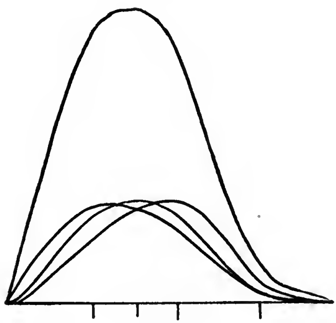


Fig. 8.

mopsia is nearly complete; if complete the three curves would exactly coincide throughout. Fig. 5 gives the probable relations of excitability of the three processes in the normal eye, showing how each color is excited by practically all rays of the spectrum, but principally in a certain range. In these and the following curves the horizontal axis represents the spectrum, and the ordinate at any point represents the relative degree of excitation of the process by the light from that point in the spectrum. The curves are not intended to represent any specific ratios, only the general positions being in point. Exact forms for the curves have been computed by several theorizers, but such computations are, after all, of little value, since they represent the carrying out of the results of certain postulates.

Curves I, II, and III, in fig. 5, show the probable relative excitability of the red, green and blue processes respectively, for the normal eye. Curve IV represents the relative brightness of the different parts of the spectrum as determined by the flicker method. Curves I, II, and III are so drawn that the sum of their ordinates at any point on the spectrum (X-axis) is equal to the ordinate of curve IV at that point.

Curves I, II, and III in figs. 6, 7, and 8 are arbitrarily modified from the curves in fig. 5, so that they may represent the color-vision abnormalities described. Curve IV in these figures is, accordingly, derived by summing the ordinates of curves I, II, and III.

Fig. 6 shows the probable excitability of one type of yellow-blue parachromopsia (red-green blindness), in which the spectrum is of practically normal length. This was formerly supposed to be "green-blindness" and is often designated by the term "proteranopia." Fig. 7 represents the excitability in another type of yellow-blue parachromopsia, where the spectrum is shortened; formerly called "red-blindness"; "deuteranopia." There are all sorts of parachromopsias intermediate between these two, constituting, as we said before, the more numerous sorts of color-blindnesses. Other abnormalities than "yellow-blue" vision are known to exist, and may be represented by proper modification of the curves.[1]

The normal eye is not equally sensitive to light

[1] The tri-chrome theory must not be understood as an explanation of the facts of "color-blindness," or of the other complex phenomena of color vision. It is merely a comprehensive statement of all the facts; a descriptive theory, in short. It is not the only possible statement, but has the virtue of being the simplest. We can, for example (contrary, it is true, to general opinion), give just as thorough a statement with red, yellow, and blue as the fundamental colors, and work it out logically to cover all the known facts; but it would be more complicated. A slightly less complicated theory than this might be constructed with four fundamental processes and colors—it is all a matter of drawing the curves for the normal spectrum. Still other possibilities are open, but for the present it seems best to rest on the simplest statement.

and color in all parts. At the centre of the retina colors are discriminated with the greatest ease, but as you go out toward the edge of the visual field discrimination becomes more difficult, and the colors lose in saturation until at the extreme limit of visibility they are practically all gray. It is sometimes said that the margin of the retina is totally color-blind, and the zone intermediate between the margin and a certain central area, red-green blind. This is only partly true. The angular distance from the centre to which any color can be carried, and yet be visible in its proper hue, depends on practice, intensity, area, and duration. With intense spectral light, lasting but an instant, the colors can, after considerable practice, be discriminated nearly to the periphery.

8. Color Adaption and Contrast

Protective adaptation is especially noticeable in the visual realm, but takes several forms. In addition to the control of the stimulus by the iris and of the sensitivity of the nerve-endings by the retinal pigment, there are adaptive changes which go on either in the retina or in the brain, by virtue of which any stimulus tends to produce a sensation which becomes more and more gray as the stimulation continues. The most familiar example of this phenomenon is found in yellow lamplight, which soon loses its yellowness if we are under its illumination exclusively. The change is also rapid in lights which are yellow-green, bluish-green, or purple; blue changes less rapidly, and red very slowly. The change is not essentially connected with loss of total intensity, and so is not to be confused with fatigue.

In terms of the tri-chrome theory, color adaptation is a decrease in sensitiveness of processes strongly stimulated, with increase in sensitiveness of processes feebly stimulated. If, for instance, blue-green light is cast on the retina, the blue process and the green process are strongly excited, the red process hardly at all; the result is a sensation complex in which blue and green predominate. As the light continues to act, the blue and the green processes respond progressively less and less, and the red process more and more, so that the sensation complex becomes less and less saturated.

The results of these adaptative changes are clearly shown when colorless (gray) light, *e. g.*, from a gray wall or paper in ordinary daylight, is allowed to fall on the part of the retina previously stimulated by the colored light. Under these conditions the process or processes that have increased in sensitivity respond more intensely than the process or processes that have decreased, and the result is a tinge of the color complementary to the original color. This color effect occupies the exact retinal area occupied by the exciting color, and its appearance is known as the *negative after-image*.[1]

The quality of a light is determined, in the case just mentioned, by the intensive relations of the physio-psychological color components. In all cases the hue of the sensation roused by any given stimulus is a variable affair, depending on the condition of the portion of the retina on which the stimulus falls, and on the condition of the adjacent retinal areas. The latter factor determines what is known as *color contrast*, or, to distinguish it surely from the after-image effect, *simultaneous contrast*. If you look at a small gray card placed on a large colored surface, you get the contrast effect very clearly: the card will appear tinged with the color complementary to that of the background. The

[1] Adaptation may take place, and be followed by the characteristic negative after-image, without any sensation of color during adaptation being noticed. This may be demonstrated by placing the subject in colorless light, to which minute amounts of a color are continuously added.

eyes must not move during this observation, but must remain steadily fixed, or after-images will occur, and counterfeit the effect; slight movements will unavoidably occur, giving rise to narrow after-image effects along the edges of the card; so-called *edge-contrast*. The saturation of the contrast-color may be increased by covering the card and background with a piece of tissue-paper or ground glass; by squinting through the nearly closed lids; or by darkening the room (as by pulling down the window-shades). No matter what the brightness and saturation of the colored background, or the brightness of the gray, one of these changes will heighten the contrast-color.

No satisfactory explanation of the contrast effect has as yet been found, but the most plausible theory is that substances essential to the processes in the retinal area stimulated by the colored rays are drawn from the area stimulated by the gray, leaving that area, therefore, more sensitive to the other rays of the spectrum, because relatively better supplied with substances reacting to those rays. Of course the basis for this phenomenon, as well as for that of after-images, may not be in the retina, but may be in the brain; there is absolutely no means of deciding at present between the two possibilities, but the fashion is to suppose that the retinal hypothesis is the true one.

An interesting experiment which possibly demonstrates the transfer of photochemical substance across the retina, may be performed with an "Archimedean spiral," in black and white, on a pasteboard disk; this is supplied in the Münsterberg set of illusions (by the Milton Bradley Co.). If the disk is rotated steadily—a clock-work or electric motor with controllable speed is best, but a hand-power color-mixer will do—at such a rate that when the eyes are fixed on the centre, rings run outward, like those from a stone dropped in the water; if these rings are observed several seconds (the eyes not moving), and if the eyes are then quickly closed and covered with a large piece of black cloth, "retinal streaming" will be observed, the bright streamers running from edge to centre of the dark field. If the disk is rotated in the opposite direction, so that the rings run toward the centre, the streaming will be from the centre out. The closing and covering of the eyes must be very quickly done; the cloth being held on the palms of the outspread hands ready for action while observing the rings. After some practice the streaming can be observed by simply closing the eyes, without covering. A more striking method is to have a single source of light, which illuminates the disk brightly, and to cut this light off at the proper moment, leaving the room in total darkness. Turning out an electric light will not do, as the light dies too slowly.

The streaming may be observed on the disk itself while it is in rotation; it is in the direction of movement of the rings, and gives them a peculiar wavy appearance. On looking suddenly at some other object, the streaming in the reverse direction makes the object seem to expand or shrivel up in an odd way.

If we assume a definite "color substance" in the retina corresponding to each of the three hypothetical color processes, then it is a natural step to assume that these substances are attracted to the region stimulated by the white rings, and so drawn outward (or inward) with the rings. This is rendered still more probable by the occurrence of what are known as "Fechner's colors"; as you look at the disk, it will sometimes take on a red or green cast; other colors occur seldom. This can be explained by stronger attraction for one of the substances, when the rate of rotation of the disk is such that following rings coincide with the greatest concentrations of one of the substances.

9. Auditory Sensations

The nerve endings of the acoustical apparatus are in the *cochlea* of the ear,[1] and the cortical centre is in the superior temporal convolution.[2] The acoustical stimulus is a vibratory movement of the air,[3] which is communicated through the external auditory meatus to the middle ear (*tympanum*), and thence through two windows (*fenestra ovalis* and *fenestra rotunda*) in the bony wall to the vestibule and cochlea. It was formerly supposed that the little bones (*ossicles*) transmitted the vibration from the tympanic membrane to the oval window into which the head of the stirrup bone is fitted, it being thought to act like a piston; but the discovery of individuals whose ossicles have been destroyed, and who hear nearly as well as normal persons has ruined this theory. It is probable that the air of the tympanum conducts the sound, and the bones act as a damper. Vibrations may be carried to the

[1] Piersol, figs. 1242, 1247, 1248, 1251, 1252, 1255, 1256, 1257, 1259, 1260, 1264, 1268, 1271, 1272, 1273; Quain, III, pt. III, figs. 78, 87, 102, 108, 111, 113, 129, 131, 135, 136.

[2] Piersol, figs. 1042, 1043, 1071; Howell, figs. 93, 94; Schäfer, fig. 351.

[3] Hallock (Duff), pp. 301–307; Zahm, pp. 21–53; M'Kendrick and Gray (Schäfer), pp. 1149–1168; Howell, pp. 371–375.

middle ear through the bones of the skull, and so reach the inner ear. You may test this by touching the head to any object emitting feeble vibrations, as a tuning-fork, violin, or piano, faintly sounding.

The exact manner in which the direct excitation of the auditory nerve endings (hair-cells on the basilar membrane) occurs has been the subject of much speculation. The Helmholtz "piano-string" theory was formerly held to be a satisfactory explanation, and, indeed, it is in accord with many of the psychological and pathological facts of audition; but, nevertheless, the anatomical details of the cochlea are now believed to be against that hypothesis. Helmholtz supposed elements in the basilar membrane free to vibrate selectively to the rates of movement to which they were adapted, and by their vibration to excite the contiguous hair cells. The vibration rates to which these elements were supposed to be "tuned" increased progressively from the apex of the cochlea to the "lower" end of the membrane; thus the series of perceptible pitches corresponded to the series of hair cells and vibratory elements functionally connected with them.[1]

The latest investigations point to the excitation of

[1] For details on the Helmholtz Theory, see Howell, pp. 376–379; M'Kendrick (Schäfer), pp. 1171–1185.

the hair cells by the movements of the tectorial membrane: Beyond this, we are still in the realm of speculation. A number of theories have been elaborated in addition to that of Helmholtz, and two of them seem to be worthy of entertainment. These we may call briefly the *telephone theory*, and the *extensity theory*.

The telephone theory antedates Helmholtz's, but has been recently revived in modified forms. Briefly, it holds that pitch is conditioned solely by the frequency of the nervous impulses transmitted to the brain—the pitch-characteristic being thus supposed to be a product of the brain cells. Now, whatever the exact mechanism for transforming the vibratory impulses transmitted to the inner ear into hair-cell stimulations, the apparatus highly sensitive to one rate will not be so sensitive to other rates. Hence the need for a series of such apparatus (which is furnished in the cochlear structures) that will give the maximal sensitivity to a great range of vibration rates. This is mechanically the most rational of all the theories; it also has the advantage of explaining the pathological phenomena, and many other details, on practically the same simple grounds as does the Helmholtz theory, while not open to the objections to the latter.

The extensity theory is less happy mechanically, but more strictly in accord with the psychological facts. Moreover, it does not turn the whole matter of pitch over to unidentified brain activity, but puts it on a basis where auditory sensation is strictly comparable with other sensations. This theory holds that the frequency of the vibration determines the length of the series of hair cells (measured from the vestibular end of the total series) stimulated by a given tone. The slower the vibration, the more cells stimulated. Below a certain rate, all the nerve endings are stimulated; above a certain rate, none.

So far as we can discover there is but one elementary auditory quality. It is customary to speak of pitch as quality, but that is an unjustifiable use of the word, for the difference between red and blue is not at all of the same sort as the difference between a low and a high note, although physically they both correspond to a difference of vibration rate.

It is true that as notes are sounded they differ in a respect other than pitch, which again is commonly called quality. The note of the violin, when of the same pitch as the note of the flute, is readily distinguishable from it. Low and high notes of the same instrument differ more or less in the same way. This difference is one of complexity and intensity of components, and in strict discourse should not be called qualitative. The best word available for this quasi-character of tones is *timbre.*

The Helmholtz theory of audition makes pitch analogous to local sign of touch and sight. The "telephone theory" might assign a strictly qualitative nature to pitch, although acceptance of the theory does not necessarily commit one to the qualitative view. On purely psychological grounds, pitch is analogous to extensity of visual and tactual sensation and we shall, therefore, treat it further under the head of extensity.

10. Cutaneous and Subcutaneous Sensations

Scattered through the skin, and the tissues immediately beneath it, the mucus membrane, the peritoneum of the abdominal cavity, the tissues adjacent to the apposed joint-surfaces, and in the muscles, tendons, and bones themselves, there are numerous sensory nerve endings, of a wide range of complexity, which respond to mechanical stimulation and to temperature changes. The joint, muscle, and tendon endings we will discuss in the next section, treating here only those in and immediately beneath the superficial coverings and linings.

The simplest of these organs are no more than slight knobs on the ends of nerve fibres, in contact with cells of the tissues in which they are placed. A development from the knob is a little disk, or concave plate, in contact with a cell as the cup with an acorn. In a third form, the nerve ending is between two specialized cells. In higher forms there are several knobs, or platelets, on branches of the nerve fibre, or fibres, which are enclosed within special cells or structures. The most complicated organs contain networks or "skeins" of nerve fibres of great intricacy.

As these different sorts of nerve endings were discovered they were given the names of their discoverers. Thus there are "end-bulbs of Krause," "Pacinian corpuscles," "plume-organs of Ruffini" and so on. As more types are discovered, and as they are found to form a series in increasing complexity, these names become of less importance except to the anatomist.[1]

The cortical centres for cutaneous sensation are

[1]For dermal and sub-dermal structures and organs see Piersol, figs. 867 to 875, and 1146 to 1148; Quain, figs. 389 to 398, 402, 403, 407, 408.

variously located by different physiologists. The most probable theory is that they are near the "motor zone," on the anterior side of the fissure of Rolando.[1] This statement holds also for the similar sensations from the mucus membrane, and from the subcutaneous tissues. For convenience, and in accordance with established custom, we will refer to these all as "cutaneous" except where we make specific distinction.

The qualities of cutaneous sensation are fairly distinct. *Touch*, *tickle*, *warmth*, and *cold*, are easily discriminated. *Pressure* is possibly of a different quality from touch. *Pain* is commonly considered as a specific quality of sensation, but of that we will speak below.

Touch is aroused by light mechanical stimulation of the skin (or of the mucus membrane, etc.). It may also be aroused by electrical stimulation, by radiant heat, or (on the mucus membrane) by the action of certain substances denoted as "astringent." Tickle is aroused by a lighter stimulation, and pre-eminently if the stimulus is of the stroking sort. It is practically impossible to arouse tickle without in some degree arousing touch also, and light touches are very apt to give gargalic sensation

[1] Piersol, figs. 1041–1043.

along with the tactual; nevertheless, the two sensation-qualities are so distinct that they are unmistakably discriminated. They are also strongly distinguished in respect to intensity of stimulus and motor response. A very light stimulation will arouse a powerful tickle sensation, and the impulse to move the hand to the spot tickled, or to move the tickled member, is usually irresistible. The development of this strong reflex through the necessity of guarding against insects has often been conjectured. If the stimulation is increased in intensity, the sensation of touch replaces that of tickle, and the sensation intensity is much reduced, as is also the strength of the reaction-impulse.

The production of tickle sensation usually involves also the production of organic processes and sensations in addition to the specific reflex. This general bodily disturbance, which doubtless has its function in the acceleration and intensification of the reaction, is commonly known as tickle, or ticklishness; but this we are not discussing here. We are referring to the quality of the superficial sensation alone.

Pressure, as we use the term (usage in regard to "touch" and "pressure" varies very much) is aroused from organs deeper than the skin; or at least it is aroused by physical pressure heavier than is required to arouse touch. It may be of the same quality, nevertheless; inspection shows in it nothing certainly different from intense tactual sensation free from the gargalic; and common usage treats touch and pressure as one.

Warmth and cold are distinct qualities, although dependent on variations in the same physical temperature continuum. In this respect they are perhaps analogous to touch and tickle. The conditions for the arousal of warmth and cold are complex, and as yet not well understood. When the skin has been maintained at a certain temperature for a short time it usually ceases to respond to that thermic condition with either rhigotic or thalpotic sensation. This temperature is, therefore, called the *neutral point* for that portion of the skin at that particular time. If now the skin is subjected to temperature conditions above this neutral point, the nerve endings are so stimulated that warmth sensations occur; conversely, if the skin is subjected to a temperature below the point of neutrality, *pro tempore*, cold is felt; the sensation persisting in either case until a new neutral point is established. There are, however, cases which this formulation does not seem to fit, and a formulation in terms of a *temperature-zero* has been attempted. When the temperature of the skin is above this zero (it is supposed) warmth sensations are aroused; when below, cold. This theory may be stated adequately as follows: When we feel cold (or warm) the temperature of the skin is below (or above) a temperature at which—under conditions otherwise the same—we would feel neither warmth nor cold. This may be true, but it doesn't seem to help much.[1]

As the temperature of the body varies in different regions, objects which feel warm to one part

[1] Perhaps the safest hypothesis is that the nerve endings adjust themselves to a rate of heat-radiation from the skin, if that rate lies within a certain range, and is maintained for a certain length of time, so that they are not stimulated. If, now, the rate is suddenly changed, stimulation of the appropriate end-organs takes place and continues until the organs adapt themselves to the new rate. If the change is made gradually the protective adaptation may take place with very little, or practically no, sensation as in the case of color adaptation. Thus, if the hand is placed in water which feels "neutral," and held still while the temperature of the water is slowly raised or lowered, the water may be heated or cooled to a point which would normally feel hot or cold to the hand, yet in this case no sensations be aroused. I have seen a patient's hand which was kept in warm water for several hours for the treatment of an abscess. The water became slowly hotter, and so scalded the hand that the skin came off over the whole surface, yet the patient found the water only comfortably hot. Frogs have been frozen stiff, or boiled to death, while making no efforts to escape or giving other signs of discomfort; the water in which the animal was placed being changed in temperature very slowly. It is true that these last illustrations bear more specifically on the so-called pain sense; but see text.

may feel cool to another. The cold and warmth processes may be aroused by agents other than temperature changes; pepper, for instance, arouses warmth. Or, if these "warm" substances do not directly excite the nerve endings, they at least lower the neutral point.

It has been alleged that heat is a combination of the warmth and cold qualities, and certain experiments seem to support this view. The significance of the experimental results is, however, a matter of doubt, and there is as yet no sufficient reason for considering "heat" as other than an intense and perhaps "painful" warmth sensation.[1]

Pain is often listed as a specific quality of sensation. This usage arises in part from consideration of the topographic distribution of cutaneous sensation (see below) and in part from imperfect analysis. The use of the word pain in this connection is due to a confusion of the pricking or stinging quality of the sensation aroused by the stick of a needle with the powerful unpleasantness which often

[1] The impulse to the interpretation of heat as warmth *plus* cold comes, doubtless, from certain analogies, between warmth and red, and cold and green. We usually term the reds "warm" colors, and greens "cold." If heat were a combination, either psychologically or physiologically, of warm and cold, it would be analogous to yellow. The next step would be to analogize touch to blue, and pain to white.

characterizes such sensations. By sticking the hand with the needle carefully, so that the sensation is not unpleasant, the same quality can be aroused, and then seems to be no other than a small, intense heat sensation, chiefly distinguished from a true heat sensation by not being accompanied by sensations of warmth (less intense heat) from adjacent localities and by being smaller than the heat extensity. By these differences, and possibly by differences in the time relations—the rapidity of development and fading of sensations—we are usually able to distinguish the sensation from a heat stimulus from that of a sticking or cutting stimulus. Sometimes, however, we are misled and may feel a prick as a burn, or *vice versa*.

Itch is usually a combination of tickle with warmth or heat. Often the warmth has scattered points of relatively high intensity—prickling—which makes the itch highly unpleasant. Rubbing the itching areas relieves the situation by temporarily annulling the tickle.

Ache, such as may be aroused by plunging the hands in ice-water, is not a cutaneous sensation, and is capable of being aroused generally throughout the organism. We shall speak of it under organic sensation.

Not all of the dermal sensations are to be aroused readily from any point of the skin. If you move a cool or warm metal stylus lightly and carefully over the skin, you will find that only at certain points is the thalpotic or rhigotic sensation produced, unless between these points the stylus is allowed to rest long enough for heat to be transmitted laterally. You may mark these points where the sensation appears directly with small ink spots (one color for the spot stimulated by the warm stylus and another for that stimulated by the cold); then you may test for "pressure points" with a thin bristle, and "pain points" with a fine needle. You will find that many points in the skin may be penetrated painlessly, and on many the pressure of the bristle will not be felt, if the bristle is not too stiff. You make a chart on the skin of the points which are sensitive, and if the marks are made with indelible ink you may find that on following days the same points will respond, and the ones which did not respond continue insensitive, if the degree of stimulation is the same.

A great deal has been made of this topographical distribution of sensation, since it was discovered, thirty years ago. It was at first supposed that the points indicated the locations of specific end-organs, and pieces of skin have been cut out and subjected to microscopic examination in the hopes of determining these organs, but without success. The permanence of the sensory points has been doubted by many investigators from the first, and it has at last been pretty well established that we have not to do with points, but with large areas, and that the points of maximal sensitivity within these areas vary considerably from day to day. The error of the earlier investigators was in marking the points on the skin, thus prejudicing their succeeding tests on the same areas.

The latest physiological investigations indicate that there are three sorts of cutaneous and subcutaneous sensibility from the physiological point of view. These are: (1) *Deep sensibility* to heavy pressure and to movement of the tissues, as when a member is flexed. (2) *Protopathic sensibility*, "pain," heat, and cold; heat stimulated by temperatures above 45° C. and cold by temperatures below 20° C. (assuming the neutral point to be about 37°). (3) *Epicritic sensibility*, touch and tickle and warmth and coolness; warmth and coolness produced by temperatures lying between the neutral point and 45° and 20° respectively. If certain sensory nerves are severed, areas supplied by them lose sensations of the second kind, but the first and third are unaffected. Severance of certain other nerves destroys sensitiveness of the third sort, without affecting the first and second. And, finally, severance of certain "motor" nerves destroys sensitiveness of the first sort only.

These facts indicate that there are two sets of nerve endings giving warmth and cold sensations, but under different conditions—the one set responding to slight stimulations, and capable of only a feeble action, the other set requiring a much greater stimulus, but capable of intense response. These last-mentioned organs may also be excited by mechanical stimulations, as pressure or cutting. There are perhaps eight types of nerve endings, according to their functions, as follows: tickle, touch, weak warmth, weak cold, heat and "sharp pain," cold (strong), deep pressure, and "dull pain" or ache. Or perhaps two sensory processes may be the functions of one organ.

In certain diseases which affect the spinal cord and roots of the nerves, we find interesting dissociations of sensation, differing from those just described, where nerves are severed at some distance from the spine. In the degeneration of the spinal cord known as syringo-myelia, all sensations of cold, warmth, and "sharp pain" are lost from large areas of the body without affecting touch or pressure. In other diseases touch alone may disappear,[1] and in other conditions touch and cold are lost, but not warmth and heat. In some instances the sensibility of the hairs alone has been lost.

11. Kinæsthetic and Cœnæsthetic Sensation

The muscular and visceral sensations furnish us with another striking illustration of the difficulties which beset psychological analysis. The qualitative distinctions within these classes are scientifically no less important than in the other sensory groups, yet the distinctions have to go unmade. In the case of the muscular sensations, we attend so predominantly to what the sensations signify—to the ideas they arouse—that we are not able to notice adequately the sensations themselves. Perhaps the ability to attend analytically to these sensations would unfit the patient for the simplest routine of life, so important is it that we attend to what they mean, rather than what they are.

Under the head of muscular sensation we include all those which result directly from muscular move-

[1] In the cases reported, however, it is not certain whether deep pressure did not go, too. Tickle undoubtedly was lost, also, but no report is made of that, it being usually assumed by the clinician to be a form of touch.

ment, excepting those already described as dermal and subdermal, although touch, for example, is aroused when the arm is flexed or extended.[1] We include, therefore, sensations produced by excitation of endings in the muscles,[2] in the tendons, and in tissues near the joints. When I raise my arm, the contraction of the muscles excites the platelets which are in contact with its fibres, the change of tension of the tendons probably excites endings therein, and the movements of the head of the humerus in the shoulder socket, and of the apposed surfaces in the elbow joint, excite endings in the tissues surrounding them; and the sensation-complex resulting from all these excitations—or in the last resort, from their cortical effects—I call the "feeling of raising my arm." If the muscular contraction occurs, but the arm is held by external force, the details of stimulation in muscle and joint are somewhat different; the muscle does not change its shape so much, and certain nerve terminals are doubtless less stimulated, others more stimulated, than if the movement had occurred, the articular

[1] For sensory endings in the muscles, see Piersol, fig. 876.

[2] It is possible that the deep pressure already mentioned is really a sensation from nerve endings in the muscles, stirred by the pressure, and ought to be classed as muscular sensation; I am at present inclined to that opinion.

surfaces are subjected to pressure, not to friction. This sort of stimulation arouses, through its brain effect, a sensation-complex which we call the "feeling of effort," or of "weight."

Whether different qualities are produced from the joints under different conditions, and whether the relaxation of a muscle arouses a sensation of quality different from that excited by contraction, we cannot say. The differences on which our judgments depend may be all the results of combinations of a single joint-quality and a single muscle-quality, the extensities and intensities varying.

It is difficult to analyze the organic sensations, not because we do not attend directly to them, but because there is no experimental way of varying them, and they occur normally in such regular complexes that the noting of elements is almost impossible. You must remember that if we saw purple only in the hue called "magenta," and never in the hues nearer the spectral colors, we should probably never guess that it is red *plus* blue. So it is with nausea, lassitude, and such organic contents; they may be complexes of elements which occur in different combinations, but so regularly that they might as well be elements, so far as our experience goes. We are in much the same position here that we are as regards odors. Whether the elements are many or few, we are unable to tell.

The organic sensations seem not to be aroused by direct action of external stimulation, and those tissues which possess this form of sensibility alone (as, for instance, the peritoneum covering the intestines, and the intestines themselves), may be pinched, cut, burned, or otherwise maltreated, without the production of any sensation. Even powerful intestinal contractions, artificially brought about, produce no effect sensationally. Yet, under certain conditions, which may, for all we know, be chemical stimulations within the tissues, or changes in the channel of flow of the nervous currents originating in these tissues, decided sensational results are produced; witness the juvenile belly-ache.[1]

One sensation-quality which does not quite come under the above description, but which ought perhaps to be included under cœnæsthesis, is dizziness, or vertigo. This is produced either directly or indirectly by the stimulation of the nerve endings in the semicircular canals. These canals, which lie approximately in three planes, at right angles to

[1] There is a theory that belly-ache is due to the irritation of the abdominal peritoneum, which is sensitive to pressure, cutting, etc., giving only a "painful" sensation.

each other, and so are sensitive to rotation in any direction, are supplied by a branch of the same nerve which supplies the cochlea, but the sensations are by no means auditory. Pathological irritation of the semicircular canals produces symptomatic dizziness, and if the canals are completely destroyed the patient can no longer be made dizzy. Dizziness is associated with various nervous phenomena, notably the rhythmic eye movements known as *nystagmus* (whirling until one is dizzy will produce these movements), and can be produced in so many ways (eye disease, indigestion, mental shock, are some of the ways) that any conclusion as to the exact function of the semicircular canals is at present impossible.

The "dark-brown taste" to which we have referred earlier is perhaps due to excitation of nerve endings in the mucus membrane by substances produced directly or indirectly as a result of abnormal chemical changes in the alimentary canal. In the general organic feelings of well-being, dejection, placidity, etc., as well as in more specific emotional content, it is possible that an important causal factor is stimulation by chemical substances (hormones) secreted by the various ductless glands, and poured by them into the blood.

The painful sensation known as ache is apparently the function of various tissues deeper than the skin and mucus membrane. It is a true cœnæsthetic sensation, although seemingly allied to intense cold. This suggestion of cold is doubtless a matter of association, cold being a common cause of ache.

CHAPTER V

THRESHOLDS OF CONSCIOUSNESS

1. Stimulus-Thresholds

In order that a stimulus may produce a sensation it must satisfy certain limiting conditions called *stimulus-thresholds*. These conditions, which are strictly physical, are matters of (*a*) wave length or molecular character, (*b*) intensity or amount of energy per unit of time, and (*c*) duration of action of the stimulus and extent of area affected by it. All these conditions are capable of being expressed as magnitudes.

Of the first type we have given one illustration already, in speaking of odors, which must have the molecular weight of HCN at least. Probably similar determinations may be made for gustable substances. Light-waves must have a length of not greater than *circa* seventy-five hundred-thousandths of a millimeter (.00075 mm.) and not less than thirty-eight hundred-thousandths (.00038 mm.) in order to arouse visual sensation. The longest air vibration which will arouse a sensation of tone is about twelve meters, and the shortest about one-half of a millimeter. These magnitudes are thresholds.

If we consider ether-vibrations of sufficient energy falling on a normal retina, commencing with waves too long to be visible and steadily decreasing in length, we can conceive that when a certain wave length is reached a sensation of light will occur; it will "enter the mind" or "enter consciousness" at that point. This point at which the sensation "steps in" is accordingly dubbed the *threshold*. In the cases of sound and light there are two thresholds; you can approach the limits of sensibility from either direction; and the same may be true of smell. There may be gases which are odorless because their molecular weights are too great.

These thresholds are sometimes—and incorrectly—called qualitative. There is no such thing as a qualitative threshold. Clearness and accuracy can be attained by referring to the auditory wave-frequency thresholds, the visual wave-length thresholds, etc.

The second sort of thresholds occur in the series of intensities of stimulations, and this sort of threshold is always meant by the term when not expressly qualified to signify otherwise. These thresholds may be referred to as the acoustical intensity-threshold, the optical intensity-threshold, etc.

The acoustical and optical intensity-thresholds are theoretically measurable as certain amplitudes of waves of a given length (see next chapter), but practically they are measured in a much more primitive way. The acoustical threshold is expressed as the distance through which a given ball must be dropped on a given plate or block, at a given distance from the ear, in order to produce an auditory sensation. The optical threshold is usually determined by finding the proportion in which a given beam of light may be reduced, and yet arouse a visual sensation. As might be expected, such determinations are not very satisfactory.

The osmical threshold is accurately determined by finding the least amount of a given substance which, infused in a unit quantity of dry air, will produce the appropriate sensation under the best conditions of inhalation. So the geusical threshold is determined by finding the least amount of substance which, dissolved in a unit quantity of distilled water, will arouse taste sensations.

The haptic threshold is determined by laying weights on the skin or by pressing it with delicate springs of metal or hair, giving known amounts of pressure. The hapto-algetic threshold may be similarly measured by finding the least pressure on a given area producing "pain." The intensity-threshold for warmth and cold cannot be measured adequately by any simple method.

The stimulus acting on any organ must act for a certain length of time before a sensation is produced, and, if the intensity is low, a duration may be found which will allow no sensation to be raised into consciousness. A light, intense enough to be clearly seen under ordinary conditions, may remain invisible when allowed to fall on the retina for only a few thousandths of a second. Conceivably, this duration-threshold is only an aspect of the fundamental intensity-threshold; for the energy applied in the brief time measured by the duration-threshold is just sufficient to raise the neural process to the point at which a sensation is produced.

The area-threshold of stimulation, which is important only in vision, is doubtless also of derivative nature, the energy being distributed over an area wider than that mathematically corresponding to the external object or its projection on the organ.

