EMOTIONS OF NORMAL PEOPLE

CHAPTER I

Normalcy and Emotion

Are you a "normal person"? Probably, for the most part, you are. Doubtless, however, you have occasional misgivings. Your "sex-complexes", your emotional depressions, or your "hidden fears" seem to you, at times, distinctly abnormal. And so psychology might adjudge them. On the other hand, you undoubtedly experience milder fears, furies, petty jealousies, minor hatreds, and occasional feelings of trickery and deception which you have come to regard as part of your *normal* self. And psychology aids and abets you in this notion, also. In fact, many psychologists at the present time frankly regard "fear" and "rage", not only as *normal* emotions, but even as the "major" emotions. By some writers[1] "choc", or emotional shock is suggested as the one element essential to normal emotion. Some psychological experimenters have compelled women subjects to cut off the heads of live rats, proudly presenting reaction data thus obtained as a measure of normal emotional response to an adequate stimulus. One of the most eminent investigators of emotion[2] goes so far as to advocate retention of "fear" and "rage" in normal human behaviour, for the purpose of supplying bodily strength and efficiency! This suggestion seems to me like recommending the placing of tacks in our soup for the sake of strengthening the lining of the alimentary canal. I do not regard you as a "normal person", emotionally, when you are suffering from fear, rage, pain, shock, desire to deceive, or any other

[1] D. Wechsler, *The Measurement of Emotional Reaction*, New York, 1925, Chapter X.

[2] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, New York and London, 1920, Chapter XV.

emotional state whatsoever containing turmoil and conflict. Your emotional responses are "normal" when they produce pleasantness and harmony. And this book is devoted to description of normal emotions which are so commonplace and fundamental in the every-day lives of all of us that they have escaped, hitherto, the attention of the academician and the psychologist.

Normal Emotions are Biologically Efficient Emotions.

If, as psychologists, we follow the analogy of the other biological sciences, we must expect to find normalcy synonymous with maximal efficiency of function. Survival of the fittest means survival of those members of a species whose organisms most successfully resist the encroachments of environmental antagonists, and continue to function with greatest internal harmony. In the field of emotions, then, why should we alter this expectation? Why should we seek the spectacularly disharmonious emotions, the feelings that reveal a crushing of ourselves by environment, and consider these affective responses as our *normal* emotions? If a jungle beast is torn and wounded during the course of an ultimately victorious battle, it would be a spurious logic indeed that attributed its victory to its wounds. If a human being be emotionally torn and mentally disorganized by fear or rage during a business battle from which, ultimately, he emerges victorious, it seems equally nonsensical to ascribe his conquering strength to those emotions symptomatic of his temporary weakness and defeat. Victory comes in proportion as fear is banished. Perhaps the battle may be won with some fear still handicapping the victor, but that only means that the winner's maximal strength was not required.

I can still remember vividly the fear I once experienced, as a child, when threatened, on my way to school, by a half-witted boy with an air-gun. I had been taught by my father never to fight; so I ran home in an agony of fear. My mother told me, "Go straight by F——. Don't attack him unless he shoots at you, but if he does, then go after him". I was an obedient child, and followed orders explicitly. I marched up to F—— and his gun with my face set and my stomach sick with dread. F—— did not shoot. I have known, ever since that well-remembered occasion,

that fear does *not* give strength in times of stress. Part of the strength with which I faced F——'s air-gun came from my own underlying *dominance*, newly released from artificial control. But most of it belonged to my mother, and she was able to use it in my behalf because I *submitted* to her. *Dominance* and *submission* are the "normal", strength-giving emotions, not "rage", or "fear".

Present Emotion Names are Literary Terms, Scientifically Meaningless

Yet my initial researches in emotion were not concerned with normal, biologically efficient emotions. I began to try to measure the bodily symptoms of deception in the Harvard Psychological Laboratory, in 1913,[1] and later continued this work in the U.S. Army, during the war,[2] and in some court cases.[3] But the more I learned about the bodily symptoms of deception, the more I realized the futility of trying to measure complex conflict-emotions, like "fear", "anger", or "deception", without in the least knowing the normal, fundamental emotions which appeared in the process of being melodramatically baffled in laboratory or court-room torture situations.

What does the average teacher of psychology mean when he glibly rattles off the words "fear", "rage", "anger", and "sex-emotion"?[4] Almost any literary light of the Victorian era, if asked to define these words, would have answered, readily enough: "They are names for emotions possessing distinctive conscious qualities, experienced by everybody, every day. These easily recognized, primitive emotions constitute the very backbone of literature." I submit that the backbone of literature has been transplanted intact into

[1] For reports of these researches see: W. M. Marston, "Systolic Blood Pressure Symptoms of Deception," *Jr. Exp. Psy.*, 1917, vol. 2, p. 117. W. M. Marston, "Reaction Time Symptoms of Deception," *ibid*, 1920, vol. 3, pp. 72-87. W. M. Marston, "Negative Type Reaction Time Symptoms of Deception," *Psy. Rev.*, 1925, vol. 32, pp. 241, 247.

[2] R. M. Yerkes, "Report of the Psy. Committee of the National Research Council," *Psy. Rev.*, 1919, vol. 26, p. 134.

[3] W. M. Marston, "Psychological Possibilities in the Deception Tests," *Jour. Crim. Law and Crim.*, 1921, vol. XI, pp. 552-570. W. M. Marston, "Sex Characteristics of Systolic Blood Pressure Behaviour," *Jour. Exp. Psy.*, 1923, vol. VI, 387-419.

[4] The substance of the following paragraphs appeared originally in an article by the writer, entitled "Primary Emotions," *Psy. Rev.*, and is reproduced with the kind permission of its editor, Prof. H. C. Warren.

psychology, where it has proved pitifully inadequate. The whole structure of our recently christened "science", in consequence, remains spineless in its attempted descriptions of human behaviour. Most teachers of psychology, it would seem, are still unable to define these time-worn emotional terms with greater exactness or scientific meaning than that employed by literary men of the last century.

Nor can the average teacher be blamed. Theorists and researchers upon whom the teacher must depend for his scientific concepts have written many hundreds of thousands of words on the subject of emotions, without attempting definite, psycho-neural description of a single basic, or primary emotion. On the other hand, nearly all writers seem to accept the old, undefined literary *names* of various "emotions" without question; each writer then giving these terms such connotation as they may happen to hold for him, individually.

Consider, for example, the term "fear". This word seems to find its way, unquestioned, into nearly every emotions research reported to the literature of psychology and physiology. What does it mean? The James-Langeites say "fear" is a complex of sensations, perhaps largely visceral, perhaps not; perhaps the same in all subjects, but probably differing importantly in different individuals. Surely the unfortunate teacher of psychology can extract little comfort from such vague guess-work. Besides, the physiologists have proved, with their customary thoroughness, that the condition of consciousness traditionally termed "fear" in popular and literary parlance, cannot be composed characteristically of sensory content.[1]

What then of the physiologists? They use the term "fear", it appears, quite as blithely and trustfully as do the James-Langeites. Cannon uses the word "fear" throughout the entire course of his extremely valuable work entitled, *Bodily Changes in Pain, Hunger, Fear and Rage.*

But how does he differentiate it from "rage", or from "pain"? He points out physiological similarities, but no measurable differences between these "major emotions". Cannon assumes that the so-called sympathetic division of the autonomic nervous system is always activated by the "fear"

[1] For summary of investigations touching this point see W. M. Marston, "Motor Consciousness as a Basis for Emotion," *Jour. Abn. and Soc. Psy.*, vol. XXII, July-Sept., 1927, pp. 140-150.

pattern. But he cites various other effects of "fear", such as nausea, weakness, vomiting, etc., which would be ascribed, by many writers, to vagus impulses. Moreover, "rage", "pain", and other "major emotions" also discharge characteristically into the sympathetic, as Cannon himself emphasizes.[1] So we are left, again, high and dry in our search for any specific meaning for the famous word "fear".

What must be done is to give up attempts to define conflict-emotions, and go down to the very roots of biologically efficient behaviour and discover the simple, normal emotions that lie buried there. This book attempts that task. It attempts to describe the emotions of *normal* people, and *people are not normal when they are afraid, or enraged, or deceptive.* When the simplest normal emotion elements are revealed, it becomes a comparatively easy matter to put them together into normal compound emotions—in real life or in the psychological laboratory. It becomes comparatively easy, moreover, to detect—and to remove—*the reversed interrelationships between normal emotion elements which are responsible for these conflicts and thwartings in "fear", "rage", "jealousy" and the other abnormal states.*

In What Terms can "Normal Emotions" be Described?

But a person who calls himself a psychologist is in a peculiar position these days. Before he can write about the psychology of emotion, or intelligence, or, in fact, about the psychology of any human behaviour, he must define what he means by psychology. The introspectionistic psychologists, now considered unscientific, regarded any exposition as psychological which described its phenomena in subjective or introspective terms. Now the introspectionists are pushed into the background. In their place we find a great variety of teachers and researchers all naming their diverse methods and observations "psychology". We have, for instance, in the field of emotions, the physiologists, the neurologists, the physiological psychologists, the behaviourists, the endocrinologists, the mental-tester-statisticians, the psycho-analysts, and the psychiatrists. Each of these types of worker confesses himself to be a psychologist, and, moreover, each maintains that his are the only psychologically worth-while results. Psychology

[1] W B Cannon, *Bodily Changes in Pain, Hunger, Fear, and Rage*, New York and London, 1920, pp. 277-279

to-day, like Europe in the Middle Ages, is being fought over by feudal barons who have little in common save tacit acceptance of the rule that spoils shall be taken whenever and however possible.

In what terms, then, can we describe simple, normal emotions, with any expectation that one or all of psychology's warring factions may regard our terminology with aught but disdain? I once made the mistake of using the term "will-setting" in a discussion of bodily emotion mechanisms; and, although several American psychologists of various sorts strove manfully to read the article in question, all gave it up in the end. I once asked Dr. Watson a question containing, stupidly enough, the word "consciousness". "I'm sorry", said Watson, in a tone of genuine regret, "I *don't* understand what you mean, and so I can't answer your question." I once remarked to an eminent psycho-analyst, that I had enjoyed the play "Outward Bound". "O ho!" this friend triumphed. "So you have an Oedipus complex!" then added, plaintively, "When *are* you going to learn psycho-analytical terms? You might have told me about that Oedipus, instead of letting it out of the bag in that round-about fashion!" In the first two instances I thought I had said something, but found I had not. In the last instance, I did not think I had said anything, but found that I had committed myself irretrievably. What is one to do in describing normal emotions?

Only this. One may try, at least, to "reinterpret and correlate the old fog signals", as Ogden aptly puts it,[1] and so correct some "errors in manipulating the logos" by an attempted application of "the science of orthology". Which means, of course, that we first have to find out what the various types of psychological writers really are talking about, each in his own peculiar dialect. And then we have to devise a sort of psychological Esperanto, defining each new term, as we use it, with meticulous exactitude. The task is not an easy one. But to induce the different types of researchers in psychology of emotion to unite their efforts toward describing *normal primary emotions* would be worth any amount of effort. Each of the varieties of psychologist named has something vital to contribute to this central problem, if he would only get over his language difficulty and play the game.

[1] C. K. Ogden, Editorial: "Orthology", *Psyche*, July, 1927.

CHAPTER II

Materialism, Vitalism and Psychology

Our problem is: What are the underlying desires, or wishes, that lead some scientists to insist upon mechanistic conceptions, and others equally eminent, to espouse some form of scientific vitalism? For in psychology, as in other sciences, a materialistic or vitalistic bias may be found at the root of nearly all factional schools, or contentious groups. Sometimes, of course, the underlying desire relates solely to the advancement of the personal fortunes of the workers concerned; and such purely egoistic motives probably play a considerable part in the evolution of every scientific doctrine. In addition to this, however, originators and promulgators of conceptual systems of thought, nearly always possess hidden desires to push science in this direction or that, "for science's own sake". The goal selected is the one that accords most closely with the basic emotional set of the scientific agitator. And the emotional sets of scientists may be classified, broadly, into two elementary groups, materialistic and vitalistic.

The Mechanistic Set

Mechanists are "hard-boiled". They are chronic sceptics, and must be shown. They pretend to base all their conclusions upon material evidence, and seldom observe that their own aggressive disbeliefs in the existence of this or that are based upon temperamental rejection of the very proffered evidence which their creed holds sacred. Their rationalization of their own emotional bias runs something like this: Science is the study and exposition of material causation. "Material" means always "cruder, less complex forms of energy". Therefore, true science is the study of the influence of simpler energy units upon more complex energy units. And, since we can account for everything we have experienced in this way, why waste time imagining that there exists any other type of

CHAPTER III

The Psychonic Theory of Consciousness[1]

The question, "What is consciousness?" has been asked, but not answered, since the first dawnings of speculative thought. The present age, however, can boast of a new question all its own: "Does consciousness exist?" To one whose common-sense life has been spent outside the intellectual fantasies of academic shades this question might seem ludicrous. Nevertheless, professors of the older school are beginning to experience a considerable degree of bepuzzlement when confronted with the task of convincing a healthfully sceptical younger generation that there is such a thing as consciousness.

"What is it?" ask the student readers of Watson. "Where is it? Prove to me that consciousness exists!"

In vain does the instructor insist that "everyone knows what consciousness is, because everyone is conscious"; that "many phenomena which cannot be 'kicked' (seemingly the prescribed behaviouristic test for recognizable being), can yet definitely be shown to exist."

"Very well", reply the students, "show us, then."

Objective evidence of the existence of consciousness must necessarily be indirect evidence, just as is the case with electricity, Hertzian waves, and even disturbances of propagation in nervous tissue. No wireless wave, electric current, or nerve impulse is in itself sufficiently tangible to be made subject to observation by human senses aided by such instruments as are at present available. The effects of these various forces upon observable materials, however, are accepted not only as proofs of the existence of the forces under

[1] "The Psychonic Theory of Consciousness" made its first appearance in the *Journal of Abnormal and Social Psychology for July*, 1926. The theory was amplified in an article appearing in *Psyche* for July, 1927. Portions of both articles are reproduced in this chapter, and the author makes grateful acknowledgment to the editors for their kind permission to reprint the material.

examination, but also as scientifically descriptive criteria by which the nature of the unseen causes may be determined. Thus, an electric current may actuate a voltmeter or an ammeter; a Hertzian wave may produce differences of conductivity within an audion tube; and a nervous impulse may result in easily recorded contractions of a strip of muscle fibre.

If, then, examination of consciousness is approached with similar objectivity, we must assume that consciousness itself, or the physical mechanism used to produce it, constitutes a definite, physical force, capable of registering its presence and nature by causing changes in some observable material. Further, this force, consciousness, if it exists anywhere, is to be found in the more complex reactions of the normal, adult, human being. In terms of the preliminary analysis of causation arrived at in our last chapter, we are now called upon to prove that a vitalistic-type cause called consciousness actually exists in some part of the human organism and that this supposedly complex form of energy exerts a measurable influence upon simpler energy units, within the body itself, capable of observation with the unaided senses or with laboratory instruments.