2. Stimulus Difference Thresholds

Two stimuli may be different in intensity, in wave length, in duration, or in some other feature, and yet there may be no difference noticeable in the sensations corresponding to the stimuli. So far, it is an open question whether this failure to observe a difference in the given respect means that the sensations are really the same in that respect, or whether they are necessarily different (assuming that the conditions of the organ and environment are equivalent, except in respect to the difference of stimulus under consideration). The fact remains that a certain measurable difference in stimuli is necessary in order that a corresponding difference may be perceived in sensation.[1] The magnitude of this required difference is called the *difference threshold.* The difference threshold is usually expressed as the increment or decrement which must be made to any stimulus before the increased or decreased stimulus produces a sensation differing in the corresponding way from the sensation produced by the original or "standard stimulus."

[1] This statement is subject to the consideration of the "Constant Error." See next section.

3. Other Thresholds

There are other thresholds which we have not considered above. Note that we have so far been dealing with the stimulus-threshold, or the stimulus difference threshold. They are sometimes called "sensation-thresholds," but the other designation is the accurate one. They are always determined by the measurement of stimuli which produce a specified effect before consciousness. There are other thresholds which are not the measurements of stimuli at all.

We may determine, for example, the least time interval perceptible as such; or the least space interval in touch or vision. Or we may determine the difference threshold for time intervals. These matters are not relevant here except to forestall the supposition that all thresholds are stimulus-thresholds.

4. The Constant Error

Suppose I wish to find the stimulus difference threshold for intensity (which for brevity we may call the I. D. T.), for a pressure of twenty-five grams on the centre of the palm of the hand. Obviously, the general method of procedure must be to place on the selected spot of the patient's hand a weight of twenty-five grams, alternating with weights slightly greater and slightly less, until we find the least weight which is felt as heavier, and the greatest which is felt as lighter, than the twenty-five-gram ("Standard") weight. The elaborate technic and many precautions necessary to make our results significant, we need not describe here, but one feature of the experiment is of present importance: If the "Standard" weight is given first in each case, and the second weight ("Variable") is varied appreciably, the patient (who, of course, is not allowed to see the hand and weights, and is not informed as to their actual weight values), will in very many cases declare the "Variable" heavier or lighter than the "Standard", when the two are exactly equal. You may find at the end of your experiment, for example, that the weight which is on the average just perceptibly heavier than the "Standard," when the "Standard" is given first, is actually lighter than the "Standard"! But this disconcerting result is not at all erroneous or troublesome. If you make an equal number of experiments with the "Variable" first and the "Standard" last, you may find the results the converse of the first set—the just perceptibly lighter weight being now heavier than the "Standard."

In short, your results include two factors; the I. D. T., and the constant error (C. E.) due to the order of the weights. The second of two weights is not judged under the same conditions as is the first, and *vice versa*. You must always make experiments in both time orders (S–V and V–S), and by comparing the results in the two cases determine the C. E. of time order, before you can determine the approximate D. T.

Constant errors, due to all sorts of factors, contribute to the complexity of the problems of experimental psychology, and in many cases the determination of the magnitude of the C. E. under definite conditions becomes a method of solving important problems.

CHAPTER VI

SENSATION-INTENSITY

1. Intensity of Sensation and Intensity of Stimulus

As we have already implied, the intensity of sensation depends in general on the intensity of the process in the end-organ and brain, which in turn depends in part on the intensity of the physical stimulus. There are, therefore, two relations to be considered: (1) the relation between the stimulus and the nervous process, and (2) the relation between the nervous process and the sensation. Concerning each of these relations we have practically nothing but the bare fact that, *ceteris paribus*, an increase in the intensity of one is connected with an increase in the intensity of the others.

The condition of the sense-organ has an important influence on the intensity of the sensation resulting from a given stimulation: fatigue and adaptation can modify the result immensely. Thus, the light sensation aroused by light striking the dark-adapted eye may be very much brighter than the sensation aroused by a light many times more intense acting on the light-adapted eye. These facts do not offer any serious logical obstacle to the formulation of statements of intensity relation, as all such are simply required to specify that the relation holds only for a uniform condition of the sense-organ and nervous connections; but they introduce serious practical difficulties, because it is not always possible to ascertain whether the condition of an organ is uniform during any given period of experimentation.

The difficulty of the discovery of definite intensity relationships of sensation and stimulus is increased by the difficulty of estimation. Direct measurement of sensation-intensities is impossible. We can only compare one sensation with another, and determine which of the two is more intense. And this determination is strictly relative. The apparent intensity of a sensation is affected by other sensations, aside from any change in the actual intensity of the sensation. For instance: a candle burning near a coal-oil lamp seems dimmer than the same candle burning beside the flame of a minute gas-jet; yet, if the experiment is performed in moderate daylight, the candle flame is practically as bright sensationally in the one case as in the other. When the time factor enters, and sensations present are compared with past sensations, the relativity of the judgment of comparison becomes greater. But even when the time factor is not present, the comparison of sensations of any sense is relative.

Taking into account the relativity of sensations and the relativity of the estimation of sensations, we find difficulties enough to account for the fact that no laws of the quantitative relation of stimulus-intensity to sensation-intensity are discoverable at present. The nearest approach to a law of this kind is "Weber's Law," which deals with the intensity difference threshold only.

2. Weber's Law

If we express the intensity D. T. as a ratio of the just perceptible increment (or decrement) to the Standard, we may state Weber's Law in the following terms: The I. D. T. for different values of a standard stimulus varying in intensity only is practically constant if the general condition of consciousness remains the same. This law holds, however, only for mean ranges of intensity; for feeble or very high intensities it is invalid.

Weber's Law may be expressed less technically, but yet accurately, as follows: The ratio of the intensity of a standard stimulus to the just perceptible increment in intensity is the same as the ratio of the intensity of any other standard to its just perceptible increment (or decrement), provided the sensations aroused by the two standards differ only in intensity, and provided that the general mental and physical condition of the patient is the same in the tests with the different standards. There will be in any case a minimum standard and a maximum standard, below which and above which, respectively, the equality will not hold.

As a concrete example of the uniformity described by Weber's Law, we may give the following. If the pressure of fifty grammes on the finger needs to be increased to fifty-one grammes in order that the increase may be noted, the pressure of one hundred grammes will need to be increased to one hunderd and two. In other words, the I. D. T. at fifty grammes ($\frac{1}{50}$) is the same as the I. D. T. at one hundred grammes ($\frac{2}{100}$). Above perhaps four hundred grammes, and below perhaps ten grammes, the ratio will be somewhat different.

The provisions to which we have given place in the formulations are exceedingly important. Among other cases in which these provisions preclude our expecting the I. D. T.'s to be equal, the following may be noted: (1) Different senses, or different qualities; thus, we would not expect to find the I. D. T. for sugar the same as that for blue light, or even for salt. (2) Different individuals. (3) Different portions of the sense-organ, as the centre and periphery of the retina. (4) Different extensities or durations of sensation. (5) Different conditions of the patient, as rested and fatigued. In addition, we do not find a constant D. T. for any other character than intensity. Weber's Law has no bearing on the D. T. for color change (wave length), or pitch, or duration. It applies to intensity only.

Weber's Law was given its name in honor of E. H. Weber, who first discovered the facts which it describes. The first formulation, and the application of the name, were the work of G. T. Fechner, who attempted to give the law an application to stimulus differences greater than those just perceptible, and to turn it into a statement of the relation of stimulus-intensity to sensation-intensity. Fechner's attempt, based on the assumption that all just-perceptible differences in sensation are equal, resulted in "Fechner's Law," and "Fechner's Formula," which expressed the relation as a logarithmic equation. The discussions, controversies, and investigations consequent on this formulation constitute the subject sometimes called psycho-physics. Fortunately for the student, the whole matter is chiefly of historical importance, and may be safely ignored in an elementary course.[1]

3. The Comparison of Intensity Differences

The determination of the just perceptible difference involves an equating of intensities. In order to find what intensities seem equal to a given intensity, we must find the greatest which seems less and the least which seems greater; conversely, in determining these thresholds, we have substantially determined the intensity equivalents. In addition to finding equal-seeming intensities of sensation we may also compare *differences* of intensity with regard to their equality or non-equality; but we find that the results of these judgments are less uniform than those of mere intensity.

If we find two sensations, S_1 and S_2, which ap-

[1] The analytically inclined student may be disturbed by the careless way in which we speak of the discriminating of differences of stimuli, instead of the discriminating of differences of sensation corresponding to certain differences of stimuli. We trust, however, that the discussion gains in simplicity without losing in clearness by that looseness.

For an adequate discussion of Fechner's addition to Weber. see James, Principles of Psychology, vol. I, chap. XIII, pp. 533–549.

pear exactly as different in intensity as two other sensations, S_3 and S_4, we might expect to find on the analogy of Weber's Law, that the stimuli of the first pair have the same intensity-ratio as the stimuli of the second pair. Letting the intensity of the stimulus be represented by R, the relation in question may be expressed, $R_1/R_2 = R_3/R_4$. This relation, which is demanded by Fechner's Formula, is actually found to hold in many cases. In other cases, however, the relation has been found to be more nearly that of equality of stimulus differences; $R_1 - R_2 = R_3 - R_4$, and this divergence has given rise to some acrimonious controversy over the "correctness" of the one result or the other. As a matter of fact, both are correct. Some individuals will rather uniformly select "equalities" of the first type, and other individuals will select equalities of the second type. Certain individuals will select neither type of equality, and still others will select both.[1]

[1] In extensive experiments on nearly sixty persons, using the same apparatus and same conditions throughout, I have found that in selecting a light-brightness or weight-intensity which seemed midway between two standard light or pressure intensities, the persons fell into four classes: (1) Those who selected the geometrical mean; (2) those who selected the arithmetical mean; (3) those who selected a mean which was the arithmetical mean of the geometrical and arithmetical mean; (4) those who selected approximately the harmonic

4. The Relativity of Sensation

The relativity of sensation-intensity and intensity-differences; their variability, that is, according to the various conditions mentioned in the preceding sections, may account for the apparent "relativity" of sensation-quality, which is usually included by specification or implication in references to the "relativity of sensation." It is often implied that the quality of a sensation is not determined by a definite stimulus acting on a corresponding nervous mechanism, but by this action in conjunction with all the other nervous and mental activities. Color contrast, and all the other conditions in which now this sensation, now that, are gotten from the same stimulus under different conditions, are cited in support of this view. These phenomena may not be due to qualitative variability at all, but simply to the variability of intensity.

A qualitative change in a sense-content may be one of three things. (1) It may be a change in the intensity or intensities of one or more of the quali-

mean. Some of the persons were too irregular to be fairly classified at all, a few alternated between two types, and one person insisted on selecting two means, approximately the arithmetical and geometrical, which he insisted were both good, although not "of the same sort."

tative elements present in the content. (2) It may be the addition of a qualitative element, or of qualitative elements not previously present. (3) It may be a simulation, due to a direction of the attention more strongly or less strongly to certain elements.

A sensation of pure red (if such is obtainable) may become more intense, or less intense, and may completely disappear; but, so long as it remains, it can be nothing but red. The same stimulus which now arouses pure red may, in a different condition of the eye, arouse some blue also; in which case the result is purplish. So daylight, which "normally" excites the three colors in such proportions of intensity that "white" results, may, if the eye is adapted to purple light, excite the green process with unusual intensity; hence, the green after-image. Distilled water does not ordinarily excite the taste-buds, and hence there is no gustatory sensation; but by the previous action of some drug the nerve endings may be made sensitive to the effect of the water; this is, in effect, the lowering of the stimulus-threshold.

5. Beats

An important phenomenon of intensity in the auditory realm is that of beats. Beats are periodic fluctuations in the intensity of a sound, commonly arising when the stimulus (air-waves) is composed of vibrations from two separate sources, as two tuning-forks, or pipes, or strings, giving notes of proper pitches. Two sources of sound will give rise to beats if (1) the note of one is less than (*circa*) thirty vibrations per second faster than the other, or (2) when twice the rate of the lower is less than thirty vibrations faster or slower than the other. These beats are called beats of the first and second orders respectively. Beats of the third and higher orders exist theoretically, but are so weak as to be practically negligible. For the physical theory of the interference of the sound-waves, which produces the alternate maxima and minima corresponding to the beats in sensation, the student may refer to any good treatise on sound, or on general physics.

A single source of sound, as, *e. g.*, a bell, may produce beats through the interference of the partial tones contained in its note. It is this which gives the tremulous character to the sound of a bell. Alternate reinforcement and diminution of the intensity of a single note may be produced also by various extrinsic means. Tune a bottle to the note of a tuning-fork by pouring in water to the right height, and then rotate the fork, holding it horizontally over the mouth of the bottle: the beats thus produced are of the same character as those produced by two forks sounding together. The vibrato or tremolo of the human voice, which is an effective embellishment when used sparingly, and which mediocre singers employ without reason or mercy, is in some cases purely a matter of intensity-variation, *i. e.*, beats; in other cases (in most cases, in fact) it is partly a matter of pitch changes.

CHAPTER VII

PROTENSITY AND EXTENSITY OF SENSATION

1. The Duration-Character

THE duration or protensity of a sensation is to be discriminated from the duration of the experience, and from the duration of the stimulus. A stimulus acting one second may produce a sensation lasting less than a second or more than a second. The sensation may not be experienced during a certain period of its existence; perhaps it may not be experienced at any time; at least there are sensations which are unnoticed during a part or the whole of their existences. We cannot say with certainty that any sensation is experienced from beginning to end; perhaps all sensations have unexperienced phases. Even if we should admit, as certain metaphysicians would have us do, that the duration of the sensation and the duration of the experience of the sensation are equal and coterminous, we should still be obliged to hold that the duration of the one is logically distinct from the duration of the other, for the duration which is characteristic of the sensation is actually experienced along with the other characters (quality, intensity, etc.). In other words, the duration experienced is not the same thing as the experience of the duration.

The protensity or duration of the sensation as directly experienced is distinguished from the duration as measured by its relation to series of other events, whether these events are other sensations directly experienced (as in the immediate estimate of time) or whether they are members of an ideal series based on mathematical subdivisions of the parallel of latitude (minutes and seconds).[1]

It is the duration of sensation as an experienced fact to which we refer in speaking of the protensity or duration-character. A sensation without it could never be brought into the time relation, and time, as we experience it, could not exist apart from sensations. Time, however, involves more than sensation-duration, as we will see later.

The direct comparison of two sensation-durations is much more difficult than the comparison of intensities. In the first place, it is impossible to ex-

[1] This mathematical relation of sensation-duration to a standard time series is often loosely designated the "duration of sensation" as distinguished from the "experience of the duration," the last name being applied uncritically to the duration-character of the sensation, the estimated duration, and the experience of these.

clude a multitude of other sensations (bodily, etc.) which insist on taking a part in the comparison. In the second place, since in most cases the durations compared must be in succession, the memory factor becomes especially disturbing. For these reasons, very little has actually been accomplished in the investigation of the difference-sensibility for protensity, although there has been a great deal of experimentation in the general field of time-content.

2. Extensity

Extensity is related to space as protensity is to time. In each case the sensation-character is so intimately built up into the complex that it is difficult to analyze it out; but the analysis is the less difficult in the case of extensity.

Extensity can best be demonstrated in the dermal sense. Provide yourself with a small cork stopper and a small wooden rod with a blunt, very slightly rounded point. Touch your wrist or lower arm alternately with the rod and with the cork, avoiding hairs and veins, and pressing just hard enough to arouse touch sensations. Notice that the touches have different "bigness", although neither has any space-form; that is, you cannot discriminate any parts in either; you cannot discriminate edge from middle, or one side from the other. The difference which you observe is one of extensity. In a corresponding way, extensity-differences may be demonstrated in the visual field.

Extensity-differences depend physiologically on differences in the number of nerve endings stimulated. In general, the more nerve endings stimulated, the more extensive the sensation, but we cannot expect to find any definite relation of number to extensity which would hold for different parts of the organism, or even for different parts of a sense organ. Extensity-differences occur wherever there are nerve endings capable of stimulation in different numbers, as in the senses of vision, touch, warmth, cold, and bodily feeling.[1]

In the case of auditory sensations, the extensity, if it exists, is probably that which we commonly

[1] The difference in volume between different aches, for example, is often noticed. In smelling, it is possible that practically the whole group of nerve endings which are capable of responding to a given odor are stimulated every time the odor is aroused, as we find no pronounced differences of extensity with any one odor. Whether different odors have different extensities we cannot say conclusively. The sensations of smell, nevertheless, have extensity, even though differences therein are obscure; it is the apparent (or real) sameness or the practical unimportance of differences, which makes us overlook the character in olfactory experience. Yet we ought not to say even that it is practically unimportant, until we are certain that it plays no part in the puzzling composition of odors.

call *pitch*. The nerve endings (the hair-cells) in the cochlea of the ear form a linear series (or multiple linear series) running the length of the basilar membrane, and it is probable that high notes (rapid vibrations) stimulate only the cells situated at the end nearer the middle ear; lower notes (slower vibrations) stimulating a larger number. It is well known that the destruction of the cochlear nerve endings nearest the middle ear (at the basal extremity of the basilar membrane) destroys the sensitivity of the ear for high tones, but not for low ones, and this agrees well with the extensity theory, but with no other except that of Helmholtz.

The introspective fact that the difference between low and high tones seems like the difference of extensity of other sensations; the fact that the sounding of a low tone obscures a feeble high tone, while the sounding of a high tone does not obscure a feeble low tone; the fact that the highest audible tone, no matter what its actual pitch, always seems "approximating zero," that is, having no conceivable terms beyond it in the pitch series; these and other facts point to the correctness of the pitch-extensity theory.

Pitch is no more noticed habitually as a mere sensation-character than are extensities of other sensations. We do not weave it into a space system, probably because of the lack of muscular adjustments for that function, but we do, nevertheless, organize the different extensities in the usual mathematical way. One result of the organization is the musical scale, and we normally perceive tones in the scale relation, although usually not with mathematical exactness. Exactness is attainable for theoretical purposes, just as exact space measurements are possible in spite of the fact that our ordinary estimations of space "by eye" are mere approximations to accuracy.

3. Overtones and the Musical Scale

The method in which the *diatonic scale* which we use (in theory) at present, and the modifications of it employed in musical practice, were developed, is an interesting and important chapter in the psychology of auditory sensation, but a chapter which can only be sketched at present. The scale has developed through the need of conforming to the natural series of *overtones* or *partial tones* (see below), the advantage of avoiding beats, and the simplicity of wood-wind instruments with regularly spaced finger-holes (primitive flutes), these instruments giving scales which are "near"-diatonic.

Overtones, or *partials,* are tones that sound along with the proper or fundamental tone of a source of sound; or, rather, they are components in the total note, which are higher in pitch than the principal component or fundamental. Partials of various number are produced by all the common sources of sound, and may be easily demonstrated with an instrument of the "sonometer" type; a long gut or piano wire stretched on a sounding-board or box. Strike the string with a piano hammer (a small rod wrapped with cloth will do) at a point one-quarter the distance from one end to the other, and then touch it lightly in the middle with a feather or small wad of cotton; the fundamental note of the string will stop, but a note an octave higher will continue sounding. This octave tone is called the *first overtone,* or the *second partial* (the fundamental being the *first partial*). Strike the string at one-sixth and touch at one-third, and you will hear the *third partial.* Strike at one-eighth and touch at one-quarter, and you hear the *fourth partial.* If you touch where you have struck, the partial corresponding to the point of touching will not be produced, or will be very faint; this shows that it is the striking and not the subsequent touching that produces the partial; which means that the upper partial is produced along with the fundamental. With a little practice you can in fact soon acquire the ability to pick out the partials without touching or stopping the string.

In instruments of the horn or trumpet type, with proper blowing and without manipulation of the valves or slides, the partials up to the eighth or ninth may be made to sound without the partials below the particular one sounded in each case. This gives a sort of scale whose notes are far apart at the bottom and closer at the top, and in this scale we can play the melodies known as "bugle calls." Since these notes (with a modification of the seventh) are included in the diatonic scale (in the brass instruments of the modern orchestra we simply add the intermediate notes by manipulation of the valves or slides) we may reasonably suspect that such wind instruments have been important in fixing the notes of the modern scale.

In another way the partials have helped to fix the intervals of the scale, especially the octave, the interval between the fundamental and the second partial, which is relatively strong in the human voice. In a room or cave some of the notes previously sung are still vibrating while another is being sung (or played) so that the present note must "harmonize" with the overtones of the previous note.

The musical interval between two notes is measured by the ratios of the vibration-frequencies of the two notes to each other; thus, the note of 256 vibrations per second and the note of 320 vibrations per second are separated by the same interval as the notes of 320 and 400, the interval, namely, of 4:5. The intervals separating the successive notes of the diatonic scale (c, d, e, f, g, a, b, c; or ut, re, mi, fa, sol, la, si, ut), may all be expressed by small fractions, and are $\frac{8}{9}$, $\frac{9}{10}$, $\frac{15}{16}$, $\frac{8}{9}$, $\frac{9}{10}$, $\frac{8}{9}$, $\frac{15}{16}$. The relative rates of vibration of the notes separated by these intervals may, therefore, be represented by the numbers 8, 9, 10, $10\frac{2}{3}$, 12, $13\frac{1}{3}$, 15, 16. The rates of vibration of the harmonic partials (the partials of the voice and of musical instruments are *practically* harmonic) are 1, 2, 3, 4, 5, 6, 7, 8, and so on; the second vibrating twice as fast as the first, the third three times, the fourth four times, and so on.[1] It is evident that the diatonic scale is the series of harmonic partials from the eighth to the sixteenth,

[1] The harmonic partials are those whose vibration-rates are integral multiples of the rate of the fundamental. A partial whose rate is $2\frac{7}{9}$ times that of the fundamental would be classed as non-harmonic. Tuning-forks, bells, and metal plates produce non-harmonic partials.

with $10\frac{2}{3}$ substituted for 11, and $13\frac{1}{3}$ for 13 and 14.

The partials up to the ninth are, as said before, easily produced on wind instruments (and of course on stringed instruments, in isolation, by stopping the strings as described), so we are not surprised to find that in the earliest scales discoverable, in India, China, and the British Isles, these intervals are included. The notes employed in these scales are, as represented in our scale, c, d, e, g, and a♯, or 8, 9, 10, 12, $13\frac{1}{2}$. Now the most obvious thing about the overtone series is the octave relation, $1:2$, $2:4$, $4:8$, etc., so that the intervals $8:10:12:14:16$ are equivalent to the intervals $4:5:6:7:8$; and hence all the intervals of the primitive scale are really given by the overtone series up to nine, except that the seventh partial is replaced by a slightly lower note.

The modification of the seventh partial is the first step in the process of simplification which has given us the modern scale; for as the series $8:9:10:12:14:16$ gives no two intervals alike, the slight flatting of 14 to $13\frac{1}{2}$ replacing $12:14=6:7$ by $12:13\frac{1}{2}=8:9$, or, still better, flatting to $13\frac{1}{3}$ and so replacing $12:14:16$ by $12:13\frac{1}{3}:16=9:10:12$, thus duplicating intervals already in the scale, simplifies matters much. In the same way, when it was desired to insert additional notes in the larger gaps, the notes chosen were not 11 and 13, but such notes as would introduce the fewest new intervals; and these would be the notes 8 : 9 above $13\frac{1}{3}$ and 8 : 9 below 12, *i. e.*, $10\frac{2}{3}$ and 15, which introduce only one new interval, $10 : 10\frac{2}{3} = 15 : 16$.[1] The scale as derived contains, therefore, only three different successive intervals; 8 : 9, 9 : 10, and 15 : 16; the *major tone*, *minor tone*, and *semitone*. Having derived these three intervals, the ingenuity of musicians led to the combination of the intervals in other orders to fill out the octave, but the one which came nearest to the overtone series is the one which has survived in use.

A still further development has displaced the diatonic scale, which is practically not used at all now. If a note is inserted between 8 and 9, 15 : 16 below 9; and another 15 : 16 above 8, the two notes ($8\frac{7}{16}$ and $8\frac{8}{16}$) are separated by an interval of 2025 : 2048. The pairs of notes similarly placed between $10\frac{2}{3}$ and 12, and $13\frac{1}{3}$ and 15 are separated by the same interval, and the pairs between 9 and

[1] The interpolations of course made by sound, not by the abstract ratio; but the proper sound is obtained only if the physical conditions which are expressed by the mathematical ratio are observed.

10, and 12 and $13\frac{1}{3}$ by a slightly larger interval. In the scale derived in this way—the *chromatic* scale—a♭ is slightly lower than g♯, and so on. So much for the amplification of the scale; now for the simplification. The chromatic scale is absolutely impracticable except for a few gifted musicians. If a single note standing between the proximate sharp and flat were substituted for the two, the resulting scale of twelve notes would be simpler, but too irregular. The obvious way to reduce the irregularities is to divide the octave into twelve equal parts, doing away at one stroke with the distinction between a♯ and b♭, etc., and with the two sorts of whole tones (8 : 9 and 9 : 10) and the two sorts of major fifths. Thus we have a scale called the *equally tempered scale,* which is a little less satisfactory than the chromatic scale in some respects, but immensely superior in other ways. The equally tempered scale has proved so superior to all other tempered scales (other scales constructed to simplify the chromatic scale) that it is universally adopted, and all modern keyed instruments are tuned in it—or, we might say, tuned *to* it, since tuners do not always succeed.

The Chinese and the Hindus achieved a twelve-fold division of the octave, as did probably the

Greeks also. Any people influenced by the harmonic partials and alive to practical musical needs was certain to hit upon some sort of tempered scale. The Chinese and Hindus went still farther, and worked out subdivisions smaller than the twelfth of the octave, but seem to have made little practical use of these minutely built scales. Savage peoples, who had not harmonic instruments (horns, etc.) and whose music was produced out-of-doors, seem to have developed scales not built in the octave at all. This statement applies to some North African tribes, at least, and to ancient Egyptians of low caste. Information on these matters is for the most part seriously defective, even in regard to existent tribes, and much observation has been rendered worthless by the assumption of the observer that the savages are attempting to use intervals represented in the diatonic scale, and that their deviations from these ideal intervals are due to their clumsy vocalization and inaccurate "ear."

4. Timbre

The character of the tones of different instruments, or, as we say, their *timbre*, is altogether dependent on the presence of overtones or upper partials. The particular partials present, and their relative intensities, determine the voice of the instrument.

The partials depend on the fact that the string, or column of air, or other vibrating body, is vibrat-

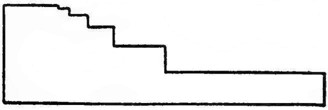


FIG. 9.

FIG. 10.

FIG. 11.

Figures 9, 10, and 11 are intended to represent schematically the relations of fundamental and overtones in notes of the organ-pipe, violin, and clarinet, respectively. The pitch is represented by the length from left to right, and the intensity by the height from top to bottom. The relative intensities of the partials in a given figure are somewhere near those actually existing in the characteristic notes of the instrument. In the representation of pitch the length of the partials is arbitrarily made inversely proportional to the vibration rate. Notice that in the case of the clarinet (fig. 11) the second partial is missing, while the third partial is relatively strong.

ing not only as a whole, but in segments. The intensities of these segmental vibrations depend on the form and material of the sonorous body and the way it is excited or set in motion. The voice of a violin, for example, depends in large measure on the condition of the wood, glue, and varnish of which it is made, and the way in which it is bowed. Pick the strings, and the note is not only short in duration, but has a characteristic timbre because the relative strengths of the partials are not the same as when the string is bowed. The difference between the tones of a cylindrical flute and a clarinet is partly due to the "bell" on the end of the clarinet, but more to the excitation of the flute by blowing across a hole and of the clarinet by blowing through a reed. The note of the trumpet differs from that of the cornet because of the different taper of its bore.

5. Extensity and Intensity

Extensities are comparable in the way in which we compare intensities, and we find difficulty in abstracting the extensity-differences from the more complex space-differences just as we find in the case of duration and time. The physical measures of just perceptible differences are found to increase with the extensities compared, but apparently not in such a simple way as is formulated for intensities in Weber's Law. In pitch, in general, when we can succeed in neglecting the metrical factor of scale relationships, differences seem equal when the corresponding differences in vibration rate are equal. This *may* mean equal differences in number of nerve endings stimulated.

Intensity is influenced by extensity, and *vice versa.* It is well known that a small spot of light falling upon the retina is sensationally not so bright as a larger spot of the same physical intensity per unit of area. A weight of one gram resting on one square centimeter of skin feels not so heavy as a weight of ten grams resting on ten square centimeters. A gustable solution applied to half of the tongue is productive of a stronger flavor than the same solution applied to a smaller area. These effects are in part due to the relatively greater extent of margin of a small area, and the consequent greater reduction of stimulus energy through *irradiation* to surrounding areas, but there may be other causes at work. In the case of auditory sensation, the conditions are such as to appear at first the reverse of those described above; a high note of given energy sounding more intense than a low note of same energy. This is doubtless because a high note affects a fewer number of nerve endings, and hence the actual stimulating energy is greater per unit of nerve ending than in the case of the lower note.

Intensity frequently affects extensity through the spreading or irradiation just mentioned. The excitation from a strong stimulus spreads out over a larger area in the sense-organ than in the case of a weak excitation. This is readily demonstrated in vision by noting the apparent increase in size of an electric light filament as it begins to glow.

The reader should note that our statement that intensity influences extensity, and *vice versa*, is metaphorical, and that the exact statement in terms of the two characters and the corresponding features of the stimulus is that the stimulation-conditions which determine the extensity and the intensity of sensation are in certain cases, at least, mutually dependent.

CHAPTER VIII

LOCAL SIGNIFICANCE

1. Localization and Local Sign

Sensations of touch and temperature on any part of the body are "localized" more or less correctly; that is, are felt as coming from the locality of actual origin. This discrimination must be based on differences in the sensations from the different regions, which sensations we have come to be able to refer to the proper places. Suppose, for instance, your eyes are closed, and some one noiselessly touches you on the hand, using a small rod of cork to obviate temperature sensations. You can decide at once that it was on the right hand and not on the left; which is sufficient proof that the sensation from the one hand is different from the sensation from the corresponding point of the other hand. The important question is: What are the differences which serve as the basis of this local discrimination? Differences in intensity, extensity, and duration can be ruled out, for variations in these regards do not influence localization except in extreme cases. Differences in quality are also excluded, for the tactual sensation has probably the same quality everywhere on the skin, and temperature sensations, which may certainly be obtained in different regions with identical quality, are also localized.

The fact that localization does not depend on quality is more apparent in the case of the eye. Stimulations of different points of the retina (if not too close together) are always discriminated as different, and by habitual association referred to the relative angular positions from which the stimulating rays of light must come. The discrimination of positions in the visual field depends, in short, on the discrimination of positions on the retina. And though the hue of a color roused by a given light stimulus varies according to the part of the retina stimulated, there are many different points in the retina giving the same qualitative mixture, which are, nevertheless, discriminated. The hues, moreover, may be varied through the whole range of the spectrum without affecting the locality discrimination; the discrimination, therefore, cannot depend on quality.

The character of sensation which furnishes the real basis for localization is thus demonstrable only by a process of exclusion. The uniform association of this character with the space position of the end-organ prevents our separating it analytically from this spatial factor, but since the character must exist as a basis for the space localization, we give it the name of *local significance*, or particularizing, *local sign*. Physiologically, local sign probably depends on the individual end-organs which are active, but nothing more can be said at present.[1]

2. The Discrimination of Local-Sign Differences

In order that a difference in local signs may be noticed, it must have a certain minimal value, which, however, is variable. Similar points on the corresponding fingers of the two hands can normally be distinguished, but if the hands are kept behind a screen for some time, and the fingers not stimulated, the patient tends to become uncertain as to which hand is touched. The signs apparently

[1] There is a theory that local signs are muscular sensation accompanying the primary sensation, or are the images of muscular sensation arising from the past experience of the muscular action necessary to bring the hand, or other member, to the spot on the skin with which the sign is connected. This theory is rather a work of supererogation, because it must assume a local sign of the sensation in order that it may rouse the proper muscular images; in other words, the theory does not touch the problem of local significance at all. That muscular sensation has a great deal to do in the discrimination and systematization of local signs is another matter.

are so nearly alike that the person forgets which is which unless he has a chance to freshen his memory from time to time. In general, the closer two points are on the skin, the nearer alike are the local signs of the sensations aroused therefrom; consequently, on any part of the body there is a certain minimal distance by which two simultaneously applied compass points must be separated, if they are to be felt as two. If the distance between the two compass points is less than the minimum, the two points are felt as one, because the difference in local signs is not enough for discrimination, although the two may be felt as "bigger" than either alone, probably because more nerve endings are stimulated in the former case.

The minimal distance of separation of two stimulating points felt as two is commonly known as the "two-point threshold, and the determination of this threshold is called "æsthesiometry." [1]

[1] Several explanations have been proposed for the physiological side of the two-point threshold, but so far it remains principally a matter for theory. A probable theory is based on the fact that all dermal nerve endings are connected with deeper-lying nervous structures, and that the endings connected with one deeper organ are interspersed in the skin with endings connected with other of the deeper structures. Any touch stimulus, therefore, is apt to affect two or more of the deeper organs, and if we assume that the local sign is associated with the deeper structure rather than with the dermal ending, it follows that a touch gives a combination of

In order that practice may influence the localization of sensation, and in order that differences in local sign may be discriminated at all, it is necessary that the signs to be discriminated shall at some time occur in independence of each other. If two signs or groups of signs are habitually aroused together, it is difficult to discriminate them; if they are invariably aroused together, discrimination is impossible. Touches on the opposite edges of two adjacent fingers are easily discriminated; touches on the apposed edges are not discriminated so readily, especially if near the palm; and if two normally apposed spots are simultaneously stimulated, the experience is apparently of a single touch. This last phenomenon results from the fact that the apposed areas are usually stimulated by a single object.

In the case of the eyes, the necessity of indepen-

sensations of different local signs. The relative intensity of the sensations in a given sensation-combination is accordingly the datum for the minute localization of the mass. This theory is supported by the fact that practice greatly reduces the two-point threshold, and by the fact that in many cases a single touch is perceived as two or even three.

The threshold varies from one millimeter or less on the tip of the tongue and the finger-tips, to several centimeters on the middle of the back. It bears no definite relation to the intensity-threshold, or to the intensity difference threshold on the different parts of the body. It is smaller on the more motile portions of the body.

dent stimulation is strikingly made evident. Normally, when any point in one eye is stimulated, a definite *corresponding point* in the other eye is stimulated in practically the same way. Hence, if under experimental conditions one eye alone is stimulated by light, the person is unable to tell, from that stimulation alone, which eye is affected.[1] This peculiarity of vision is of practical importance, for the stimulation of corresponding points in the two eyes produces single vision; that is to say, if two images nearly identical in form and detail, are thrown on corresponding portions of the retinæ, a single object is seen, whether the two images come from a single "real" object or from a stereoscopic picture. On the other hand, if the images of an object fall on portions of the retinæ not corresponding, the object is "seen double." This effect is easily produced by crossing or "walling" the eyes, or by pushing on the ball of one eye with the tip of the finger (on

[1] This may be demonstrated in a dark room. Let the person gaze at a feeble light, as a pinhole gas flame, or phosphorescent spot, having both eyes open and his head fixed in position. You may bring a card in front of one of his eyes, and he will be unable to tell which eye is seeing. The light, if a gas flame is used, must be so dim that he cannot see the card itself, and he must refrain from winking. Another demonstration may be made with a pair of spectacles, one lens plain and the other slightly prismatic. The person will not know which image is displaced.

the lid, of course), or by bringing a prism before one eye.

Corresponding points, as the term is used in psychology, may be defined as points on the two retinæ which are normally stimulated by rays of light from a single point in an object upon which the eyes converge. Corresponding areas of the retinæ are, accordingly, areas which correspond point for point.

3. Local Sign In Auditory Sensation

It is possible that local sign plays an important part in auditory sensation. According to the Helmholtz theory, pitch really reduces to local sign. If each rate of audible vibration should stimulate a small group of hair cells on the basilar membrane, each corresponding sensation would have a specific local sign, and these, differing from one another in accordance with the separation of the hair cells in the series, would form a linear series. The sensations would not be localized, there being no muscular mechanisms to assist in the associative process; so the series of pitches would remain a series of practically pure local signs.

Assuming that the Helmholtz theory is not correct, and that pitch is *primarily* extensity of auditory sensation, local signs may still be important in connection with tones. Each pitch may come to be associated with a certain local sign, namely, that of the group of end-organs at which the excitation on the basilar membrane ends. Thus, the series of local signs becomes the series of symbols of the extensities primarily constituting pitches. Extensity itself can be estimated only approximately by direct observation; this is true in both visual and tactual estimation, and it is possible that the person of "uneducated ear" distinguishes pitch-differences crudely because he attempts to judge in this way. The person of "musical ear," on the other hand, has possibly acquired the ability to notice the local signs, which lend themselves to more accurate identification, and has formed an accurate system of associations between these local signs and the marks of musical notation. Nothing is more certain than that musical and non-musical people employ different methods of estimation of pitch, and that the cultivation of the "ear" is a process of learning how to observe.

The immediately foregoing remarks do not apply to cases of organic defect in the auditory apparatus. There are persons who can never learn to distinguish pitches accurately; some peculiarity of their aural mechanism doubtless prevents the excitations from being sharply defined, a condition which may properly be designated *amblacousia.*

4. Olfactory Local Sign

Local sign may have something to do with the baffling composition of odors. Some of the peculiar similarities, and differences of smell sensation may really be identities and differences of local sign. We must remember that we never experience the local sign of dermal or visual sensation without its associative connection with space, nor local sign of auditory sensation apart from the corresponding extensity; hence, local sign unassociated with either of these factors, or associated with extensity in a non-serial way, would not be naïvely identified.

CHAPTER IX

RELATIONAL ELEMENTS IN THE CONTENT OF CONSCIOUSNESS

1. General

In discussing sensations we have necessarily discussed the relations in which they are experienced, but with reference always to the sensations. Now we must focus our attention on the relations themselves, and consider them in their turn as elements of content.

Just as you directly perceive sensations, so you perceive relations. This red is perceived as different from green; as like that other red; as brighter than this one; as lying on the table; as more beautiful than this dingy color; and so on. But it is not only sensations that are involved in complexes of relations; emotional content (assuming for the present that it is a specific content) is equally involved with the relational factors.

In the treatment of relation we encounter much more difficulty than in the treatment of sensation, because of the way in which relations complicate themselves in groups which seem like single relations; and also because of the elaborate processes through which we learn to perceive certain of these systems. We can develop in this chapter only the general line of analysis to which this content must be submitted, and amplify only enough for the purposes of the other portions of our work which come into close connection herewith.

The most conspicuous peculiarity of relation-content is that it has no definitely assignable nervous process corresponding to it. We know of no "centre" in the brain for the perception of relations, and we do not know that it is a cortical function at all. We must not suppose that perceived relations depend on, or are functions of "brain-paths," or "association fibres;" brain-paths represent simply connections established between different factors of content, by the operation of which the factors function together; the physiological connection is not the same thing as the experienced connection or relation, and the physiological connection may function perfectly whether a specific relation is experienced or not. It is true that there are a number of motor processes which assist in the perception of relation, but their neural consequences are no more to be considered as the counterparts of the experienced relations than the neural excitation caused by the movements of the eye are to be considered as the counterpart of the color sensation, in the obtaining of which the eye-movements assist. These points will become clearer as we proceed to the analysis of complex perceptions. For the present we may repeat, that while we incline to believe that there are specific brain processes corresponding to the relational content of consciousness, as there are to sensational content, the belief is as yet merely a detail of the general *a priori* theory of the relation of nervous process to experience.

The enumeration of elementary relations or groups of elementary relations is a difficult, not to say impossible, procedure in the present stage of psychological analysis. The greater number of familiar relations are doubtless complex. The relations of causality, of inadequacy, of up and down, and so on, are really involutions of a number of relations whose final analysis is, perhaps, not yet to be made. To particularize: the relation which we call causality involves the relation of succession —or, perhaps, simultaneity—the relation of invariability, and, according to one view, the complex of relations involved in the "transfer of energy."[1] Take now the factor of succession; is it a simple relation? Probably not. It involves the relations of betweenness and difference, with a certain resemblance, and the peculiar relation to other phenomena involved in time.

As examples of relations which are *probably* elementary we may name the following: difference, identity, similarity, greater, less, betweenness, direction (peculiar to space), a relation peculiar to time, agreement, and possibly the relations of good and bad. At any rate, it is difficult to see how these can be resolved into any other relations: but the list is only a suggestion.

2. Platonic Ideas and Matter

The importance of relations in the content of consciousness, and in the supposed world lying behind experience, has always been recognized, and perhaps rather overestimated than underestimated. The "Ideas" of the Platonic philosophy are nothing less than systems of relations; at least this philosophy is pretty good common-sense when the

[1] Of course, these relations are not perceived in this combination; that is to say, we never perceive causation outright, but perceive a part and imagine the rest.

"Ideas" are so interpreted. The philosophy called "Idealism" always emphasizes the relations in the content, making them the prime or essential part, and the sensory factor trivial or secondary. Surprising as it may seem, the apparently opposed theory of "Materialism" has simply abstracted some of the most universal and characteristic relations from the content of consciousness and given them the names of "Matter" or "Substance." So, from the psychological point of view, these two systems are more nearly identical than opposite. Empiricism, which we believe to be a more adequate view, recognizes the importance of relational and non-relational content, and does not attempt to set either above the other.

3. Intellect

The perception of relation is commonly called *intellect*, in both scientific and popular discourse. In common language we speak of a man as being "intellectual" in so far as he is quick, accurate, or thorough in the noticing of relations; without regard to his keenness of sense perception, or his emotional capacity, or his will. Of course these factors of his total experience are never sundered, and each is important for the others, but high development of one does not imply development of the others to the same degree.

4. The Reality of Relational Content

There are several theories of relation-content which attempt to explain it away. The so-called "sensationalist" theory supposes the relation to be a sort of fusion or combination of the sensations. The "motor" theory supposes that our reactions to the sensory content constitute both the relations of the content within itself and to other content. While we do not wish to underestimate the importance of these theories, we wish to point out that, psychologically, they are only statements of the conditions and consequences of the experience of relations, and not explanations of the experienced relations themselves. The fact remains that relations are really perceived, and the attempt to evade this by substituting for the relation a fusion of sensations or a motor process is a waste of energy. The relation is as much a reality as the factors it relates, and we perceive it just as truly as we perceive them.

We cannot deal adequately with relation in abstraction from the other forms of content without getting outside of the field of psychology. Two sciences—or two branches of the same science, if you choose—deal specifically with relations: these two are logic and mathematics, and the serious student of psychology is advised to make himself well acquainted with both of them, not for their specific methods or results, but for their points of view.

CHAPTER X

IMAGES AS ELEMENTS OF CONTENT

1. Imagination and "Image-Types"

We have already referred to the prevalent doctrine of images as copies of sensations, or copies of sensation-complexes. This doctrine is older than Aristotle, who stated it pretty clearly, and who, perhaps, gave it its definite formulation; and it has been incorporated in some form in practically every general theory of psychology since his time. In modern times impetus has been given to the theory by the introspective and experimental work of Fechner and Galton, in whose steps many psychologists have followed.

Galton alleged that there are—or may be—images of different senses, but that images of vision and audition are the most important in the consciousness of adults. Galton compiled a "questionary" which was sent to, and answered by, a great many persons of all sorts; the object of the questionary being to determine the kinds and relative clearness of the images possessed by these persons.[1]

Imagination as an actual process or function cannot be denied, nor is there any doubt that when you imagine certain objects they will have a visual, or auditory, or other sensory reference. Some psychologists have denied the existence of images of taste and smell; indicating thereby a personal peculiarity, for the olfactory and gustatory features of imagination are for some persons the most vivid.

Muscular imagination has received due credit in the various attempts at analysis, and it has been stated with apparent justification that much of our "thinking," or trains of representation, goes on through the activity of the "images" of spoken words, and that these "images" are usually muscular, *i. e.*, representations or reproductions of the muscular sensations which occur in speaking the words. In reality, the alleged muscular images may be muscular sensations. (See below.)

In accordance with the accepted view, individuals are classified under "types" corresponding to the sorts of "images" they employ most constantly

[1] The intention of the questionary and Galton's views on the subject of images are best obtained from his *Inquiries into Human Faculty*. The gist may be found in James, *Principles of Psychology*, II, 51–57.

and readily. The predominance of images of the muscular sensations marks one as of the "motor type," and the predominance of images of the auditory or visual sensory sorts marks one as of the "auditory type," or the "visual type." A person of either motor or non-motor type may be of the "verbal type," *i. e.*, may employ "images" of heard or seen or spoken words. The terminological development has been carried still farther, but we need not pursue it beyond this point.[1]

When we come to the actual determination of "types" in accordance with the Aristotelian theory of "images," the trouble begins. Determination by the simple introspection upon which the questionaries depend is usually unsatisfactory to the patient, and still more so to the persons conducting the investigation. Several auxiliary tests have been devised, but they all depend on the interpretation of the results by assumptions which beg the whole question.

As regards the physiological processes causing or corresponding to imagination, the most natural theory based on the Aristotelian view is that the

[1] A person of the auditory type is sometimes called an "audile"; of the visual type a "visile." "Tactile," "olfactile" and "gustile" have been used also, but are not in such high repute. "Motile" is in good usage.

imagination process (production of the "image,") is simply a revival of the sensation process in a weaker form. The imagination-centres are, accordingly, supposed to be identical with the sensory centres, and the determinative difference between the imagination process and the sensation process is considered to be due to the initiation of the latter from the sense-organ, and of the former from some other brain-centre; the currents from the peripheral organs being supposed to be more powerful than the intra-cerebral discharges. This theory of the brain process on which imagination depends was quite widely held a decade or two ago, but it is now believed that the imagination process depends on a portion of the cerebrum contiguous to, or bordering on, the sensory area of the cortex.

We ought not to consider an "image" as a specific content, or a specific form of content, until we have more proof of the existence of that sort of an "image." Revived or false sensations probably do occur (the "subjective" sensations of the physiologist) but they are not what is meant by "image" or imagination. Actual normal sensations from the various organs may assist us in representation or thinking, but they are not a new form of content on that account. Imagination is a fact of consciousness; it is a way of being conscious of content of various sorts, and not a specific content, so far as we are able to determine.[1]

The specific sensory reference in imagination, which is the basis of the Aristotelian theory, is imparted in several ways, two at least of which we may point out. The sensory tang may be given because the object of which we are thinking was an object for the sense in question when experienced directly. The visible features of an object may be the important characteristics for one man, and to these principally he attends. Another man may attend principally to the sound made by the object. In recalling, or thinking, of the object, the first man will recall it as a visible object, and the second as an auditory object; each will think of it as it impressed him. But it is an unsafe leap from this bald and unexplained fact to the assumption that the first man has a "copy" of the visual sensations and the second a "copy" of the auditory sensations.

In some cases the mechanism by which the sensory mark is given is assignable. When sensations

[1] It is convenient to use the term "image" to designate the represented content, and we shall do so, in spite of our dissent from the general belief as to its nature.

from a definite sense, or sensations which are the normal concomitant of that sense, occur along with imagination, they tend to give the imagination the corresponding tang. This may be the means by which the influence of the preceding direction of attention to the object is realized, or it may be in some cases the agency which counteracts such influence. The sensations in question may be from the sense to which the imagination is ascribed; faint sensations from the retina, *i. e.*, of light, may give the visual reference to the "image"; but usually the sensations are from the motor apparatus functionally connected with the sense-organ.

In thinking of a visual object, *e. g.*, of an illuminated sign, there are movements of accommodation and convergence of the eyes, if the person is of the "visual" type. In thinking of the sound of an orchestra there are changes in tension of the muscles in the tympanum of the ear, or in the neck-muscles. If you fix your eyes on a point on the wall you will probably find it difficult to call up the picture of a ship under sail; let the eyes wander freely and the picture comes up readily. Fixate steadily a square of mosquito netting, and the picture will probably not come at all; this is because the netting offers an excellent object for steady fixation.

Some persons find a great decrease in facility of visual imagination when the eyes are under the influence of atropine; in the case of these persons the sensations of accommodation are important in marking the image.

If you can readily recall or imagine odors try the following experiment: take a deep breath, and have some one else name an odor just as you begin to exhale slowly through the nose; you will find that you do not get the image until you begin to inhale, and probably not then if the inhalation is slow. Sniff, and the image appears at once. Certain persons, whose taste images are extremely vivid, cannot get them unless the tongue is allowed to move.

A type of experiment which is noteworthy may be exemplified in the following way: put the vocal organs in position to say "Ah," and, holding them so, try to think or image the word "soap-bubble," or "parsimonious." The word will, in most cases, not "think" fluently. Such results have been held to demonstrate that the images of the words are "motor." It really shows only the close connection between the muscular sensations from the vocal organs and the imagining of the words.

The very ease with which individuals have been convinced that what they before believed to be "visual" or "auditory" images were really "muscular," as a result of experiments like the one just described, is in itself sufficient to raise a serious presumption against the Aristotelian theory. Likewise, the maintenance by certain persons, among whom are trained psychologists, that they never have any images such as Galton and others describe, is a significant circumstance. If the sensory reference is not intrinsic, but dependent on the mechanical interpretation of attendant sensations, these anomalies are quite explicable.

2. The Function of Imagination

Although the discussion of imagination belongs logically to the later chapters of this book, we must anticipate somewhat, in order to describe the behavior of the content when apprehended imaginatively, and the way in which that behavior modifies the total content in perception.

We are naïvely disposed to think of imagination as a play of fancy which may be amusing and interesting, but hardly as subserving the more practical and prosaic processes of thought. As a matter of fact, this latter is just what imagination does. Imagination is the basis of memory and of all reasoning processes, and upon it depends the perception of objects in the world about us.

Whatever has been perceived may be imagined in much the same form. Having seen a lion and heard it roar, I may on some subsequent occasion imagine a lion of the same appearance, and with the same sort of a roar. The content is indeed never exactly the same in imagination as it was in perception, but the difference may be unimportant. This approximate repetition of a former content is the *reproductive* function of imagination, and we speak of it simply as *reproductive imagination.* According to the Aristotelian theory the content is an approximate copy of a former sense-content.

On the other hand, content may be imagined in forms and combinations quite different from those of the original perception, and hence we are able to imagine things which, strictly speaking, we have never perceived. Sensory content experienced in one perception may creep in with content of another, or certain sensory factors may be eliminated from a former content. New relations may be introduced, and old relations modified. In consequence of these changes we have not only a general modification by which the content of all experience tends to lose its individuality, but also the special case which we call *creative imagination.*

One who imagines a perfectly "impossible" animal, a griffin or a "goop", is imagining a content composed or built up of the elements of a mass of content which he has previously perceived. It is only necessary to modify the human figure by changing certain contours in ways which are already familiar, and the "goop" is invented. Any one of us could imagine all the details separately, or in other combinations; otherwise we should not appreciate the "goop;" the notable feat was in imagining them combined. In poetry, the content suggested is such as we can all imagine—if the poetry appeals to us—but the poet has combined it in new ways. The scientist, in discovering a new principle, is able to imagine what he has never perceived, by imagining old content in new combinations; then, if his imagining has been successful, he is able to use new methods or arrange new conditions of experiment, so that what he imagined becomes now perceived, or he is able to demonstrate his results logically.

In creative imagination the creator is aware of the modification of the content. Along with the rest of the content he has the peculiar factor which we call newness, or novelty. He is aware that his content is a new combination. But in the general modification of content which we mentioned above, the person is less apt to be aware of the changes. The fisherman who magnifies into a three-pounder the minnow which escaped; the student who relates the hard-luck story of how he "failed" in an examination through no fault of his scholarship; are in many cases quite sincere, and base their tales on imagined content which has undergone progressive "improvement" since it was experienced in perception.

A distinction has frequently been made in the past between the *image* and the *idea*. The image was supposed to be the special content in imagination, and the idea to be that to which the image referred, or which it meant; or else the idea was supposed to be both the image and its meaning taken together. This view can be expressed by saying that the image present to consciousness *means* something (some former content) which is not "present." The introduction of the content image does not seem to answer the question as to how consciousness is able to grasp what is not "present" to it, and it seems that instead of trying to dodge the issue we might as well admit that we can be conscious of content which is not presented: in which case the copy-image is a useless supposition.

If we do not postulate a specific image-content, the distinction between image and idea is of no practical value unless we are willing to make it in the way in which it is made in every-day language. We do commonly discriminate in our use of the two terms, using "idea" in a general sense, and "image" to signify a form of idea in which the sense factors perceptible in a single physical object or limited group of objects, are especially emphasized. Thus when I "think" of the pyramids of Egypt, I usually have a content which combines vague elements of geometrical form with more definite fragments of representations of their probable builders (drawn of course either directly or indirectly from pictures and written descriptions), with a "feeling" of great distance from me, and with some actually presented muscular sensations which normally accompany the lifting of a heavy weight. These are not the only factors, but they are typical of what the idea of the pyramids involves. It is possible to think of the pyramids in another way, in which the monuments themselves, as perceptible objects, become more prominent, and their relations to other things become less important. They are then thought of as concrete objects in which color, form, and weight-content become predominant, and the factors of distance, antiquity, construction-problems, and personal and racial connections are minimized. It is useful to call the content of the former way of thinking an *idea*, and the content of the latter an *image*, but this is not to be taken as an accepted scientific usage, and the two terms must be used with caution.

So far we have been speaking especially of the sensation-content in imagination; but relations are also imagined. A composite sensory content is presented in a complex of relations, and when we imagine a similar content it also is set in and permeated by similar relations. We have shown above that in what we have called an image a limited group of sensory content may be important, as against the importance of a wider group in what we have called an idea, and we should also point out that in the idea the relations which enter into the content are to a large extent external to the central feature, while in the image the relations within the central factors of content are the most important, the external relations sinking into insignificance.[1]

[1] The increasing difficulty of arousing "images," which frequently accompanies prolonged scientific training, is partly

In the instances given the central content is constituted by the features intrinsic to the pyramids themselves, as perceptible objects, and the external relations are the relations to geography, engineering, the peculiarities of the builders, etc.

It is possible to have an imaginative content in which the relations are the central feature, and the sensory factors are purely incidental. Such a content is a further development of what we have above described as the idea, in the common parlance, and is properly called an *abstract idea*, or *concept*.[1]

The three types of content in imagination are therefore what we may call the *image*, the *idea*, and the *concept*: and we maintain that, as content, abstracted from the mode of being conscious of them, they involve only sensation and relation.[2]

The difference between the image of a horse and the idea of a horse ought to be already clear to the reader. In thinking of a horse of such a size and

due to the habits of ideating engendered by that training. The scientist habitually apprehends all data in relation to other data, and loses to a greater or less extent the power to isolate which is characteristic of the artist.

[1] The concept is sometimes identified with the Platonic Idea, and it may seem that we have committed ourselves to this view; but that is not quite the case.

[2] This statement is to be taken with the question previously raised; whether feeling is ever strictly imagined: but if feeling is a form of sensation, the statement is accurate without qualification.

color and attitude, and with that sort of qualification only, you "have an image"; but if you are simultaneously conscious of the usefulness of that animal as a beast of burden, or his importance as an enemy in an encounter, or his evolutional relation to other animals, or his need of hay and grain, you "have an idea." Now just carry this differentiation a step further, and let the particular horse dwindle in significance, and the relations to burdens, oats, and so on, become more emphatic, and you "have the concept" of a horse.

The preceding illustration makes apparent an important fact about concepts, and one which is sometimes overlooked. There are as many different concepts of a horse as there are different individuals who conceive it—in fact, each individual has many concepts of the equine species—differing according as they emphasize this or that set of relations; and yet in the large sense the concepts agree, since an animal which will agree with the concept of the zoölogist or the artist will also satisfy the concept of the hostler. (The specimen which is ranked high under one concept may, however, be ranked low under the other.)

While the various concepts of a horse held by different individuals pretty generally agree in function, there are other sorts of concepts which do not. The concept which one man has of morality, or of a moral being, is often incommensurable with the concept held by another man on nominally the same subject. This is probably because the concepts of neither are adequate; that is, neither has grasped a really definite and coherent system of relations.

CHAPTER XI

RETENTION, MEMORY, AND RECALL

1. Retention

As we have indicated already, one general condition of imagination is the previous perception of what is imagined, although the content in imagination does not necessarily have the same form and combination which it had in the former perception or perceptions. One who has never perceived light—one blind from birth—cannot imagine color,[1] and a similar limitation applies to any other sensation, because sensation cannot be built up from anything else. As with sensations, so with relations; if they are not first apprehended, they cannot be conceived, although we may form concepts involving relations which have not previously been experienced in the exact combination in which they occur in the concept. A person who had never witnessed the transformation of a substance from solid to liquid, and *vice versa,* might conceive of

[1] The blind man, by noting what others say about the objects he perceives through touch, may be able to talk intelligently about their colors, and may not even know that he does not know what color is.

liquefaction and solidification, but he could do so only if he had noticed the difference between the two states of substance, and had noticed modifications of other sorts.

The dependence of imagination on previous perception, although an undoubted fact, may not be so rigid as it is represented in such statements as those we have made above. Just as there are instinctive tendencies to actions which the individual has not learned to execute—tendencies due to the structure with which the individual is endowed by virtue of his place in the animal kingdom—so there may be instinctive tendencies to be conscious in particular ways, due to the nervous constitution of the individual and not to his experience. Until this possibility is excluded we can merely say that the dependence of imagination on the previous experience of the individual in the way described above is the general or usual fact.

The dependence of imagination on perception is given the functional name of *retention.* In some way, the effects of the past experience or content have been preserved and so the present imagination made possible. We do not know exactly what it is that is retained, but psychologists are accustomed to designate it plurally as *traces.* The experience leaves its traces, and through some activity initiated or facilitated by these traces the content is later revived as an image. Some theorizers claim that these traces are only physiological; modifications in the brain and its appendages; others insist that there are mental traces also.

On the whole, the doctrine of mental traces seems to be not an explanation of the dependence of imagination on perception, but a symbolic statement thereof which adds nothing to our knowledge on the subject.

The first notable feature of retention is the fact that it varies with the individual. One man, having experienced a certain content, retains it for a long time; another, under similar conditions, quickly loses the effects of what he experiences. This difference shows plainly in memory; we find the one man able to recall isolated bits of past experience with ease and accuracy, while the other man requires all sorts of aids in order to recall his similar experiences. The differences show also in the creative imagination; the wealth and facility of imagery of some individuals as against the poverty and sluggishness of others is due in part to the extraordinary way in which all sorts of experiences stick in the minds of some, and the difficulty with which they are retained by others. A great deal of individual variation is due to the factors we are to take up next; but after allowance is made for them there seems to be a residue of personal differences as yet unanalyzed.

In the second place, experiences which are strongly impressed, that is, are strongly attended to, or are repeated several times, are more firmly fixed and retained than are experiences not having that advantage. This accounts for one sort of individual peculiarity; two persons may observe the same phenomena, and afterwards each will be able to recall more fully the things to which he was specially attentive. A man fails to recall the color and style of the costume of the woman to whom he talks for half an hour, while his wife after one glance would be enabled to recall these details and a great many more; the man does not attend to sartorial feminine details, although he undeniably sees them. The effects of repetition are too familiar to need exemplification.

In the third place, all effects of experience tend to disappear with the lapse of time. One might say that (to use an ancient analogy) the mind is like a tablet of wax or clay, upon which experience writes.

The firmer the wax and the deeper the engraving, the more permanent the inscription; nevertheless, all inscriptions tend to become in time illegible through the slow process of disintegration of the surface of the tablet. Writing that is to last as long as the tablet must be scratched in deep at the first, or else the lines must be often retraced.

In many cases, content whose traces are apparently obliterated is really retained. As we say in common terminology, things forgotten for years may return to memory with great vividness. The causes of this abeyance are obscure; in part it depends on associative factors, as will be made clear in the next chapter, but over and above the part played by association there is an unexplained factor in the variation in facility with which the traces of past experience, or content, become active. This slight obscurity is an important basis of the pseudo-scientific theories of "subconsciousness" with which we will have to deal later. We must remember that retention is only a name for the fact that a past content is subject to being re-experienced in imagination, and that the only proof that a content is retained is in its being imagined; and, conversely, if any content of former experience is imagined, that is *prima facie* proof that it has been retained, even if the period between the original experience, and the reproduction is fifty years.

What has been once experienced may not return to consciousness in imagination, but may be effective in another way. If you learn the lines of a poem to-day, you may have "forgotten" them by next month, and be able to repeat none of them. Yet, you will find that the relearning of the poem requires less time and energy than the first learning; this is largely a matter of association, but not altogether.

The retention of the various impressions is facilitated, and in fact the retention of complex content is made possible, by association. Under that heading, as well as under the headings of memory and recall, retention must be further discussed.

2. Memory

The term *memory* is used in psychology in practically the same sense as in common parlance, but certain biologists are in the habit of using the term in another way; a practice which has brought about a great deal of confusion and unnecessary conflict of statement. If an animal acts upon any stimulus in a way which is the result of previous stimulations; if his conduct or experience (assuming that we know something about his experience) is based on the experience of the past, it is said by some writers that the memory of the past experiences or stimulations is demonstrated. There would be no objection to this use of the term to designate the influence of the past nervous processes on those of the present, if it had not been used so long to mean something more specific.

Specifically, *memory* means the consciousness of any content, with the coincident consciousness that the content has been experienced before (*i. e.*, *recognition*), and at some more or less definite date. If I remember a train wreck in which I was a participant, I am conscious of it now, (in the way of reproductive imagination), and also conscious that it happened awhile ago; I may be aware of the exact period at which it occurred, or I may not, but I at least locate it in a certain period of my past.

It will perhaps occur to the reader that the greater part of my past experience, however much it may modify my present experience and activity, is not remembered. For example: my reading and writing are the result of a number of definite experiences of my early life, yet I do not remember the content of these experiences, nor can I remember them if I try. If some one calls you by name, you will reply; yet in ninety-nine cases out of a hundred you do not remember your name at the time. You have formed certain fixed habits in regard to the particular sound to which you answer, but in few cases does it occur to you that you have heard the name in the past.

Many times we reproduce in imagination past content, without being aware that it is past content; the experience is mere reproductive imagination, not memory. The facility with which non-reminiscent reproduction occurs is at the basis of a great deal of plagiarism in literature; an author imagines a situation or sentiment which is really an exact or approximate reproduction of something he has previously read in another author's writings, but he does not remember it, and so the trouble begins. A striking example of this sort of reproduction is found in a short story or miracle-tale by a well-known American author, who relates that the story came to him in a sort of dream at night. The idea and elaboration of the tale are so similar to that of one of Tolstoi's short stories as to raise the presumption that the American author, having read Tolstoi's "Two Pilgrims," at some earlier time, reproduced it in an altered form, and failed to recognize it.

The important thing about memory is the factor of recognition by which the reproduced content is enriched. We have said enough to indicate that this factor involves or depends upon certain features of perceived time; its further treatment will accordingly be deferred to the chapter in which time is discussed.

3. Recall

Given the fact that a content once perceived may be subsequently imagined; to which fact in the abstract we give, as said above, the name retention, we inquire why the content is imagined—called back, or recalled, as it were—at one time rather than another; or we may even wish to know why or how it is recalled at all. A part of the mechanism of recall is understood, if imperfectly.

In the first place, the very fact of retention implies a tendency to come back. Whatever content has been experienced may by virtue of that fact alone return later to consciousness. The expression "spontaneity of the image" has been applied to this recurrence-tendency, the expression figuring the image as an entity with an active force pressing it toward the field of consciousness. We might develop the analogy by likening consciousness to a stage, of varying area, but strictly limited, on which a vast crowd of players are seeking to enter. Some of these players are continually sent on and off the stage by directing agencies, but if these agencies cease to operate, or leave vacancies, the images having the most energy at the moment will thrust themselves on. It is especially in dreams and reveries that content seems to revive in the way described by this highly artificial analogy.

In the second place, content revived in memory or imagination tends unmistakably to disappear soon after its entry into the field of consciousness. It may be kept before consciousness for varying periods of time through the effect of associative factors, or in pathological cases the image may monopolize consciousness for long intervals; but normally it tends to fade soon after appearing. In the terms of the analogy, the players seem to be exhausted by the effort of their appearance before the foot-lights, and need to retire to some psychologic greenroom for long periods of recuperation. If it were not for this fortunate shortness of vitality of imaged content, the stream of thought would soon cease to flow, as in the pathological cases above mentioned.

The most important factor in recall is *association.*

The content of past experience is so linked together that given any perception or imagination-content before consciousness it tends to bring in certain other content. This linkage is designated as association. Because association is of wider interest than is its function in recall, we shall give it a chapter by itself.

CHAPTER XII

ASSOCIATION

1. The Principles of Association

Association is the organization of experience, by virtue of which the various kinds and parts of content constitute a whole; it is the functional interconnection of the objects of experience as we find them; not a force or activity. The statement of the principles or laws of association is by no means an explanation of anything, but simply a convenient summary of observed facts.

I. The Principle of Integration.

The total content of consciousness under normal conditions is unified or organized into a unity. The various factors which we distinguish are given not as distinct elements fortuitously collocated, but as inseparable parts of the total content. This organization or integration has two directions: (1) Organization in simultaneity, and (2) Organization in succession.