Most of the human family have observed, without the aid of a psychologist, that some human activities seem to the subjects themselves to be more conscious than others. Habitual responses, such as walking, twirling a watch fob, or swinging a stick, often do not seem to be accompanied by any consciousness whatever. On the other hand, the making of momentous decisions which may occupy many hours, days, or weeks, exemplify the type of human action which seems to include the greatest relative amount of consciousness. The question as to whether or not habitual actions are, in truth, totally devoid of consciousness may be regarded at the moment as purely academic. If our subjects unanimously report more of the phenomenon called consciousness in one sort of behaviour than in another, and if there are objectively observable effects which seem to proceed *pari passu* with the increase in consciousness, this constitutes scientifically acceptable proof that consciousness is a material force acting upon our bodies as a vitalistic-type cause. In exactly the same way, the fluctuating needle of the voltmeter is accepted as offering scientific proof of the invisible presence of an electric current acting as a

vitalistic-type cause over the materials of the instrument. Should this causally effective force, consciousness, be identified later with nervous energy in some part of the brain, it would still remain a vitalistic-type cause, that is, a more complex form of energy than the materials moved. Moreover, when psychology has properly performed its task, we shall hope to find physical consciousness explicitly described in terms of physical energy units.

Our first question, then, is: What changes in bodily behaviour characteristically accompany this reported consciousness?

Proofs of Consciousness

1. The more conscious a reaction is, the slower it is.

It has frequently been observed that the more conscious an action is, the longer is the observable delay between reception of environmental stimuli and appearance of overt bodily responses. As already noted, habitual actions occur very quickly after contact with the stimulus; whereas, in the making of momentous decisions, overt activity may be delayed for days or weeks. Reflexes like the knee jerk, where no accompanying consciousness can be detected by the subject himself, manifest a still shorter reaction time than the habitual responses; while certain "thinking" activities, which may persist over a period of many hours, and which are recognized as intensely conscious throughout the entire period, may never manifest a detectable ultimate response. One observable effect of consciousness upon bodily behaviour, then, would seem to be a lengthening of the time interval between stimulus and response.

2. The more consciousness accompanying a response, the longer it persists after the stimulus is removed.

Quite in contrast to the first-mentioned result of the influence of conscious energy upon bodily behaviour is a second equally common effect. Strictly reflex, or habitual actions, tend to cease very quickly after the removal of the environmental stimulation that brought them about. For instance, a machine operator in a factory does not continue to press down the stopping lever of his machine after the machine has stopped. One does not continue to make watch-fob-twirling movements

when dressed in pyjamas, nor to swing the legs in a walking movement after stretching oneself out in an easy chair. On the other hand, if a greater amount of consciousness is attached to a given action, the action is likely to persist for a much longer period after complete removal of the effective stimulus. Suppose a young man has responded to the stimulus of a chance remark that he is "mentally abnormal" by deciding, after some weeks of cogitation, to become a psychiatrist (an actual case which came to my attention in clinic). He begins to act upon this remark within a few months by entering a medical school, but long years of training must follow before he can even begin to analyze his own personality. During these years he may not once have encountered any repetition of the suggestion that he is mentally unbalanced, but his original reaction, which was initially accompanied by intense and prolonged "consciousness" of both emotional and intellectual varieties, has persisted without abatement throughout a period of years after the disappearance of the environmental stimulus. Probably most physiological authorities would agree that such a tremendously extended response represents not a single reaction, but a long series of reactions. Since most of these responses are centrally initiated, and all are unified to accomplish a single purpose, the original stimulus must have evoked a large volume of energy somewhere in the central nervous system which continued to control behaviour for a long period of years. In conformance with this idea, R. S. Woodworth[1] in his theory of "tendencies to action" and "preparatory reactions" holds that "damned up energy" may exist in the central nervous system for periods of months and years, escaping in tiny rivulets as the dam is punctured by appropriate environmental stimuli.

3. The more conscious a response is, the less its rhythm corresponds with the rhythm of the stimulus.

Habitual or reflex actions show a much closer correspondence between the rhythm of end effect and the rhythm in which the stimulus is received than do more conscious responses. In the swinging of a cane or regulation of a semi-automatic machine, the rhythms of bodily response are adjusted automatically to the rhythms of stimulation. This type of adjust-

[1] R. S. Woodworth, *Psychology*, New York, 1925, pp. 82-84.

ment is still more marked in such highly reflex activities as skilled chorus dancing, playing the piano, or using a typewriter. On the other hand, the more conscious the action becomes, the more the automatic correspondence between rhythm of stimulus and rhythm of response tends to be broken up. Let the dancer become suddenly aware of her steps, the typist of the keys, the pianist of his notes, and the established rhythm is shattered. Grace dissolves into jerky awkwardness, speedful accuracy into hesitant blundering and rhythmic harmony to lagging dissonance. " Introverted " persons, or those customarily given to expressing a great deal of "self-consciousness " while reacting to a stimulus, are notoriously awkward in games or physical exercises requiring close approximation of the rhythm of bodily responses to the rhythm of an environmental stimulus. Their physical actions are jerky, and indiscriminately slower or quicker than the rhythm of the physical stimulus to which they are attempting to adapt their own rhythms of action. The increased consciousness seems to interfere with the correspondence between rhythm of stimulation and rhythm of response.

4. The more conscious a response is, the less its intensity corresponds with the intensity of the stimulus.

Within limits, the intensity of simple reactions, involving little consciousness, corresponds rather closely with the intensity of the physical stimulation. A vocalist unconsciously sings louder if the volume of the piano accompaniment is increased. Small adjustments in the reactions of walking are made " unconsciously " in response to differences in intensity of pressure stimulation presented by the path along which one is walking. A slight up grade which increases the intensity of the pressure upon the feet and also increases the intensity of muscular pressure upon the proprioceptive sense organs, is " unconsciously " followed by corresponding increase in the intensity of muscular exertion. But in responses which are reported as involving a great deal of consciousness, there may be little or no correspondence between the intensity of the stimulus and the intensity of reaction to the stimulus. In the case of the young psychiatric student just considered, the chance remark concerning his possible abnormality constituted a stimulus of slight intensity indeed. The same remark, or similar ones, had probably been made concerning nearly all of this young man's friends with no

particular effect, yet in the specific case cited it released a volume of energy regarded as " conscious ", which was probably many thousands of times as intense as the stimulus, and which was also more intense than reactions to other stimuli much more intense than this stimulus. On the other hand, instances might be cited where increase of consciousness decreases intensity of response as compared with the intensity of the stimulus—as when the singer thinks " The piano is too loud—I will sing pianissimo and force him to follow ". Or the reduction in intensity of the response may be a positive inhibition—this in turn to be accounted for by the positive agency of some active force within the organism. An example of an effect of this sort is to be found in the total elimination of overt actions which is caused by " pausing to think " after experiencing an irritating stimulus. One child may slap another child's face with considerable strength. Remembering the nursery adage of " count ten before you strike back ", the assaulted youngster finds that by the time he had counted ten he does not feel inclined to strike back at all. Voluntary increase of consciousness seems to have eliminated reaction to an intense stimulus altogether. Consciousness, then seems, on the whole, to alter markedly the correspondence between intensity of stimulus and intensity of respose.

5. The more consciousness attaches to subliminal stimuli, the greater is their tendency to summation.

A stimulus evoking little or no consciousness, so far as the subject is able to observe, and which is too weak to produce a response, is not apt to bring about the reaction toward which it tends, even though the " unconscious " stimulus be repeated a large number of times. For instance, during my first two years of residence in New York City, I passed the Metropolitan Museum, riding in buses or automobiles, probably a hundred times or more, without making any move toward entering the building. On one of my earliest trips up-town a companion had pointed out the Museum, and I had formed a habit of looking toward that side of the street in passing. But my subsequent visual sensations, though they controlled eye movements, evoked no thoughts or emotions concerning the building or its contents. In short, visual perception of the Metropolitan Museum constituted an almost " unconscious " stimulus, of too slight intensity to arouse the reaction of

entering the building, toward which it tended ; and constant repetition of this stimulus failed to bring about the final response. After more than two years of residence in the city, a guest from another part of the country chanced to expatiate, in my presence, upon the wonders of the Metropolitan Museum. This stimulus, though it intrigued my interest temporarily, and was accompanied by many fully conscious thoughts and feelings,also proved too weak a stimulus to result in a Museum-seeing reaction. More than a month later another friend expressed enthusiasm concerning the Metropolitan, arousing still more consciousness concerning it. This stimulus, added to the first highly conscious stimulus, sent me to the Museum. It seems to me highly improbable that the numerous habitual-view stimuli entered into the final summation of energy which brought about the response, or that another two years of viewing the building almost daily would have resulted in my entering it. One may argue, of course, that the two descriptions, by friends, of the museum's contents, were more intense stimuli than were mere views of the outside of the building ; and so they were. But the point to be noted here is merely that two stimulations which evoked much consciousness added themselves together to provoke a certain response, while a hundred little-conscious stimuli failed to bring about the same result. Many other instances of the same sort, from every-day life, might be cited. A person may gaze " unconsciously " at a store, as he walks by it, every day for months, without entering. A " window ticker " may then appear in the show-window, and the subject may become conscious of a momentary wonder as to how the thing works. Next day this same consciousness concerning the ticker may again occur. On the third or fourth day the individual is likely to enter the store and purchase the cigarette or other article advertised by the ticker. It is not our present task to speculate as to *how* the additional consciousness was aroused by the advertising device ; it is our present purpose to note that consciously experienced stimuli tend to add themselves together more quickly and effectively, upon repeated presentation, to evoke the reaction toward which they tend, than do stimuli " unconsciously " contacted.

6. The more conscious a response is, the more subject it is to fatigue.

The more consciousness accompanies any activity, the more quickly fatigue sets in, no matter whether the response is one of " thinking ", or one of violent physical exertion. Many a distance runner has found himself miraculously refreshed by some sudden roadside occurrence that " takes his mind off " his own movements. His fatigue, in other words, becomes less when the consciousness attached to his own running is lessened. A person whose continuous occupation is " thinking " along scientific lines may learn to increase his attention-span, correspondingly diminishing his mental fatigue, by ceasing to introspect upon his own thinking while he is doing it, thus cutting possibly in half the volume of consciousness accompanying his mental activity. Eventual physical fatigue is inevitable, of course, as a result of muscular fatigue products generated in the course of strenuous exercise or work ; but the tirelessness of a well-trained and hardened body is amazing when the muscular tasks undertaken are regarded as mere matters of course, and are performed, as far as the subject can tell, unconsciously. The endurance feats of the American Indian, and the astonishingly continuous exertions of the pioneer type of person, in all lands, are illustrations in point. Where much consciousness is, there much fatigue will be, also ; and the limits of endurance of unconscious activities, of all sorts, are difficult to determine.

7. The more conscious a reaction is, the more variable is the threshold value of its stimulus.

Another easily observable effect which consciousness seems to have upon responses to which it attaches is to render less predictable the exact intensity of environmental stimuli necessary to bring about the reactions in question. Simple reflex reactions can usually be evoked by physical stimuli of approximately the same intensity. There is a margin of variability even here. The knee jerk, for example, as Carlson[1] finds, shows marked increase of excitability, with presumable lowering of threshold stimulus intensity, during strong hunger contractions of the empty stomach. Nevertheless, even the difference caused by hunger pangs in the stimulus intensity necessary to call forth the patellar reflex, could not be measured outside the physiology laboratory.

[1] A. J. Carlson, *The Control of Hunger in Health and Disease*, *p*. 85, Chicago, 1919.

Activities more complex than the simple reflex but still reported to be unconscious are definitely conditioned upon a specific intensity of stimulus. The unconscious response to the legend naming the destination of the street car or 'bus may frequently fail to occur if the electric illumination of the sign be reduced only slightly. Persons frequently fail to stop a street car because the letters of the legend on the front of the car are smaller than those to which they have accustomed themselves to respond. Machine operators who depend upon a certain sound in the machine they are operating to set off a reaction of shifting gears, may fail to perform the required act if the sound has slightly less than the customary volume. A housewife, using an electric coffee percolator, and depending for a signal that the coffee is done upon a certain sound made by the bubbling water, may fail to turn off the electric current at the proper moment if the crucial bubbling sound be less intense than usual.

On the other hand, where the activity is more highly conscious, it is impossible to name a fixed intensity of stimulus which will invariably set off a given reaction. Consider, for example, responses which necessitate a great deal of consciousness such as a decision to play tennis or to take a two hundred mile automobile ride. Upon one occasion a normal subject may assent immediately to a casual suggestion that the tennis be played or that the trip be undertaken. Next day, perhaps, no amount of persuasion or even moderate financial inducement would evoke the reaction of playing tennis or driving the car. Should these very reactions become habitual, as a part of the subject's professional duties or principal life activity, his consciousness concerning the actions would be tremendously reduced, also the margin of variability of the intensity of stimulus to which he responded. Again, it is necessary to call attention to the fact that we are not considering at the moment the psycho-neural mechanisms by which these differences are brought about. The significant point seems to be that when a large amount of consciousness attends a given response it may be evoked at one time by a stimulus of very low intensity and at another time it may require an exceedingly intense stimulus; while if an action is habitual or "unconscious" it is brought about upon all occasions by stimuli of nearly equal intensity.

8. The more conscious a response is, the more readily it can be inhibited.

Highly conscious actions are more easily susceptible to inhibition than are responses carrying little observable consciousness. A love response, for example, which may have occupied the consciousness of a young woman for many days or weeks, is frequently completely inhibited by a chance frown or impatient gesture on the part of the loved one. The most fiercely aggressive purposes of an adult human male, carrying with them both prolonged and intense consciousness, may similarly be interrupted easily by inhibition at a crucial point, even though the intruding stimulus be of no greater intensity than the disapproval of a partner or the absence from the city of another individual concerned in the enterprise. On the other hand, habitual responses such as walking or finding one's way to one's place of business through crowded traffic of a great city, may fail to be inhibited or impaired in the slightest degree even by the most intense variety of stimulus such as business failure, or the loss of a loved member of one's family. They are inhibited only when brought into consciousness by the loud honk of an approaching motor. If an adult eats food with his knife, he can only overcome such a fixed habit by making himself fully aware of his act every time he performs it. If a person is performing a task which requires him to think out every move, a single suggestion on the part of another may suffice to inhibit the response altogether. Consciousness, then, seems to be associated with ready inhibition of response.