(1) We find organization at any given instant in the content of consciousness. If we liken the total

content to a rope, a cross-section of the rope represents the state of the content at any given time. If we analyze this cross-section of content we find it reducible to the factors already enumerated (sensation and relation, with feeling and possibly image; the association as content, is relational). We do not suppose that these elements originate individually and then unite, like chemicals thrown into a beaker; we consider them as arising in the combinations in which they are found, and likewise declining; by both processes modifying the complexes in which they exist.

We find the cross-section of content made up of several smaller unities—again like the rope, although the rope strands are merely contiguous, while these complexes are more or less interconnected, the same element often forming an element of several. If you are looking at a rotating color-wheel, and also thinking of the end of the hour, the content of your consciousness is composed of several subdivisions somewhat like the following: *A*. A complex of color and sound sensations with relations and images (which you call the color-wheel) with certain emotional factors, perhaps interest, perhaps ennui. These tend to form a special group, possessing an internal coherence not shared with the other groups described below, although the emotional element, and perhaps some sensational elements, may be common. *B*. Your thinking of the end of the hour depends on the function of a specific group of content (mostly imaginative), both sensory and intellectual, with emotional coloring, perhaps of desire, impatience, or aversion, or perhaps the ennui above mentioned. Imagery of the length of time yet to elapse, of the occupations to commence, of the heat of the sun outside, and so on, may supply the nucleus of this division of content. *C*. A third group, or set of groups, is composed of bodily feelings, with certain sights and sounds not involved in the first mentioned groups—the moving of shadows across the wall; the buzzing of a fly; the pressure of the clothing on the skin; the warmth or chilliness of parts of the body; visceral sensations, thirst, and so on; with, perhaps, certain emotional coloring not germane to the other groups.

Each of the three groups mentioned is separable under scrutiny into several subgroups. The analysis, or a stage in the analysis, of group *C* is obvious. In group *A* the treatment is not so easy. Perhaps we find the visual factors forming the nucleus of one subgroup, and the auditory that of another, but in some cases it seems that the auditory and visual factors are united with each other as firmly as auditory with auditory or visual with visual.

In many cases we find, before reaching the ultimate elements, peculiar small groups which are called *fusions,* in which several sensations of the same mode can be discriminated. Thus, the hue of the revolving wheel may be a fusion of several primary colors; purple is a fusion of red and blue; the taste of the lemon-drop in your mouth is a fusion of sweet, sour, and a slight bitter. It is a question whether we ought not to include under the term "fusion" combinations not of the same mode, as warmth and touch sensations, taste, and smell.

In applying the name "fusion," we mean to imply that while these combinations function as units in practically the same way as do elementary sensations, they can be perceived as complex, by attentive observation. In this analysis the complex content changes: it is a commonplace that the taste of lemonade is not simply the taste of lemon *plus* the taste of sugar, but has an individuality of its own. This change is readily made intelligible if we remember that in analyzing a fusion we bring in or emphasize relations which were not previously in the content, or else were not vivid; and that in experiencing separately the elements of the fusion, as the sour and the sweet, we have in the contents a different relational nexus, and perhaps, also, different imaginative sensory factors from those present when the fusion is experienced even with attempt at analysis.[1]

(2) We have said that content is organized not only in simultaneity, but also in succession; it is integrated in longitudinal as well as in cross-section. The present content is essentially connected with that of the future and of the past. Moreover, each group, subgroup, and element has an actual life history. No sensation, for example, comes into existence instantaneously; it rises, reaches a maximum of intensity, and then falls back. So a cross-section of any portion of the content of consciousness at any time represents only a stage in its development. In this the analogy to the rope comes up again; the rope is made up of fibres, each having a definite length, short as compared with the length of the rope; but here also the analogy fails, as there

[1] The student may be surprised at the way in which the "individuality" of the lemonade taste may be made to decrease. Take a glass of lemon-juice solution and a glass of sugar solution, of such strength that when equal quantities of each are mixed in a third glass a good lemonade results. Then taste the three solutions in alternation, making careful comparisons.

is nothing in the rope to represent the temporal development of the subgroups.

It is clear that psychological research has a twofold problem at any point which it attempts to investigate from the side of content: first, to analyze a given content, and, second, to trace the development thereof. The solution of the second problem is much more difficult than that of the first, for it really involves the solution of the first for a number of successive stages. If I wish to study emotion of a certain type, for example, I must not only analyze such emotion at a given moment or stage, but must also make or assume analyses at several moments in its life history, in order to understand its development and the longitudinal connection of its elements. The same treatment should eventually be applied to the total stream of consciousness; by performing adequate analyses at enough points in the life history of the individual we might get a comprehensive view of the psychic life.

II. The Principle of the Middle Term, or Mediate Association.

Two contents or factors in content which are not strongly linked directly may be linked each to a third term, or they may be linked through several intermediaries; and this mediate linking of the two may be more important practically than the direct associations with the intervening term or terms. If M and N are two factors in content which are so far apart in time that M has practically faded out before N commences to rise, but if P occurs while M is vivid, and is still effectively on the stage when N becomes vivid, the three may form a fibre in successive association, uniting M with N through P. The name "Bud" and the jaw movement of gum-chewing are, perhaps, associated in your experience not because you have heard the one and seen the other at the same time, but because each has been associated in simultaneity with some other feature or features of an individual. Other examples will readily occur to the reader. Emotional content is especially apt to form a third term in this way. Those contents which have been experienced together under the influence of strong emotion are more firmly associated thereby, other things being equal, and what has been experienced with a certain quality of emotion at one time is associated mediately with what has been experienced at another time under the same sort of emotional conditions.

III. The Principle of Intellectual Association.

The association of two elements or groups of content is stronger in so far as a definite relation or system of relations is perceived as subsisting between them. If I notice that two things are similar or dissimilar in some regard, or if I notice that one immediately follows the other, or if I perceive or imagine that one is the cause of the other, or that they are spatially related in a certain way, these things are more strongly associated than if the relations had not been noticed.

IV. The Principle of Redintegration. (Principle of Reinstatement; Principle of Associative Recall.)

When any content appears in imagination or apprehension there is *ipso facto* a probability that the other contents associated with it will appear also: in other words, a total content tends to be reinstated as soon as a part of it is introduced. The events are analogous to what happens when you try to pull a weed out of a tangle in the water; you find that you pull out a large quantity of others which are ensnarled with it.

There are several ways in which this revival of past content through association may take place.

(1) The associated factor may reappear in the same organization as before. If you meet to-day a person whom you met yesterday, you may be again conscious of some of the circumstances in which you met him before. The stage setting, as it were,

in which he was placed is revived as soon as he reappears. In repeating the words of a poem the imagery and emotions appropriate to the words and phrases which have been associated with them come up in proper synthesis. Moreover, the successively associated factors are repeated in their former sequences; the words of the poem are recalled naturally in the order in which they have been linked in the text of the past experience. The series of words forming the poem are, as the result of the past experience, associated in a whole in which imagery and emotional coloring bind them together in multiple bonds. Words and phrases in one portion of the poem are so linked by intermediate terms and directly with phrases in other portions, that having once commenced the recitation of the poem we are in little danger of being carried off the thread into something else. But if we were restricted to associations between simultaneous or immediately successive factors, we would be apt, when we have recalled the line "lead kindly light," to finish it up "of other days around me," and still more apt to finish "Yes, that was the reason (as all men know), in this kingdom by the sea, that the wind came," by adding "up out of the sea, and said, 'O mists, make room for me.'"

In poetry the enveloping rhythm furnishes a continuous bond in association which would operate to prevent transitions such as those we have just suggested; in some cases, however, the transitions from one text to another would not alter the rhythm, especially if it is a matter of different bits from the same poem. In prose, of course, there is nothing but normal mediate associations to prevent the various texts we have memorized from being "pied" in recall.

The rhyme furnishes in some poetry an additional means of association. Certain sounds are given by their position in the rhythmic structure, and, by repetition, an especial emphasis and duration in consciousness, so that there is immediate association between one rhyme word and the ones preceding and following it. Rhymes, alliterations, and all such devices are to be considered as means for the production of associative bonds, tying the stanzas together in a more unified whole than would otherwise be achieved. They are not æsthetic ends, but are mechanism for the production of ends æsthetic, or even practical, as in the jingles by which we manage to fix elusive facts of history.

(2) The time order of the former content may be modified in the recall. The setting in which I

saw the person yesterday may not recur when I see or think of him to-day, but may come in afterward. On the other hand, things which were experienced in succession may be imagined or remembered simultaneously, or when one is perceived the others are recalled simultaneously with it. After the child has experienced the sight of the medicine, followed by the taste, and perhaps subsequent nausea, the mere sight of the proffered mixture arouses coincidently the other factors.

(3) Very frequently contents which have been mediately associated become immediately associated through the dropping out of the middle terms or term. Seeing a load of coal put in suggests the sifting of ashes; hearing a huckster announcing soft crabs suggests finding a gold watch; yet the various terms which in the beginning mediated the association do not occur to me until afterward, if at all. This sort of modification of association by the elimination of terms is so common that it largely escapes our notice.

V. The Principle of Relative Strength.

We may say that the possibility of the reinstatement of any content through association with another content present to consciousness is proportional to the strength of the association, and that therefore if a given factor, M, is associated with two contents, P and Q, which are too different to come in together, the one most strongly associated with M will come. (The so-called principle of conflicting associations.) But if P is associated with M, and also with K, which is just disappearing, and with S, which is present throughout, whereas Q is associated only with M, P may be brought in, in spite of the stronger connection of M with Q than with P; for the other associations assist in reviving P. (This is sometimes called the co-operation of associations.) We may illustrate by the poetical fragments given above: the Longfellow poem may be much more familiar to you than the one by Poe, and hence "the wind came up" more strongly associated with "from out of the sea" than with "out of a cloud by night." In that case, if some one should repeat to you "the wind came up," alone, you would finish the line Longfellow-wise. When the earlier lines of the poem of Poe are given you too, you finish the line accordingly because of the co-operating associations of "out of a cloud by night" with these earlier lines.

The concept of "strength" of association must be admitted to be very vague. After all, it is constructed, like the concept of retention, from the fact that things do come back, and that they come back in specific ways, as we have been trying to show. When we say that *M* is more strongly associated with *P* than with *Q*, we mean simply that unless some other factor operates, *M* will call up *P* rather than *Q*.

The strength of any association depends, like the retention of content, upon the vividness with which the associated factors are impressed, and on the repetition of the impressions in succession or simultaneously. This needs no extended discussion here. The strength of the association is also increased by each recall through the association; the oftener *M* calls up *P*, the more readily it will do so.

2. Voluntary Recall

We often make the attempt—successful or not—to recall some definite content. This attempt, or performance, seems at first inspection to be absurd. If I am not conscious of a given content how do I know what it is? The recall is actually set in motion, or we attempt to set it in motion, by a process which is naïvely described as "Thinking of the things we know to be associated with the required content," trusting to the associations to bring the required content before consciousness. But we ask: How do I know what is associated with the required content, if I do not know what that content is? And how do I manage to bring up the things associated with the required content?

The fact is that these contents are already there, or some of them are, and it is their presence that brings the desire for the sought factor. Some factor, *M*, comes up, which is in a certain relation to something else, and yet the present factor and the relation do not bring up the missing one. So I attend to some other factor suggested by *M*, to see what it will suggest; if this does not suggest something satisfying the relation, it may suggest something which will make the proper suggestion. For example: I see across the room a man whose name I do not remember. The fact that I am approaching him calls up the impending salutation, and the relation of the visible man to a name; yet the name is not recalled. The appearance of the man recalls Mr. Blank, at whose house I was introduced to the man; I hold the idea of Mr. Blank and the meeting in consciousness, and these factors recall the joke Mrs. Blank made on the man's belying his name; still the name does not appear, although I am getting "warm." This incongruity of man and name, if attended to, may suggest his voice, and then the name—Singer—may come up at once. This is a typical instance of voluntary recall, and the only voluntary element is the "holding of the attention on certain content," to get the maximal effect from its associations.

Sometimes the factors on which the attention is held in voluntary recall are relations. Thus, in trying to think of a man's name the relation of rhyming with something may come up, and by attending to that relation a rhymed word will in many cases appear, and assist in the final solution of the problem. Sometimes we start with a number of relations and seek that which will fulfil them; start with a concept, in short, and let it develop into an idea. This is conspicuously the case in the solution of riddles.

3. The Probable Physiological Basis of Association

The exact physiological bases of association are as yet unknown. We assume that there are some processes in the brain corresponding to these functions, but what they are or where they are located has not yet been discovered. It has been quite the fashion to ascribe association to the formation of "brain-paths," lines of conduction from one cell or group of cells to another; but this was intended only as a picturesque metaphor; for, taken literally, it would imply a special cell or group of cells for each idea capable of being associated with another, or other absurdities which no psychologists or physiologists entertain. Some theorizers have assumed the existence of a special association centre in the frontal lobes, but so far there is not much real evidence for the theory.

CHAPTER XIII

PERCEPTION

1. The General Nature of the Content in Perception

We have already indicated that perception comprises more than intuition or direct apprehension; that is to say, that the content in perception includes more than sensations and relations. Perception[1] is the consciousness of a content which in usual cases includes (1) present sensations, (2) present relations interwoven with the sensations and other content, (3) imaginative content, and (4) emotional factors. With regard to the third category, we ought to say at once that by far the most important thing in the imagined portion of the content of perception of adults is conceptual. The merely sensuous imagery may play a part, but it is relatively unimportant in comparison with the systematized relationships in which the intuited content is placed.

Suppose I stand some distance from a railroad track and observe a passing train: I obtain a com-

[1] "Perception" is used loosely in common discourse for any sort of understanding or comprehension. We are using it here in a strict, technical sense.

plex perception-content which it is worth our while to analyze. In the first place, there are the elements of light and color. The locomotive, the cars, the smoke, the trees which form the background, are presented as an aggregate of many hues and shades. At the same time are presented sensations of other modes; the panting of the locomotive and roaring of the wheels and shriek of the whistle, the smell of the smoke, and the trembling of the ground. These sensations are only a small part of the total content. Not only do I notice the spatial relation of the colors—that the dark and shiny locomotive precedes the red cars, that the smoke hangs above the trees and spreads out—but I notice the likeness of the smoke to the clouds, the contrast between the red and the green of the trees, and so on. Moreover, I am conscious that it is a passenger train, which means, probably, that I imagine people within it: I imagine the wheels turning, although I cannot see their rotation; I image other features according to my habits of thought. Certainly, whatever I perceive of a sensory nature, beyond a few patches of color and a few sounds and smells and the vibration, is imagined.

More important than the intuited content, or the imaged sensory content, is the fact that I recognize the object as a railroad train; I am aware of its relations to iron tracks, stations, transfer of passengers, purchasing of tickets, and numberless other details, some of which, like the passengers inside, may be imaged, but the greater number of which are not. On account of this conceptual synthesis of the content, my train as I perceive it is vastly different from the train a savage would perceive from my view-point, although he would experience the same sorts of sensations and the same presented relations as I do. So, too, the train as the content of the railroad man or of the farmer would differ largely from mine, because in each case a different set of relations would be emphasized by the individual's past experience, and be aroused to unite as a concept with the intuited factors.

The function of the concept in perception is sometimes called *apperception*. The concept and the imaged sensory factors connected with it are called the *apperception mass*, and the directly apprehended sensations and relations the *apperceived* factors. These terms are now falling into disuse.

The concept is built, developed, and extended, by experience. Any new perception is apt to modify the concept which functions therein. The first time an individual rides on a train, which before he has merely seen—and heard—from a distance, he apprehends a lot of new relations which thereafter recur in the concept. If perchance he sees some one run over, the train is perceived with new elements of relation, and henceforth all trains will be perceived in the light of a concept modified by those relations.

Changes in the concept may take place also without perception; when the sensory content which fills out the concept and makes it concrete is only imaged. When, for example, I speak to you of trains, you imagine them; your concept attaching itself to the sensory content which you call up, just as if it were apprehended in reality. If then I tell you of the running over of some one, or explain the problems of maintaining equilibrium on curves, or providing sufficient elasticity to allow starting and stopping, the imaged content takes in new details, and the modified concept will govern your next perception of a train.

We may reach a stage of conceptual development in which concepts are modified without the necessity of filling in, even imaginatively, with sensory content. New relational factors are learned, usually by inference, and these are amalgamated with the concept already in existence: or the process may be one of elimination, certain supposed properties of a certain thing being found not properly belonging to it, and the concept being contracted accordingly. It is difficult to show instances of this purely intellectual modification of concepts in every-day life (although it undoubtedly occurs there), but in science the process is clearly exhibited. The atom, for instance, was conceived with an approach to adequacy, and as new facts were learned the concept was modified accordingly, until it has become vastly different from that held by scientists twenty-five years ago. Yet sensory imagination plays little part in this readjustment, being more a disturbing factor than otherwise. In less abstruse cases, where imagination might have a rôle, the scientist economizes energy and increases accuracy by leaving it out.[1]

The development of perception is, therefore, in reality, the development principally of conception. The sensory factors are very simply controlled, and

[1] We may distinguish three types of conceptual modification, which *possibly* correspond to stages of mental development. These stages are: (1) The perceptual, (2) the concrete imaginative, and (3) the conceptual modification of concepts. *Possibly* animals are restricted to the first type, but of this we have no proof. In the case of adult human beings the first type rarely occurs pure, but undoubtedly many persons never attain in the slightest to the third type.

only a small amount of experience is needed to make them practically as perfect as they ever may be. The individual is endowed by his parentage with his sensory apparatus; it is developed in part through the demands made upon it by his experience, but largely through the general development of the body, just as the hair grows. A little practice is needed to direct, focus, and converge the eyes properly, but these adjustments develop in the individual largely of themselves, demanding only *use* to fix the development. The child of a few years is equipped sensationally as well as he ever will be, and much better than he will be in adult life.

2. Perception, Illusion, and Hallucination

Perception may be "right" or "wrong." The incoming sensory content may be united with the proper concept, or it may be united with an egregiously inappropriate concept. The former case, where the perception is "right," we are accustomed to call *true* or *normal* perception, and the latter case we call *illusion*. To take an extreme case: a sheet is hanging on a bush in the dark, and some one seeing it unites the visual appearance with his concept of a ghost: his perception is illusory, yet he may receive sensory and relational intuition-content practically agreeing with that of another person who unites it with the appropriate concept and perceives truly.

The freshman who looked at the page-heading in my copy of the *Critique of Pure Reason* and exclaimed in amazement, "Transcontinental dialect! What in the dickens is that?," probably received from the printed words sensations not very different from those I received; but since one, in reading, notices but a part of the letters in a word, imagining or dispensing with the rest, the freshman's unfamiliarity with the transcendental dialectic resulted in the noticed letters calling up the concepts associated with them in his experience. If you see a man on the street, and say, "Ah, there is Richard Roe; I must speak to him about that book," and then find on overtaking him that it is not Roe at all, but John Doe, who scarcely resembles Roe on close scrutiny, your mistake lies in that to certain sensory factors intuited you added the imagined facial expression, etc., of Richard Roe, and the concept you have formed of that gentleman.

The contrast between perception and illusion disappears when we examine them closely. The extreme cases we have instanced, where the concept is hopelessly inadequate, are few in comparison with the cases in which the inadequacy is not so pronounced. Many persons at the present time conceive a trolley-car as dragged along by the trolley, vaguely supposing that the "current" in the wire carries the trolley along with it, as the cable "grip" is carried by the cable. When such a person has found out the way in which a street-car is actually propelled, the content of his perception of a car is appreciably changed; and yet the error is of no practical consequence to the mistaken man as long as he does not attempt to fill a position as a carman. On the other hand, a slightly inadequate perception of a car as regards its speed, or of an invalid as regards his condition, may have the most serious consequences. Perhaps the truest statement would be that none of our conceptions and perceptions are quite adequate, but some are near enough to adequacy for practical purposes.

One special type of "false" perception has received the name of *hallucination*. In this the intuited sensational factor is reduced to a minimum, or at least is not of any practical consequence in the total perception. The essential sensory factors are all supplied by imagination, but the complex is mistaken for, or at least has the apparent character of, reality. Hallucinations occur to almost all of us in what we call dreams, and sometimes in waking life, but waking hallucinations are usually attendants of mental disease.

Hallucination and illusion are to be distinguished from pseudo-hallucination and pseudo-illusion. Pseudo-hallucination is often found in dreams, where the content has the semblance of perception-content, except that the dreamer is distinctly conscious that it is a dream, and not real. So, in waking life, there often occur experiences which have many of the marks of perceptions, but which we know are imaginations. There is something about the experience or the content which gives the lie to the impressiveness of the other factors. The semblance of reality produced in pictures and on the stage is to be classed as pseudo-illusion. The familiar geometrical illusions, on the other hand, are true illusions in most cases, for the semblance has all the characteristics of true perception-content, in spite of the fact that we know it is not. We have to do here with a percept and an additional concept which do not fuse or unite.[1]

[1] Hallucinatory perceptions must be distinguished from subjective sensations, secondary sensations, and after images,

3. The Determination of Perceptual Truth and Falsity

The discussion of illusion brings us to the consideration of the criterion of truth in perception. Here we find two questions. First: When, and in how far, is a perception true? and second: How do we decide whether a sensation is true or sufficiently near the truth? As a matter of fact, the grounds on which we decide practically the truth of a perception are by no means those which would be assumed for the philosophical justification of the decision. The statement of the grounds on which we actually judge the validity of a perception does not cover the grounds on which a thoroughly adequate determination could be based.

There are two practical tests of truth and falsity. The first may be called the *social test*. If my perception is illusory or hallucinatory, it is in most cases shared by no one else, and, conversely, if it is shared by no one else it is an illusion or hallucination. If, for example, you see a translucent hand beckoning from the door-way, and others in the

and from the phenomena in certain pathological cases where, for example, the smell of a certain odor is persistently present to consciousness, without the normal stimulation. All these cases are of present sensations due to definite sensory processes in the sense mechanism.

same room see nothing of the kind, you know that you have an hallucination, and if you are wise will consult a competent physician. If you hear some one talking, whereas other persons in the same room hear only the trickling of water from a leaky faucet, you conclude that you were mistaken in your perception.

The social test is not thoroughly trustworthy. Frequently your perceptions are right and those of your companions wrong. The obstinacy of one man in insisting that he hears the crying of a child, when the others are equally confident that the sound is the moaning of the wind in the trees, saves the child's life. It is possible, also, for a number of people to be simultaneously illuded, as a number of "authentic" ghost stories show. Persons of the same general type and training placed in similar circumstances will perceive in much the same way, and there is nothing surprising in the fact that a number of people will bring up wrong concepts of approximately the same sort, if the conditions are about the same for all. For example, if several persons are expecting to see a ghost, that is, if the appropriate concepts and images have been recently and vividly attended to, the sensational data which suffices to revive and unite with the ghost-concept of one may suffice for the others.

The important practical test is your own *further experience.* If the pin you see on the floor can be picked up, and stuck into something, it is still considered as a pin. But if it fails to give all the sensations (visual, tactual, etc.,) expected from a pin, you conclude that your first perception was wrong. If the man you take for an acquaintance does not respond to your words in the way you expect, you conclude that after all he is some one else. And so on. A large part of the perceptions of our experience are proved inadequate by the further transformations of the content, and are revised accordingly.

The philosophical question as to the real nature of truth arises from the consideration of the possibility that we may be more or less deluded in our daily life without becoming aware of it. So many times we act on a misconception, and yet our action fits the case sufficiently well, that we wonder if any of our tests give us anything really fundamental. One school of modern philosophy insists that anything is true in so far as it works, and no farther; that truth is just the fact of standing the practical test. An older conclusion is that a perception may be true or false quite regardless of my action on it; that when I perceive a bottle in the road in the moonlight, it either is or is not a bottle, even if I do not get off my horse to investigate it. But no one has been able to propose a really satisfactory explanation of the nature of truth.

4. The Causes of Illusion

The immediate cause of illusion is not different from that of normal or correct perception. The imaginative content which is in the one case inadequate, and in the other case adequate addition to the intuited factors, is in either case revived through association. It is not necessary that the reproduced content should be previously associated with the directly presented content in the perception; it may be called up through an associative linking with some other content factor in consciousness. Thus, you take the shadow by the roadside for a robber, not because that particular impression of light and shade is essentially connected with the figure of a man, but because your consciousness is already filled with imagination of brigands and hold-ups. In commoner cases, you misread a printed word, or mistake spoken words because something you have just read, or heard, or thought of is associated with the idea corresponding to the misreading or mishearing.

In normal perception, you make out the cold cylinder you grasp in the darkness of the garden to be the hose because you imagined it to be there (or possibly you conceived it as there) before you touched it; if you did not, it gave you a shock, and the perception came more slowly after additional factors had been experienced. Waiting for the train, the distant whistle is easily recognized, when otherwise it would have passed for one of the features of the storm roaring about you. In reading, the words are recognized by the appearance which you sense in an inadequate way, assisted by the images excited by the preceding words and sentences.

Association directly between the reproduced factor and the intuited factor of the perception content is an important feature in the greater part of our perceptual life. Experience is a constant succession of perceptions whose contents are unexpected until they occur, and the imaginative parts whereof are not contributed from the just-preceding, or contemporaneous contents. The seen or otherwise intuited impressions call up the imagery associated with them from the past, and it may be adequate to the occasion, or it may not. The notes of the flute which fall upon your ear from the next house are perceived as the sound of that empty-toned instrument although you had not been thinking of flute or flute-tone until these notes smote your ear. The spider crawling on your knee may have been entirely unexpected until he met your eye, and yet you perceived him immediately. The sound of some one shutting the door, which turns out finally to have been the creaking of your chair, was not perceived wrongly because your consciousness was filled with the idea of some one entering the room, but because that particular sound was associated in your past experience with the other sensations from shutting a door.

In determining the definite perception based on a given intuited content, the factors we have earlier described as governing the "strength" of association and likelihood of recall play a large part. If a certain sense-content is strongly associated with certain other factors, either through repeated experience of them in conjunction, or because of the recency or impressiveness of such an experience, that sense-content will tend to call up those factors regardless of whether they are the right or wrong things at the time. Moreover, the mere recency, frequency, and vividness of past experience of a given content which is at all capable of assimilation to intuited content, increase the probability of its being revived by the intuited content, in accordance with the principles of retention and recall. The co-operation of associations is also of importance in many cases; if you notice the peculiar noise, and at the same time notice the movement of your body in your chair, you will be less apt to perceive the opening of the door, although the sound alone might have called up that illusory perception.

Fine discrimination of sensations favors correct perception. The creaking of the chair was not precisely like the sound made by the opening of the door, so that the presence or absence of the illusion depends, in part, on the delicacy with which auditory differences are apprehended. In so far as sensory complexes seem alike they tend to call up the same associated factors, because the features of the contents which are noticed are associated with these factors; and in as far as the contents are discriminated, that is, in as far as other factors than the common ones are noticed, they tend to call up their special associates.

5. Space Perception

In the analysis of perceived space we find one of our knottiest, but most interesting, problems. The history of philosophy includes much discussion of the question whether space is an actual external reality (the *a posteriori* theory), or whether it is something mental—a "form" in our minds, superposed on the world in perceiving it—(the *a priori* theory). The discussion of this question has really little to do with experience or its content, being based on conventional definitions of "mind" "external world" and other terms, much as the moves in a game are determined by rules; but it has had an unfortunate influence on attempts at psychological analysis.

We must start from the fact that there is in our perceived content a factor which is practically the "space" of common parlance (not the "space" of the mathematician or metaphysician), and attempt to analyze this factor.

The line of opposition has been drawn in the past between the "nativistic" and the "genetic" theories of space perception. In large part, the controversy between those holding these two views has been an unwitting discussion of the *a priori*-

a posteriori question, complicated by the question whether we have to learn, as individuals, to perceive space, or whether we perceive it instinctively. Involved in the controversy is the still further question whether space as perceived is *sui generis*, or whether it is constructed in some way out of elements which are non-spatial. The genetic view insists that we learn to perceive space, and is usually *a prioristic:* the nativistic view holds to instinctive space perception, and may take either the *a priori* or the *a posteriori* tack. The apriorists, of course, believe space to be *sui generis;* the aposteriorists, whether nativistic or genetic, may take either side of this latter question.

While our business here is primarily the analysis of the space-content, keeping clear of the metaphysical problems as far as possible, we shall not hesitate to assume that we as individuals learn by experience to perceive space in its detailed form, although a part of our perceptive ability is native or instinctive. This, however, is nothing but assumption, and our suggestions as to the probable development of space-content must be understood in the light of that fact.

The characteristic thing about the space-world is that everything in it stands in definite and peculiar relations to everything else therein; relations which are analogous to some found outside of the space-world, but which are characteristically different from them. These space relations we recognize when we refer to distance, direction, contiguity, intervening objects, and other characteristic features of the spacial factor of our content.

In addition, space depends on the relation of magnitude, which is found also in non-spatial content, and likewise upon the universal relations of similarity, difference, etc.; but these are not, properly speaking, factors in space.

Space relations can be intuited only as founded upon the extensity-character of sensation. Whether, having been perceived, they may be imagined—may form part of a conception—without the imaged sensation, is another, and questionable, matter. Our own opinion is that when space is strictly conceived it loses its true content-character, and becomes merely a mathematical system of relations which is marked by a correspondence to the space of perception and imagination.

The difference between extensity and *extension;* between the mere sensational volume and space, is this: as soon as you begin to discriminate extensive parts within a sensation, or mass of sensation, you have space. The perception of the extensity as divided; as having one part set off against another part—the perception of extensity in relation—is the perception of extension or space.

In gustatory and olfactory sensation we have no distinction of extensive parts, and in consequence no gustatory or olfactory space. These sensations may be more or less massive or extensive, but that is all. The same is true of sounds; the volume of a tone may change, but there is no space-character to the tones because there is no relation of extensive parts of any tone, but simply a relation of extensities of different tones. We may say, with great probability of correctness, that if we were restricted to these sensations there would be no space in the content of our perceptions.

Vision and touch supply the necessary conditions for the perception of a space-world. In these senses we have extensive magnitudes which are not homogeneous, but which are differentiated by local signs. One extensive portion of sensation, (if of sufficient magnitude), is immediately different from other portions, and hence we may believe that an animal having only one of these sorts of sensation, or any sort of sensation in which extensity and local signs are developed, perceives space, although the space may not be very complex.[1]

The fundamental spatial relation seems to be *betweenness.* This differs essentially from the mere intermediacy of other continua, although we commonly represent all sorts of intermediacy in the spatial terms; as, for instance, a series of values by points on a straight line. The perception of betweenness in space may depend on the perception of time; that is, when an object moves over the skin or retina it occupies a certain position between the moments at which it occupies other positions; and by repetition of these experiences the spatial betweenness of the various points is brought to perception. Yet it is not at all certain that the spatial betweenness may not be perceived as directly as the temporal.

The perception of the intermediacy of local signs in an extensity continuum furnishes the primary datum of space. The relation of direction may be reducible to these factors *plus* the implication of motion; but this is a mere conjecture. The occurrence of the same local sign in two different series, as a stimulus moves in actually different directions

[1] For the "musical" ear the series of pitches may therefore form a rudimentary space-system.

over the sensitive surface, may be the first clew to difference of direction.

Distance is primarily the amount of difference in local sign between two points; this corresponds roughly to the least number of local sign differences discriminable between the two points. You will find for example, on the skin, that two points appear separated by an interval approximately proportional to the number of different points discriminable in the straight line between them. This is why the points of a pair of compasses or scissors a quarter of an inch apart appear more widely separated on the finger-tip than on the arm, and still more widely separated on the tip of the tongue. Of course, if no points are discriminable between two given points, they will be perceived as one point.[1]

So far we have considered only the factors which enter into space of two dimensions, that is, of surface. An animal endowed with touch or sight, or both, but with no sensation of movement, would

[1] An interesting experiment may be made by drawing the points of a pair of compasses across the face from side to side, allowing one point to pass above and the other below the mouth, and observing the apparent variation in the separation of the points when the distance between them is constant. Also, try drawing the points abreast down the arm, or down the leg from knee to ankle.

have experience of a space in which sensations appeared, moved about, and vanished; but the removal of the stimuli from the skin would simply cause the sensation to be unperceived, and stimuli at greater or less distances from the eye would simply give sensations of less or greater area. The animal with touch and sight would probably perceive two spaces, for the chance that he would identify his tactual and visual surfaces is slight. But, given the power of sensations from the movements of the sense-organs and members of the body, and unified space perception in three dimensions becomes possible.