9. The more conscious two or more responses are, the more they tend to facilitate or to interfere with one another.

There is, we find, another characteristic propensity of conscious behaviour which very closely resembles the ease of inhibiting just considered. Reactions of a simple reflex type to which little consciousness is attached do not seem to be markedly influenced by other responses which may happen to be simultaneously taking place. Highly conscious reactions, however, are readily facilitated or impeded by the addition of further conscious elements of behaviour. An interesting experiment, frequently performed by students of psychology, is to train oneself to write automatically while performing arithmetical sums, or while carrying on trivial conversation

with another person. When this ability has been acquired, we have a situation where two reflex processes, each as slightly conscious as it is possible to make them, proceed simultaneously without any observable influence one upon the other. Similar effects of the same sort are found in every day life. A person with very little social training can converse readily on superficial subjects, while dropping sugar or lemon in his tea. An automobile driver is required to manipulate the wheel with one hand, turn on the lights, perhaps, with the other hand, regulate the accelerator by pressing down with his right foot, and let in the clutch by raising his left foot from the floor of the car. Frequently he must perform all these actions simultaneously and without mutual influence one upon the other.

What happens when the response is necessarily accompanied by a great deal of consciousness? Suppose that a couple of research students are deep in discussion of the apparatus required for a given experiment. Another student brings into the room a piece of apparatus which he has used in his own work. Inspection of his apparatus requires the initiation of a new and complicated group of reactions on the part of both students concerned in the original discussion. Yet their inspection responses will be sure to combine in some way with the discussion already going forward. The new apparatus may harmonize with the plans tentatively evolved. In that case a very noticeable increase in the vigour and volume of the discussion will immediately occur. Or, as the apparatus is inspected, it may present hitherto unsuspected difficulties in the procedures under consideration. In that case the new set of reactions produced conflict with the preceding responses, the conflict manifesting itself to the casual observer in the form of hesitation, argument, and disagreement. There is little likelihood that inspection of the newly-presented apparatus can proceed simultaneously with the preceding discussion or that it even can alternate with this discussion without influencing it by way of facilitation or conflict or both. When responses already going forward attach to themselves much consciousness, it usually will be found impossible to undertake a new set of conscious responses simultaneously. If the super-added reactions fail to inhibit the preceding conscious behaviour altogether, which is always likely, the new reactions will combine with the old either by enhancing their efficiency

or by introducing obvious conflicts. Whether this result is due to what has traditionally been called "increase of associative connections" *pari passu* with increase of consciousness, or whether it is to be explained by some more explicit neurological mechanism, the fact remains that the more conscious any two reactions are, the more likely they are to inhibit one another, to facilitate one another by alliance, or to diminish one another's efficiency by conflict.

10. The more conscious a response is, the more easily it is abolished or enhanced by drugs.

Highly conscious responses may be abolished completely by the use of drugs, while reflex reactions of low order involving little consciousness proceed with only slight diminution under moderate dosages of anaesthetic. In taking ether, the responses carrying the largest amount of consciousness are first abolished. The "unconscious" reactions proceed substantially undiminished after the patient has taken all the anaesthetic he is able voluntarily to inhale.

Other drugs, such as various forms of morphia and Indian hemp, in certain appropriate dosages, produce tremendous enhancement of the most highly conscious reactions while having a negligible effect upon the more unconscious types of behaviour. The highly imaginative writings of DeQuincy may be cited as examples of intensely conscious responses greatly enhanced, according to DeQuincy's own report, by appropriate drugs. These same drugs at advanced stages of their influence upon the body may abolish or inhibit the habitual reactions, also; but the first effect to appear as well as the most quantitatively marked influence seems to be exercised upon the most highly conscious activities of the subject.

W. W. Smith has shown[1] that moderate doses of alcohol produce what he calls an "all or none" effect upon the emotional responses of his subjects. That is, the highly affective reactions carrying with them a great deal of consciousness require a much more intense stimulus to set them off. When, however, these highly conscious responses are evoked, their intensity is out of proportion to the intensity of the stimulus. We have already noted that conscious emotions were subject to greater variability of effective stimulus intensity and also to less close correspondence with stimulus intensity than are

[1] W. W. Smith, *The Measurement of Emotion*, ch. viii., p. 124.

the little conscious, or "unconscious" responses. Smith's work, therefore, seems to indicate that the influence of small amounts of alcohol is markedly apparent in those responses to which is attached the larger amount of consciousness. Drugs, then, whatever be the direction of their effect upon the body, appear to exercise their influence more clearly upon the reactions involving most consciousness.

In summary, there are ten easily observable objective changes in human behaviour appearing simultaneously with the reported increase of consciousness, namely:

1. Longer period between application of the physical stimulus and appearance of bodily response.
2. Persistence of bodily responses after the physical stimulus has been removed.
3. Less correspondence between the temporal rhythm or intervals manifest in the reaction, and the time intervals at which the environmental stimulus is received.
4. Less correspondence between the intensity of the final bodily response and the intensity of the stimulus.
5. Increased tendency for several stimuli, each too weak to arouse the response by itself, to add themselves together and jointly evoke the reaction toward which they tend.
6. Greater fatiguability.
7. Greater likelihood that the same reactions will occur, at different times, in response to stimuli of different intensity.
8. Increased tendency to be inhibited by stimuli of comparatively slight intensity.
9. Increased tendency to combine with, or to conflict with, simultaneously imposed responses.
10. Increased susceptibility to the influences of drugs.

These ten behaviour variances, then, may be shown to appear in human behaviour *pari passu* with the reported appearance of consciousness. Like the sparks from Ben Franklin's kite-string they reveal a specific but as yet undescribed type of energy. Is this energy identical with consciousness?

There is, of course, a logical possibility, not to be overlooked, that the effects noted may be ascribable to the same vitalistic-type cause that simultaneously produces consciousness, instead of the effects being ascribable to consciousness itself acting as a vitalistic-type cause. Elaboration of this logical issue, however, is largely academic. All the effects noted

must be attributed, because of their positive nature, to some form of potent energy; and it is more of a philosophical than a psychological issue to decide whether this potent energy *causes* consciousness or *is* consciousness. The later form of expression seems, for scientific purposes, more simple and accurate.

If there exists, then, a describable form of energy somewhere within the human organism capable of influencing behaviour in the ways noted, and if this potent form of energy is always found appearing simultaneously with consciousness, we may state, for psychological purposes at least, that *the form of energy thus discovered is consciousness.* Should consciousness turn out to be an energy by-product of the primarily potent form of force producing effects enumerated, then we should find inevitably a new series of observable effects which the energy by-product, consciousness, exercises, both over the parent energy directly, or over the physical behaviour results supposed to be produced jointly with consciousness, indirectly.

Consider an analogous situation. During electrolysis of water, two sets of physical phenomena are readily observable—the giving off of hydrogen gas, and the formation of bubbles on the electrodes. For a time, after the current is turned on, these two sets of changes run parallel to one another, and during that initial period the mistake might be made of attributing one phenomenon to the causal agency of the other, instead of considering both as results of a common cause, the electric current. But, after a short time, the formation of bubbles interferes, slightly, with the passage of the current, so that the more bubbles are formed, the less hydrogen is given off. This change in relationship reveals, at once, that a common cause of both phenomena must be sought. So far as my own researches reveal, there is no indication of a change in the parallel relationship between symptomatic behaviour and consciousness, which might suggest that both are attributable to a common cause. In short, granted a complete correspondence between symptomatic behaviour effects, and the appearance of consciousness without subsidiary variance, there is strong likelihood that consciousness and the primarily potent energy cause of the behaviour symptoms are identical. When the nature of this energy is discovered, it can definitely be described, like any other form of energy.

Consciousness Is Not Intra-neuronic Energy

What, then, is the nature of this conscious-energy? Where is it to be found? The simplest suggestion, in answer to these questions, seems to be that consciousness, in its physical aspect, is merely intra-neuronic energy. When physiologists, who naturally tend toward this hypothesis, are asked to account for the presence of much consciousness in some responses, and little or no consciousness in others, they reply that only in the more highly evolved portions of the brain is there a sufficient accumulation of nervous energy, or a sufficient intensity, or some other attribute of nervous energy, to produce consciousness. A few theorists may, perhaps, suggest that somewhere in the brain is a special kind of nerve cell capable of manufacturing conscious energy; but, so far as reported to the literature, no new type of brain cell, differing basically from neurones in other parts of the central nervous system, has been discovered. Such a suggestion, therefore, represents sheer imaginative speculation, and need not be resorted to until all known sources have failed to yield a trace of identification of any known form of energy with consciousness. What, then, of the physiologist's proposition that a sufficient mass of nerve impulses, *per se*, may constitute consciousness?

Does nerve trunk conduction actually correspond with consciousness? There are many difficulties in the way of such a theory.

First, and most important, we find that the ten types of effect upon human behaviour enumerated above as probable results of consciousness, do not find their physical basis in intra-neuronic phenomena at all. They are, rather, attributable to synaptic influence. The ten varieties of end-effect mentioned, together with several other similar effects, are listed by Sherrington[1] as inhering in reflex-arc conduction only, and not in simple nerve-trunk conduction at all. Sherrington further shows that the salient characteristic of reflex conduction is the fact that synapses are interposed in the total nerve impulse circuit. It is at these synapses that phenomena occur producing the effects reviewed. That is to say, the fewer synapses in any nervous circuit, the less prominently may we expect the effects which we have seen to be typical of consciousness to appear.

[1] C. S. Sherrington, *The Integrative Action of the Nervous System*, p. 14.

The simple reflex acts, characterized by least consciousness, would contain, on the other hand, by far the greatest proportion of intra-neuronic disturbances, or simple impulses of conduction within the nerve trunk, and by far the fewest synapses. If these nerve trunk impulses truly constitute consciousness, as some physiologists maintain, there is a complete contradiction between evidence and theory. Where least consciousness actually appears, the greatest proportion of nerve trunk activity is to be found, and vice versa. It seems impossible, therefore, to define consciousness as the totality of changes, or energy within simple nerve tissue, since this does not contain the mechanisms for the effects most characteristic of consciousness in our every-day experience.

In the second place, the same nerve trunks may be used for several purposes, that is, to convey impulses ultimately associated with two or more diverse varieties of consciousness. By the all-or-none law, each nerve fibre must respond *in toto* if it reacts at all. If, then, different units of consciousness ultimately appear due to ultimately diverse paths over tiny lengths of nerve trunk in the brain, could they escape marked resemblances, one to the other, when the greater portion of their purely intra-neuronic constituents had been identical? Pain impulses, for example, seem to travel during the first part of their circuit, at least, over identical sensory neurones with cold, pressure, auditory, visual, and many other types of afferent excitations, modally distinct in consciousness one from the other.

This point[1] has been adversely criticised by A. Forbes,[2] of Harvard Medical School, who cites the work of Adrian and Zotterman. C. J. Herrick,[3] however, states, "From this it would appear that most sensory nerves may, upon occasion, function as pain nerves." Herrick holds that the painful quality of consciousness is superadded to the ordinary sensory consciousness of the receptor apparatus stimulated, "unless the stimulation is excessively strong". Moreover, according to both physiological and psychological theories of vision, and other senses, excitations ultimately producing different sensations may originate in the same sense organ, thus making the

[1] The argument under discussion was advanced more briefly by the writer in "The Psychonic Theory of Consciousness," *Journ. Abnormal and Social Psychology*, July, 1926.

[2] In a letter to the writer.

[3] C. J. Herrick, *Introduction to Neurology*, 1920, p. 277.

long, afferent conductor paths to the higher centres identical. But no part of this identity seems to be left in the final sensory consciousness.

On the motor side, the term, " final common path ", speaks for itself. All motor impulses must travel final common paths with impulses originating from many different sources, so that all must have large identical elements of intra-neural excitement. Physiologists, to be sure, might attempt to avoid this further problem by denying the existence of such a thing as motor consciousness altogether, even though, in so doing, they introduce an inconsistency into their conception of consciousness by maintaining that half the nerve impulses of the body (motor nerves) are not conscious, while the other half (sensory impulses) are conscious. Without pursuing further, at this time, the arguments for and against motor consciousness, we may emphasize the fact that the lack of similarity in various sensory elements of consciousness initially employing identical afferent nerve paths still stands as evidence against the physiological theory that nerve-trunk excitement *is* consciousness.

In the third place, different neurons appear frequently to be used in manufacturing identical elements of consciousness. Centrally aroused sensation such as, for example, " memory " of the colour red, or of muscle sensations in the legs or arms, or of the tone of a violin, may be consciously no whit different from the originals of these remembered sensations when the sensations were evoked directly by environmental stimulation of appropriate sensory nerves. Yet we know that nervous impulses cannot travel backward down the afferent paths so that the actual nerve impulses responsible for the remembered sensations must differ greatly from the intra-neuronic impulses which brought about the original sensations themselves. If consciousness consisted of the actual totality of nervous impulses concerned, in each case, then a remembered red sensation might be expected to differ substantially from red sensations which resulted from nerve impulses travelling up the optic nerve. Granted that both environmentally aroused red and the remembered red sensation utilized the same final sensory paths in the visual centres of the brain, there would still be the entire amount of optic nerve trunk energy possessed by the original sensation but not by its memory. Is it probable to suppose that this added increment of energy, if this energy were consciousness itself, would add nothing to the totality of consciousness in the original red sensation ?

This proposition might indeed contain greater probability were it not that the optic tract nerve trunks are of great length as compared to the microscopic lengths of conducting fibres in the higher centres of the brain. If each unit of nerve impulse energy is conscious, it is hard to see how the very short conductor tracts of the cerebral centres could contribute a greater total amount of simple nerve impulse energy than could the long afferent nerve trunks ; and it is still more difficult to guess how the relatively tiny conductor trunks in the brain could contribute enough nerve impulses to obscure altogether the quantity of intra-neuronic energy contribued by the afferent nerve trunks. If, as previously noted, the presence of large identical units of nerve energy in the manufacture of different sensations does not make these different sensations in the least similar, no more does the presence of a considerable volume of nerve trunk energy in connection with a given sensation seem to cause the sensation to differ in the least from an identical sensation manufactured without a similar volume or locale of nerve trunk participation.

In the fourth place, although there seems to be a mnemonic factor intrinsic in the behaviour of a single neurone in forming habitual junctions with neighbouring cells[1] there clearly could exist no structural changes within the nerve itself which could actually constitute the process of functional conjunction, since this process by definition takes place in the synapse, externally to the intra-cellular protoplasms of all neurones concerned. Thus no train of consciousness could be consecutive or continuous, if it were regarded as being constituted by the changes within any nerve cell in a reflex arc, for whenever any nervous impulse passed from neurone to neurone the propagation of energy between the cells would be of a totally different nature[2] and so it would no longer be included in our

[1] C. J. Herrick, *Neurological Foundations of Animal Behavior*, New York, 1924, p. 112.

[2] C. S. Sherrington states : " . . . the intercalation of a transverse surface of separation or membrane into the conductor must modify the conduction," and : " It (the synaptic membrane) would be a mechanism where nervous conduction, especially if predominantly physical in nature, might have grafted upon it characters just such as those differentiating reflex-arc conduction from nerve-trunk conduction." *The Integrative Action of the Nervous System*, p. 17.

definition of " consciousness ". Moreover, since all facilitations and conflicts between impulses seeking to use a common neural path must occur for the most part in the synapses between the antagonistic neurones and the cell which both sets of impulses are seeking to enter, such alliances and antagonisms could find no counterpart among " conscious " phenomena, were the latter confined to intra-neural activities. Yet frequently reported " feelings of conflict ", " conscious thwartedness ", and, on the other hand, " relief " and " feelings of harmony " seem most probably to depend upon these very extrinsic relationships between opposed and allied nerve impulses which we have been considering.

Finally, we know that different rhythms of stimulation, simultaneously applied, and using the same final common path to evoke the same muscular response, do not interfere with each other or break up the existing rhythm of response.[1] This would indicate that two separate nervous impulses, though they may use the same neurones simultaneously, do not fuse or combine in any way within the conductor nerve cells. If this be so, then identification of " consciousness " with intra-neuronic change would leave totally unaccounted for all those " psychological " fusions, alterations, and recombinations of " conscious " elements which are continually reported by nearly all observers. If such fusions actually do occur, as supposed, at the synapses, no possible change within the individual neurones in any reflex chain could ever give them " conscious " representation.

Consciousness is Synaptic Energy

We have seen, during the foregoing brief review, that there exist substantial objections to the definition of consciousness in terms of nervous impulses. We have, therefore, the question still with us : What is consciousness ? Before discussing the intra-neuronic theory of consciousness, ten types of effect which consciousness seems to have upon human behaviour were mentioned. These ten types of influence were cited as proof that an active energy is generated somewhere in the human organism possessing the attributes of consciousness. During discussion of the first of our reasons for rejecting the intra-neuronic theory, the fact was disclosed that, although

[1] C. S. Sherrington, *The Integrative Action of the Nervous System*, p. 188.

the ten types of conscious influence do not have their causal origin in nerve impulses of conduction, their origin is attributed by neurological authorities to whatever happens at the synapse. Sherrington lists some thirteen of fourteen phenomena as characteristic of synaptic influence upon nerve conduction as follows[1] :

1—latent period
2—after discharge
3—loss of correspondence between rhythm of stimulus and rhythm of end effect
4—interference with grading of intensity
5—temporal summation
6—fatiguability
7—variability of threshold value of the stimulus
8—inhibition
9—mutual facilitation and conflict of impulses (treated separately in Sherrington's original work)
10—increased susceptibility to drugs : also, irreversibility of direction of nerve impulses, marked refractory period, " bahnung ", shock, dependence upon blood circulation.

It will be noted that the first ten synaptic influences listed correspond to the ten influences consciousness exerts over human behaviour. It is quite easy, also, to discover close correspondence between consciousness and the other synaptic influences mentioned. Such discussion of these further correspondences is omitted in order to avoid too technical an excursion into neurological subject matter.

While human reactions, from the simplest to the most complex, probably depend upon reflex arc conduction, each arc containing, according to Sherrington,[2] at least three neurones and, therefore, two synapses, the more complex the reaction, the more complex must be the reflex arcs involved. That is, the more synapses have to be passed in any response, the more must be the synaptic phenomena under consideration. As the complexity of the arc is increased, the greater will be the volume of synaptic energy as compared to the volume of simple nerve trunk energy. And, as we have observed, the greater

[1] C. S. Sherrington, *The Integrative Action of the Nervous System*, p. 14.
[2] "The reflex-arc consists, therefore, of at least three neurones," Sherrington, *ibid*, p. 55.

the complexity of the reaction the more consciousness is to be found accompanying it. Simple reflexes and habitual actions are brought about by a maximum of nerve trunk energy and a minimum of synaptic energy. Simple reflex responses contain little, or no, consciousness, which the subject himself can observe. Complex subjective responses involve a maximum of synaptic energy, and a minimum of nerve trunk activity. These are the responses which are uniformly regarded as containing a maximum amount of consciousness.

The intra-neuronic theory supposes that consciousness appears only in the higher centres of the brain, because in no other place is to be found sufficient concentration of nerve impulse energy which is regarded as a physical basis for consciousness. " The higher centres " referred to, however, are located in the grey matter of the brain, and the grey matter is characterized chiefly by the enormous number of synaptic connections which are there operative. The grey matter is, in fact, chiefly composed of microscopically small neurones, each forming a large number of synapses with many similar neurones. The cerebral centres, therefore, where some physiologists suppose consciousness to be, are composed almost entirely of synaptic junctures.

Granted that the physical basis of consciousness lies in the higher centres, made up chiefly of tremendous numbers of synaptic connections, this fact, together with the evidence offered that the effects of consciousness on human behaviour are also synaptic, lead to the conclusion that *consciousness is to be identified with synaptic energy.*

Concept of the Psychon, and of the Psychonic Impulse

" Synaptic energy " is, however, a somewhat vague term. Specific types of energy are customarily defined by describing the type of matter within which the energy in question takes its origin. " Matter " is a word that is somewhat out of vogue, since it is now the fashion to conceive of matter itself in ultimate terms of energy. Nevertheless, if one understands by the word " matter " a form of energy so permanently established that it gives rise to a comparatively uniform sort of experience, it remains a very convenient word to use in a discussion such as the one we are now undertaking.

All physical science assumes that there is some sort of matter. moving. Description of any connected series of

changes in any form of matter and its movement may aptly be termed a study of its " behaviour " in that particular level of complexity. Physics seeks to present basic descriptions of the behaviour of matter in its most elementary forms, the proton and the electron, and to trace the behaviour propensities of larger material masses back to the interaction of proton and electron systems, within the atom. Chemistry begins where physics stops, and deals with the laws of behaviour of the atom and the molecule, each containing varying numbers of protons and electrons. Chemistry deals especially with the laws controlling the combinations of atoms and molecules into more complex forms of matter. Biology deals with the behaviour of still more complex matter units, usually called " living organisms " of various sorts. Biology includes botany, which describes the type of living organisms called " plants "; and zoology, which deals with another type of living organism called " animals ". Animals are matter-units of such extreme complexity, that their component parts become subject matter for several specialized sciences. Physiology specializes in describing certain parts of the animal termed " bodily organs ", and their behaviour. Neurology selects matter-units called " nerves ", upon which the behaviour of many bodily organs largely depends, and attempts to describe the behaviour of these nerves or neurones. If, then, there exists no further type of matter-unit capable of modifying neuronic behaviour, psychology, for all I can see, is out of a job. Should I become convinced of this state of facts I should feel compelled to consider psychologists in the same relation to neurologists as are carpenters to architects, and I should, for my own part, try to escape the fixed limits of craftmanship by studying my way into the ranks of my immediate intellectual superiors.

But, if, as suggested, there exists still another sort of matter unit beyond the neurone, capable of undergoing its own particular series of changes called " conscious " or " psychical " changes, and capable of modifying, by these changes, the behaviour of neurones, then, and then only is psychology truly justified in assuming a definite place among the physical sciences by the side of physiology and neurology.

Neurologists inform us that a specific conductive structure does exist at the synapses in all types of nervous systems evolutionally above those of the coelenterates. " It is generally

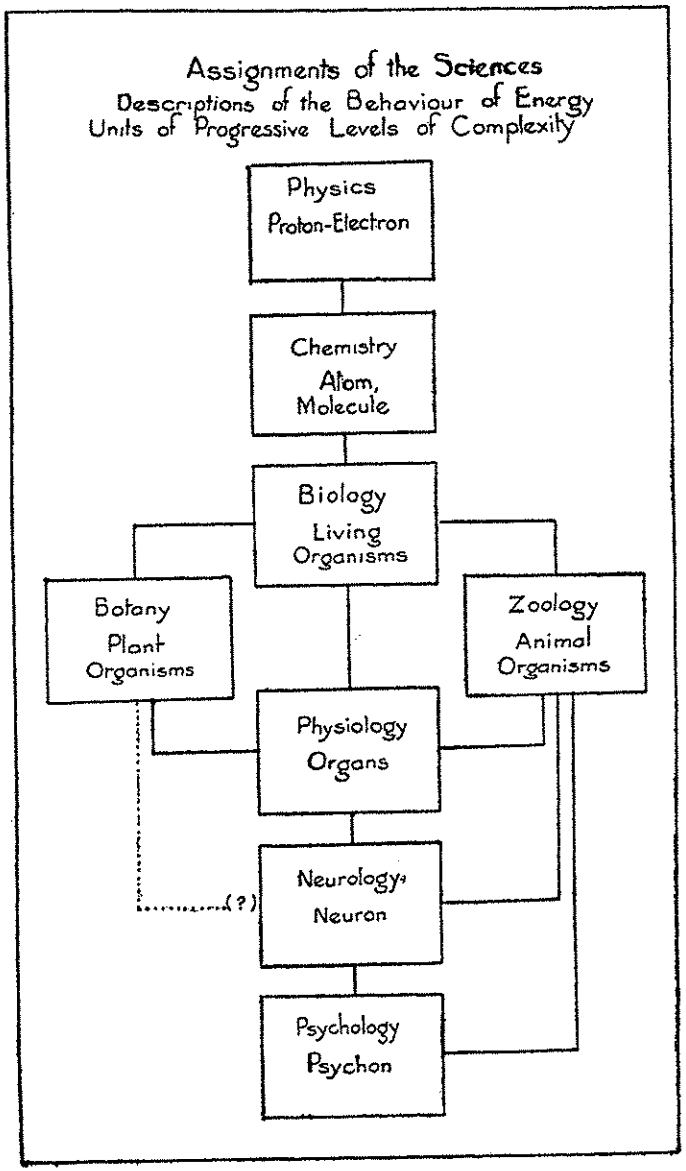


Figure 1

admitted", says Sherrington,[1] "that there is not actual confluence of the two cells together, but that a surface separates them; and a surface of separation is physically a membrane. . . . It would be a mechanism where nervous conduction, especially if predominantly physical in nature, might have grafted upon it characters just such as those differentiating reflex arc conduction from nerve trunk conduction."

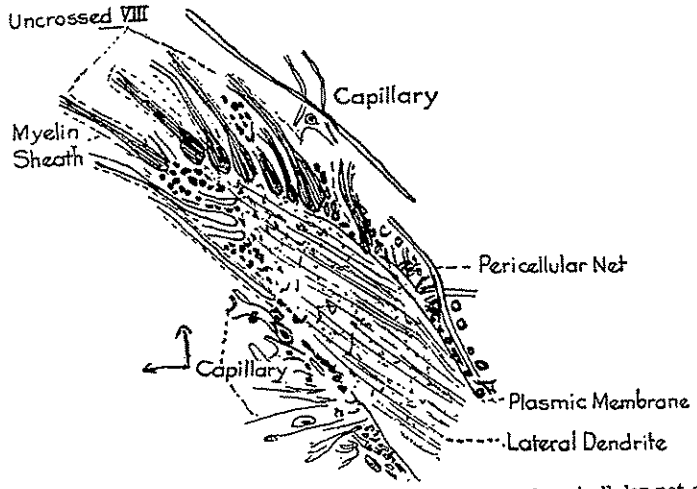
"In most groups of animals above the coelenterates", says Herrick,[2] "the cells of which the nervous system is composed (or some of them) are related to each other quite differently from those seen in the meshwork of protoplasmic strands which compose the nerve net . . . there is a membrane separating the neurones. The presence of such a barrier at the synaptic junction does not imply that the neurones are not in protoplasmic continuity, for the separating membrane itself is living substance. What it does indicate is that there is a change in the physico-chemical nature of the conducting substance at the synaptic barriers. Langley has termed this barrier 'junctional tissue', and of its great physiological importance there can be no doubt."

Physiologists, then, agree that there exists a special type of matter unit at the synapse capable of giving rise to a special type of energy which differs, in essential respects, from the nervous impulse. Neurological authorities, however, are not in such close agreement concerning the physical description of this junctional tissue. In the case of the giant Mauthner's cells, synapses between these cells and adjacent neurones can be seen and studied under the microscope by means of preparations in which the material has been fixed and stained. G. W. Bartelmez originally reported[3] that the knob-like endings of the axone fibres of the eighth nerve were seen in contact with the surface of the adjacent cell. Bartelmez saw a distinct plasm, or membrane, over the root fibres; and, where the lateral dendrite was cut squarely, a smaller membrane could be distinguished around it. There is little delay at this synapse, yet Bartelmez found that two synaptic membranes forming a junction by contact with one another

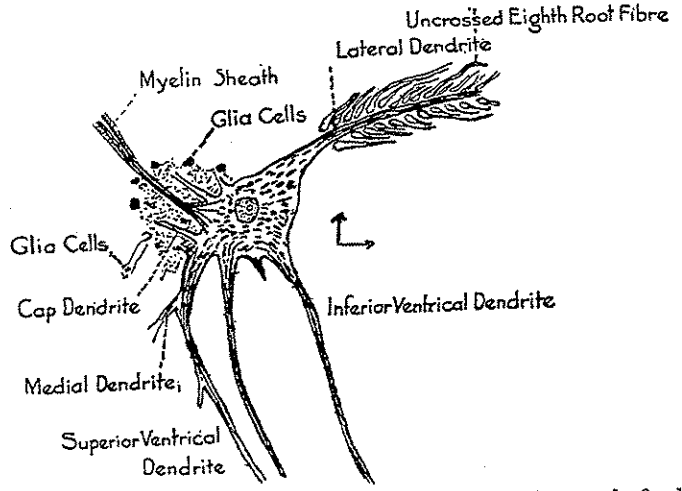
[1] C. S. Sherrington, *Integrative Action of the Nervous System*, p. 16.
[2] C. J. Herrick, *Neurological Foundations of Animal Behavior*, 1924, pp. 104, 114, 115.
[3] G. W. Bartelmez, "Mauthner's cell and the Nucleus Motorius Tegmenti," *Jour. Comparative Neurology*, 1915, vol. 25, pp. 87-128.

Figure 2 THE SYNAPSE

(From Bartelmez, *Jour. of Comp. Neurol.*)



PART A.—" The detail of the VIIIth nerve endings, and pericellular net of the lateral dendrite of Mauthner's cell, drawn from a single section of an adult Ameiurus brain fixed in osmic-Zenker and stained with iron hematoxylin . . . The section passes obliquely through the base of the lateral dendrite, and shows the bulb-like endings of the VIIIth root fibres, and the fine meshed neuropil of the pericellular net on its surface."



PART B.—" The right Mauthner's cell from a young Ameiurus male, fixed in a formol-osmic-Zenker and stained with iron hematoxylin. A semidiagrammatic reconstruction of ten sections, 5μ thick, magnified 250 diameters, to show the relations of dendrites and axone to the cell body and the two striking synapses of the cell, viz., the endings of the VIIIth root fibres (Uncrossed VIII) upon the lateral dendrite, and the axone cap covering the medial surface of the cell. Only four of the cap dendrites are shown."

had to be energized before conduction could continue through the recipient neurone. Marui, who used different fixing and staining solutions, reported,[1] on the other hand, that he was able to trace tiny connective fibres emerging through the outer membrane of the club endings, and that he traced these minute, protoplasmic threads into contact, at least, with the adjacent neurone. Says Marui, " it is clearly shown that the intra and extra cellular neural fibres communicate with each other ".