It is scarcely probable that muscular sensation by itself can give space-content. The only betweenness of such sensation is the temporal betweenness, and its function in the production of space-content can be only secondary. But it does help to develop our space-content in a very important way, the outline of which is probably as follows. By moving one member (as the finger), over another member (as the hand), we acquire the connection of the temporal series of muscular sensations with the motion or series of positions in tactual space on the hand, and the continuous stimulation of one spot on the finger. By moving the finger over some external object we obtain the same series of muscular sensations, with the same sort of stimulation of the finger. The result is the conception of a surface over which the finger moves in the same way as it moves over the hand; the temporal series of muscular sensations having become associated with a series of positions in space, (tactual sensation extension), muscular series which do not rouse the tactual series suggest series of positions in addition to those in the tactual field; hence space is immensely multiplied in extent. At the same time, since the same series of muscular sensations may condition a movement in tactual space and a movement in visual space, and the connection of two such series is invariable, the two are identified as a mere matter of mental economy; that is to say, tactual space is identified with visual space.

If the above were the whole story, space as perceived would still be a matter of surface only. The feature of tactual-muscular perception which brings "depth" into space is this: a series of muscular sensations not accompanied by a series of tactual sensations (the finger moving through the air) may end in conjunction with a definite tactual sensation, and in fact we can put no limit to the number of different series which may terminate in conjunction with a sensation of practically any local sign. Here we have the primary factor in tri-dimensional space; series of positions, of which one or at most two lie in the given surface. Finding no definite limit to the number of series terminating at any position, the step to the conception of an infinite number is easy. In visual perception we have similar conditions, in that certain series of muscular sensations correspond to series of positions in the visual field, while certain other series correspond to a single position.

It is not necessary to assume that the individual has to go through the stages from "blooming buzzing confusion" through two-dimensional space perception to tri-dimensional. It is not necessary to suppose that the infant's perceived space is other than tri-dimensional from the first. But without doubt the space relations are at first rather vague and simple, until the discrimination of local signs, and their connection with muscular sensations clears up and amplifies the content spatially as the child's motor processes develop and receive exercise. If, however, the individual does not perceive space instinctively, it seems quite possible for the factors mentioned to bring the necessary relations to his consciousness, and build up the percept of extension.

We may describe a few experiments illustrating the co-ordination of visual and tactual space with muscular sensations. Hold before one eye a prism with large side, but narrow base, turning the base either to right or to left, and closing or covering the other eye. Better still, have a prism or a pair of prisms set in a spectacle frame, thus permitting the use of both eyes, and supporting them while leaving the hand free. On looking through the prism at any small object placed before you on the bare table, the object will in appearance be displaced to one side. Keeping your hand out of sight by your side until the moment of trial, make a rapid stab at the object with you forefinger. You will find that the finger strikes to one side of the goal. Keep on trying, and, in the course of a few minutes, you will find yourself able to hit the mark fairly well. Now remove the prism from the eye and repeat the trials, and you will find that you now make misses on the other side of the target, and require some practice to get back to your normal co-ordination again.

Suppose, looking through the prism, you touch your hand or arm with a pencil; or, better still, have some one else do the touching. The tactual and the visual spaces no longer seem the same, but a little practice will bring them together as before.

An interesting experiment, named after the philosopher who gave the earliest extant description of it, "Aristotle's Experiment," has been referred to in 2 of Chapter IX. If the first and second fingers are crossed and the Y so formed is rubbed in the crotch with a pencil or rod, the rod feels double. The effect is still more surprising if the crotch of the crossed fingers is touched with the tip of the tongue or point of the nose; you can hardly fail to have the distinct perception of a forked tongue or bifurcated nose. But even this illusion can be destroyed by continued stimulation under visual control.

Although space relations may be in the first instances—and later also—intuited just as are sensations, they are in a great part of our perceptual experience purely ideal; they are reproduced in the content through their association with intuited or reproduced sensory data. This is true, at any rate, in the visual perception of space, and there we know rather definitely what the factors are which are associated with the relations.

Direction, that is, the angular estimation of space position with regard to the body or eye as a centre, is indicated by retinal local sign, in conjunction with the muscular sensations coming from the ocular apparatus and the muscles of the body, especially the neck. Simultaneous stimulation of different spots of the retina gives localization in different directions, as do successive stimulations of one spot if certain muscular sensations intervene. By the specific muscular sensations intervening between the successive occupancy of one spot by two stimuli the angle between the two is estimated; that is, the relative direction of the two from the eye.

Distance from the eye is indicated by a number of signs, which may be effective singly or in co-operation. These factors are (1) light and shade (chiaro-oscuro), (2) definition and color (aerial perspective), (3) size (linear perspective), (4) angular perspective, (5) convergence and accommodation, (6) binocular disparity, and (7) parallax.

(1) Objects in advance of others throw shadows across them, the direction of the shadows depending on the direction of the source of light. Often the depth of shadow corresponds to the degree of relief. A curious effect may be obtained from an intaglio, obliquely lighted; it will appear at times to be a cameo, with the light coming from the opposite side. A little study will show you that the lights

and shadows of an intaglio do correspond approximately with those of a cameo, if the two are lighted obliquely from opposite sides. How large a part chiaro-oscuro plays in visual perception may be illustrated by making a negative print of a portrait, and comparing it with the positive print. The reversal of light and shade makes the picture surprisingly different.

(2) Objects at a considerable distance from the eye are blurred through the irregular refraction of the air, and they likewise are tinged with color by the atmosphere. "Dim distance" and "purple peaks," indicate the practical importance of this factor. The blurring of distant objects is easily noted in nature, and its representation is frequent in paintings. The absence of the customary tinting distortion, as in the Rockies, where the air is fairly pure and homogeneous, gives rise to ludicrous mistakes on the part of those unused to such conditions. The author once heard a tourist insist that he could easily walk in an hour to the base of the mountain range at which we were gazing; the range being really more than forty miles distant.

(3) As an object recedes from the eye its retinal image becomes smaller; all lines connecting characteristic points in the image become shorter. It

follows, that if we know what size the object would appear when near, we have in this some information as to the distance from the eye at any time.

(4) The form of an angle gives some information as to the relative distance from the eye of parts of the surface bounded by the lines composing it, provided we know what the angle is really—that is, know its appearance from a certain position. A rectangular table top, viewed from a point not in a plane passing through the centre of the rectangle and perpendicular to one side, appears a rhomboid, and conversely, to represent a rectangular surface looked at obliquely a painter employs a rhomboidal figure.

(5) The eyes must turn inward more strongly to look at a near object than at a far object. Likewise, they must accommodate, that is, change the shape of the lens by muscular action for the near object. The sensations of these muscular adjustments give immediate information as to relative distances of objects fixated. Hold up your pencil a foot or so before your eyes and fixate alternately the point and a spot on the wall in line with it; you will find that the convergence and accommodation sensations are quite intense.

(6) Since the two eyes look at the presented scene from two different points of view, their images do

not exactly agree. This disparity of the images of the two eyes is turned to practical account in the stereoscope, which presents two slightly different pictures to the eyes. Since the pictures are originally taken by a camera with two lenses, from two points of view corresponding to those of the eyes, the stereoscope reproduces the binocular disparity of a natural scene. The depth given by a stereoscope view is a demonstration of the importance of the binocular disparity sign in visual perception.

(7) When you move your head laterally, the view before you changes slightly. An object may be hidden behind another when the head is in one position, and emerge when the head moves far enough to one side. An object not hidden by a nearer one apparently moves closer to or farther away from it. The relative amount of parallactic displacement indicates the relative distances of the objects.

Auditory sensations are localized in the space perceived through the visual, tactual, and muscular mechanisms, but not localized accurately. We can usually tell the side from which a sound comes by the difference in intensity for the two ears; and we may make a lucky guess as to its general direction, especially if allowed to turn the head while listening.[1] In general, however, we attach the sound to the seen, felt, or imagined object which seems an adequate cause of the sound; hence the success of the ventriloquist. There can be no direct spatial reference of auditory sensation; a state of affairs which is puzzling until we reflect that the actual direction from which the sound approaches can make no difference in the local sign of the sensation.

6. The Perception of Things

The reader has doubtless been somewhat sceptical during our exposition of the content of perception. Sensations, relations—these are all very well, and there is no doubt that we do perceive them, but the important features of the world about us do not seem to be exhausted by this simple list. We perceive *things*, in which certain qualities inhere, and although one may be persuaded that the qualities are sensations, and that the things stand in perceptible relations to one another, he can only with difficulty be convinced of the necessity of abandon-

[1] Experiments seem to demonstrate that under certain favorable conditions the difference in phase of the sound-waves affecting the two ears (when one ear is nearer the source of sound), may assist in the determination of the direction from which the sound comes. In this case the subject is, of course, unaware of the difference itself.

ing the things themselves. Nor would we desire to convince him of such necessity. We have simply labored to show the student of what stuff the things he perceives are made, without attempting to prejudice his view as to whether this world of things is entirely within himself, as Idealism and Materialism teach, or whether the conditions are as common-sense assumes them to be.

The nature of perceived objectivity offers a problem for analysis which is simple as compared with some of the other problems of content. Assuming the perception of space, we find the fundamental feature of thinghood in the location of one sensory quality or group of qualities in the same space with another. It is very probable that an animal restricted to one mode of sense would not be able to perceive "things" as we do. He might perceive spatial relations, but they would be comparable to the spatial relations we perceive in a picture. Allow him, however, the opportunity to identify visual sensations with a definite portion of tactual space, or *vice versa*, or to identify muscular sensations with parts of either space, and all the essential features of perceived objectivity are present. The "thing" which we perceive is just the coincidence of sensations of diverse modes in definite space relations, and involved in the manifold of other relations component in content. When we become metaphysical, we invent something called "substance" or "matter" to act as a mystic cause for this coincidence, but if we did not have the experience of thinghood, substance would never have been invented. The psychological problems involved in the construction of such a concept as that of substance, a concept which in itself is an experienced content, but which represents or refers to the transcending of experience, introduce no new difficulties, but belong to the mountains of details upon which we cannot touch in this outline.

7. The Perception of Time

In the field of time perception we find again the division between the apriorists and the aposteriorists, but no real genetic theory of time has been constructed, nor has any one proposed a plan of time-content reduced to non-temporal factors. As in the case of space, we may assume with probability that we learn, in part at least, to perceive time, but this is hardly more than hypothesis.

Philosophers of the past were accustomed to ascribe space to "outer perception," and time to "inner perception." As these terms are now interpreted they meant sense perception and thought (imagination, including memory), respectively, but this interpretation makes the distinction as regards space and time meaningless. We can imagine content which involves spatial relations just as well as we can perceive it, and we can certainly perceive time. It is quite probable that these older philosophers had a more subtle meaning than their words adequately express to us; but it is not our task at present to search for this.

The chief points of temporal content, upon which we shall touch lightly, are (1) passing time and change, (2) temporal extent, and (3) temporal distinction and identification.

(1) The immediate content, which is called *passing time,* is change in the content of consciousness. We do not mean to say that time is built up out of change, but that change as directly perceived, in abstraction from any critical points in the series of changes, is the passing time. By critical points, we mean conditions of content from which the change is thought to occur, or toward which it is thought to be directed. Thus, if a sensation changes from one quality to another, the two qualities are critical points, and in so far as the change is perceived or thought of under the dominance of its relations to these—or their relations to it—it is not mere passing time.

Attend, in so far as you can, to the "time stream"; try to watch the "ceaseless avalanche of time" itself instead of attending rather to the events caught in its rush, as you normally do, and you will find that the content which is thus emphasized is a restless "going, going, going"; a continual motion from nothing in particular to nothing else in particular; just continual change. This change may be in sensation, or in imagery, but as soon as it is definitely located, as soon as the whence and the whither regain their normal emphasis, the passing time merges into concrete change.

In transforming the world of immediate experience into terms of substance and its attributes, we say that change requires Time in which it may occur; we postulate time as a sort of rack into which events are packed. Such Time, if it exists, is not the object of our direct perception, and although we may conceive of it we cannot imagine it. You may image time, but it is always as it is perceived, a concrete succession of changes; or rather it is something which readily becomes such a series under inspection.[1]

[1] Time, with a capital T, is a metaphysical construct quite comparable to Space with a capital S. This is sometimes called 'physical' time, but would better be designated 'logical' or 'mathematical' time.

A succession of changes presupposes seriality, *i. e.*, intermediacy. The change would be chaos if m_2 were not perceived or imaged as between m_1 and m_3. In other words, we intuit in the change a specific relation which we may designate as temporal betweenness, or intermediacy. This intermediacy, although it is not in the passing time as perceived, is an element in all other time-content.

Rate of change is measured by the comparison of two series in content. If you notice a certain rate of change in auditory sensation, you are comparing it with the rate of change of such other sensory or imaginative content as is implicitly assumed as a standard. The perception of rate passes so readily into the perception of extent that we must at once consider that factor.

(2) Temporal extent is the amount of change between determining points. If you note in direct perception how long a sensation lasts, you are noting the beginning of the sensation and its end, which are two points of transition in the field of consciousness, between which, if we were restricted to the one sensation, and it were uniform—if it did not vary in any character from beginning to end—there would be no perceived time at all. But we are not restricted to this sensation, and we perceive

changes occurring in other sensations—increase or decrease in intensity, and so on—which in their relations to the determining points of the first sensation constitute the perceived time between those points.[1]

The duration or temporal extent may be made up of the total changes in the content; usually, however, a certain part of the content is selected, and change in other parts is not included in the total. The selected contents are normally the periodic or rhythmic muscular activities: breathing, the heart-beat, or periodic movements of the limbs, as in walking; or even purposely produced periodic contractions of other muscles, as tapping of the finger or slight movement in the throat.

For practical purposes we find it convenient to use as standard extents of time the cycles of change of certain cosmic phenomena—the periodic passage of the sun across the meridian; the stellar posi-

[1] The character of sensation which we have called duration, or protensity, is not to be confused with duration in the sense of temporal extent. The sensation would be perceived even if it were not perceived as having temporal extent; and two sensations having different physical durations would be perceived as differing in protensity even although no time were perceived as included in either.

Protensity is the character of sensation by virtue of which it can have perceived duration, independently of any changes it may itself undergo. Duration proper is the protensity filled out by change in other sensation.

tions; and so on. Ordinarily, we employ as unit the day, that is, the interval between successive noons. Primitive man subdivided the day by the positions of the sun, corrected, doubtless, by the periodic need and satiety of sleep. A little progress in astronomical observation showed the variation in solar days as compared with the sidereal, and the desire for harmonious subdivisions resulted in the partition of the day on a spatial basis, fifteen degrees of longitude being the measure of an hour, fifteen minutes of longitude, one minute of time, and so on. These astronomical divisions of time are by no means equal for perception; one minute may be perceived as ten times as long as the next.

The symbolical estimation of time is not restricted to the means of astronomical observations, pendulums, and such physical devices. Very often we measure intervals by the number of recurrences of physiological phenomena; as heart-beats, breaths, etc.; without regard to the actually perceived time-content. Before this trait was noticed certain phenomena of time-estimation were quite inexplicable; the fact that intervals corresponding to some multiple of the respiration-period were more accurately estimated than intervals falling between these in length was discovered some decades ago, and, not being referred to the respiration at the time gave rise to much tenuous speculation. In other cases the breathing rhythm seems to be of less influence and the heart-rate to dominate the estimations.

In the direct estimation of time, any variation in the processes by which we estimate, or any change in the attention to them, affects the estimation. The apparent duration of a visual phenomenon occupying three physical seconds will not differ greatly, general conditions being the same, from the apparent duration of an auditory phenomenon of the same physical measure. In neither case is the time-content the change in the auditory or visual content, but in some content—muscular, and perhaps ideational—which is the same in both cases; the beginning and the end of the estimated phenomenon simply mark off a certain amount of this change. The change in the estimated phenomenon is perceived simply as change, the rapidity thereof being determined by the amount of change in the other series—in the time—to which it corresponds.

The apparent length of intervals marked off by tactual stimulations varies exceedingly from the apparent length of intervals marked off by visual or auditory stimulation, especially in being more irregular. This peculiarity of tactually limited intervals is probably due to the fact that attention to tactual stimulation emphasizes also certain muscular sensations from the member tactually stimulated, and this sensation merges in an irregular way with the more rhythmic muscular sensation constituting the basis of the time-content.

The passing of time seems sometimes slow, sometimes fast. This feature arises from the fact that we are comparing two series of changes whose relative rates are variable. The measure of the time is the series of changes we may call *St*. The content which is timed by that measure, the mass of sensation from the world about us, itself in constant change, we may call *Sc*. Now, while the rate of change of *St* is reasonably uniform—as compared with physical standards—the rate of change of *Sc* is highly irregular.[1] If *Sc* is changing rapidly, as when a great many interesting events are happening around you, time is perceived as flying. If, on the other hand, *Sc* goes slowly, as on days of deathly dulness, time is perceived as dragging. If all the changes in content not included in the time

[1] Perhaps we should say merely that *St* is less irregular than *Sc*.

series should become insignificant, the experience would approximate to the perception of eternity; those who have been the subject of this in the delirium of fever doubtless remember the horror of it.

In retrospect, the time that dragged may seem brief, as compared with an equal physical length of the time that flew. This seeming inversion of the duration relation is due to a peculiarity of our estimation of time intervals whose filling has once passed from consciousness. When you reproduce a series of past events, you time them by the present muscular series, just as if they constituted fresh content; for you could not, if you would, reproduce the past series of sensations forming the time basis. The richer series, now taking longer to run over in memory than does the poorer series, marks off more change in the time series, that is, it seems longer. On the other hand, the events of the past interval may not appear prominently; you may remember that they excited, interested, bored, or otherwise emotionally affected you, and this memory may serve as the symbol of the time length; the tedious experience may be thought of now as tedious because the memory of the content recalls the affective or emotional experience connected with the slow passage of the time.

(3) The relations of past to present and to future are so invariable and all pervading that they almost defy analysis. Practically all we can do here is to point them out; but that does not signify that the relations are simple.

The present corresponds to the "here" of space —the origin in a system of co-ordinates—and past and present correspond to "elsewhere." If we so desire, we can carry the analogy still farther in connection with the factors *reality* and *unreality*. We may imagine either past or future as real (memory and expectation), or as unreal. I may, for example, imagine myself as having made a successful balloon ascension yesterday, or as the proprietor of a restaurant to-morrow. We might therefore liken the past and the future to the positive and negative directions of a line, and the fictitious past and future to the $\pm\sqrt{-1}$. But the analogy breaks down, for the "reality" and "unreality" are not time factors, and we can imagine content as present and unreal, as well as present and real.

"Reality" may be taken in another way, to signify the intuited as against the imagined. This, again, is not a time factor, since content may be either intuited or imagined as present. It is only in a metaphysical way that I can identify the present with reality, and past and future with unreality; for this identification is not a matter of immediate experience at all, but a symbolic way of stating the time relations. In so far as my immediate experience is concerned, both past and future actually exist.[1]

The temporal factors of pastness and futurity have essentially connected with them the factors of *familiarity* and *novelty.* What is apprehended as past is also *recognized,* that is, it has the element of familiarity; but we cannot say that pastness and familiarity are one and the same thing. Familiarity, it is clear, may attach to a content which has novelty; something may be both future and familiar. It is quite possible that these factors are ulti-

[1] There are many interesting problems in the metaphysical view of time. If the past does not exist, any account of it is pure fiction, and history and mythology are alike only attempts to systematize a present content, true in so far as they succeed; historical truth depending therefore merely on the extent and quality of our present information. To say that the past *does not* exist, but *did* exist is a mere quibble, just as it is to say that to-morrow *will be* Monday. If the past *is,* then the events of the past *were;* if to-morrow *is,* then the events thereto pertaining *will be.* To say that to-morrow will be, or that the past was, is either a misstatement or a metaphor.

Whatever the "reality" factor of content may be, analysis so far has simply indicated it. It is doubtless a relation or group of relations—a "feeling of realty," the current empirical philosophy would call it—and there we are obliged to leave it for the present.

mate elements, and we may accept them as such provisionally.

The present moment of perceived time may be said to be a mere position in which all content has its origin, and from which it ceaselessly flows. This present moment, in other words, does not include any duration. In this respect it is like the present moment of logical ("physical") time, which must be represented as a mere point on a line. The actual present, however, cannot be represented by the logical present; that is to say, that when the actual present moment is schematized in such a way as to show the various features of content and of processes connected with it, in logical time relations, this present is represented not by a point, but by an appreciable extent of "physical" time.

Another way of describing the relation between the actual present and the logical present is to say that the content may include factors which appear simultaneous, but whose physical causes (and probably whose physiological processes) are separated by some interval in the physical series. For example: a hand revolving over a dial may pass the zero mark a fraction of a second before or after a bell stroke occurs, and yet the two occurrences may seem simultaneous. The perception of the pointer at a definite place on the dial necessitates an eye movement, which, in some way not entirely understood at present, allows an "instantaneous photograph" on the retina of the pointer at the given place; without this eye-movement the image blurs. When the click appears immediately before or after the eye movement no time is perceived as intervening, that is, the visual impression and the auditory impression are judged to be simultaneous.

CHAPTER XIV

AFFECTIVE CONTENT OR FEELING

1. Affection and Cognition

PERCEPTION and imagination are classed as *cognition,* and sensation and relations, therefore, as cognitive elements. These factors do not exhaust the sum of content, or at least there are sorts of content which have not been demonstrated as reducible to sensation and relation.

When I experience an object, I may experience it qualified by *pleasantness* or the opposite. A certain amount of what for want of a better term we may call *interest* may also attach to the object. If I imagine a content it may be tinged with *desire* or *repugnance.* These factors—*pleasure, pain, desire, repugnance,* and *interest*—constitute the *affective tone* of the content in so far as they are present. They are sometimes looked upon not as factors in the content, but, (1) as ways of experiencing it, or (2) as attitudes toward it, or (3) modes in which the ego is affected in experiencing it. These three expressions, which are practically equivalent, mean nothing more than that the content of experience is not completely accounted for in analysis in terms of cognitive factors only; that the non-cognitive or affective factors are as truly *sui generis* as are the cognitive factors.

Affective content includes not only the elements (or quasi-elements) just mentioned, but also the more complex factors called *emotions* and *emotional tone*. For example, the content may be joyful, pathetic, humorous, or revolting.

Pleasure, pain, interest, desire, and repugnance, may be designated as *feelings*, or, abstractly, as *feeling*. Pleasure and pain are designated as *hedonic tone* or *algo-hedonic tone;* the experience of pleasure and pain, considered generally, is hedono-algesis.[1] Desire and aversion are designated adjectively as *conative* or *appetitive,* and the experience of them as *conation* or *appetition.*

[1] The term "feeling tone" is commonly given to pleasure-pain alone: frequently the two qualities are designated as *pleasantness* and *unpleasantness.* Some psychologists apply the term "feeling tone" also to certain obviously sensory elements or factors, especially strain and relaxation.

"Feeling" has been much used in the past in the sense of *emotion,* but is not so used at present in strict discourse.

Often, however, the term is extended to cover what we have designated as relational content; thus, a "feeling of similarity" is not an uncommon expression. In loose speaking, "feeling" is used to designate any sort of content whatever.

The most conspicuous feature of feeling and emotion is the pairing off of the different qualities and qualitative complexes in antithetical fashion. The two conative qualities are mutually opposed to each other, as are also the algo-hedonic qualities, and for almost every emotion there is an opposite. This raises the suspicion that all the emotions are based on the feelings, and that very probably there are more feelings than the ones we have named.

2. Pleasure and Pain

Hedonic tone attaches not only to sensational experiences but also to content of all kinds. An idea is pleasant or unpleasant; the memory of your misfortune yesterday involves painful elements, the idea of the good time to-morrow brings pleasure with it. The recognition of relations, whether in idea or immediate perception, rouses hedonic or algetic factors, and sometimes vividly; even the solution of a problem in Euclid brings pleasure. Emotional states can be classified on the basis of their hedonic tone.

In some respects hedonic tone resembles sensation. It has the characters of quality, intensity, and duration. Other forms of content (relations, possibly images,) can hardly be said to possess intensity. Affective elements have no specific physical stimuli: in this respect they resemble visceral sensations. But on the other hand, the feelings cannot be identified with any peripheral nervous mechanism or process; in which they are analogous to relations.

The quality and intensity of hedonic tone accompanying sensations are determined by the sen-

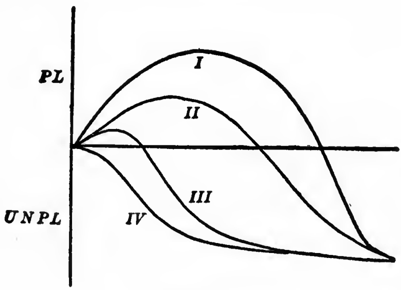


FIG. 12.

The curves in fig. 12 represent schematically the relation between feeling and sensation intensity. The abscissa represents the intensity of the sensation, and the plus and minus ordinates represent the corresponding degrees of pleasantness and unpleasantness respectively.

sations in fairly simple ways. The intensity, duration, and the number of repetitions of the sensation seem to be the important factors. If the sensation is of brief duration, it is usually pleasant at low intensities, the degree of pleasure depending on the sensation-quality, and on the individual and his condition. To most of us, a faint smell of lilac is agreeable, but as the intensity of the odor increases the pleasure decreases, changing for some persons to unpleasantness with high intensity of the sensation. (See Curve II of Fig. 12.) For other persons the odor may remain pleasant at relatively high intensities. (Curve I.) For the most part, sensations are slightly pleasant when sufficiently faint, (Curve III), although some are indeed merely neutral, and some are unpleasant for some persons if above the threshold at all. (Curve IV.)

The duration of the sensation exercises an influence on hedonic tone; or, rather, the tone varies according to the duration of the sensation. A flash of color, a brief skin-tickle, a whiff of musk, may be agreeable, although a longer continuation makes the sensation intolerable. In the cases of some sensations, the feeling may not be changed to the opposite, but simply become less pleasant or more unpleasant; but the effect of a longer duration of the sensation is always to send the tone in the unpleasant direction. At the same time, it must be remembered, the continuance of a stimulation produces progressively less response from the sense-organ, and hence less intensity of sensation.

Repetition may make a sensation which is originally unpleasant less so, or even pleasant. Bitter becomes a pleasant taste, and discord a pleasant sound, with habituation thereto. Possibly all food flavors are unpleasant to the child experiencing them for the first time; the instinct to eat and the desire to do what others do impel him to continue to ingest the food and drink offered to him, and he quickly learns to like them. Where a sensation becomes more unpleasant with repetition, the organ has undergone a change—pathological, perhaps—such that the stimulus really produces a more intense sensation, as in the case of a tooth which the dentist has been torturing intermittently; or ideal factors have entered, with their effects on feeling, as when one revolts from a formerly toothsome dish after seeing the details of its preparation.

In the realm of ideas and relations the conditions governing pleasure and pain are highly complicated. That we can remember or imagine affective elements is denied by some psychologists. Perhaps individuals differ in their power of imagining such contents. On the other hand, the idea or image of past or future experience may arouse actual pleasure or pain at the moment of the experience of the idea, and so the belief in reproduced hedonic tone may be due to the mistaking of the tone of the image for the image of the tone. The idea of past events is not always pleasant if the past content was pleasant, nor unpleasant if the past content was unpleasant. The determining causes of hedono-algetic quality seem to lie deep, and to operate in sense perception as well as in ideation; the quasi-principles above laid down in regard to sensation being, perhaps, specific results of these general causes.

In the first place, the normal physiological activities, those which go on as they should for the welfare of the individual and the perpetuation of the species, give pleasure; any interference with the usual course, or anything detrimental to the organism, gives pain.[1]

In the second place, whatever simulates some condition which is organically advantageous, gives pleasure. Drugs which produce effects on the nervous system temporarily like the effects of rest or

[1] This connection of algo-hedonic tone with the normal may be supposed to be the result of natural selection. Animals which failed to get pain from mutilation, exhaustion, or hunger, and pleasure from food and the society of the opposite sex, would have less chance for individual and racial survival than those which were "normal" in that regard. We should expect to find certain capacities for pleasure, *e. g.*, of intoxication, which are in themselves harmful, that have not been eliminated because of their connection with other and beneficial activities, or because natural selection has had no chance at them.

normal activity produce also the pleasurable accompaniments of these conditions.

In the third place, the carrying out or completion of any activity; the accomplishment of any purpose; or the contemplation of a purpose accomplished, give pleasure. The hindering or obstructing of activity; the failure to carry out a purpose; the contemplation of a plan obstructed or an accomplishment obliterated; any of these give pain. Solving a problem, carrying out schemes of politics or business, playing a game successfully, contemplating your rise from barefoot boy to banker—these are instances of the one sort. Getting "stuck" in a problem, failing to get command of a game, recalling your recent wealth or influence, are instances of the other.

The general rule, in short, is that the normal and successful performance of functions, physiological or mental, is accompanied by pleasure, and the fact that certain exceptions occur is evidence merely that the physio-psychological mechanism is not perfectly adapted for all contingencies.

As soon as we recognize pleasure and pain as primarily the concomitants of the organic welfare of the individual, we are led to suspect that they are forms of visceral sensation. We might reasonably suppose that the well-being of the vital organs, and the proper discharge of their functions, cause the stimulation of appropriate nerve endings, and as a result, somewhere in brain or in spinal cord, takes place the neural process specifically corresponding to pleasure. So too, the vital organs in unfavorable circumstances might arouse sensations of pain. Nervous excitations through the organs of "external" sense, or the neural correlate of ideational activity, being intimately connected with the condition of the organism, have possibly acquired either the power to excite the visceral organs by reflex nervous discharges, or else the power to excite directly the neural centre of hedono-algetic feeling.

This sensational theory of pleasure and pain is to be regarded merely as a live hypothesis. It is not at present any more probable than the opposite hypothesis; *viz.*, that pleasure and pain are content of a kind different from sensation.

3. Conation and Interest

Desire and repugnance are antithetical, as are pleasure and pain, and are usually so connected with the latter functionally that what is pleasant is desired, and what is unpleasant is repugned.[1]

[1] We use here the verb "repugn" as the exact opposite of the verb "desire". This usage is rare in English literature, but

Conative factors attach only to imaged, ideated, and conceived content. If an object is present to sense—intuited—it is pleasing or displeasing, but cannot be desired or repugnant. When an object is perceived, some further content connected with it may be conatively colored. Thus, when fruit is before my gaze, I cannot desire the sight of it, for that I already have; but I may desire the taste, or a continuance of the sight, or the complex relations known as ownership. So the nasty medicine forced on the child is not repugnant as he experiences it, but the taste and effects imagined as a future possibility are decidedly repugnant.

Interest is verbally the opposite of apathy, but the two factors are not antithetical, as are desire and repugnance. Apathy is really the zero-point of interest, corresponding to the neither-pleasant-nor-painful; the neither-desired-nor-repugnant. There is only one quality of interest. A high degree of interest may coincide with either the pleasant or the painful, the desired or the repugnant.

it is necessary to make this addition to psychological terminology because we have no other word which can serve as a precise term for the opposite of "desire." "Aversion" is frequently used for the noun, but is not unambiguous, and has no verb form. We might even venture a step beyond precedent and use the noun "repugn" as the opposite to the noun "desire."

The glorious sunset; the vile chemical laboratory smell; the recollected images of yesterday's good fortune; the idea of to-morrow's catastrophe; all may be permeated by intense interest.

Interest attaching to one feature of a complex content spreads over the other factors of the content. The firmer the association between the intrinsically interesting factor and the other factors, the more these share in its interest. Pedagogues universally recognize this fact, and, therefore, in presenting any subject to children, they inject anecdotes, bring out details which are not essential to the subject-matter, but which are interesting to the child,[1] and in every other way possible mingle with the dry material interesting stuff which can be as-

[1] It is customary to say "appeal to the child's interest," instead of "possess interest for the child." This form of expression indicates the survival of the view of content of various sorts as products of the "faculties" of the individual. Under the "faculty" theory the various terms designating different divisions of the field were applied indiscriminately to the content and to the hypothetical "faculty" producing the content. This "faculty psychology" is by no means dead at present, and has the greatest vitality in the realm of the feelings. The student must be careful not to allow the common ways of speaking of psychological facts to draw him into a false understanding of them. You may say "I admire St. Gaudens' statues" and "I became interested in polar exploration," but don't forget that admiration and interest, to whatever activities they may lead, are factors in the content of your consciousness, and not anything supplied by your consciousness or your ego.

sociated with it. Contemporaneous events; details concerning the person, country, or organization under consideration, and especially causes and effects, form associative nexus over which the interest readily travels. But even such artificial associations as may be formed between $\frac{2}{3}$ and the red apples used to illustrate the problem, may carry interest from the fruit to the arithmetic, for the good of the child and the success of the teacher.