Bartelmez, in still a later paper[2], criticized Marui's technique on the ground that he had used formol in the staining solution, and that the use of this fixative was responsible for the false appearance of intercellular fibres. Such connecting filaments, Bartelmez regards, therefore, as arte-facts. Sherrington[3] in a recent citation propounds a theory of synaptic phenomena which seems to assume the existence of a membrane similar to that described by Bartelmez. Forbes,[4] on the other hand, has propounded a theory of the synapse based upon the idea that the various synaptic phenomena are results of nerve impulses in adjacent neurones being compelled, at the synapses, to communicate their energy through intercellular fibres of much smaller dimensions than the nerve trunk fibres. This view would be in accord with Marui's description of the physical appearance of junctional tissue, rather than with the view of Bartelmez. The exact structural description of the connective synaptic tissue must, it would seem, be left in some doubt for the present. I believe that it will make little difference to the theory of consciousness, herein proposed, whether the junctional tissue be thought of as a pair of sheet electrodes formed from the surface membranes of adjacent fibres, or whether the junctional tissue may eventually be described by comparison to the Tungsten filaments of electric lamps. Whichever observation may turn out to be most accurate, the evidence for placing consciousness at the synapse remains unchanged.

[1] K. Marui, *Jour. of Comparative Neurology*, Vol. 30, pp. 127-158.
[2] G. W. Bartelmez, " The Morphology of the Synapse in Vertebrates," *Archives of Neurology and Psychiatry*, Vol. 4, pp. 122-126.
[3] C. S. Sherrington, " Remarks on Some Aspects of Reflex Inhibition." 1925. *Proc. Royal Soc.*, VCII, 519.
[4] A. Forbes. " The Interpretation of Simple Reflexes in Terms of Present Knowledge of Nerve Conduction," *Physiological Reviews*, Vol. II, No. 3, July, 1922, pp. 361-414.

In view of all the evidence, I submit the suggestion that *the totality of energy generated within the junctional tissue between any two neurones, whenever the junctional membrane is continuously energized, from the emissive pole of one adjacent cell to the receptive pole of the next, intrinsically constitutes consciousness.*

In expounding this theory during lectures, I have found it very convenient to employ a single term descriptive of any particular unit of junctional tissue which may be under discussion. Neurology, the science of nervous behaviour, dubs its structural unit the "neurone". Following this analogy, I have ventured to term the structural unit of psychology, which, as a scienoe, must surely undertake the study of "psychical" or "conscious" behaviour, the "psychon".

Propagation of energy upon any psychon, or unit of junctional tissue, is definitely dissimilar in nature to the passage of nervous energy through individual neurones. Following the neurological analogy to its logical completion, therefore, we may term *any wave of physico-chemical excitation initiated within a psychon, a "psychonic impulse".*

It is clearly established by neurologists that the principal function of the neurone is conduction. It is my suggestion that *the principal function of the psychon is consciousness.* Whatever conduction of energy may occur across a psychon seems incidental to the modifying major effect of impeding, regulating, and generally psychon's that energy in the course of its passage. The Tungsten filament in an electric light bulb conducts, to be sure, a certain amount of electrical energy from electrode to electrode; but the principal function of the filament is, nevertheless, illumination. Thus, while we may probably regard the psychon as a certain sort of conductor of inter-neuronic energy, we may adequately describe its chief property only, I believe, as the generation of consciousness.

CHAPTER IV

Motor Consciousness as the Basis of Feeling and Emotion

The importance to psychology as a whole of obtaining a tangible psycho-neural hypothesis of emotion can hardly be exaggerated. At the moment, investigators in the field of emotions find themselves at sea between the Scylla of James-Langeism, and the Charybdis of youthful-minded adventurers in psychological research who would persuade us to hoist the Jolly Roger, abandon all theories, and all previous results and undertake statistical correlations of how all people react under all possible circumstances. These young pirates urge the irrefutable thesis that no knowledge is absolute, and themselves conclude that any attempted formulation of disconnected emotional data into anything resembling scientific law must be nothing short of maudlin.

Such new-found insistence upon the sanctity of unrelated fact is commendable in so far as it places just emphasis upon objectivity of research method. But the history of psychology's elder sisters among the sciences, and even of psychology herself, reveals a certain dependence upon constructive theory. The laws of Newton, for example, have received important modification at the hands of Einstein and others; yet who can doubt the central importance of Newton's hypothesis to the growth of physics, and allied sciences? The atomic theory may be inadequate as a formulation of present-day chemical data; yet modern chemistry has climbed to its present height upon the scaffolding of that same atomic theory. So it is with the James-Lange theory of emotions. Psychology may be just at the point of outgrowing it, but must we abandon ourselves, forthwith, to an orgy of unscientific disorganization?

Clearly, efforts are being made to drive the psychology of emotion in that direction. There is a certain self-important

ease and nonchalance to be obtained by the method of putting out one's research results bare of theoretical analysis that has its appeal. And there is less danger of being contradicted. Yet, if psychology is to become the same sort of science that neurology and physiology are, for example, it seems to be necessary for somebody to take a chance and construct basic theories.

Physiologists' Disproof of James-Lange Theory

James' theory of emotion received two radically different formulations at his hands. The first formulation was contained in the simple statements: "We are afraid because we run away. We are angry because we attack." With this theory duly qualified, I am in entire agreement, and this book will be devoted to an attempted elucidation thereof.

When faced with the necessity of explaining his radical-sounding thought, however, James slipped over into an entirely different theory of emotion which agreed, substantially, with that of Lange. It is easy to see how James was forced into this contradictory transition. He had observed, introspectively and objectively, that bodily changes "followed directly the perception of the exciting fact", and that "awareness of these changes as they occur, *IS* the emotion". But when called upon to state how we could be aware of the changes occuring in our organism, as they occur, James found only sensory terms in existence with which to describe the awareness in question. If we didn't have sensations of the immediately resulting bodily changes, how could we become conscious of them at all? So James was compelled to suppose that the initial bodily changes stimulated somatic sensory end organs, in muscles and viscera, setting up a second series of reflex arcs productive of bodily sensations. Shrewdly forecasting, perhaps, the reports of Lennander[1] and others concerning the paucity of visceral sensory mechanisms, James did not place the same emphasis upon visceral sensation as content of emotion as did Lange. Nevertheless, he accepted both visceral and kinaesthetic sensations as characteristic constituents. In so doing, we may note that James denied his primary thesis that "emotion *IS* the awareness of these bodily changes *AS THEY OCCUR*". If emotion is made up of

[1] K. G. Lennander, "Leibschmerzen, ein Versuch, einige von ihnen zu erklaren," *Grenzgeb. d. Med. u. Chir.*, 1906, vol. XVI, 24.

sensation, then the important sensations are those set up as a result of initial bodily changes, and these sensations can only occur *after* the primary bodily changes. The refutation of this sensory-content formulation of the James-Lange theory, then, could be accomplished by showing that emotion persists after the sensations of which it was said to be composed have been eliminated.

Sherrington's Results

This work was undertaken by Sherrington[1], who performed appropriate spinal transections upon dogs, eliminating visceral and most kinaesthetic sensations following emotional stimulation of the animals. Behaviouristic evidences indicated that the dogs' emotions remained unchanged. One animal was stimulated with dog-meat, a stimulus never applied to this dog prior to operation. Evidences of what Sherrington calls "disgust" immediately appeared. Neither memory of previous sensations nor previous conditioning of symptomatic behaviour could have taken place in this instance. Sherrington concluded that emotion might be supplemented by sensations of bodily changes, but was not essentially composed of such sensory content.

Goltz's Results

Goltz proved, conversely, that all emotions but "rage" did disappear after decerebration of dogs,[2] an animal preparation permitting the sensations of which emotion is composed, according to James-Lange, to remain, but abolishing the higher correlation and motor centres. No pleasure, sex response, or even appetitive enjoyment of food could be aroused in an animal thus prepared. From various supplementary data, Goltz concluded that "rage", also, was a product of the central nervous system, but at a lower level than that required for the other emotions.

Work of Langley and of Cannon

Another approach to the problem of determining the rôle that visceral sensations play in making up emotion was made

[1] C. S. Sherrington, "Experiments on the Value of Vascular and Visceral Factors for the Genesis of Emotion," *Proc. Roy. Soc.*, 1900, LXVI, 390.

[2] F. Goltz, "Der Hund ohne Grosshirn," *Arch. fur d. gesam. Physiol*, 1892, vol. LI, 570.

possible by the work of Langley,[1] who described the "autonomic" innervation of the viscera. Langley's description indicated that if any part of the viscera were adequately innervated, large allied areas must undergo identical changes, and would, of course, produce identical sensations.

Cannon[2] was the first to apply this neurological fact to criticism of the James-Lange theory. After proving experimentally that practically identical visceral changes did, in fact, occur during "rage", "pain", and "fear" responses of animal subjects, Cannon pointed out that the conscious qualities differentiating these "major emotions" could not possibly depend upon sensory differences which did not exist. Cannon concluded, as had Sherrington, Goltz, and others, that emotional "response is a *pattern reaction* . . . in which impulses flash through peculiarly co-operating neuron groups of the central nervous system, suddenly, unexpectedly, and in a manner not exactly reproducable by volition. . ."

To an unprejudiced mind, not "brought up on" the James-Lange theory in its commonly accepted formulation, these physiological results would seem conclusive refutation of the idea that emotion consists of sensation. One loophole, however, has been pointed out frequently in discussion, by those who still cling to the sensation theory. Though any given emotion, experimentally tested, can be shown not to depend upon sensation, may not the emotion have been built up, originally, by compounding of sensations containing minute differences from other major emotional compounds, and subsequently remembered in connection with that type of stimulus? If so, the sensation compounds must have been manufactured prior to birth. For Watson has shown[3] that human infants are inherently equipped to manifest at least three responses of an emotional nature, "rage", "fear", and "love", without passing through any preliminary learning process.

Unsolved Problem

Thus we return, perforce, to James' simpler statement of

[1] J. N. Langley, "Sympathetic and Other Related Systems of Nerves"; Schäfer's *Textbook of Physiol.*, vol. II, 616-697, 1900; also *Ergebnisse der Physiologie*, Wiesbaden, 1903, vol. II, 818.
[2] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, 1920, N.Y.
[3] J. B. Watson and Rosalie R. Watson, "Studies in Infant Psychology," *The Scientific Monthly*, 1921, 493-515.

his own theory: We feel in a given way because we act in a given way. And our awareness of our reaction *as it occurs IS* the emotion. Unless we choose, like Watson, to deny that "awareness" or "consciousness" constitutes a physical phenomenon which psychologists are called upon to describe, we find ourselves squarely faced with the same problem that forced James into that untenable sensory-content formulation of his theory which we have just discussed.

The problem is: How can awareness of reaction *as it occurs* be described in psycho-neural terms?

Motor Consciousness Theory

Does anyone know why it has become so uniformly the fashion to assume that all consciousness is sensory in its ultimate nature? Is not the denial of the existence of motor consciousness the real bugbear from which Watsonian behaviourists are fleeing in their insatiable insistence upon the importance of the motor aspect of behaviour? Watson, for instance, inveighs with particular emphasis against "such elements as *sensations*, and their ghosts, the *images*". "This thing we call consciousness", he says, "can be analyzed only by *introspection*—a looking in on what goes on inside of us". And it is true, of course, that many very basic presumptions of present-day psychology have been adopted by tacit assumption upon originally faulty introspective evidence. Perhaps the non-existence of motor consciousness may turn out to be one of these unwarranted, introspective limitations upon psychological theory. We have already, in fact, reviewed a considerable line of emotional evidence plainly pointing to unmistakable affective awareness of reactions *as they occur*. Let me defy Watson's categorical statement that consciousness can be analyzed only by introspection, by attemping an objective analysis of the case for the existence of motor consciousness on the basis of the previously suggested objective description of consciousness itself.

We concluded, in the preceding chapter, that inter-neuronic energy, supposed by Sherrington and other neurologists to possess entirely different characteristics from the disturbances propagated within the individual neurones, may be called "psychonic energy". The further suggestion was advanced that there is considerable evidence for tentative acceptance of the hypothesis that *psychonic energy is consciousness.*

Before continuing with this hypothesis, it might be said that the objective evidence for the existence of motor consciousness would not be any the less striking if we were to adopt other physical theories of the nature of consciousness, such as the physiological idea that consciousness inheres in every propagated neural disturbance. The general plan and structure of the central nervous system, and other points to be considered in favour of motor consciousness would remain equally applicable. Let us consider these points of objective evidence very briefly.

Proofs of Existence of Motor Consciousness

1. Biologically, motor function is primary and sensory and connector mechanisms secondary. Parker says[1]: "To state this conclusion in the terms used in the earlier part of this discussion, sponges may be said to have among their cell combinations effectors, but no receptors or adjustors. They mark the beginnings of the neuromuscular mechanism in that they possess the original and most ancient of its constituents, muscle, around which the remainder of the system is supposed subsequently to have been evolved." "This last conclusion is reinforced", says Herrick, "by citing a number of cases in the higher animals where muscle may act independently of nerves, as in the human iris." Forbes,[2] in fact, has gone so far as to point out that muscle possesses capacity for the "single type of disturbance which seems to be a phenomenon common to muscle and nerve fibres."

It would be most unexpected, though of course not impossible, to find that the motor element, of which sensory and connector tissues remain but slightly divergent modifications, should itself completely fail of representation in the product, consciousness.

2. Motor neurones, in the central nervous system of human beings, are distinguishable from sensory neurones both as to cell structure and as to type of synaptic organization.[3] Motor

[1] Quoted by C. J. Herrick, *Neurological Foundations of Animal Behavior*, New York, 1924, p. 86. Quotation by Herrick, following taken from *same page*.

[2] A. Forbes, "The Interpretation of Spinal Reflexes in Terms of Present Knowledge of Nerve Conduction," *Physiological Review*, 1922, Vol. II, 361-414.

[3] C. J. Herrick, *ibid.*, p. 237.

cells have been shown to possess larger cell bodies, with a richer supply of chromophilic substance. In fixed and stained preparations, this substance is seen arranged in definite, discreet granules, and not diffusely, evidently for the sake of facilitating more rapid and powerful nervous discharge. The motor pathway, moreover, contains a minimum number of subsidary synapses, the large and powerful groups of motor impulses thus sweeping onward to their appropriate organs of discharge with a minimum number of interruptions, once these impulse groups have won the right of way at the central synapses. The motor cells, in short, are constructed for carrying larger and more powerful units of energy; while the sensory tracts seem designed to carry smaller but more variegated impulse groups.