Desire and repugnance spread, but not simply along the lines of association. In certain cases the invariable associates of desired or repugnant things become invested with the given feeling, sometimes to the exclusion of that which it originally attached; but these cases—fetichism, so called—are exceptional. In general, the organic whole which is ideated—for example, a trip to Europe—is desired (or the reverse) in so far as one or more important factors in the idea have the feeling, but the conative feeling does not tend to flow over and color the other cognitive factors, or at least not to the same extent as does interest. However ardently you desire the European trip, the sea voyage essential thereto may remain repugnant, and certain details of continental travel remain conatively neutral.

But your interest in the means and conditions of travel swells almost in proportion to your interest in foreign lands.

In the particular instance cited, the abhorred factor—the ocean trip—becomes desired, in spite of its unpleasantness, as soon as you begin to make definite plans for beginning your vacation. You contemplate the voyage as a necessary link in the chain of causation which will bring the intrinsically desired details of the stay on the other side. *Conative feeling, in other words, spreads along the line of causal relation in the regressive direction.* If you desire anything, you will desire the causes thereof, unless those causes are so tinctured with repugnance that the desire of the effects cannot overcome it. There are persons who are such "poor sailors" that not all the joys of the other continents can overcome their aversion to the uneasy ocean.

Conative feeling never spreads progressively along the line of causation. You may be averse to the sea voyage because of the repugnant consequences; but no matter how much you desire to take ship, the consequent *mal de mer* will never become in the least desired. However fierce may be your longing for any pleasurable content, it will not add one jot to your desire for the consequences, nor subtract one tittle from your repugn for them.

The desire or repugnance attaching to a cause—or what is conceived as a cause—does have an influence on the interest attaching to the effect. If the effect has the opposite conative feeling, it is decreased in interest, sometimes even to the apathetic point. The dipsomaniac, eager for the pleasant excitement of intoxication, does not desire the next day's wretchedness; but that result he refuses to ideate—it has no interest for him while his desire for intoxication lasts, and interest, as we shall see, is one of the important conditions of attention. In this curious relation of interest to antagonistic conative feeling is doubtless to be found a clew to the further understanding of interest.

4. Emotion

Emotion includes in the first place the affective elements just mentioned, and perhaps other such elements. In the second place, it includes among its factors bodily sensation, and in the third place intellectual factors. Sensory imaginative content is included in many instances.

The affective elements are combined in an organized content in normal consciousness in the manner we have indicated in the preceding section; either hedonic tone, or either conative factor may appear with any degree of interest: if both hedonic tone and conative factors are present, (as in ideation), repugnance goes with pain and desire with pleasure. In morbid imagination the conditions may be reversed; pleasure may be coupled with repugnance and pain with desire.

A few examples of affective combination in emotion will illustrate the possible exclusions of one or another of the three feeling groups. Grief or joy may be entirely devoid of desire and aversion. Grief may lose interest until it sinks approximately to apathy. Ennui is painful, rather apathetic, and repugnant in so far as its continuance is ideated. On the other hand, the idea of the removal of its cause is pleasant and desired. Hate may be devoid of hedonic tone, and full either of desire or repugnance, according as the object of the hate is thought of as suffering or prospering.

Examples of morbid emotion are found in cases of asceticism where the "pleasures of the flesh" are thought of with aversion, and various sorts of pain are desired. The ideal of the monkish life is to rid the ideas of things, commonly desired or repugnant, of their normal pleasure or pain: in so far as this ideal is realized the emotions are not morbid; they are abnormal only in the sense of being unusual. It is possible that in some diseased mental conditions (other than the quasi-ascetic) the patient may desire what is thought of as painful, and be averse to what is thought of as pleasant.

In *æsthetic emotion* desire and repugnance are excluded. My present emotion with regard to the Fifth Symphony of Beethoven is not æsthetic; it is a commonplace affair in which the desire to hear the symphony predominates: the emotion while listening to the symphony is æsthetic if no desires are mingled in it. The painting of a mere basket of fruit can hardly arouse æsthetic emotion, because the desire to taste the fruit is excited if the painting is skilfully done (there are exceptions, however), and the representation of a beautiful woman is decidedly unæsthetic if it arouses sensuous desire. So, too, in so far as anything arouses repugnance, it is an unæsthetic object.[1]

The ideals of art are not satisfied by the mere arousal of æsthetic emotion. Art aims to carry us to

[1] The ideal religious emotion is complementary to æsthetic emotion, in that desire and repugn are included, and pleasure and pain excluded. The common type of religious emotion, or what passes for such, is generally tinctured heavily with hedono-algetic factors.

the point where the sensuous and intellectual content is minimized, and the feeling element is paramount. This aim can be attained measurably by painting and sculpture, but more adequately by poetry and music. In poetry, the ideas called up by the words are necessarily definite and in so far obtrusive, but the skill of the poet is exerted to subordinate this machinery to the results achieved by its aid. This is the reason why description, narration, or philosophizing, essentially interfere with the poetic effect, although they may produce a pleasing result; and the poet accordingly employs them only in so far as the ideas they arouse are fragmentary and therefore subordinate to their feeling.

In music, we are less trammelled by the cognitive. The mere sounds are not of high interest in the total complex, and they do not in general arouse definite ideas. There are exceptions, in what is known as "programme-music," in which certain passages are supposed to suggest the singing of birds in the woods, etc., and although some musicians condemn this intrusion of ideas, it may be helpful in some cases. The mingling of music with sensuous and intellectual content in opera, while a lower form of art for those able to appreciate pure music, may be a means by which more powerful feeling is roused in certain persons than they would otherwise experience. The purity of the feelings is one ideal, and the strength of feeling and richness of content is another, between which the choice is a matter of personal response.

5. The Cœnæsthetic Factor in Emotion

The discovery that emotion contains much vague and undiscriminated bodily sensation was made about thirty years ago, simultaneously, by James of Harvard and Lange of Copenhagen. Prior to that time the opinion prevailed that the bodily factors we experience when emotionally moved are consequences of the emotion proper—the theory of Descartes. Spinoza had stated the doctrine of the bodily factors as an integral part of the emotion, but in a crabbed and symbolic way which produced but slight effect on psychology. Lange and James went so far as to claim that the emotion consists wholly of bodily sensation—the so-called James-Lange theory—and although we are not inclined to grant this claim it is not because we are essentially at variance with the James-Lange view, but because they mean by emotion only what is left over after the intellectual and ideo-cognitive factors are excluded, and possibly after the exclusion of what we have designated as the true affective factors, while we prefer to use the term in the wider sense in which the public understands it.[1]

The trembling of the limbs, the modified beat of the heart, the peculiar visceral states, and, perhaps, the results of certain glandular activities, are certainly a large factor in *fear*, and if they are abstracted the characteristic emotion is dispelled. So in the case of pathos; the emotion derives its specific character from certain sensations connected with swallowing and relaxation, characteristic of satisfaction, and with the retching movements characteristic of disapproval or disgust; for the essential thing in pathos is a mingling of these two emotional complexes. Other illustrations of the cœnæsthetic factor in emotion may readily be found.

The mass of sensation in emotion is undiscriminated and vague. When you pick out this factor and identify it with the respiration, and identify that factor with the leg muscles, and the other factor with the intestinal condition, the emotion is thereby destroyed. It is only so long as these sensations fuse

[1] For a statement of Professor James's theory, and the multitude of facts which support it, read the chapters on "Instinct and Emotion" (XXIV and XXV), in vol. II, of his *Principles of Psychology*.

into an undifferentiated mass that they are a "color" or "background" for the cognitive content; when discriminated they are cognitive content themselves, losing their quasi-unique character. Moreover, the visceral sensations are always vague, and identification of them is difficult, even when one makes great effort to analyze.

It is possible that in many cases the actual sensations are replaced by images thereof; so that a man whose heart and diaphragm no longer respond to the stimulation of a threatening circumstance still may feel fear through the recall of the appropriate sensations in imagination. This supposition would be contrary to the seeming fact that bodily sensations are in general not imagined, but, nevertheless, it is not yet excluded.

6. The Cognitive Factor in Emotion

An emotion is always built up on some cognitive content, and loses its distinctive character when considered apart from that factor. The reference of the emotional complex to the "object" of the emotion furnishes the basis of its specific organization. Emotional content not attached to a specific cognitive content—which has not a specific "object"—is not dignified with the name of *an emotion,* but is called an *emotional mood.* Joy and sorrow, divested of the definite reference to the object or event which they envelop, become mere elation or depression. Hate which is not the hate of some one or thing is a mere savage mood. These moods are common, and may be produced by strictly physiological causes; melancholy, the mood corresponding to grief, is notoriously a result of disordered bodily functions. On the other hand, an emotion may resolve itself into a mood which persists long after the transition.

In addition to the general reference of an emotion to its "object," there are explicit relationships or groups of relationships involved in emotions. These relations appertain primarily to the "object," but are essential to the emotion. Thus, reverence and contempt involve the perception or conception of the object as superior or inferior in some respect; usually a relation of the sort we designate as personal. Fear involves the consciousness of the object as threatening us; hope, as possibly attainable. Despair permeates the object which is ideated as forever sundered from our possession. Love has been defined as pleasure *plus* the idea (or perception) of the object producing the pleasure; this half-truth brings out clearly the fact to which we refer. Mere pleasure, with the perception of the pleasing object, is "taking pleasure in the object," and nothing more; but given the proper relation in which the object is conceived as standing to other things, the emotion may become one of warm approval; and, given certain relations in which the object is conceived to stand to yourself, the emotion may become love.

From the above considerations it ought to be evident that any analysis of the emotions which attempts to reduce them to sensations alone, or to sensations and affective elements, is inadequate.

7. The Classification of the Emotions

Many attempts have been made in the past to enumerate the principal or distinctive emotions, or to tabulate the main classes into which all emotions should fall. Success has crowned none of these efforts; they have not even gained ground from which further advance may be made.

The varieties of emotion are actually indefinite, and practically infinite in number. One emotion shades off into another by slight gradations, and definite delimitation is entirely out of the question.

We might, indeed, make rough divisions of emotions on the basis of hedono-algesis, setting those which contain painful factors over against those which contain pleasant. Or we might classify on the basis of desire and aversion. A distinction has been made also between the egoistic or self-regarding, and the altruistic emotions. Many other principles of classification might be suggested, but they are for the most part applicable to a few cases only, and they are all practically useless.

CHAPTER XV

ACTION AND WILL

1. Action in General

THE actions of which the human body is capable may be divided usefully into two classes: physiological reflexes and consciousness-reflexes. The first class, which includes the actions in which consciousness plays no essential part, is but indirectly of interest to the psychologist, although of extreme importance in vital function. The physiological reflex may be produced artificially by direct excitation of the muscles by mechanical, electrical, or chemical stimuli; by electrical stimulation of the efferent (motor) nerves; by stimulation of the motor cells of the cortex or in the lower centres; and perhaps by electrical stimulation of certain sensory nerves. The exact method of production of the natural physiological reflexes—such as breathing, heart-beat and arterial dilation and contraction, intestinal peristalsis, glandular secretion, pupillary reflex—need not be discussed in detail here. In the case of the pupillary reflex and the heart-beat, the activity of the muscle probably is determined largely by local stimulation. In the case of breathing, the movements are wholly initiated by nerve-currents from centres in the cerebellum. The movements of swallowing are probably brought about through tactual sensations (from the mouth) which excite certain nerve-centres, which in turn excite the muscles of the mouth and gullet. This last process is usually in part a consciousness-reflex.

Actions of the second class are those in which consciousness plays an important rôle, and of these four types may be distinguished: sensational reflexes, or sensory-motor processes; perceptual reflexes; ideational reflexes, or ideo-motor processes; and voluntary actions, or volitional processes.

In the sensational reflex the consciousness necessarily involved is a sensation merely. Thus, the hand is mechanically retracted upon coming into contact with a hot object; the mere apprehension of heat is sufficient to bring about the reaction, and the apprehension of a definite hot object is not necessary, although it may be important for further action. Winking when a cinder gets in the eye, is another typical sensational reflex. It is possible that some of the instinctive actions of the young animal may belong to this class. The first sucking movement of the babe, for example, may be conditioned by the mere tactual sensations aroused by the nipple on its lips. On the other hand, these actions may be mere physiological reflexes, or they may, for aught we know, depend on definite perceptions.

The perceptual reflex, depending on apprehension of content more complicated than mere sensation, is in adult life more important than the mere sensational reflex. The almost unavoidable winking when some object comes quickly toward the eye; the instinctive putting up of the hand to ward off or catch an object; the flow of saliva at the smell of savory food; the unintentional mimicking of an acrobat by an interested spectator: these are typical perceptual reflexes.

The consciousness immediately antecedent to an action may not be of presented content at all, but may be purely ideational. Action under such conditions we designate as ideational reflex. There are many cases in which the mere thought of an act brings the act about. Think of blinking; of inhaling deeply; of looking behind you; of yawning; and the act will occur. Thinking of the result of the act may be sufficient to produce it; in many cases, thinking of a word is accompanied by the speaking of the word. It is probably true that every act thought of, either by imaging the act or by imaging the result thereof, would immediately "realize itself" if there were not other factors which interfere, as there are in most cases. In hypnosis it is probable that these inhibitory factors are suppressed, and hence the ideas communicated to the patient have a chance to work themselves out rather freely. If you arouse in the patient's consciousness the idea of a horse, contradictory ideas being in abeyance, he will produce (as nearly as his bodily capacity permits), the acts characteristic of a horse.

Certain ideas are linked with certain muscular and glandular activities, although they are not the "ideas of" the activities, nor "ideas of" the results. The rather complicated ideational content involved in the notion of shame, for example, causes relaxation of the blood-vessels in such a way as to give rise to a blush. The idea that some one has treated you with indignity causes the changes which are felt in anger. An individual's idea of his superiority to other people may cause him to laugh or to smile. The list of illustrations might be extended indefinitely.

If the ideational or perceptual reflex is complicated, *i. e.*, if there are a number of details of action which must occur—some simultaneously and some in succession,—in order to produce a definite effect, as in walking or in catching a ball, but if, nevertheless, the group of activities is as a whole dependent on the ideational or perceptual fact, as in the instances mentioned, the combined actions are called an automatic action. If an automatic action or a complicated physiological reflex occurs without its having been learned, it is said to be instinctive. If a nestling of a certain age is thrown into the air, it will fly; this first flying of the young bird is an instinctive action.

Voluntary action is an ideo-motor process, but it includes more than the mere ideational reflex. The specific differentia of the voluntary action is desire (or the opposite). If I merely think of grasping the ink-well which stands on the desk before me, I probably shall not act on the idea. But if I desire to grasp the ink-well, I shall grasp it, unless very influential counter-ideas are in my consciousness.

2. Volition

We have indicated above that volition is an emotional state which involves as its essential features an idea of a future condition (anticipatory idea) with desire of (or repugnance to) that condition. Not every emotion of desire (or of repugnance) is, however, a volition. A volition is an emotion of desire[1]—what we commonly call the "desire of" something—in the absence of any influential contrary idea and conation. If you see some choice fruit on a tree and are devising means by which you may obtain possession thereof, it is immaterial whether we say you desire the fruit, or that you will to get it. But if you entertain the idea that the taking of the fruit would be wrong, or suspect that the owner is near; and are averse to the act or its consequences under these conditions; and if the aversion is strong enough to prevent the plucking of the desired fruit; we should call your content desire, and not volition.

The total content of consciousness, where it is marked by opposing ideas and conation, is called

[1] We shall speak only of desire, but with the understanding that the same remarks apply also, *mutatis mutandis*, to cases in which the conative factor is repugnance.

deliberation. Put in active terms, you deliberate over (literally, weigh) the desirable and undesirable possibilities in the way of results of the action. One of the ideas may shortly gain the ascendancy; the other either fading out of consciousness or losing its conative strength, and thus the content become a volition. This resolution of opposition or subordination of inhibitory content, by which the mind "pulled several ways" becomes "confirmed in one direction" is called decision or consent. Sometimes it is called the fiat.

We are prone to think of deliberation as the hesitation of the self between alternative lines of possible activity, and of decision as the active choice by the self of the one or the other. The part played by the self in deliberation and decision may be made more intelligible later, but for the present it is sufficient to say that the most adequate conception of these states is as mere matters of content; there is no discoverable force—as of an Ego or active self—at work transforming the content.

It is not necessary that deliberation or decision should precede or form a part of volition. The anticipatory idea may be offset by no ideas of opposing acts or of restraints, and yet the act which succeeds may be strictly voluntary. The boy who sees the apple, anticipates with desire the ingestion thereof, and takes possession of it without a thought of owner's rights or owner's wrath, performs an action as truly voluntary as if he deliberated over the situation for some time, and came to a decision with an experience of great effort. The line between volition and desire (emotion) is manifestly not sharp, nor is there any great need of making any sharp distinction, either in ethics or in psychology. The distinction between voluntary action and ideomotor process is clear for the extreme cases, but the two run into each other in a middle ground, where discrimination is impossible.

The desire of a given effect is called the motive of the desire of its cause, or the motive of the volition based on the latter desire. The boy's desire or will to project the stone through the window may be motived by a desire to annoy the occupants of the house. The term motive is applied also to certain other antecedents of an act; the boy's motive for the window-breaking may be said to be the hatred with which he regards the householder. The motiving emotion has always desire or repugnance as a constituent; it is because the boy's hatred for the man includes as its prominent factor a desire to see him degraded in some way, that it can be considered a motive. A non-conative emotion cannot motive any desire or volition.

3. Volition as Activity

There is one method of describing will, which calls a volition complete only when to the anticipatory idea, the desire, and the predominance of these, there is added the perception of the realization of the idea. Thus when I thought conatively of picking up the inkstand, and then proceeded to grasp it, I completed the volitional state by the perception of my fingers closing around the glass. A volition regarded from this point of view is more than a mere content or combination of content; it is a process, and cannot be represented by a cross-section of consciousness; it finds its individuality not in any specific sort of content, nor in any specific combination of content at any one time, but in a definite sequence of states of content. This is the doctrine of will as a psychological activity. It differs from the description of volition we have above given merely in the application of terms. All depends on the choice of the specific features of the complicated process which shall be designated by the term volition.

According to the system just stated, if the volitional process does not issue into fulfilment of the idea, but stops just before the last stage because of some external restraint, it is called determination, or wish. Thus, I determine that I will buy some paper when I next go down town; and I wish to go to the opera to-night. The difference between wish and determination depends on the anticipatory idea; if its intellectual factors include possibility, the resultant state is determination; if possibility is not included, it is merely wish. The distinction between volition and determination is frequently only a matter of point of view: I try to catch a car, but miss it; from the point of view of catching the car my content was mere determination, but from the point of view of my decision to run for the car, the state was volition. It is not advisable to give much attention to the activity definition of will, or to the problems growing out of it.

4. Automatic Action

In descending now to automatic action, we mark two stages; first, the elimination of desire, and, second, the elimination of the anticipatory idea.

In carrying out a definite series of activities you, in many cases, do not will each one; even when each act is separately ideated or undertaken, it is not desired. In an earlier chapter we have spoken of the spreading of the desire from the effect or end to the causes or means; but although this does occur in some cases, it is not essential. Thus, if I desire to get a book from the library across the street, I get up, put on my hat, go across and ring the bell of the elevator in the library, so performing a number of acts which are ideationally initiated, but which individually are comparatively free from any appetitive factor. At the same time, in the course of getting my book I have performed several acts which are not even consciously initiated, although they are like the ones just mentioned, in that they might be initiated ideationally. Walking, for example, can be done by voluntarily placing the legs and body in the requisite successive positions, but usually it proceeds without either the desire or the idea of these positions. So it is with opening the door, avoiding a car, catching my hat just as the wind lifts it from my head, etc. These are all acts which may be involved in the total action of getting the book, and not only may take place mechanically in the proper order as if they were premeditated severally, but actually are more efficiently performed when they are mechanical.

If the movements essential to the carrying out of a series of activities are not perfectly uniform, but require variation to fit the environment (as in walking on uneven surfaces, turning corners, stepping over gutters, etc.) these variations are introduced as perceptual reflexes; you see the gutter, for example, and the appropriate modification of the action of the muscles occurs without any further conscious intervention. The whole series of walking movements may take place in the same way: my idea of getting the book may be succeeded by or include no idea of locomotion; the mere perception of my local situation may start my legs moving.

An automatic act may be considered as a series of reflexes, perceptual, sensational, or physiological, in which each completed detail serves as a stimulus for the next. Thus, in walking, the shifting of the weight to the left leg may be the stimulus for the extension of the right leg, and so on: these two acts are themselves complex, and the series of muscular contractions which produces them are connected in a reflex way; when one is completed or reaches a certain stage, it sets off the next one. So, the whole process repeats itself automatically and is continued until inhibited by a new idea, perception, or sensation. It is probable that every functionally connected series of acts tends to pass in succession from perceptual to sensational and physiological reflex-types, as regards the initiation of the particular acts.

5. Instinctive Action and Learning

The difference between an instinctive action and an automatic action or complicated reflex whose sequences and combinations are acquired, is simple in theory, although in practice discrimination is not always easy. The action of a young bird's wings in its first flight are instinctive—it never learned these actions. Your actions in waltzing are acquired—nature may have endowed you with the capacity for the essential movements of the feet and legs, but you had to learn the right combinations laboriously. The co-ordinating wing-movements of the fledgling may be initiated by the perceptions aroused when the bird first finds itself in the air, or they may be simply complicated physiological reflexes. On the other hand, the conclusion that either of these suppositions is true is at least premature. It is possible that the flying may be initiated by ideas or even by the desire of flight. Other instances of complex actions which are instinctive —*i. e.*, not acquired,—are the feeding of young birds and young mammals, and the first creeping, walking, and talking of young children. Our adult activities are based throughout on instincts, but in the development of these activities the acquired part comes to overshadow the instinctive. The turning of door-knobs, buttoning of coats, playing of violins, manipulating of complicated scientific instruments, the use of knives and forks, and so on *ad infinitum,* are actions initiated by the visual or tactual perception of certain objects; yet the combinations of muscular processes necessary to the accomplishment of these actions have been learned in past experience.

Learning, in the domain of action, is in every case the combining of simple or relatively simple activities which primarily occur instinctively or accidentally, for the accomplishment of something which none of the simple acts could compass. Such learning may proceed in one of three ways:

(1) The combination may be entirely accidental. The child may by chance make the "th" sound and associate the sound with the proper position of the tongue and lips. The dog confined in the yard noses frantically at the gate until accidentally he trips the latch. If the animal is thus fortunate several times he may form an association

between the percept of the latch and the appropriate action.

(2) Imitation. A child may learn a new purposive combination of movements at one stroke by seeing the action performed by somebody else. A peculiar hop or skip, the winding of a clock or mechanical toy; the buttoning of a garment; may be new, but performed fairly well the first time. By far the greater number of actions called imitative are, however, combinations of movement processes already learned, applying to specific objects or purposes. Almost all of the imitative bodily postures and gestures fall into this class. Such activities as the putting on of clothes, eating with forks and spoons, and the great mass of practical activities in general, are learned slowly, and can be called imitative only if you wish to apply that term to every non-instinctive action.

In learning by imitation, strictly so-called, the individual sees an act performed which he recognizes as a combination of certain more elementary processes of which he is already master, and then proceeds to perform this group of actions in the specific order and combination, for the first time. An act which is *repeated* by imitation must be one which the subject has previously performed.

Imitation therefore presupposes a high state of development "mentally" and muscularly. All the components of the imitative act must be under ideational control; must be, in short, capable of being voluntarily performed. If a child can say *shoo* and *gar* volitionally or as ideo-motor reflexes, he can succeed tolerably well in imitating your utterance of "sugar." But if the child has not learned to say the word or the two syllables separately he cannot imitate it. It is possible, however, that if he can voluntarily say "thu," he may recognize a similarity of that sound to "su" and make the substitution.

Imitation has really a small place in the field of learning. In most cases it applies to the already learned. The mere incentive to learn furnished by our observation of what others actually do ought not to be called imitation: the term indicates either a perceptual or ideational reflex, in which the essential percept or idea is of a similar act performed by another person.

(3) Conceptual analysis. At a higher stage of "mental" development, the individual is able to make new movement-combinations by a process of analysis. A certain situation is presented, which requires a number of movements in combination and succession, *e. g.*, the operation of a typewriter.

The beginner may without assistance discover the functions of the keys, the spacer, and the shift, and proceed to combine these functions; to alternate characters and spaces, to hold down the shift while printing a capital, and to hold down the shift and spacer while underlining or accenting. In all this combination there need be neither accident nor imitation, although all the movements here combined are put within the individual's power by instinct, and accident, assisted by imitation. Once learned, the combination becomes automatic, if the operator becomes in any wise expert.

Although for aught we know the lower animals may "learn" actions altogether without the aid of consciousness, man learns chiefly through volition. But the terminus of the learning process is that condition of efficiency in which volition, ideas, and other content of consciousness are eliminated as far as possible from the sequences of the action.

6. Habit

One of the most important features in the development of action is *habit*. Once a volition has occurred, it is easier for it to occur again. It may occur the first time after "hanging fire" a long time in the "strife" of opposing ideas, but next time the strife is shorter. With each repetition the process is accelerated and made easier, until finally the idea alone will produce the action, and we have the first step toward automatism. If a series of actions occurs habitually in the same order, after sufficient time, not only the essential desires and volition, but the ideas as well, will be eliminated and the series once started will unroll mechanically unless modified by new sensations; automatism will be complete.

Habitual repetition may modify the action in another way. The sensory content which at first aroused the anticipatory idea and desire may become able to do the work alone, by the progressive elimination of the two factors mentioned, thus giving rise to the acquired reflex. The sight of the letter put into your hands may be followed by the opening of the letter, even when you have neither idea nor desire of the act or its consequences.

The instinctive reflex has been called an *inborn habit.* Whether the tendency to act in a certain way is, or is not, the result of the habits formed by preceding generations, the instinct is certainly on the exact plan of the habitual action, and can be understood only by beginning with the latter and working down to the former. Yet the order in analysis is not necessarily the order in history, and we need assume nothing as to the mechanism and process in the development of the instinct. So far as any one knows, tendencies to think and feel may just as well be inborn as may tendencies to act, and hence we must be cautious in classifying any given act of the young animal as reflex, ideo-motor, or voluntary.

Habit is an enormous factor in our psycho-physical existence, and has received its due attention from the psychologists. But as yet no explanation has been found for the method of operation of habit. The building up of habit has been likened to the formation of channels by streams of water and to the wearing of paths by successive footsteps which erode the soil deeper and deeper. The laws of habit are sometimes stated in terms of "brain-paths," but we must remember that this form of statement is merely a carrying out of the analogy just mentioned, and means little in physiology. All we can do at present is to state the facts psychologically, and admitting that they have their physiological conditions, keep a sharp lookout for what may be discoverable concerning these conditions.

Note

The "motor tendency of thought" may be exhibited in the case of a normal subject by any of the usual means for recording "automatisms." For instance, have the subject's hand resting on a planchette, or, better still, on a glass plate resting on three steel balls which roll on a second plate, the upper plate having attached to it a pencil which bears upon a strip of paper. Have a screen so interposed that the subject cannot see his hands nor the pencil and paper. Let him see you trace a line on the wall in front of him, or hear you describe such a line verbally. In nearly every case the subject's hands will move, as shown by the pencil record, in a way corresponding to the line.

Buckle a strap around the subject's head (over the top of the head and under the chin), and fasten to the strap on top of the head a wooden point. Let the subject stand (with eyes closed) under a sheet of smoked paper supported at one edge and resting on the wooden point. Tell the subject to stand perfectly still, and mention to him interesting objects actually or suppositionally lying in certain directions from him, and he will be found to move in the designated direction, or the opposite, according to the nature of the object.

CHAPTER XVI

THE SELF, OR EMPIRICAL EGO

One of the most obvious distinctions in the content of experience is that between the self and the not-self; between the *me* and the remainder of the world. Several different distinctions have, however, been described in terms of self and not-self, and the terms are even at the present day used in a variety of significations. Sometimes the terms self and not-self have been applied to an assumed substantial soul, and the world of experience respectively; sometimes to "mind" and its contents; sometimes to the content of consciousness and an assumed external reality. We are referring here to none of those distinctions. For Psychology, the self and the not-self are both content: with a self and a not-self that are not content we have practically nothing to do, no matter what may be our articles of faith on the question of the reality of these.

We have found in the content nothing but sensations, relations, and feelings, and possibly images. If this is a complete list of the kinds of content, then the self or "me" is made up of these factors, or at least can be resolved by analysis into them. We cannot rigidly prove that there is not an objective self *sui generis* which pervades, accompanies, or is somehow experienced along with the general content. All that we really need to say is, that no one has been able to demonstrate such a factor in content. When you analyze, the self reduces to the forms of content we have described, and no residue can be detected. The self must then be described either as certain factors of content in combination; or as a certain form of combination of content, in simultaneity and succession; or as both. How large a part the form of combination of content plays in the self is a problem too difficult to be taken up here, and is not important for our purposes. Under any plan of description the self is wholly content.

The first elements we notice when we attend to the self and attempt to analyze it, are bodily sensations. Sensations of warmth, cold, and pressure from the surfaces, with sensations from the joints, muscles, and viscera; combine into a mass which is constantly present, even in the lighter phases of sleep. This mass is a part of the "me" in a profound sense. On the other hand, certain other sensations from the same organs are not fused with this mass, but stand off from it as something foreign. While we can make no very definite statement on this point, it is probable that anything which gives a sensation a distinctive position, as, for example, relatively high intensity, sharp spatial or temporal limits, or strong associative connection, tends to separate it from the vaguer mass which is at the foundation of the self.

The feelings are the constituents of the self which are next in importance to the sensations, and they are, apparently, without exception involved in the self. However you may feel—whatever feelings you may "have"—these feelings are a part of *you;* to name them is to describe in part the sort of self you are—or "have"—at that specific time. The emotions, which we have concluded are masses of unanalytically apprehended sensations and feelings, are necessarily also factors in the self. This fact was understood by various psychologizing philosophers long before the present theory of the emotions was elaborated. The emotions, they said, are modifications of the self, and hence of a different order from "perceptions" and "ideas."

The self, furthermore, contains all the other sensations (and relations) which make up the perceived human body. The visual and auditory "sensations of the body" are included without respect to their distinctness or sharp definition. The body, in short (as an experienced fact, not as a materialized supposition), is fundamentally the self. A striking demonstration of the truth of this statement is found in the uniformity with which all naturally developed religions which assume a persistence of the self after death ascribe to it a body of some sort.

Psychic individuality, or self-hood, means thus more than mere capacity for experience. It means the existence of a specific, although complex, content which is persistently present; which, although it changes its total character, changes slowly; and which hence is the standard against which all other content is measured. The self forms accordingly the basis for the perceived continuity of the ever-changing content. Its rhythmic variations with the solar day and the physiological condition serve as the clock of consciousness. When hungry, the idea of the normal steps for obtaining food are brought up through normal association. In the morning, the recurring associations with the morning state of the self bring up the proper ideas for that time of day almost unfailingly. The intricate system of associative nexus which bind past experiences together and make our relatively orderly mental life possible *might* be controlled in some other way, but as a matter of fact they *are* controlled by the particular associations of this bodily self with the other factors in the manifold.

The self is by no means exhausted by the body and the feelings. Many things to which the body stands in a particularly intimate relation are absorbed into the self. Family, business, and social relations, for example, tend to become relations *within* the self.

The mass of habitually experienced content is the self. "Thoughts" are in some respects more important than percepts. "As a man thinketh, so is he," is trite but largely true. The phases of personality which are essentially habitual ways of thinking, or habitual sorts of thought content, we usually designate by the term "character." But the habitual trains of thoughts are, as we know, determined to a large extent by the feelings, and not only by mere feelings, but by emotional complexes. So that in the healthy individual, self, including character, is a rather coherent mass of content.

In many cases an apparently normal individual possesses a double character. The church-going business man, on Sunday, for example, may really think admirable thoughts, which may be allowed to find expression in suitable action. On other days he thinks only of business, and his actions are quite at variance with his Sunday doings. It is quite probable that he builds up a double set of sensational selves, too, one of which is associated with each of the thought-complexes. The evidence for this assumption is found in the fact that his facial and bodily expressions change with his change of character, and give grounds for suspecting more profound organic modifications. Certainly, he has two sets of emotional habits. He really is not a hypocrite, in an ethical sense, but is a diseased person, a monster with two selves.

There are an indefinite number of possible principles of bifurcation of the self, and these bifurcations may be incipient or thorough-going, that is, they may affect only the habits of thought, or may affect the bodily sensations. A man may be pure-minded at certain times, and lewd at others; he may be a buoyant optimist and a downcast pessimist; and so on *ad infinitum*. And any of these divisions of character may by the gradual formation of associations become a cleavage affecting practically the whole personality. There may be three of these fractional personalities, or even more, in a given case.

It is probable that none of us are completely free from the taint of divided personality, but most of us need not fear any disastrous developments. The dangerous cases are those in which one side of the character has been long repressed, but is still smouldering. The individual, for instance, gives rein usually to the moral member of his team of selves, and allows the lewd character to express itself only at the infrequent times when he thinks he is safe from the observation of his associates. In this case, some change in the bodily condition, deeply stirring the whole self, gives the repressed self its chance, and flaring up, perhaps suddenly, it becomes dominant. In extreme cases the sets of ideas constituting the character side of the previously dominant self, and the other groups of ideas associated with these, are completely lost, and hence the patient not only evinces a seemingly new personality, but actually loses the memory of years of his life. These sudden changes are called *alterations of personality,* and in the cases where there is repeated change from one personality to the other or others, the terms *alternation of personality* and *alternating personality* are applied. These cases will be further discussed in Chapter XIX.

CHAPTER XVII

THE DEGREES OF CONSCIOUSNESS

1. Consciousness, Attention, and Vividness

Up to this point we have restricted our discussion as far as possible to the objects of which we are conscious and the behavior of these objects, that is to say, to the items and processes of content. Now we must undertake the seemingly impossible task of examining consciousness itself. How it is possible to examine consciousness, and in what consists the operation which we thus designate, are problems which are beyond the scope of the present undertaking. As a matter of fact we do study or discuss consciousness, whether directly or indirectly.

For practical reasons we have somewhat anticipated the discussion of kinds of consciousness, and have entertained the possibility of distinguishing two kinds; the consciousness of content "present" (intuition) and the consciousness of content not "present" (imagination). The fact that neither of these can exist separately, but that what we really find is consciousness of a content partly present and partly not present, is no obstacle to the analytical consideration of the two kinds, and establishes no presumption against the value of such consideration. The case is precisely the same as in the discussion of sensation as such. At the present time, however, there seems to be no practical advantage in the lengthy discussion of these or other hypothetical sorts of experience.

Consciousness varies in degree. One extreme of the range of variation is commonly known as a high degree of attention, or concentration of attention. The other extreme is inattention, to which the term subconsciousness is also applied. The general designation of attention is thus given only to the higher degrees of consciousness. If referred to the content, the degrees of consciousness are degrees of *vividness*, which is sometimes called *clearness*. Thus, to say that I attend to a sensation or percept is equivalent to saying that the sensation or percept is vivid. The content not attended to is non-vivid. In a somewhat better use of the term we speak of a high degree of vividness and a low degree of vividness in the two cases mentioned. Whether any content may properly be said to be not vivid at all is a matter which we will consider later.

The term attention properly signifies a condition or state of consciousness itself. Sometimes it is applied to a certain content as well. When I attend to a sound, I am conscious of an adjustment of head, and possibly of a change in the tension of the muscles of the middle ear. When I attend to a light, I am conscious of an adjustment of the internal and external muscles of the eye. In addition, in both cases, there are sensations of strain from the muscles of other parts of the body; the chest, the face, perhaps, also, the arms and legs. All these factors are sometimes included under the head of attention. Again, the motor adjustments as apprehended by another individual are referred to by the name attention. A dog, for example, is said to "attend" to an object when his sense-organs are so adjusted as to give him the best condition for stimulation by the object, although we make no assumptions as to the dog's consciousness. The student may later find it difficult to escape falling into confusion on account of the varying uses of the term by different authors.

The total content of consciousness at any given moment is conventionally spoken of as the "field of attention" or "field of consciousness." It is likened to the visual field, *i. e.*, to the mass of visual content "spread out" before the eye at any given time. This analogical treatment is quite defensible, since we may consider visual content as typical of all content. In this field of consciousness, as spatially analogized, we may represent the highest degrees of vividness at the centre, and the lesser degrees by zones at different distances therefrom. The centre of this conventionalized field is called the "focus," and the most remote portions are called the "fringe" of consciousness.

A question which naturally arises at this point is as to the number of discernible degrees of attention. Are there three degrees: a focus, a fringe, and an intermediate region? Or are there only two grades, focal and non-focal? or are there four, five, or more grades? This question may be left open for the present, as no adequate means of determining the number of degrees has yet been found.

2. Vividness and Intensity

Vividness is sometimes confused with intensity. Hence it is necessary to distinguish carefully between the two, as well as to consider their connections. Suppose you are talking to a friend, while a large clock is ticking loudly on the mantel. The clock, we will suppose, is in your range of vision, and the ticking is plainly audible, but neither is of much consequence in your total content until your friend remarks "what a curious old clock!" Immediately the clock (visual and auditory) becomes vivid, and the features and voice of the person become reduced in vividness. Has the intensity (loudness) of the ticking, or the brightness of the visual sensations increased? Not to any appreciable extent; neither has the loudness of the speaker's voice decreased, nor the intensity of the visual presentation of his features waned. The "focus of consciousness" has shifted, or rather, the impressions have shifted as regards the focus, but changes in intensity, if they occur, are purely accidental, and are due to such factors as change in position of the eyes, or in the tension of the ear-muscles. (We are not considering, of course, the possible actual changes in the physical intensity of the voice, or in the illumination of the room.)

Attempts have been made to determine the effects of vividness on intensity of sensation, with results which are seemingly contradictory, but really harmonious. The characteristic method of experiment is to find what intensity of a sensation of given quality will be judged equal to the intensity of a sensation of the same quality which immediately precedes or follows it, when the subject "gives full attention" to one of the pair, and is "distracted" somewhat from the other by accompanying sensations, or by performing mental labor, as adding or multiplying, or repeating verses. The other conditions are kept as constant as possible for both sensations.

Some experiments have apparently shown that a sensation to which full attention is given, is judged equal to a sensation which is less vivid, when the intensity of the more vivid sensation is slightly less than that of the less vivid one. Other experiments have shown, on the other hand, exactly the reverse. Hence we have had some experimenters claiming that attention to a sensation increased the intensity while others have claimed that the attention decreased the intensity.

As a matter of fact, these experiments have no bearing at all on the question of the relation of intensity and vividness. They simply bear on the judgment of relative intensity, which is a different matter. Similar results may be obtained in the case of judgment of size, as when two squares are compared; and in the case of judgments of quality.

That intensity affects vividness we cannot deny. A rapid change in the intensity of any sensation—either increase or decrease—tends to bring it to the focus of attention. Of several sensations or sensation-complexes, the most intense will probably have strongest claim on the attention, other things being equal. Other factors are, however, so much more important that little effect is produced by the mere intensity.

3. Factors Determining Vividness

A. Sensational Factors.—Intensity, we have just considered. Extensity and area may operate in the same way. The larger tends to obscure the smaller. Of two pictures hung on the wall, equally lighted, and not essentially different in coloring, character of subject, etc., the larger will get the attention first. Of two touches, two tones, two pains, similar statements may be made. Quality may have some influence. Red, for instance, may attract the attention more than blue. Visual sensations usually take precedence over auditory, and olfactory over both. All of these sensational factors are of slight importance as compared with the others mentioned below, and their effects may be due to the feeling factors which accompany them.

B. Affective Factors.—In the case of feelings, intensity is more important than in the case of sensations. The more intense feelings always have a great advantage in vividness. Perceptions and ideas attended by intense feeling are therefore usually found to be occupying the focus to the exclusion of complexes with weaker feeling-components, in accordance with the association factors mentioned below. Whether one sort of feeling is more effective than another in this way, we have no grounds for affirming or denying, since it is not possible to equate intensities of two sorts of feeling. We can decide that the pleasant feeling of one complex is approximately the same in intensity as the pleasant feeling of another, or at least not appreciably different, but comparison of pleasant feeling with unpleasant feeling in degree of intensity is definite only when one is noticed to be relatively much greater than the other.

C. Association Factors.—The whole matter of the rise of ideas through association is one of vividness. One percept or idea occupying the focus of consciousness tends to bring in its associates. If the primarily focal content forms with its associates what we call a single object, the associates are simply added to the focal content. If the associates, on the other hand, form objects distinct from the primary content, the latter drops out as one of the former comes in. The feelings associated with a certain percept or idea come under the first rule, hence the tendency above noted, for the content having the more intense feeling associated with it to gain the ascendency over the content with less intense feeling associates. The statement that two distinct objects are attended to successively applies only to the case where one of them occupies the focus before the other is called up through association. That two different objects may occupy the focus simultaneously under certain circumstances is perhaps true, but is to be considered later. It must be noted, however, that when several distinguishable objects form a functionally connected group, as a hunter and his prey, a church and the congregation, they may constitute at a given time a single co-ordinated content, although from other points of view they may constitute distinct, even conflicting, contents.

D. Relational Factors.—Relations determine vividness of related content, inasmuch as they form nexus among the factors of content. Nothing need here be added to the discussion of the function of relations in association. On the other hand, relations seem to have a distinct advantage in vividness over sensorial content. In a focal content the relations are usually the most vivid part. This is especially true of "thought." Our thinking constantly tends to be conceptual, rather than of the sensory-imaginative type. In actual perception the situation is often reversed, and the sensational factors are focal at the expense of the relational.

E. Other Factors.—Anything singled out, or specifically characterized objectively, is thus made liable to especial vividness. The first and last letters of a written word, a note or word marked by a preceding or succeeding pause, a trilled or syncopated note, a bit of color in the scenery unlike the surrounding hues, an element having a humorous significance or any other emotional coloring widely different from that of other elements—these receive especial attention. The list is indefinitely long.

4. Attention and Interest

Interest is sometimes named among the conditions of attention. That the feeling we have earlier referred to by the name of interest does predispose to vividness the content associated with it, is indisputable. The same is true of any emotion or emotional factor.

When, as is sometimes the case, attention is treated as exclusively a matter of interest, the term interest is not used to designate an affective content, but an abstract potentiality. Interest ascribed to any possible object means in this case the fact that when that content arises it will probably be vivid (*i. e.*, attended to), and that the probability of the rise of that content is relatively high. Interest is in this sense by no means a cause of attention, but a mere abstraction from the observed or probable course of attention-changes.

It is so easy to shade from one meaning of the term interest to another, that the student must be on the alert when following any exposition of the psychology of attention in which the term is given an important place, lest he be led to accept as analysis what is merely a confusion of thought.

5. Vividness and Practical Advantage

The greater efficiency of conceptual thought as compared with thought which depends more largely on the sensory image can hardly be disputed. By efficiency we mean here the celerity and accuracy with which a conscious result is obtained, as in solving a problem, or making a decision. Hence, the tendency to greater vividness of relations as compared with "imaged" sensations can be regarded as having arisen or having been conserved because practically advantageous. The same interpretation can be brought to bear on every general condition of vividness. The objects which are most intense and most strongly charged with feeling are the ones to which it is, in general, mentally advantageous to attend.

6. Judgment

The distinction between concept and judgment is entirely a matter of relative vividness among the factors of these complexes. If I have the concept of a horse, with a definite relation of horse to hay especially vivid, I have (psychologically) a judgment which I express (logically) by saying that the horse eats hay.

In general, a judgment involves two concepts; but again, in general, no concept stands alone. I cannot conceive a horse without several other subsidiary concepts entering into the content, and, in the judgment, one of the subsidiary concepts, with a definite system of relations linking it to the central concept, simply becomes more vivid.

From the preceding it ought to be plain that the function of the judgment is the growth of the concept. If the relation emphasized by the judgment is already a part of the concept, the judgment is *analytic*. For me to form the judgment which I express logically by the proposition, "Water lays dust," adds nothing of value to my mental content or functions. My concept of water already includes the relations to desiccated substances, which I call *wetness*. But when I first discovered that water can be produced by the union of two gases, the judgment constituted by my apprehension of that (to me) new relation of water was *synthetic*. It permanently modified the concept. Included in my concept of water from that time forth was that relational complex which I express when I say, "Water is composed of oxygen and hydrogen."

7. The Scope of Attention

How many things—how many functionally distinct factors in content—may be attended to at once? In general, only one, as you may verify introspectively by the aid of a little experimentation. Arrange several articles on a table in front of you, and if a clock is ticking, or a gas flame audibly roaring in the room, and if the finger is pressed firmly on some hard object—*e. g.*, the edge of a paper-cutter—you will have a sufficient range of objects. Attend to one of the content factors, and the others coincidently recede from the focus of consciousness. Seldom, if ever, can you succeed in retaining two of the objects at high vividness.

When an object—an ink-bottle, for instance—is low in vividness it may be rather uniformly vivid. But when the focus of attention shifts to the object it is apt to fall upon some limited feature. Thus, when attending to the ink-bottle, you will find that it is the top, or the bottom, or the cork, or the label, or the ink, or some such detail which is focal. The other portions of the bottle are less vivid. We may say in general that the content occupying the focus of attention is relatively simple. But, in a content which does at one time occupy the focus, we may later (in memory) discover many details. These details, in the later analysis, occupy the focus successively.

Several relations can be focal simultaneously only in so far as they join in a single concept. Two distinct concepts are probably never present at once, even in the formation of a judgment.

CHAPTER XVIII

THE TIME RELATIONS OF CONSCIOUSNESS

1. Presentation and Image

In earlier chapters we have concluded that what is commonly known as the image is not different in kind from sensation, but that the difference is in the way of being conscious. The difference, in short, is in the time factor. If we are now conscious of what is now here, the content is called sensation; if we are now conscious of what was formerly here, the content is called image. The time factor needs somewhat further elaboration.

There are two distinct temporal phases of a presentation, which may be provisionally distinguished by reference to the assumed cortical process. The presentation does not cease when the cerebral process ceases. We may call the phase of sensation in which the cortical process is active the primary phase, and the phase after the practical cessation of the cortical process the secondary phase. This secondary phase of the presentation is distinct from the image.

If we observe a regular series of brief visual or auditory sensations—clicks of a telegraph sounder, or flashes of light—we find that they may be so arranged that the successive sensations do not fuse; each is separate and distinct from the preceding and succeeding ones; but several may be simultaneously present to consciousness. If four successive sounds, for example, are given in one second, they may be apprehended simultaneously, although not as simultaneous. You may easily demonstrate this, employing taps of your finger or pencil on the table. When the fourth tap is in its primary phase, the preceding three must be in their secondary phases. If they were yet in the primary phase, the four would fuse into one continuous sound. Compare the four just when the fourth arises with the same four a few moments later (as memory images), and you note the difference at once. As apprehended simultaneously, they are *sensations* and not *images*.

This peculiarity of sensations is of great importance in practical life—as, for example, in "taking" telegraphic messages, where the operator is conscious of a sequence of dots and dashes as a whole, instead of having to carry the first part of a letter in memory until the last arrives. In spoken and written language, too, this power of consciousness is of enormous importance. If you were listening to the preceding sentence you would not have to understand "enormous" and carry it over in memory to modify "importance"; you would grasp the two literally together with a vast saving of mental process. In addition to the practical consequences of the secondary phase of sensation we find an important æsthetic factor in rhythm, which is made possible by it, and to the discussion of which we shall proceed in a moment.

This apprehension, simultaneously, of factors which are apprehended as non-simultaneous, is described by the term, "the specious present." The present moment, referred to content alone, stands as a mere inextended point dividing the past from the future. Since mathematics and logic must regard time altogether from the point of view of content, we have come to regard this as the *real* present. Hence, the term "specious present" (apparent or seeming present) applied to the present of consciousness.[1] But this "specious" pres-

[1] This explanation of the term "specious" as applied to the present is in strict accordance with the intention of Mr. E. R. Clay, who first used the term. *Cf.* James, *Principles of Psychology*, vol. I, pp. 606 *ff*. Other explanations (as that of the Century Dictionary) are obviously erroneous.

ent is just as "real" as the other, and there is absolutely no confusion between the two presents. Because I apprehend the successive terms A, B, C, D simultaneously, I do not necessarily apprehend them as simultaneous.

2. Rhythm

A fairly regular sequence of stimulations—clicks, taps on the skin, flashes of light, etc.—does not usually give rise to a uniformly progressing series of sensations. The greater part of our sensations belong in definite groups, as in the case of words of language, and the grouping habit is so thoroughly ingrained in us that we group objects which have no intrinsic demands for such treatment.

Suppose we allow water to drip slowly from a small tank onto a tin plate, producing thus a distinct noise for each drop. Let the rate of flow—*i. e.*, the rapidity of the succession of drops, be controllable. Suppose at first we choose a rate of between two and four drops a second. In listening to the perfectly uniform series of sounds thus produced, you will find that very seldom does it proceed monotonously. In most cases the sounds are automatically grouped in twos, threes, fours, or sixes. The exact numerical size of the group will depend on the rate, the intensity, the listener, and on suggestions he may get from other processes he is experiencing or has experienced; as the "clickety-click" of the street-car which passed the building a moment or two before.

The listener can easily give himself suggestions as to the grouping. If he thinks of hearing a "three-group" the drops will usually organize themselves in that form. The chief limitation is that the groups will in general not extend over two or three seconds, although occasionally larger groups are formed. This temporal limit seems to be the *span of consciousness,* or the limit of the "specious present." Another limitation is in the number of the sensations; too many in a specious present give rise to confusion and abolish regular grouping.

If the terms of the series are absolutely uniform in the case of the water-drops, and if the degree of attention is fairly constant, the grouping depends altogether on the time relations of secondary phases of the sensations. When the final term of a group arises the foregoing terms of that group are still present; with the arrival of the first term of the next group the group just completed disappear from consciousness as presentations—the slate is washed, as it were. This sort of a rhythm is apparently due to the periodic contraction of the specious present, occurring at the beginning of each group.

In many cases attention is not uniform. The drops may be heard in groups of four, for example, and the vividness of the first drop may be higher than that of the succeeding three. This is "subjective accent" properly so called.

The rhythm is much more distinctly and readily developed if "objective accent" is permitted. If, for example, by holding the finger on the tin plate on which the drop falls during the time of three drops, and lifting it for the fourth, the intensity of the fourth drop is made relatively higher than that of the others, the drops will tend to fall into groups of fours, the accented drop usually being the first of each four. Various devices are employed for producing series of auditory, visual, and tactual sensations, and if these devices are so manipulated that periodic variations in intensity, extensity, duration, quality, or local sign are introduced, these variations serve as accents to determine the grouping. Periodic variations of the time relation of the stimuli may also produce the same effect.

With objective accent the periodic shrinking of the specious present takes place just as when there is no objective accent; and the groups are usually eliminated as wholes. If the groups are very short two or even three groups may be eliminated simultaneously, the contraction of the specious present taking place with every second or third group.

An important source of objective accent is found in muscular sensation. Very often, when there seems to be a purely subjective accent, it will be found that the stimulations are accompanied by slight muscular contractions in finger, arm, throat, chest, or elsewhere, and these are accented by variations in intensity, so that the grouping of the externally presented sensation is really directed by the accenting of the muscular sensations. It is possible that pure subjective grouping is a very rare occurrence.

Rhythm is important in music and in poetry, especially in the former; the span of consciousness demanded by the rhythmic groups has a large share in the determining of the emotional character of the composition. A short musical unit tends to light, vivacious, or joyful effects, irrespective of the rapidity of succession of notes, or of the melodic intervals employed. A unit which "draws out" the specious present slightly beyond the normal length produces a sombre effect. A still longer unit, which is divided between two not long spans of consciousness, gives an effect which is solemn, but not sad. Specific effects are produced by units of such length that two occupy a long span or a short span. All these effects are modified—sometimes counteracted—by the other musical factors introduced by the composer. In music of the so-called "intellectual" sort there is no regular relation between the musical unit and the span of consciousness; the unity here is intentionally ideational and does not appeal to the average hearer, who is baffled in his natural attempts to fit musical unit to specious present, and only by repeated experience acquires the other method of appreciation.

3. Duration of Attention to Continuously Presented Sensation

The rhythmic variation of the span of consciousness which we have just discussed has to do only with sensations of an intermittent nature. We must now consider cases where the stimulus is continuous and, hence, the sensation is continuously presented. Such a case is afforded by the note of a steadily vibrating tuning-fork, or the noise of a small stream of water.

In most cases these continuous noises, if rather loud, persist in the focus of consciousness for some time; perhaps for minutes, perhaps for hours. After awhile, however, the sound may become marginal. The duration of a continuously presented sensation or sensational complex in focal consciousness depends on the rise of other sensations or ideas which may take its place. If you sit beside a water-fall with your mind at rest, the purl of the water may continue vivid for hours, or if temporarily obscured by the other presentations of nature or by fleeting ideas, returns quickly to its place. But, if you have a problem to solve, a book to read, a friend to talk with, or a hill-side to watch for game, the water-fall quickly becomes an inconspicuous factor in the total field of consciousness. So it is with all other presentations. The intense stimulus may force the sensation into the focus for awhile, but finally the mere intensity becomes ineffective.

The effect of habituation in eliminating the persistent sensation from attentive consciousness may be illustrated in a great many ways. The noise of the street which annoys the countryman staying at your house is practically unnoticed by you; yet the ear does not lose its sensitiveness to the noise as does the nose to a continuing odor. During the greater part of the day you hardly notice the sensations aroused by the rubbing of your clothing on your skin; to a savage first clothed the sensations are intolerable. The lights of the lamps and windows on the street at night you scarcely notice at all; your rural friend is so attentive to them that he can hardly converse with you. We find, in general, in addition to the physiological adaptation which protects us from continued stimulation, a sort of protective adaptation of consciousness itself by which the persistent sensations not eliminated by physiological adaptation are relegated to the marginal consciousness, unless they exercise solicitations other than those of mere intensity.

The relegation of intense sensations to marginal consciousness through habituation is realized also in case of sensations not continuous, but which are repeated at frequent intervals. The train rushing by every half-hour; the clock striking every hour; even a church-bell ringing at morning, noon, and night; soon becomes without power to disturb the focus. If the interval between stimulations is long this habituation does not occur. Thus, a church-bell ringing only on Sunday mornings may be as vivid at the end of a year's disturbance thereby as at the beginning.

4. The Fluctuations of Minimal Sensations

Sensations of uniform minimal intensity show a peculiar intermittence in presentation, to which is commonly applied the confusing name "fluctuations of attention." If one attempts to listen to a sound, for instance, which is physically constant and just above the threshold, he finds that the sound is clearly discernible for short periods and in intervening periods is not to be heard at all. The times of absence and presence may vary from a fraction of a second to over ten seconds. Faint sensations of certain other modes behave in the same way. A small gray spot on a background slightly darker, for example, will appear and disappear periodically under the best obtainable conditions of attention and accommodation.

It has been supposed that these fluctuations are due to varying states of muscular adjustment in the end-organs, and, in fact, slight changes in accommodation have been found to accompany the visual fluctuations. This theory is excluded by experiments which absolutely preclude any adjustmental variation and which yet find fluctuations occurring. The theory which is most probable assumes the physiological cause to be a periodic variation in the functioning of the nervous mechanism; either of the nerve terminals of the end-organ or of the cortical cells. The variation, if it occurs, is very slight, for no periodic increase or decrease in intensity of a sensation from a physically constant stimulus continuously above the threshold is discernible.[1]

The phenomena in question are therefore not "fluctuations of attention" in a sense in which that expression would naturally be taken. If the attention does actually shift from a sensation under observation, the disappearance of the sensation cannot be noted unless the disappearance comes before the shift or after the attention returns. Yet the fluctuations are, in another sense, those of "attention," for the essential condition of the experiment is that the attention shall be to the image of the presentation in the intervals when the sensation is not intuited.

The difficulty of distinguishing between the sensation and the image in the case where the stimulation is minimal enormously complicates observation. In certain cases the observer is unable to distinguish at all, as is shown by his continuing to report the sensation long after the stimulus has been suspended completely but gradually. In such

[1] This is true for auditory sensations, at least.

cases the characteristic fluctuation cannot be obtained; the sensation seems either present all the time or absent all the time.

5. The Selective Fluctuations of Vividness

When several complexes are presented they are apt to occupy the focus alternately. As I gaze at the desk before me my attention is centred now on the ink-bottle, now on the pile of books, now on the ink-bottle again, now on the drop-light, now on the stack of letters. Even when I attempt to attend continuously to the ink-bottle I find that I am attending to it only for short periods, the focus being occupied by various other things in the intervals. Not visual presentations alone jostle the presentation of the ink-bottle. Auditory, tactual, olfactory, and organic presentations take their turn. Ideas also flip in and out to the detriment of my study of the ink-receptacle.

This periodicity of focal consciousness is one of its most uniform characteristics. In general, we can attend to anything only by a succession of short periods. This holds for ideas, of course. Try to think of any one thing and see how intermittently you succeed.

Many striking illustrations of the selective fluctuations of attention are easily available. Retinal rivalry is one such. Place in a stereoscope two simple pictures which are radically different; a number of concentric circles in one, and a number of parallel lines in the other; or two large letters, or two fields of different colors. On looking through the stereoscope in the usual way—one eye seeing each card—it will be found that the two figures or two colors are seen alternately. Sometimes both of two colors will be seen, but in different parts of the field, or parts of both diagrams will be seen simultaneously.[1]

The "stair-case figure," "tumbling block figure," and other illusions of "reversible perspective" are also illustrations of fluctuations of attention. These are simple figures so drawn that the space relations are ambiguous. Thus, in Figure 13, the skeleton chair may be seen either facing you or facing away

[1] If the two pictures are so arranged that no detail of one occupies a retinal point corresponding to a point of the other eye, occupied by a detail of the other picture, the two may combine. Thus, if a figure before one eye has an open space in the centre, and a smaller figure be presented to the retinal area of the other eye corresponding to this space, the figures may be seen combined. Some observers report binocular color combinations; red presented to one eye, and blue to the other, giving purple, etc. But this observation may for the present be doubted. Complementary colors will give gray, because adaptation to the two takes place rapidly.

from you. After seeing it both ways it is practically impossible to see it either way continuously. Attempts have been made to connect these changes with eye-movements, or spatial shifts of attention, *i. e.*, from one point of the figure to another. At certain times the chair will face you while you at-

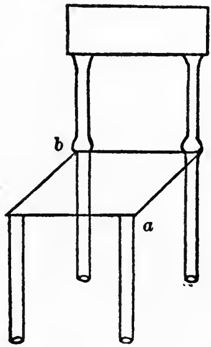


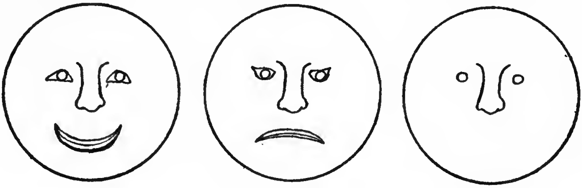
FIG. 13.

tend to the corner at *a*, and reverse its position when your attention shifts to *b*. This is as if the point fixated tends to become the *near* point. But the same shift of perspective may be produced with the opposite shift of attention; all depends on which habit is formed. In general, any such objective way of determining a shift of the perspective operates through association. You expect to see the figure in a certain position when a certain change is made, or you have uniformly observed it in a certain position with a certain direction of attention. Hence, the result.

The percept based on the lines of the reversible perspective figure is largely reproduced. The simple lines of figure 13, for example, are associated with other features of chairs in both positions equally well. We have, therefore, a selective fluctuation of the two reproduced factors, first, one uniting with the presented content, and then the other taking its place. The exact moment of the transformation may be determined by such factors as shift of eye in any direction, provided the shift has become associated with that particular change.

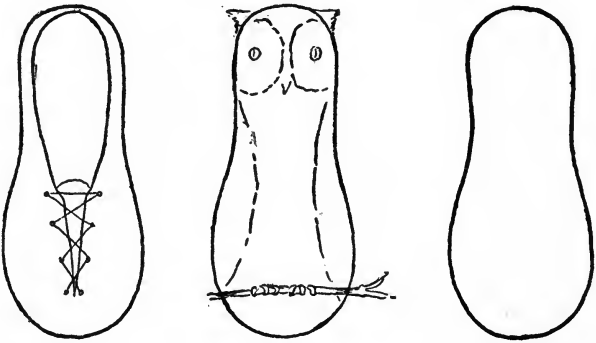
Figures 14 and 15 show a sort of fluctuation akin to that of the reversible perspective figures. After looking carefully at *a* and *b* (of either figure), *c* alone will probably be seen alternately with the aspect of *a* and *b*.

Fluctuations of perception based on ambiguous impressions of senses other than visual might be produced. These ambiguous impressions are, however, not so simply obtainable in the other sense-realms. One experiment may be made in the following way: Obtain a revolver with round barrel and a bottle having a neck of the same diameter and thickness as the muzzle of the revolver. Press the muzzle of the revolver and the mouth of the bottle alternately on the temple of the subject (first



a b c

FIG. 14.



a b c

FIG. 15.

removing the cylinder of the revolver!), allowing the subject to see the object each time. Then, with the subject's eyes closed, press either one against the temple and *in many cases* he will perceive the ring of pressure and temperature sensations alternately as the pistol and as the bottle.

6. The Conditions of Constant Attention

Constant attention to one object in a normal condition means one of two things: either the object is intermittently in the focus or else the object involves several discriminable details which occupy the focus alternately or in succession. To attend in actual continuity to a bare sound or color, even to one of considerable intensity, is impossible. But the sensation may persistently return to the focus after each ousting, and the results be practically the same as if it had occupied the focus continuously. In the case of a more complex object, as the ink-bottle on your table, you find, as we already have noted, your attention shifting from feature to feature.

The strongest determinant of persisting recurrence is emotional coloring. That which you desire or hate or love, etc., dwells long (with due regard to the principle of intermittence) in the focus of attention. The naturalist may observe for hours a certain small animal because he has a strong emotional interest in it and in its relation to certain other animals. His attention courses rapidly over a great many details, and many factors related to it, but comes back again and again to the same features.

It may be asked, "Why does not the boy continue to attend to his Latin lesson, since he hates it?" The answer is that he really does not hate it: it has not even that vital emotional interest for him. It deadens his emotions in so far as he attends to it, and, hence, he does not attend, except as far as the fear of consequences or desire of reward, or pride, or some other emotional state may supply the necessary coloring. Give the boy something he hates—a boy rival, a hysterical teacher—and he will attend to that object with ease and persistence.

CHAPTER XIX

THE SUBCONSCIOUS

1. The Lower Limit of Vividness

A SENSATIONAL object may be reduced enormously in vividness by the change which we describe as passing from the focus into median consciousness, and yet the intensity of the sensation be little, if any, reduced. This fact suggests the question how far this reduction of vividness may be carried. There are two forms of this question: (1) May a sensation of zero vividness exist? A sensation of zero vividness would be one of which no person is conscious at all. This question is strictly metaphysical, and although it is possibly the most fundamental of all the questions concerning consciousness, we cannot consider it here. (2) May a sensation be so reduced in vividness that analytic consciousness of it is impossible? An affirmative answer to this question would involve the admission that there might be consciousness of the given sensation in a complex of which it is a part, although the sensation is not capable of being singled out therefrom. There can be no doubt as to the existence of sensational objects in this condition, and it is to this condition that the term "subconscious" is properly applied. The term "subconscious" has been much misused of late by quasi-psychologists and by physicians, and it has been made to cover a multitude of bizarre and absurd theories; hence, the conception of a psychological subconsciousness needs our careful consideration.

2. What the Subconscious is Not

Popular writers tend to confuse the subconscious with the conditions of automatic and reflex movements. Because a complex action, such as walking or knitting, is learned through consciousness of the details of the action, and is later performed without consciousness of these details, the details, it is said, have been turned over to the "subconscious." Of course this is true if by subconsciousness we mean simply that which is below the level of consciousness, and certainly these details are taken care of by physiological mechanisms which do not require consciousness to direct them. The authors to whom we refer really mean more than this, and conceive of a lower level of consciousness attending to the whole mass of such automatic actions. There have not been lacking enthusiasts who have considered digestive functions and the growing of the nails as supervised by this subsidiary consciousness.

Another misuse of the concept of subconsciousness is to consider it as the repository of forgotten ideas. The remarkable fact that something which has not returned to consciousness for a long time—some incident of childhood, for example—may at any time come back, has led the wilder theorizers to suppose that all content is contained in the "mind" in very much the same form in which it was originally in consciousness. The normal consciousness, they say, includes but a small part of the total field. The vast remainder is in subconsciousness. Recollection is, accordingly, only the movement of an idea from subconsciousness into consciousness. The idea existed in your mind during the interval when it was forgotten.

It is absolutely necessary for the student to rid himself of all such fantastical notions. Content forgotten is in general not in any sort of consciousness, although it may have its effects in present consciousness. The learning of motor-adjustments is the process of turning those adjustments over to mechanisms which need no conscious supervision.

3. The Two Sorts of Marginal Consciousness

As I sit here writing I do not consciously hear the ticking of the clock. Yet, if the clock should stop I would be aware of the stopping. I may be so absorbed in my task that if the clock strikes I do not notice it at the time. But several minutes later I may recall the striking and in memory count the strokes.