What reason is there to suppose that the smaller units of psychonic energy constitute consciousness, while the larger, simpler units do not? Or, if consciousness is thought of as inherent in the nerve impulses themselves, why should more powerful accumulations of such impulses be supposed to have lost the conscious characteristic? Moreover, the contrast between motor and sensory impulse characteristics, just emphasized, naturally suggests the corresponding contrast between the powerful but comparatively simple sweep of "major" emotions consciousness, and the less insistent but more variegated awareness of discreet sensations. If we find two types of neurone, two types of synaptic arrangement, and two types of impulse groups, what objective reason can be found for granting consciousness to one and denying it to the other?

3. Again, motor phenomena may occur independently of sensory stimulation. Any given impulse or battery of impulses may be blocked at its entrance to a common motor path, not by rival impulse groups, but by the previously existing chemico-physical conditions within the nervous material itself. If sensation is the sole element of consciousness, such phenomena could never attain conscious representation, for they could only result in absence of sensation on the arc of stimulation. Is such an absence of awareness of motor obstruction compatible with the commonly observed ability of the subject verbally to report them accurately?

4. Affective states accompanying motor discharge give

every evidence of being far more diverse than the ensuing sensations of resulting bodily changes could possibly be.[1] Conversely, many investigators report great diversity of bodily changes (with necessarily corresponding diversity of sensory awareness of these changes) resulting from motor discharge accompanied by approximately uniform emotional states.[2] The emotional consciousness, in both classes of cases, is evidenced by verbal report, and also by observed *motor attitude, or set* of the subjects, both human and animal. It is amusing to note the confidence with which various experimenters purporting to be utter disbelievers in consciousness, name a given emotion, and assume its existence in the subject solely on the basis of a motor attitude naturalistically observed without instruments of precision of any sort. Can it be that these cynical objectivists are depending upon their own *introspection*?

If, however, we assume such reports to offer some degree of objective evidence in favour of the existence of emotional consciousness radically differing from resultant sensations, but closely agreeing with the motor attitudes, or pattern of the primary response, it becomes exceedingly difficult to correlate such emotional states either with sensations or with the conscious relationships between sensations. It is very easy, on the other hand, to account for such emotional consciousness if we are willing to correlate it with " motations ", or simple units of motor consciousness and their inter-relations in the primary motor pattern.

5. Affective tone may, apparently, be changed by altering the motor set, without the slightest change in associated sensations. In a series of experiments upon myself lasting over a period of ten years, I have three times succeeded in eliminating altogether the unpleasantness of severe toothache by changing my " subconscious ", or " unconscious " motor set from one of resistance to one of complete acceptance of the stimuli imposed. Each time, this change of motor set has been objectively evidenced by faintness, pallor, and drops

[1] W. B. Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, 1920, New York.
[2] C. Landis, " Studies of Emotional Reactions," *Jour. Comp. Psy.*, 1924, Vol. IV, 447-509. (And other studies, all uniformly negative in findings).

in systolic blood pressure; possibly to be accounted for by an opening of vagus channels of motor discharge hitherto closed against the pain stimuli. Twice the full unpleasantness returned upon resumption of resistant motor set.

Boring[1] and Carlson[2] both mention subjects in whom the unpleasantness of hunger pangs was absent. Instead appeared faintness, and passivity of motor attitude, nausea taking the place of food-seeking responses. I studied a subject of this type for three years, and succeeded in retraining her in such a way that hunger pangs now appear with very intense unpleasantness. The change in the subject's motor attitude, from passivity to extreme food-seeking activity, which has accompanied this restoration of unpleasantness, is very marked, and is, to some extent, verified, also, by systolic blood pressure readings. Another preliminary experiment, performed in 1926 under my direction, was the change in attitude of a number of subjects toward stimulation with hydrogen sulphide, presented at all times in a perfume bottle as a new type of perfume.[3] No pleasantness could be induced. But one subject, owner of a restaurant, so far lost unpleasantness, following change of motor attitude from resistance to acceptance, that he failed to understand why several customers left his lunch room after the bottle had been freshly opened during meal hour. Olfactory fatigue or sensory adaptivity can be excluded because of the length of the interval, twenty-four hours between stimulations.

All these results are very difficult (although perhaps not altogether impossible) to account for on the basis of changes in sensory consciousness alone. But the simple, obvious, explanation would seem to be found in the assumption that there exists a basic awareness of motations and their inter-relationships. Conflicts of motation, evidenced by resistant motor set, seem unpleasant: while removal of motor conflict seems to result in corresponding removal of unpleasant consciousness.

[1] E. G. Boring, " Processes Referred to the Alimentary and Urinary Tracts: A Qualitative Analysis," *Psy. Rev.*, 1915, vol. XXII, 306-331, at p. 320.
[2] A. J. Carlson, *The Control of Hunger in Health and Disease*, Chicago, Second Edition, 1919, p. 92 ff.
[3] Experiment performed by Tufts student, in 1925-1926, not yet published.

6. I have pointed out elsewhere[1] that the work of Head and Holmes[2] furnishes striking evidence of the dependence of effective consciousness upon freedom of motor outlet, and consequent increase in the number of motor conflicts and alliances taking place in the central nervous system. When the inhibitory effect of the cerebrum is removed, through thalmic lesion, over-reaction and increase of effective consciousness simultaneously occur. I spent nearly a year trying to work out an explanation of this and similar phenomena without departing from the fashionable assumption that consciousness is made up of sensations and their inter-relations, and nothing else. Herrick and other neurologists have spent a much longer period upon the same problem, faced with the same bugaboo of denial of motor consciousness.[3] Yet adoption of some such simple platform as the psychonic theory of consciousness not only permits, but necessitates, acceptance of motor consciousness as the true basis of feelings and emotions. By doubling the number of psycho-neural elements of consciousness accepted as basic, we do much more than halve our resulting complexities of psychological theory. All rouud-about influences of motor set upon sensation vanish from discussion, and motation may be treated with the same objective simplicity as sensation.

But we have still to face the big guns of current psychological opinion, for psychology, at the moment, unequivocally denies the existence of motor consciousness in any form. Whence arises this attitude ?

Motor Consciousness Not Previously Identified with Affection

The ostensible reason for denying the existence of motor consciousness, as customarily given in the older days of psychology when it was thought necessary to discuss the issue at all, was the lack of introspective proof that discernable elements of motor consciousness could be identified in connection with resultant bodily movements. That is, in response to a given sensory stimulus, and with kinaesthetic sensations

[1] W. M. Marston, " Thoery of Emotions and Affection Based Upon Systolic Blood Pressure Studies," *Am. Jour. Psy.*, 1924, vol. XXXV, p. 496 ff.
[2] H. Head and G. Holmes, " Sensory Disturbances from Cerebral Lesions," *Brain*, 1911, vol. 34, p. 109.
[3] C. J. Herrick, *Introduction to Neurology*, Phil., Second Ed., 1920 ; see especially pp. 284-290.

eliminated in one way or another, an arm or a leg might be moved, yet the subject, who was, of course, prevented from visual observation of his own movement, remained unable to say whether or not any part of him had been moved. To be sure, the results of some of these experiments were seriously questioned ; and cases, equally valid, at least, were cited by Wundt and others wherein certain paralyzed patients reported " innervation feelings " resulting from will to move the paralyzed members. In these cases no actual movement or kinaesthetic sensations of movement were possible.[1]

Similarly doubtful reports concerning observation of, or failure to observe the " innervation feeling " or supposed unit of pure motor consciousness, have been printed from time to time. But, of late years, the issue has given way to other controversies of more simple and immediate interest, and psychology has gone on, serenely, putting up as best it might with a single basic category of consciousness, sensation, into which all conscious experiences have been squeezed, no matter how distorted they become in the process. It is small wonder that many psychologists have found some comfort in assuming that meaning, intent, and purpose, and other conscious elements of obviously motor character must depend upon an immaterial basis[2], since all available material basis has been pre-empted by the greedy presumption of sensation, and to define motor experience in sensory terms is an agony no accurate introspectionist cares to endure.

Actually, psychologists seem to have failed to find motor consciousness, all these years, simply because they did not know what they were looking for, and consequently did not recognize motation as such, when it was repeatedly thrust upon their attention. From earliest known speculations concerning the nature of feeling tone, or affection, come repeated assertions that feeling tone inheres in sensation, or that the affective qualities of pleasantness and unpleasantness are integral parts of sensory experience. So close has the introspectively observed union between feeling tone and sensation proven, that it has defied successfully the attempts of the most severe logical analysis to pull it apart. Curiously

[1] For brief summary and discussion of this early controversy, see E. B. Titchner, *Text Book of Psychology*, New York, 1912, p. 169 ff.
[2] Wm. McDougall, for instance, holds that meaning, value, purpose. and unity of consciousness have no physical correlates in the brain, W. McDougall, *Body and Mind*, 1918, pp. 175, 271, 298, etc.

enough, it seems not to have accurred to these psychological analysts to perceive, in feeling tone, the simplest possible manifestation of motor consciousness, under normal conditions.

Motation has been thought of as a *sensory awareness of movement*, and has, therefore, been sought in the impossible form of consciousness of passage of motor nerve impulses engaged in skeletal muscular innervations. Psychology has been looking for a sort of *motor-nerve sensation*, informing the subject whenever a motor impulse shall have passed over the nerve trunk under examination. Such awareness, if found, would still be sensory in nature. And were such an element of consciousness as an "innervation feeling" actually to be discovered, it must prove something of a mixture of imagined kinaesthetic sensations informative of movement, and sensory awareness of the object resisting movement (whether a limb of the subject's own body, or an environmental object). Such a composite experience would not, by any means, justify separate classification as a basically unique type of motor consciousness, since all its constituent elements would be sensory. Psychology, it seems, has been searching for a new type of being in the guize of a three-legged man, not realizing that, were such a person found, he would represent merely a monstrosity of the race already known.

Emotional Stimuli are Central, Never Environmental

There is, in addition, a psychological reason for psychology's absorption in sensation to the exclusion of motation. The stimulus to sensation is an obvious, environmental one; while the stimulus to motation, assuming motation to be integrative, psychonic energy in the motor centres, is a hidden, inaccessable stimulus. The particular motor impulses which, in synaptic juncture, form motation, flow from a stimulus concealed within the central nervous system and consisting of the resolution of sensory impulses evoked in the sensory centres by the initial, easily observed environmental stimulus. It is a commonly recognized fact that, while a given environmental stimulus always evokes virtually the same sensation on all occasions, these sensations may, at one time, be followed by feelings of pleasantness, and upon another occasion, by feelings of unpleasantness. The motor impulses evoked on either occasion can not be directly observed, though we have noted, earlier in this chapter, the possibility of indirect proof

that different motor impulses are, in fact, evoked whenever different affective tones result.

It is not altogether surprising, therefore, that psychology, like Tito Melema in George Eliot's *Romola*, has taken the seemingly easiest way out of a difficult problem, by denying all claims for recognition emanating from the hidden source of its supply. Thus have psychologists unconsciously sought, by ignoring the central motor impulse situation altogether, to obtain a false simplicity of scientific description which should define feelings and emotions in terms of sensory consciousness.

Despite its present, fancied security, however, psychology cannot hope ultimately to escape the problem of determining the basic principles of both sensory and motor integration. It is by these integrative processes that the initial afferent impulses, mechanistically caused by environment, are manufactured into psychonic sensory energy units or sensations. It is by the now hidden attributes of these centrally produced sensation units that all forms of connective integrations, and motor integrations, are vitalistically caused.

Analysis of Intervening Factors Between Environmental Stimulus and Bodily Movement

The central, psychonic energy stimuli, which act upon the efferent nerves by exciting motor impulses within them, possess individual characteristics as distinctive and as definitely discoverable as those now attributed to sensory stimuli. They constitute intermediate, vitalistic-type causes in the total chain of causation connecting environmental stimulus with final bodily behaviour. Their nature and, consequently, their influences upon motor discharge are not determined predictably by the nature of environmental stimuli which indirectly evoke them, because there are too many intervening causes which are shaped, primarily, by the integrative laws of the subject organism, and by the condition of the organism when stimulated. If all these variables were known, then a complete psycho-neural description would have to include the following items:

1—Mechanistic-type causes;
- (a) environmental stimulus, causing
- (b) afferent, sensory, nerve impulses, causing
- (c) sensations, i.e. psychonic impulses in sensory centres, causing

2—Vitalistic-type causes ;
(d) thoughts, i.e. psychonic impulses in connector centres, causing
(e) motations, i.e. psychonic impulses in motor centres, causing
(f) efferent, motor, nerve impulses, causing
(g) bodily behaviour.

The older, introspectionistic schools of psychology were inclined to skip from cause (d), thoughts, to cause (f) motor impulses, amalgamating cause (e), motations, with one or more of the foregoing units. It will hardly do, now-a-days, even for psycho-physiologists, to consider causes (c) and (d), since both are damned by introspective colourings ; so that a wider gap is now left, nearly all psycho-physical accounts jumping from cause (b), sensory impulses, to cause (f), motor impulses. In such accounts sensation and motations, both, are usually treated as occurring somewhere along the line of sensory excitations in the central nervous system. But the Watsonian behaviourists are the nimblest jumpers of all. They skip jubilantly from cause (a), the environmental stimulus, to final result (g), bodily behaviour. What a world of psychological trouble they think they are saving themselves ! But what unbridgable gaps would be left in the causal chain between stimulus and response, if these behaviourists really followed their own descriptive formula ! It would be like throwing a few drops of acid into a huge vat full of unknown, seething chemicals, and then analysing a sample of the vat mixture to determine the control which the acid-stimulus had exercised over the original contents of the vat.

The fault of the fathers of psychology, the introspectionists, lay not in trying to describe too many causes in the psycho-neural chain, but rather in omitting one very crucial cause, motation. For, as we have seen, the motor nerves and synapses possess a unique structure and organization of their own, and therefore require analysis and description as a basic type of cause in the total picture. " In short ", says Herrick,[1] " in both reflex and deliberative (including voluntary) reactions we may say that the nature of the neural process is abruptly changed when it ' turns the corner ' from the afferent to the efferent limb of the arc."

[1] C. J. Herrick, *Neurological Foundations of Animal Behavior*, New York, 1924, pp. 235-6.

Reviewing psychology's attitude in denying motor consciousness, we may compare it to that of a little child who is able to appreciate the causal connection between his own toys and Santa Claus, or the delivery man who brought them to him, yet is utterly unable to understand where the new baby came from. He thinks someone must have brought it, as his toys were brought, and he is speciously satisfied when told the doctor delivered his little sister. Psychology has been able, so far, to connect its sensations with causes that it can see and touch, yet it seems unable to connect its feelings with causes that are hidden and inaccessible. So psychology is satisfied with the suggestion that its feelings are brought, ready-made, by the same general type of agent already known, that is, the environmental stimulus. And, psychology further reasons, anything thus obtained, including emotion, must be a kind of sensation.