We are constantly subjected to stimuli of all sorts which give rise to sensations, but these sensations do not rise to any considerable degree of vividness. In the vast majority of cases these sensations and sensation-complexes cannot be recalled or remembered unless unusual means are employed. Normal recall, as we have explained, depends principally on association, and association depends on vividness. Various means for the recall of what was perceived marginally or subconsciously may be employed. For example, the subject may be hypnotized, and, when questioned in that state, may give evidence of the recall of percepts which he did not notice at all. The subconscious percepts may be obtained, in the first place, by calling his attention strongly to some visual object to which he turns the line of regard, and simultaneously displaying some object in peripheral vision. In the hypnotic state the subject may describe the object which he did not know that he saw. The theorists have explained this by saying that by hypnosis the subconscious part of the mind is made conscious. This really amounts to saying that we don't know as yet how the phenomena are produced. The recall of subconsciously perceived objects may occur in a reverie or in the pathological state of "crystal gazing." In the latter state the subject, thrown into a state of light hypnosis by gazing fixedly into a crystal sphere or a bowl of water held close to the eyes, obtains visual hallucinations in which former percepts, subconsciously perceived, appear. Another aid to the recall of subconsciously perceived objects consists in showing the subject a part of the former object, which may recall the remainder of the details, since association of a certain strength is established even at the low vividness of the subconsciously perceived object.

In none of these cases is it necessary to assume a subdepartment of consciousness in which the percepts are held over between the original perception and the recall. The contents are perceived, disappear, and are recalled just like any percepts, except for the fact that the low vividness of the perception makes recall difficult.

The effect of the subconscious perception may be demonstrated, even when recall is impossible. If you present to a subject a number of cards containing simple marks or designs, some of which he has previously seen subconsciously, and if you ask him to choose several from the number, he will be apt to choose the ones which were previously seen. The above are typical experimental procedures for demonstrating the existence of subconscious perception.

The second sort of marginal consciousness is rather hypothetical. If it exists, it is the content produced by stimulation which is so low in intensity that it cannot be vivid even under the best normal conditions. A sound, for instance, may be so weak physically that it cannot be perceived, although the air-waves are actually causing nerve-excitation in the ear. This is shown by the fact that the sudden stoppage of a very weak (physical) tone may be clearly perceived, even though the tone itself may have been imperceptible. It may be said that the tone was in marginal consciousness, or subconsciousness, and this view is supported by the introspection of the persons taking part in such experiments. What is heard at the moment of the interruption of a stimulus is described as the *cessation* of a tone, and not simply some disturbance which might be taken to mean the cutting off of the stimulus. The interpretation of these phenomena and similar phenomena in other sense-realms is beset with difficulties; neither the arguments for the subconscious explanation nor the objections to it are very weighty. Hence, the matter is best regarded as a problem for experimentation rather than for theorizing.

4. Multiple Personality

The strongest impulse to postulate a subconsciousness of the sort we are unwilling to admit comes from certain phenomena of abnormal psychology which are known as "alternations of personality" or "multiple personality." In some cases a patient may suddenly forget the events of his past life and lose the habits and traits of character which previously have distinguished him. He becomes by this rapid transformation a man of an entirely different sort; he may call himself by another name; we may say he has a new personality. The patient may continue for months in his new life, and then suddenly his former memories may return, and with their return the memory of the intervening months be lost. He returns to the first personality and knows nothing of the second. After a longer or shorter time the patient may relapse into the second personality, remember now all that occurred when he had this personality, and forget both periods of the first. The two personalities may continue to alternate, or, in other words, the person may continue to alternate between the two conditions. There may be three or more distinct personalities involved and the conditions in regard to memory may be much more complicated than in the case which we have just described. The patient, for example, when he has personality No. 1 may know nothing of what has occurred when he had either of the other personalities. But when he has personality No. 3 he may remember perfectly all that happened while he was in the other two states. He may insist that the experiences in states 1 and 2 were not his experiences, but were the experiences of some other person.

If we conclude, as some psychologists have done, that the different abnormal personalities exist simultaneously, and that sometimes one, sometimes another, gets the upper hand, forcing the experiences, memories, and processes forming the others out of consciousness, either as subconscious or co-conscious states, the statement of the case from the point of view of pathology and therapeutics is simple. The personality of the individual apparently has lost its organic unity, and has fallen into two or more fragments which are loosely connected with each other. If by the use of proper means (as, *e. g.*, hypnosis) the fragments of the personality are reunited, the patient is cured. But the hypothesis of co-consciousness gives us no real information as to the actual significance of the patient's symptoms, nor as to the actual processes involved in the removal of the symptoms.

The acceptance of the subconscious or co-conscious explanation of alternating personality would logically involve the acceptance of the same explanation for the forgotten ideas of normal life. On the other hand, we can state the facts of the aberrations of memory in pathological cases without involving the hypothesis of the unknown, just as easily as we can state the conditions in normal cases. In neither the pathological nor the normal cases is it necessary to assume that forgotten ideas are carried along in a co-consciousness during the period in which they are not remembered.

As for the non-ideational factors involved in personality—habits of action and emotion—the assumption of a co-consciousness adds nothing to the explanation of their appearance and disappearance. To say that a man has a certain habit of speech, for example, means simply that, as a matter of fact, his vocal organs move in a certain way. If the vocal organs cease to function in the way indicated, and function in a different manner, the habit has become non-existent. It cannot coexist with the new habit, although the nervous mechanism may not be so completely modified that it will not eventually return to its earlier condition and reinstate the old habit.

It is true that a large part of habit is ideational; the bodily functions are influenced by the processes in representative consciousness. But an emphasis on this aspect of habit simply brings us back to the first problem: how to account for the ideas which were in consciousness and may be in consciousness again, but are out of consciousness at present.

We are justified in concluding that the assumption of a detached subconsciousness or co-consciousness to explain the phenomena of alternating personality is not at present defensible, since the ideational problems involved in these phenomena are quite like those involved in all mental life, and the problems of neural disposition and modification are not affected in any way by the hypothesis of co-consciousness.

CHAPTER XX

THE EGO

EXPERIENCE cannot be completely accounted for in terms of bare consciousness and the content alone. Experience of any content intrinsically implies something experiencing that content. The immediate fact of one's own consciousness is always something which may be expressed by the words, "I perceive," "I feel," "I imagine," etc. The "I," or real Ego, which is the essential centre of reference for the whole of the content of consciousness, is not itself a fact of content, and hence is not a feature of psychological analysis: it is the one thing which, as the subject, stands over against the whole of objectivity, and hence, while not discovered by any analysis, it is involved, not only in every attempt at analysis, but in every bit of experience.

The celebrated formula of Descartes, *Je pense, donc je suis,* expresses what is immediately given as a fact of experience. *Thinking,* in the Cartesian terminology, is exactly synonymous with *being conscious* in ours. What Descartes says is that consciousness is intrinsically something which concerns an "I" or "Ego": that there is no such thing as impersonal experience. So far we must agree with Descartes; but he follows this statement of inevitable introspection with the assumption that the "I" is a thinking *substance*, and in this step we cannot follow.

The "I" is not anything which can be defined in terms of objectivity—as the metaphysical *substance* is necessarily defined. It is the pure subject, which is uniquely and antithetically removed from all objectivity, and which is yet involved in all reference to objectivity.

Any attempt at the discussion of the "I" involves us in a maze of paradoxes. The "I" cannot be discussed, because it is actually non-objective. It has no qualities: and yet this very statement is a quasi-qualitative ascription. The only unambiguous statement we can make concerning it is that "I experience" or "I am conscious."

There is a method of explaining away the "I" sometimes adopted by psychologists, which consists in assuming that content experiences itself. Thus, one "state of consciousness" (using this term as synonymous with the term "content") is assumed to experience the state which just precedes it in time: or, one group of content factors is assumed to experience the remainder of the factors in any given content. The subject, in accordance with this theory, is identified with one portion of the content, and the other portions of content are described as the apprehended objects. There are several other forms of the content-subject hypothesis. One form of the hypothesis does not suppose a definite part of the content functioning at a given time as the subject, but simply assumes in a more vague way that the varying details of the content which is present at a given moment are present by virtue of being in a definite sort of mutual relationship. This relationship constitutes at once the consciousness and subjectivity: it is subjectivity without a subject.

These views assume at once more and less than experience gives us. They assume, in the first place, a relationship in content which we cannot find there. That I experience a certain red may be defined as a relation between red and the other factors of content, and we do actually experience relations in this connection; but the relations we find in the content are all relations which determine the red as it is experienced, and are none of them, severally or together, identifiable as the experience. On the other hand, these theories simply ignore the fact that in searching the content for any sort of relations we are assuming a point of view totally outside the content from which to make the inspection. This omission is much the same as that which is made by those philosophers who claim that the universe is just one substance, which, looked at in one way is called matter, and looked at in another way is called mind. They fail to see that the point of view from which the one substance is looked at, now this way and now that, is something assumed in addition to the one substance; if substance is strictly one, and if there is nothing else, it can look at itself from only its own single point of view. When we try to make consciousness depend on content alone we are neglecting the fact that we are now representing consciousness from an outside point of view and have not given a fair account of consciousness till we indicate how we got to this point. If we represent this consciousness in any sort of symbolic way, as we may represent content, it is *ipso facto* not adequate, because we still are assuming a consciousness of the symbolization without which it is impossible.

We are obliged to assume, then, a point of view or point of reference over against content; perhaps the "transcendental unity of apperception" of

Kant; and it is just the orientation to this point of view which constitutes consciousness. It, of course, cannot be symbolized or described, because as soon as it is described it becomes no longer the point of view to which the consciousness refers.

We speak of this transcendental point of view as "I." The "I," if we accept the fact of it, must not be supposed to be active. Activity of any sort is an objective fact and is in the objective world. The "I" is the pure subject and is incapable of anything except being a subject.

It may be asked, of what use is it to suppose the "I," which has no qualities, cannot be analyzed or scrutinized, and can do nothing; and, also, if it is not describable or scrutinizable, how can we know it is there. The answer to both questions is, that the "I" is of no use, but that our analysis of the content of consciousness presupposes it, and hence we admit it. We do not observe the Ego, but it is involved essentially in every observation. It is really the only thing that observes or is conscious: hence, it has immediate claim to existence.

The view outlined above is believed to be that from which a satisfactory and adequate account of consciousness can be given. It is a view which is much older than modern civilization, but fits in as acceptably with scientific psychology as with ancient philosophy and religion. It is the only view which completely justifies the universal practice of modern psychology in leaving the "I," or Ego, out of its analysis; for if the Ego were not transcendental it would have to be treated analytically in psychology, instead of being merely assumed. Being transcendental, the Ego has practically no interest for psychology or science.

Modern psychology is truly said to be psychology without a soul, but if the transcendental point of reference or subject is what is meant by the term soul, psychology not only does not deny the soul, but positively affirms it. We must, however, bear in mind the fact not only that we can know nothing about the Ego, but that there is nothing to be known about it.

CHAPTER XXI

THE OCCULT

1. The Study of the Occult

In discussing the transcendental Ego we were upon dangerous ground. So much bias exists among those persons whose fields run into that of psychology that it is impossible to make any statement, however judicious, concerning the Ego without incurring the antagonism or contempt of some of these individuals. The same conditions surround us in the discussion of the occult. It is quite noticeable that writers who have expressed opinions on this subject have met with a great deal more than intellectual dissent from their opinions. Especially unpleasant has been the position of those who have agreed with none of the extreme views on psychic research, and in consequence have been denounced from all sides. This explanation is necessary in order that the student may know that what is set down in this chapter is not apt to be approved by even a considerable minority of reputable scientists, to say nothing of the vast company of fanatics.

Just what is here meant by the occult, the reader will gather as he proceeds. The things treated under this heading are properly the subject-matter of what is called psychic research, but in one way or another are also interesting and important for psychology. Psychic research is at present in disrepute among scholars, largely because psychic researchers do not take a logical psychological attitude toward the phenomena they investigate. Psychic research, the investigation of phenomena which are alleged to be not in accordance with accepted views of natural law, is a perfectly legitimate activity. Its purpose is two-fold: first, to accumulate data for psychological study; and second, to rout rascals and to dispel popular superstition.

2. Telepathy

It is popularly believed that the thoughts of one person may directly influence those of another. This belief is somewhat akin to the ancient superstition that the eye of one person is able to affect another person. Vision is sometimes called touch at a distance, and it is hard for the savage (and philosophical savages are still extant) to believe that when his eye rests upon another person or object something does not go out from his visual organ to take in the percept of the other, much as his finger would be stretched out to get a tactual impression. From this naïve conception of the physics of vision the belief in the evil eye probably arises, and from it comes also the harmless superstition of the present day, that one person can attract the attention of another by gazing intently at the back of his head. It is possible that the fully developed eye-power superstition involves the alleged phenomena or thought-transference, as well as the supposed power of the eye itself. Telepathy, which is believed in by many persons at the present time, is the (alleged) effect produced on the consciousness of one person by the mental operations of another.

As a matter of fact, we have been able to discover no communication between persons except that which takes place through what we call the physical world. I may have the sensation which you have if I am subjected to the same stimulus. I may think of the object of which you are thinking if some common perception is associated with the object in each of us. By a perfectly definite chain of association two or more persons often arrive with approximate simultaneity at the thought of something which has not been directly mentioned. If, however, one person thinks of a certain object *because* another thinks thereof, the thought of the second person must have expressed itself in some objective sign which was perceived by the first person, and which aroused the thought of the given object by normal association.

Certain interesting phenomena which are commonly designated by the term "mind-reading" offer confirmation of this conclusion. Mind-reading is frequently undertaken as a parlor amusement, and some of the most striking results are obtained by amateurs. A subject may be sent from the room while the remainder of the company decide on some act he is to perform on returning. The subject is brought in by two of the company acting as guides, usually with their hands on the shoulders of the subject. All the company think intensely of the appointed action, and the subject in many cases proceeds to perform it, after more or less delay.

Variations may be introduced into such an experiment which prove that the subject perceives (usually marginally) slight pressure sensations from the hands of the guides, which, by association, bring up the idea upon which the designated action follows. As might be suspected, the experiment succeeds best when the subject is convinced that he is receiving mental influence, and fails when he attempts to interpret pressure sensations consciously. Not all persons succeed as subjects; a condition of mental equilibrium is required in which slight associations may be effective; a condition not easily obtained by every one.

Sometimes the mind-reading succeeds when there is no contact between the subject and any one else. Such cases are very few, the professional demonstrations being pure humbug. In the few cases that are genuine, the subject is able to interpret changes in the breathing of the company as signs that he is starting to do the right or wrong thing, or else is guided by faint sounds made by the vocal organs of those thinking of what he is to do. The majority of adults partially articulate words in thinking, and this slight vocal action occasions air-waves which may affect the ears of the subject, and thus produce the effects subconsciously. If the subject be blindfolded and have the ears stopped (a difficult condition to obtain, by the way), mind-reading without contact will in no case succeed.

There is a wide-spread belief that in hypnosis the patient is responsive to the thoughts of the hypnotizer. The phenomena of hypnotism are sometimes described in terms of the influence of one mind on another, but this influence is always produced in the normal way—by physical signs. The hypnotizer may think as much and as intensely as he pleases, and the patient will not fathom his intention unless he gains some inkling of the thought by visual, auditory, or other sensations. In certain cases the hypnotized patient may interpret signs more readily than does the normal subject, but such is not always the case. The exact nature of the hypnotic state is not yet clearly understood. The ideas suggested by the hypnotizer occupy the patient's mind, driving out any which are conceptually incompatible with them, and, if they are ideas of action, the actions follow mechanically according to what we would expect under the principle of ideomotor activity when all checks and inhibitions are removed. This description of the hypnotic state does not explain it.

3. Mysticism

Closely related to the theory of telepathy is the doctrine of mystic knowledge. This doctrine, which is found in the writings of many modern men of letters, comes to us directly from the Neoplatonic philosophy of the so-called Alexandrian school. The writings formerly ascribed to Dionysius the Areopagite, but now admitted to belong to the fifth century, embody the Neoplatonic doctrine in its characteristic form; and these writings, translated and studied by the scholastic philosophers, have been the direct sources of mediæval and modern mystical beliefs.

In brief, mystic knowledge is supposed to be a form of cognition absolutely different in character from sense perception and intellectual apprehension, and vastly superior to these. In ecstasy, which is the technical name for the act or state of mystical knowledge, the subject is alleged to be in direct contact with some form of ultimate reality. In Maeterlinck's system, this ultimate reality, which the soul is supposed to know or experience in this mystic way, may be another soul: in the original system, and the system of certain other modern mystics, the reality which is experienced is the Divine Being.

The nature of this mystic knowledge is, according to the theory, indescribable, because it is entirely removed from the sphere of ordinary knowledge, in which sphere only are descriptions and explanations possible. The statement which comes nearest to the mystic's doctrine, is that in ecstasy the soul is united with God (or with another soul).

The mystic experience must be carefully distinguished from the seeing of visions or the hearing of voices (as in the case of Joan of Arc), and from the "feeling of the presence" of some one—a feeling in which many people believe. The mystic experience is not at all the acquirement of the ordinary form of knowledge in a mysterious way: it is an extraordinary form of knowledge. The experiences which approach this condition, but which remain in the ordinary sphere, may be conveniently designated as *pseudo*-mystical.

With the claims of mysticism psychology has strictly nothing to do. When some one tells me that he has had a kind of experience which has absolutely no relation to my experience, I have as little ground for admitting the truth of his statement as for denying it. Nevertheless, when the experience of another person can be satisfactorily explained in terms of our own experiences, we must provisionally explain it in that way. The mystic distinctly tells us that in ecstasy there is consciousness—but no perception or imagination or intellectual process. From which we conclude that the experience—if it really occurs—is of pure feeling. This conclusion we believe to be satisfactory and final.

4. Spiritualism and Mediumship

A large and varied assortment of performances and superstitions have come to be included under the name of spiritualism or mediumship. Mediums, or "psychics," or clairvoyants, pretend to produce table-tipping, slate-writing, playing on musical instruments, and other physical phenomena without ordinary physical means. They read the future and the past, and put you in communication with Julius Cæsar, or Flashing-Eyes the Indian maiden, or your great-grandfather. A few words about these performances are appropriate here.

In the first place, supernatural mediumships—the production of physical effects without adequate physical causes—must be excluded from the discussion. The table-tippings, slate-writing, "spirit-photographs," and other tricks have been explained and exposed until they have become merely a source of weariness. Every supernatural medium who has been carefully investigated has been found to be a fraud. All the tricks of the psychics have been done by Kellar and the stage magicians, and many of the performances of these men have defied the investigation of scientists, until the magicians themselves have furnished the explanations.

The production on slates or other surfaces of writing or pictures which are claimed not to have been produced by natural hands and processes, is conclusive proof of fraud. When a medium causes a table to tip or rise into the air, apparently without physical aid or support, or causes voices to sound or instruments to play, which voices and which playing are claimed not to be the medium's or her assistants', she brands herself as a humbug. The materialization of a spirit is convincing evidence that the medium presumes on the crassest credulity on the part of her patrons.

In other cases, the mediums are possibly honest. Psychic healers who claim to heal broken bones or bacterial diseases by mental treatment, sometimes when the patient does not know that he is being treated, may think they can perform these miracles. People have always believed in witchcraft and sorcery, and the sorcerers themselves, whether voodoo doctors or "Christian Science" practitioners, are usually ignorant enough to share the belief. On the other hand, the psychic treatment of nervous disorders is an established and valuable method, the "mental" state of the patient having a profound effect on his "bodily" functions. Psychotherapy is employed by scientific physicians, and it may often be employed by the most ignorant sort of charlatans with great success. If the patient thinks that he is receiving treatment and is being benefited, the benefit frequently follows.

Psychic treatment cannot take the place of other sorts of medical treatment where these are indicated. In diseases of other than nervous origin the patient's state of mind is important, but its importance is relatively small. Many patients, of course, get well without medical attention—physicians do not claim to "cure" any disease, but simply to assist nature in its fight against it—and many cases occur in which the patient thinks he has a disease from which he is really free, and, upon feeling better, he may be of the opinion that he has been cured of that disease. Hundreds of cases of cures by "Christian Science," which are described as having been cured after the patients had been given up by the doctors to die of a disease, have been investigated, and in not one case out of fifty has it been found that such a diagnosis had actually been made.

In natural mediumships there is no pretence of effects produced in a supernatural way. If writing and other phenomena are produced, they are the work of the medium, and no claim is made to the contrary. The only question at issue is as to the significance of what is written or spoken by the medium.

The natural mediums usually claim that what they have to communicate comes from the "spirits" —a "spirit" takes control of the hand or the vocal organs of a medium and expresses itself by means of them. This hypothesis would explain some of the remarkable things which have been "communicated" by certain mediums, if it were not for the fact that we don't really know what we mean by the term "spirit." The "spirits" would seem to be decaying fragments of former personalities, since their communications are usually trivial, and mixed with much pure rubbish. For the present it is safest not to adopt any hypothesis whatsoever for the explanation of natural mediumship, but to hold the few remarkable results of experiments with mediums as interesting data requiring much to be added before any explanation can be attempted. It is by no means impossible that it may all be explicable as chance and cheating. The societies for psychic research have for a long time been engaged in investigating all cases of mediumship which seem geniune, but have received little recompense for their labors. Certainly they have learned nothing about the future life—the existence of persons after what we call death.

It is to be noted that the natural mediums who have seemed genuine can be counted on the fingers. By genuine is here meant that they are not consciously trying to deceive: that the information they furnish comes from a source unknown to themselves. The large body of professional clairvoyants, soothsayers, and psychics is simply a group of impostors.

REFERENCES

The student is urged to compare the view-points and interpretations of the foregoing treatise with those of other texts. The most important shorter treatises are: Ward, article, "Psychology," in the Encyclopædia Britannica, eleventh edition; Angell, *Psychology;* Titchener, *Text-Book of Psychology;* Külpe, *Outlines of Psychology,* and Maher, *Psychology.* The important longer ones are: Ladd and Woodworth, *Elements of Physiological Psychology;* Wundt, *Grundzüge der physiologischen Psychologie;* Ebbinghaus, *Grundzüge der Psychologie,* and James, *Principles of Psychology.* The last named is the most important of all in point of theory.

As a manual for the further study of the data of psychology Ladd and Woodworth's book is especially to be recommended. Recent books and articles on any topic may be located by consulting the *Psychological Index,* which is issued annually by the *Psychological Review,* and contains all the titles for the year on psychology, philosophy, and the relevant parts of neurology and physiology.

Below are given a few references on points which are emphasized in the foregoing treatise, some of the articles being in agreement with our positions and some not.

On the Greek theory of the PSYCHE: Turner, "Aristotle as a Psychologist," *Catholic University Bulletin,* XVII, 299–317; Aristotle, *De Anima* (in Hammond's *Aristotle's Psychology*), especially books I and II.

On the original use of the term PSYCHOLOGY: Hamilton, *Lectures on Metaphysics,* Lecture VIII. The definitions of the present science of psychology given in standard treatises do not differ much from the definition we have given in chap. I, § 1. Stout, *Manual of Psychology,* Introduction, chap. I, § 1, gives a definition which is somewhat broader and possibly more accurate. The definition given by Pillsbury, *Essentials of Psychology,* does differ essentially from the orthodox one, and might be made the basis of a distinct sort of psychology. Pillsbury, however, virtually abandons his definition, and follows rather conventional lines. Kirkpatrick, *Genetic Psychology,* approximates more nearly to a "behavior" psychology.

On the restricted meaning of CONSCIOUSNESS: Hamilton, "Philosophy of Perception," in *Discourses on Philosophy and Literature.* See also Mill, *Examination of Hamilton's Philosophy,* chap. VIII. For a modern discussion of consciousness, see Hicks, "The Relation of Subject and Object," *Proceedings Aristotelian Society,* VIII (1908), 161–214. For a purely functional theory of consciousness, see James, "Does Consciousness Exist?" *Journal of Philosophy,* etc., I, 477–491. The title of this article is, of course, not to be taken literally, but is to be understood as questioning the validity of a certain theory concerning consciousness.

On ELEMENTS of content: Watt, "The Elements of Experience," *British Journal of Psychology,* IV, 127–204.

On the identification of SENSATION AND BRAIN PROCESS: Loeb, *Comparative Physiology of the Brain,* chaps. I, XV–XVIII, and especially IX; Forel, *Nervous and*

Mental Hygiene, chap. II; Pearson, *The Grammar of Science*, chap. II, § 4. Many physiologists who practically adopt this view do not formulate it definitely. Certain physiologists explicitly reject the theory: see Howell, *Physiology*, pp. 182, 183. Certain others grope in utter confusion, making absolutely no distinction between consciousness and object, or between matter and either of these; see McNamara, *The Evolution and Function of Living Purposive Matter*, in which the paragraph in the middle of page 148 is typical of the whole book.

For a clear statement of the PARALLEL THEORY and the arguments for it, see Mercer, *Sanity and Insanity*, chap. III. An instance of the difficulty found by even the best intentioned parallelists in actually maintaining a position on the theory may be observed by attempting to interpret the section headed, The Appearance of Consciousness, in chap. III of Angell's *Psychology*, in the light of the statements made in the section headed Terminology, in the same chapter.

For a statement of the INTERACTION THEORY, see Ladd and Woodworth, *Elements*, pt. III. James's *Principles* is based on the interaction theory.

For Huxley's theory of the NATURE OF MATTER, see his essay on "The Physical Basis of Life," particularly the latter portion thereof. On this problem, see also Mill, *Examination of Hamilton's Philosophy*, chap. XI.

For the telephone THEORY OF AUDITION, see Rutherford, "The Sense of Hearing," *Lancet*, 1887, I, 2–6. On the extensity theory: Ter Kuile, *Pflüger's Archiv*, LXXIX, 146–157, 484–509; Dunlap, "Extensity and Pitch," *Psychological Review*, XII, 287–292.

On MUSICAL SCALES: Ellis's translation of Helmholtz's *Sensations of Tone;* Sabine, "Melody and the Origin of the Musical Scale," *Science,* N. S. XXVII, 841–847. Naumann, *History of Music* (Praeger's translation).

On VISUAL SENSATION in general, the articles by Nagel and by Von Kries in Nagel, *Handbuch der Physiologie,* are especially to be recommended. See also Greenwood, "Studies in Special Sense Physiology," in Hill, *Further Advances in Physiology* (1909). On the STREAMING PHENOMENA, see Wohlgemuth, "On the After-Effect of Seen Movement," *British Journal of Psychology,* Monograph Supplement No. 1.

On the variability of the TEMPERATURE SPOTS: Crawford, "A Study of the Temperature Sense," *Psychological Review,* V, 63–112; Kelchner and Rosenblum, *Zeitschrift für Psychologie,* XXI, 174–182.

On the DISSOCIATION OF DERMAL SENSATION qualities by syringomyelia and other nervous diseases: Starr, *Organic and Functional Nervous Diseases.*

On RELATIONS AS ELEMENTS OF CONTENT: Huxley, *Essay on Hume,* chap. II; Woodworth, "The Consciousness of Relation," *Essays Philosophical and Psychological in Honor of William James,* 485–507; McGilvary, "The 'Fringe' of William James's Psychology," *Philosophical Review,* XX, 137–164. An interesting attempt at the analysis of relations is contained in Spencer, *Principles of Psychology,* second edition, II, chaps. XV–XXVI. See also Brunschwig, *Das Vergleichen und die Relationerkenntniss.* The specific question as to the existence of relation content is involved in the less sharply defined question whether or not "imageless thought" exists, and the two are sometimes confused. On imageless thought,

see Titchener, *Lectures on the Experimental Psychology of the Thought Processes.*

On IMAGES AND IDEAS: Aristotle, *De Anima,* book III, chaps. III and VII, On Memory and Recollection, and On Dreams (in Hammond, *Aristotle's Psychology*); Hamilton, *Philosophy of Perception,* foot-note on the history of the term idea; Alexander, "On Sensations and Images," *Proceedings Aristotelian Society,* X (1909), 1–35; Colvin, "The Nature of the Mental Image," *Psychological Review,* XV, 158–169; Angell, "Methods for the Determination of Mental Imagery," *Psychological Review,* Monograph Supplements, XIII (1), 60–108; Stout, *Manual of Psychology,* book IV, chap. I.

On CONCEPT AND JUDGMENT: Mill, *Examination of Hamilton's Philosophy,* chaps. XVII and XVIII.

On the PLATONIC "IDEA": Plato (Jowett's translation), *Parmenides,* 132, *Phædo,* 100–106, *Republic,* book VI, and especially book X, 596–598. (The numbers are those in the margins.).

On ASSOCIATION: Claparède, *L'association des idées,* and Calkins, "Association," *Psychological Review,* Monograph Supplements, I, (2).

On SPACE PERCEPTION: Wundt, *Physiologische Psychologie,* sixth edition, II, cap. 13, § 5 and cap. 14, § 6; Ribot, *German Psychology of To-day,* chap. IV; Sully, *The Human Mind,* II, Appendices B and E; Kolbenheyer, *Die Sensorielle Theorie der optische Raumempfindung;* Von Aster, "Beiträge zur Psychologie der Raumwahrnehmung," *Zeitschrift für Psychologie,* XLIII, 161–203.

On TIME PERCEPTION: Montague, "A Theory of Time Perception," *American Journal of Psychology,* XV, 1–13;

Nichols, "The Psychology of Time," same Journal, III, 453–527. Hamlin, "On the Least Observable Interval," etc., same Journal, IV, 564–575.

On the question whether FEELING is sensation or is *sui generis*, and on the DEGREES OF CONSCIOUSNESS: Titchener, *Lectures on the Elementary Psychology of Feeling and Attention.* On the James-Lange theory of the EMOTIONS, see James's defence, "The Physical Basis of the Emotions," *Psychological Review*, I, 517–529.

On RHYTHM: Bolton, "Rhythm," *American Journal of Psychology*, VI, 145–238; Stetson, "A Motor Theory of Rhythm," *Psychological Review*, XII, 250–270, 293–350; Dunlap, "Rhythm and the Specious Present," *Journal of Philosophy*, etc., VIII, 348–354.

On the SUBCONSCIOUS: Hart, "The Concept of the Subconscious," *Journal of Abnormal Psychology*, IV, 351–371, gives an excellent outline of the theory we reject; Jastrow, *The Subconscious*, presents implicitly a theory which is even more extreme.

On ALTERATIONS OF PERSONALITY and multiple personality: Prince, *The Dissociation of a Personality*, presents an extreme view strikingly, and illustrates the fact that a difficult problem may be literally dramatized to an apparently simple solution. Other standard books are: Azam, *Hypnotisme et double conscience*, and Binet, *The Alterations of Personality.* See also, in this connection, Janet, *The Mental State of Hystericals*, and *The Major Symptoms of Hysteria.*

On the OCCULT in general, Lang, *Psychic Research*, in the Encyclopædia Britannica; and Moll, *Hypnotism* (English from fourth edition, 1910), chap. XIII. On MIND READING and telepathy: Moll, *op cit.*, 62, 63, 455–

458, 510–519; Pfungst, *Clever Hans* (Rahn's translation); Hansen and Lehmann, "Ueber unwilkurliches Flüstern," *Philosophische Studien,* XI, 471–530. Curtis, "Automatic Movements of the Larynx," *American Journal of Psychology,* XI, 237–239. Laurent, "Les procédés des liseurs de pensées," *Journal de Psychologie,* II, 481–495.

On MYSTICISM: Underhill, *Mysticism,* gives the best presentation from the mystic's point of view. Jones, *Studies in Mystical Religion,* gives an historical account. The writings of (the *pseudo-*) Dionysius the Areopagite have been translated by Parker. The writings of Maeterlinck and of Emerson are good instances of the modern outcroppings of Neoplatonism which to a large extent tincture all theological discourse of the present day. See, for example, Maeterlinck, "The Awakening of the Soul," and "On Women," in *The Treasure of the Humble;* and Emerson's essay on *The Oversoul.*

Questions concerning dreams must have been suggested to the reader by several portions of our book, but we have avoided this topic because so little is known about it. Interesting speculations and controversies concerning dreams are rife at present, but the statements of these would be too long for this treatise. The student may profitably read two books which represent the more scholarly attempt to study dreams: Mourly Vold, *Ueber den Traum* (Klem, editor), and Foucault, *La rêve.* A book which is having a great vogue at the present time among medical men, and which makes of an arbitrary theory a religious dogma rather than a scientific hypothesis, is Freud, *Traumdeutung.* See also Jones, "Freud's Theory of Dreams," *American Journal of Psychology,* XXII, 283–308.

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