When psychology grows up, it will learn that there exist certain end-products manufactured exclusively at home. It will learn that, in the study of sensation, the stimulus is outside the body, while the response, sensory consciousness, is within ; but that, in the study of motation (emotion), the stimulus, connector-motor consciousness, is within the body, and the response, bodily behaviour, is outside. Both types of stimuli, and both types of responses must be described with equal objectivity. But easily observed environmental stimuli to sensation must be treated as causes, while readily measured bodily responses to motation must be treated as effects. If these underlying causal relationships are clearly understood and accepted, psychology should have a comparatively easy time of it figuring out the unknown quantities in both equations.

Summary

To summarize, I have tried in this chapter to set at naught the professional taboo upon motor consciousness. Analysing consciousness objectively according to either the psychonic or physiological theories, there are no less than six types of evidence tending toward the conclusion that motor consciousness must exist, constituting an equally important classification with sensory consciousness. Since the motor mechanisms of the central nervous system differ essentially in structure and organization from the sensory mechanisms, the suggestion has been made that motor consciousness in its physical machinery

must be studied as a distinct and separate cause within the total psycho-neural picture. We have tried faithfully to set forth in order the series of causes which connect the environmental stimulus with the final bodily response. We have found one link in this chain of causation, motor consciousness has been ignored, so far, by all schools of psychology. Upon enquiry as to the probable reason for psychology's odd conduct in this matter, it has seemed most probable that motor consciousness has not been recognized because it has never seemed to occur to anyone to identify it with feelings and emotion. Psychology has been searching " innervation feelings " and sensation-like awareness of movement upon the chance of finding motor consciousness concealed somewhere therein. But, of course, it was not there. *Motor consciousness is affective consciousness.* The simplest units of motation or motor consciousness are the feelings of pleasantness and unpleasantness ; while next in the complexity series of motations come the primary emotions.

At the beginning of this chapter our analysis of physiological refutations of the James-Lange theory showed that by far the most important and pressing problem in psychology of emotions is the same problem that James first recognized and then answered erroneously. That problem is, how can awareness of motor response as it occurs be described in psycho-neural terms ? This chapter has proposed a new answer to this problem. We are conscious of our motor responses as they occur through motor consciousness, motation, or affective consciousness which are all synonymous terms. Motor, or affective consciousness is psychonic energy released within the psychonic, or connective tissues of the motor synapse of the central nervous system.

CHAPTER V

Integrative Principles of Primary Feelings

Denial of the existence of motor consciousness has brought psychology to an impasse in the field of theory of feeling tone, just as it has hampered the adequate development of theory of emotion. Wundt's[1] tridimensional theory of feeling tone, propounded in 1896, constitutes the only radical departure from general agreement that pleasantness and unpleasantness are the only two primary feelings. Wundt supposed that there were six primary feelings : pleasantness and unpleasantness, excitement and depression, tension and relaxation. Wundt's theory was based almost altogether upon introspection, probably accurate enough as far as it went, but not linking up the four extra feeling tone elements with definite psycho-neural mechanisms proving them to be primary feelings.

Titchener, also highly versed in introspection, maintained that " excitement and depression, tension and relaxation are general names for a very large number of different affections."[2] That is, Titchener's own introspection led him to believe that the extra feelings named by Wundt, did, in fact, exist, but that they should be treated as complex affective experiences rather than primary feeling tones. The only type of objective data advanced by Wundt in support of this suggestion consisted of studies (including measurements of physiological changes supposedly symptomatic of six affective primaries) designed to show that all six alleged primary feelings, as introspectively reported, occurred independently of one another, and especially independently of any connection with pleasantness and unpleasantness. S. Hayes,[3] and others,

[1] W. Wundt, *Grundzüge der Physiologischen Psychologie*, ii, 1902, p. 263.
[2] E. B. Titchener, *A Text-book of Psychology*, New York, 1912, p. 251.
[3] S. P. Hayes, " A Study of Affective Qualities." Ph.D. Thesis Cornell. *Am. Jour. Psy.*, 1906, XVII, pp. 358-393.

published studies precisely refuting the results of Wundt in this particular, tending to show that the four additional feeling tone experiences were either intimately associated with pleasantness and unpleasantness, or else were still more complex experiences not independently correlated with any objective criterion which could be set by experimental conditions. The whole controversy gradually petered out; and with the decline of introspectionists' supremacy very little has been heard of any list of primary feelings containing other elements than pleasantness and unpleasantness. We may, therefore, confine our attention for the present to a discussion of the original pair of feeling tone primaries for the existence of which there seems to be ample evidence of an objective nature.

Primary Feelings are Pleasantness and Unpleasantness Originating in Motor Alliances and Conflicts

Theories of the physiologists and neurologists seem to be fairly well in agreement that unpleasantness is associated with conflicts or mutual interferences between nerve impulses, while pleasantness is characterized either by an absence of conflict or by a free unimpeded flow of impulses in the central nervous system. C. J. Herrick[1], whose opinion may be taken as fairly representative of the physiologists, says, " The normal discharge then, of definitely elaborated nervous circuits resulting in free unrestrained activity is pleasurable, in so far as the reaction comes into consciousness at all (of course, a large proportion of such reactions are strictly reflex and have no conscious significance). Conversely, the impediment to such discharge, no matter what the occasion, results in a stasis in the nerve centres, the summation of stimuli and the development of a situation of unrelieved nervous tension which is unpleasant until the tension is relieved by the appropriate adaptive reaction." And again, " The unrelieved summation of stimuli in the nerve centres, involving stasis, tension, and interference with free discharge of nervous energy, gives a feeling of unpleasantness which in turn (in the higher types of conscious reaction at least) serves as a stimulus to other associative nerve centres to participate in the reaction until

[1] C. J. Herrick, *Introduction to Neurology*, 1920, Phila. and London, pp. 286-287.

finally the appropriate avenue for an adaptive response is opened and the situation is relieved. With the release of the tension and free discharge, the feeling tone changes to a distinctly pleasurable quality." It may be noted that Herrick does not specify in which type of nerve centres, sensory or motor, the unrelieved summation of stimuli or the normal discharge of impulses is presumed to occur in order to evoke unpleasantness or pleasantness. Herrick says, however, in a neighbouring passage, that such a stasis may be brought about by the conflict of two impulses for the same final common path. Such mutual facilitation and interference of nerve impulses must be presumed to occur in some appropriate connector or motor centre of the central nervous system.

The work of Head and Holmes[1] clearly indicates that whatever changes in nerve impulse behaviour are to be associated with increases of pleasantness and unpleasantness are to be found chiefly upon the motor side of the various reflex arcs involved. These authors studied human subjects suffering from thalamic lesion. The most important effect of the lesion in these cases was to remove a considerable proportion of the normal inhibitory influence exercised by the cerebral hemispheres over the motor discharge. The behaviour changes as noted by Head and Holmes consisted of exaggerated physical reactions to sensory stimuli with parallel increase in the pleasantness or unpleasantness which was felt in connection with the sensation experienced. There seemed to be no change in the sensory threshold nor any significant alteration of any part of the purely sensory reaction. The whole effect, in short, was upon the motor side rather than the sensory, and it was this increase in the number and degree of motor alliances and interferences which corresponded exactly with the increase of pleasantness and unpleasantness as reported by the subjects.

As a result of this research and other similar data accruing to psychology from the medical sciences, it is generally assumed that the free flow of nervous energy as well as the mutual conflicts and interferences between nervous impulses which the physiologists and neurologists definitely correlate with affective tone, are to be looked for primarily in the motor centres rather than in the sensory centres. R. S. Woodworth,

[1] H. Head and G. Holmes, " Sensory Disturbances from Cerebral Lesions," *Brain*, 1911, vol. 34, p. 109.

for instance, expresses his interpretation in this fashion,[1] " Putting this fact into neural terms, we say that pleasantness goes with a neural adjustment directed towards keeping, towards letting things stay as they are; while unpleasantness goes with an adjustment towards riddance." A " neural adjustment towards letting things stay as they are " must consist of a free flow of unobstructed motor impulses, all in alliance, because all are directed toward a unified behaviour pattern of the whole organism which is meeting with no opposition. An " adjustment toward riddance " must with equal certainty consist of a motor set rather than sensory set; and carries, also, suggested implication that there is some motor conflict with the object which the individual would rid himself of. Motor sets, then, seem to be regarded as neurologically responsible for primary feelings rather than sensory sets.

How Do Motor Alliances and Conflicts Reach Consciousness?

This result confronts psycho-physiological theory of feelings with the same problem faced by the theory of emotions considered in the last chapter. The problem is: If our primary feelings of pleasantness and unpleasantness depend upon alliances and antagonisms between nerve impulses in the motor centres, how does this motor phenomenon ever reach consciousness?

Theories That Feeling Is an Integral Part of Sensation

Two different methods have been used in attempting the impossible task of getting motor phenomena into consciousness in terms of sensation. The first method, employed by many psychologists of the older school, consisted of setting up the simple hypothesis that feeling is merely an integral part of sensation. Pleasantness or unpleasantness would then be referred to as aspects of sensory experience, and we should be compelled to assume there is no sensation free from affective tone. This assumption would not be so far from the truth, but it is far more difficult to account for the changes in feeling tone which a given sensation may undergo without any change whatsoever in the sensory stimulus. The change in feeling seems to accompany a change in motor response to the sensation experienced, rather than to inhere in the sensory consciousness itself. There remains also, the extreme difficulty of finding any neurological mechanism by which a motor effect that takes place *after* could be reflected back in such a way that it could become an integral portion of the sensory event which had gone before and which might well have been completed by the time the motor phenomenon occurred.

[1] R. S. Woodworth, *Psychology*, New York, 1925, p. 178.

During my own approach to the problem, being awed, at the time, by Psychology's current taboo on motor consciousness, I worked for the better part of an academic year in trying to discover in the literature of either psychology or neurology feasible mechanisms by which motor conflicts and alliances could be conceived of as adding feeling tone to their preceding sensations. The best expedient which I was able to hit upon was to suppose that a motor blockage might cause the sensory impulse blocked to increase its intensity in the sensory centres, above the upper limen of qualitatively distinct sensory consciousness; while mutual facilitation of motor impulses might be supposed to result in a drop of intensity in the sensory impulses below the lower limen of sensation. This theory only defined pleasantness and unpleasantness as near-sensations (that is, supra-liminal and sub-liminal sensory awareness), but it was the best I could do in warping motor phenomena into sensory terms. I thought the suggestion a rather ingenious one, at the time I worked it out, but after some two years of observation and experiment I found that there was just one trouble with the theory. It wasn't so. Feelings, and the motor phenomena upon which they depend, simply cannot be defined even in near-sensory terms. They distinctly occur *after* the sensation is completed, and with entire independence of it. I was driven, after thus disproving my own theory, to abandon altogether, as most psychologists had done before me, any attempt to regard affective tone as an integral aspect of sensation.

Theories That Visceral Sensations Are Also Feelings

The second method, a modern one, by which even at the present moment, many psychologists are striving to drag motor phenomena into consciousness in terms of sensation, is the arbitrary appropriation of certain sensations, usually visceral ones, to constitute feeling tone *ipso facto*. Just why visceral sensations are so generally thought to possess especial affective value would be very hard to say. One reason

galvanometer, the action currents resulting from increased tension of the muscles in reflex contraction, and have shown that one battery of proprioceptive afferent impulses is evoked as a result of reflex contraction of the muscle, and that a second battery of afferent impulses is evoked as the muscle contraction meets increased opposition from the load it is trying to move.

Importance of Tonic Mechanisms

We may consider briefly the extent to which the entire operation of the central nervous system depends upon the interaction between tonic and phasic systems of reflex nerve excitation.

The psycho-neural concept which looked upon the brain and spinal cord as mere separately strung telephone wires with a switch key to be turned on at the synapses, is passing rapidly. Herrick says[1] " but the concept of the reflex is not a general master key competent to unlock all the secrets of brain and mind, as all seem to suppose, and it has of late been subjected to very searching physiological analysis ". And again, " all the parts of each such reflex system are so intimately and variously connected with one another and with parts of other systems by collateral branches of the nerve fibres and by correlation neurones that anatomical mechanisms are provided for innumerable modifications of any typical or primary reflex pattern. Which, if any, of these cross connections will be activated in any particular response will be determined by the aggregate of external and internal factors at the moment operating ".

By far the most important of the internal factors operating at any moment are the various units of tonic energy continuously exciting large tracts of the brain, spinal cord, and peripheral nerve trunks. It has long been known that the cerebellum is chiefly concerned with maintaining the constant tonic motor discharge necessary to keep the body in its natural state of equilibrium. The cerebellum has been called primarily the " balancing brain ". " Its cortex ", says Herrick,[2] " seems to be a great reservoir of latent nervous energy which

[1] C. J. Herrick, *Neurological Foundations of Animal Behavior*, pp. 234-6.
[2] C. J. Herrick, *Neurological Foundations of Animal Behavior*, p. 242.

may be tapped for discharge into any neuromotor apparatus as needed. Its stabilizing influence may be compared with the action of a gyroscope on a large steamship, ensuring the steady progress of the vessel in its course by compensating the buffeting of wind and waves."

Sherrington has proved that not only is the cerebellum to be regarded chiefly as an organ of tonic discharge, but also, that certain centres of the brain stem are concerned with maintaining tonic motor outflow. Sherrington found that decerebrate rigidity which seems to represent a state of natural reflex equilibrium with the normal inhibitory regulation removed cannot be abolished by ablation of the cerebellum.[1]

Lashley has found[2] that the cerebral cortex itself, may be largely concerned with maintaining tonic discharge. He says, " A normal function of the stimulable cortex is to supply a sub-stratum of facilitating impulses which act in some way to render the final common paths excitable by the more finely graduated impulses ", (which emanate from phasic reflexes).

These few quotations from recent writings and research reports will serve to show that the concept long held by many psychologists with regard to the central nervous system as an inert mass of conducting material within which the environment could cause phasic reflex excitations to play about with no other control than that exercised by other phasic excitations which happen to be simultaneously aroused, is no longer tenable. A more apt metaphor would represent the central nervous system as a powerful dynamo generating energy at high and rather regular speed throughout the life of the organism. Phasic excitations aroused by the environment from time to time are to be thought of as passing hands upon the rheostat switches controlling this dynamo. One phasic influence increases the speed of the generator, others may slow it down. Some phasic impulses may reduce the response in conductors already energized by the dynamo while others may increase such excitations. But unless the mechanical and chemical laws of the planet itself be abrogated, (that is, unless gravitation, temperature, air pressure, etc., cease to exert their natural influences upon the organism) the great dynamo

[1] C. S. Sherrington, *Integrative Action of the Nervous System*, p. 302.
[2] K. S. Lashley, " The Relation between Cerebral Mass Learning and Retention," *Journal of Comparative Neurology*, August, 1926, vol. 4.

of the central nervous system may be expected to grind out its daily and hourly quota of tonic motor discharge, pretty much regardless of minor changes and influences of the particular environment in which the organism is placed.

What the transient phasic reflexes do very largely determine is the particular outlet through which the energy generated by the dynamos shall be brought into contact with environment.

Herrick says[1] " What particular motor centres will receive the nervous impulses discharged from the cerebellum is apparently determined less by what is going on in the cerebellum than by what systems are in actual function in the rest of the nervous system . . . The circuits acting in the brain stem tend to capture and utilize the cerebellar discharge."

Lashley has reported evidence tending to show a result quite astounding to the older telephone connection theory of action. By eliminating the cerebral motor cortex in an animal trained to certain definite motor habits, Lashley found that impulses to particular muscles do not leave through the pyramidal tracts from the so-called motor area of the cerebrum.[2] He concluded in a later research that the phasic motor impulses descending from the cortex by extra pyramidal paths thus produce the " finer shades of adaptive movement ".[3] Which may mean, as far as one is entitled to guess from incomplete results, that the motor area itself is chiefly concerned with routing tonic discharge continuously to the so-called voluntary muscles all over the body, thus maintaining all these different muscles in a more or less stabilized condition of continuous excitation. Whenever this reflex equilibrium might be changed in such a way that one muscle receives a larger increment of tonic energy than other muscles, an adaptive bodily movement would result. The phasic or transient environmental stimulus would then constitute merely a hand on the lever shifting the tonic outflow slightly from one muscle to another. This effect might be accomplished within the nervous system either by increasing the tonic outflow itself at an appropriate synapse, or by

[1] C. J. Herrick, *Brains of Rats and Men*, Chicago, 1926.
[2] K. S. Lashley, " The Retention of Motor Habits after Destruction of the so-called Motor Area in Primates," *Archives of Neurology and Psychology*, 1924, vol. XII, p. 249.
[3] K. S. Lashley, " The Relation between Cerebral Mass, Learning and Retention," *Journal of Comparative Neurology*, August, 1926, vol. 41.

facilitating the transmission of energy through a nerve path and synapse common to phasic and tonic motor impulses.

Recent researches, on the whole, appear to describe the constant tonic motor energy as a rather uniformly stabilized mass of motor discharge which may " capture ", or " be captured by " the transient motor energy units called phasic impulses.

This " capture " of tonic motor discharge by phasic impulses, or the " capture " of phasic excitations by tonic impulses, takes place, necessarily, at motor synapses appropriate to the psycho-neural level of the response ultimately manifest. Psychons in all these centres must be in a continuous condition of excitation, prior to the reception of phasic impulses, as a result of the constant out-flow of tonic motor energy. According to the psychonic theory of consciousness, therefore, there exists a certain residuum of motor (affective) awareness, in all animals above the coelenterates (that is, animals possessing synaptic nerve mechanisms), from before birth until after death (at least as " death " is now defined by medical certification). Normally, this residual motation should be felt as mild, pervasive pleasantness, since motor impulses from different tonic mechanisms, and from different tonic centres must be supposed normally to be in closely ordered alliance, thus affording a certain constant increment of mutual facilitation at common psychons. The existence of such a continuous background of pleasantness in the normal individual is in close accord with results (experimental, clinical analysis, and introspective report) from a great majority of the subjects, friends, and students whom I have studied. It appears to be the basis of " *joie de vivre* ". Experience of its existence seems to restrain from suicide most of the persons still alive, (at least, those who have not been restrained by dread of the suicidal instruments, as suggested by Watson[1]).

Concepts of " Motor Self " and " Motor Stimuli "

The total of psychonic (synaptic) excitation, existing at any given moment in the subject organism as a result of reflex tonic motor discharge, may be called, for convenience, the " motor self ". Definition of this term does not include any phenomena not objectively described or indicated.

Phasic motor impulses forming psychonic (synaptic) con-

[1] J. B. Watson, *Behaviorism*, New York, 1925, pp. 147-8.

junction with tonic motor excitations may conveniently be termed "motor stimuli", and are to be regarded as being in exactly the same relation to the motor self as are afferent impulses to the organism's sensory mechanisms. *Motor stimuli thus objectively defined, are not to be confused, under any circumstances, with environmental stimuli, which may be defined as objects or forces acting upon the organism's sensory recoptors.*

Principles of Response of Motor Self to Motor Stimulus

Using the terminology just defined, then, we may summarize the possible relationships so far worked out between the motor self and the motor stimuli as follows : Motor stimuli may first of all either ally themselves with, or antagonize the motor self within motor psychons at any level in the central nervous system. Such motor stimuli will evoke, in return, corresponding alliance or antagonism from the motor self. The resulting situation, which is referred to by neurologists as mutual facilitation or conflict of impulses, will thereupon enter consciousness as pleasant or unpleasant motation. This motation, if pleasant, will be added to the normal, pre-existing pleasantness constituting the motor self ; or if unpleasant, it will diminish or supersede the normal pleasantness of the motor self.

But, as noted, it is exceedingly difficult to find a situation where this relationship of mutual facilitation or antagonism exists all by itself without some superadded effect upon the existing intensity of the motor self. It would require a motor stimulus of exactly the same intensity as the motor self[1] to bring about an ultimately simple relationship of alliance with no other relationship existing between stimulus and reagent. Since intensity differences, then, between motor stimuli and motor self will be found in most cases to exist, our analysis showed that this second general type of complicating relationship might usually be found added to the simple pleasantness or mutual facilitation.

[1] It is necessary to emphasize the fact that this one to one relationship might not consist of absolute equalities of intensity, but rather of equal intensities *relative* to the reacting power of tonic and phasic impulses, the former being more easily interrupted than the latter, according to Sherrington. Comparisons between intensities of tonic and phasic excitations should always be understood as including this qualification with regard to the relativity of the measure.

Motor Self and Antagonistic Motor Stimuli (Inferior and Superior)

Let us attempt to discover, then, in the first place, the general principle of reaction manifested by the motor self in changing its intensity or volume, in response to inferior or superior intensity or volume of an antagonistic stimulus. "Inferior" and "superior" as used in the discussion to follow must be taken to mean "intensity or volume of motor stimulus inferior to existing intensity or volume of *the motor self*," and "intensity or volume of the motor stimulus superior to the existing intensity or volume of the motor self". We have already noted, during our brief consideration of the regulative tonic mechanisms, that the tonic discharge may be increased or decreased as a reaction to opposition influences exerted upon the balance of the body or upon tension of the muscle tonically innervated. Such a change of body balance or muscular tension, no matter by what influence this change is brought about, tends to *increase* the intensity of tonic motor discharge. It is to be assumed in all instances of this increase of tonic discharge which we have so far considered, that the intensity of the motor stimulus was *inferior* to the intensity of whatever rival tonic motor impulses might have successfully retained possession of the disputed final common path to the muscle in dispute. For if such had not been the case, how could the increased tonic discharge have been measured by means of the increased contraction of the muscle in question ?

That is to say, if an opposed motor stimulus tries to reach the flexor muscle over a final common efferent path held at the moment of stimulation by tonic impulses which are using the final common path to reach antagonistic extensor muscles, and if we find as a result of intervention of the phasic motor stimulus that the contraction of the extensor is heightened, we must assume that *the tonic impulses or motor self were able to hold full control of the entrant psychon* to the final common path. *This would seem to mean that the motor stimulus was less intense or powerful than the already existing tonic discharge.* Had the motor stimulus been of superior intensity to the motor self, it would have dispossessed the tonic impulses of their control over the entrant psychon to the final common path and we should have observed a contraction of the flexor muscles instead of an enhanced contraction of the extensors.

We may assume, then, that *a motor stimulus of inferior intensity results in an increase of the motor self.*

In the experiment reported by Sherrington where an increased load placed upon the extensor muscles of the dog by physical pressure exerted by the experimenter upon the limb in a flexor direction, it is true that the physical superiority of an antagonistic stimulus failed to dispossess the motor self of its hold upon the efferent paths to the extensors. But a *physically* superior force could not, of course, possess any integrative power or significance whatever, unless it gave rise to intervening phasic reflexes which this particular brief movement of the limb did not do. When a phasic reflex of greater intensity than the tonic discharge was evoked by electric stimulation, the tonic discharge into the extensors was diminished, during the persistence of the intervening reflex, to the point where it exerted no observable power of dimunition over its successful phasic rival.[1] The fact, then, appears to be that a successful intervening *phasic reflex of superior intensity to the existing tonic discharge results in a dimunition of that same tonic discharge* (*and motor self*) throughout the persistence of the superior motor stimulus.

We find, then, that the general rule of intensity relationship between motor self and motor stimulus seems to be as follows :

(1) *An antagonistic motor stimulus of inferior intensity to the motor self evokes an increase of intensity from the motor self as reagent.*

(2) *An antagonistic motor stimulus of superior intensity to the motor self evokes a decrease of intensity from the motor self as reagent.*

Motor Self and Allied Motor Stimuli (Inferior and Superior)

We still have to consider whether the same principle of change of strength by the motor self holds good for motor stimuli allied to the motor self, since both types of motor

[1] " Post-inhibitory rebound " was later found by Sherrington to have no correlation with the amount of tonic activity inhibited, and therefore is not attributed solely to a continued cumulative increase of tonic energy during the interim that the intervening stimulus is in control of the final common path. It evidently represents however a secondary central reaction to the intervening motor stimulus which occurs as a result of primitive integration occuring in the absence of the animal's cerebral hemispheres. Post-inhibitory rebound is to be interpreted, perhaps, as a subsequent resurgence of tonic energy rather than an increase in the motor self while the superior motor stimulus is in control.

stimuli so far considered have been antagonistic in the effect upon the final common path. The experiments of Forbes, Campbell and Williams, already cited, indicate that an intervening reflex *allied* to the tonic discharge in its end effect upon the muscle jointly innervated, would tend to have the same effect of *increasing* the tonic discharge or motor self that occurred, as we have already seen, as a result of intervention by an antagonistic motor stimulus of inferior intensity. So far as one can tell, the motor stimulus evoked in experiments of the type mentioned would be of equal or inferior volume to the pre-existing motor self, if evoked from a normal animal in the natural way. When a greater load is placed upon any muscle already in a state of tonic contraction (as in the case where the dog's leg was passively moved by Sherrington in an anti-tonic direction) the same effect is produced upon the increase of tonic discharge as would be produced ultimately by intervening allied phasic reflexes of inferior volume.

Sherrington describes the reflex neuro-muscular situation, in the matter of tonic reinforcement, as follows[1] :—The extensor muscle of the knee, in the instance discussed, constituted the effector organ into which the tonic impulses were discharged. When this muscle was passively stretched by attaching appropriately calibrated weights, afferent impulses were evoked from receptor organs in the muscle fibres. These excitations entered the cord, and efferent, tonic reinforcement impulses emerged from the cord, and travelled back, over the efferent axone trunk, to the muscle which gave rise, originally, to the reflex. A greater number of individual muscle fibres were stimulated to contraction, as a consequence of this motor discharge, than were previously working. Thus the antagonistic weight imposed upon the muscle was compensated for, and the muscle as a whole resumed nearly the same position as before the weight was imposed.

The individual muscle fibres, it is held, cannot undergo partial contraction. Each fibre contracts to its maximum or not at all. Therefore, tonic reinforcement must always take the form of bringing more individual muscle fibres into play. It is supposed that individual axon fibres, in the efferent nerve, innervate individual muscle fibres. Therefore,

[1] This data is reproduced from notes taken by the writer at a lecture delivered by Sir Charles S. Sherrington, before the New York Academy of Medicine, New York City, October 25, 1927.

the total muscle contraction depends upon the number of individual muscle fibres maximally contracted; this depends upon the number of individual axone fibres excited (maximally or not at all by the all-or-none law of nerve conduction); and this depends, in turn, according to Sherrington, upon the amount of nervous excitation which reaches the motor centre where the efferent fibres receive their stimulus to excitation.

Sherrington has evidence that each motor fibre has an individual, synaptic threshold of excitation, within the motor centre. The afferent reinforcement disturbance, when it arrives at this motor centre, " grips " its maximum number of motor fibres immediately, then loses its grip on those fibres having the highest synaptic thresholds, and continues to activate, for some time, the motor fibres with lower thresholds.

Suppose, then, that an allied motor impulse, of less strength than the existing tonic discharge, arrives at the same motor centre from some other source within the higher centres of the central nervous system. This allied motor stimulus, by definition, is not able to " grip " as many of the individual efferent nerve fibres as are already being activated by the total tonic excitation at the centre. Yet there is an unused margin of potential tonic excitation coming into the centre over the afferents from stretched muscle fibres. This potential increment is not able, by itself, to become kinetic, psychonic (inter-neuronic) excitation, because it is unable to pass the synaptic thresholds of the efferent fibres which remain to be activated. This potential, unused increment of tonic energy should be released, however, by the mutual facilitation between it and its new ally, the phasic, allied motor stimulus of inferior strength. As a result, the potential tonic increment will become active, psychonic impulses, crossing to the hitherto dormant motor fibres of comparatively high threshold, thus *increasing the motor self by an increment equal to the strength of the allied, inferior, motor stimulus.*

Suppose, on the other hand, that the allied motor stimulus which arrives at the common motor centre is *superior* in strength to the existing motor self, or tonic excitation actually crossing the efferent reinforcement synapses. Exactly the same release of the potential tonic increment may initially occur. But as soon as the superior ally grips its full quota of efferent fibres, a new type of phenomenon must result. More individual axon fibres will be excited, and more individual

muscle fibres will be contracted than the total, compensatory tonic reinforcement calls for. That is, compensation for the weight constantly imposed upon the muscle will be carried beyond the point where compensation is complete. If 25 per cent. of all muscle fibres are needed for complete compensation, and 35 per cent. of the total number of fibres are actually shortened by the superior, allied motor stimulus, then the tension imposed by the load on the muscle will be distributed between a larger number of individual fibres, and each fibre will undergo correspondingly diminished tension.

Parallel with the diminution of tension in each muscle fibre activated, the intensity of stimulation of the proprioceptive sensory organ within each muscle fibre will be decreased, and total afferent reinforcement excitation sent to the motor centre, will diminish by a corresponding amount. Following this diminution, a smaller number of efferent nerve fibres will be gripped by the tonic excitement, *per se;* and, *pari passu,* the total strength of psychonic excitation of tonic origin will suffer decrement. Since this psychonic excitation is synonymous with the motor self, we find that *an allied motor stimulus of superior strength ultimately decreases the motor self by a decrement equal to the amount of the ally's superiority.*

The clearest indication that such a theoretically predictable result does, in fact, occur is to be found in the apparent diminution of muscular tonicity and other bodily resultants of tonic discharge during " sexual " (love) passion. There are easily observable signs of bodily lassitude and weakness, especially in women subjects, at the same time that the passion itself is felt as most intense and pervasive. This weakening of the self in order to surrender utterly to a loved one of superior strength is aptly described in Sappho's immortal lines:

" For when I see thee but a little, I have no utterance left, my tongue is broken down, and straightway a subtile fire has run under my skin, with my eyes I have no sight, my ears ring, sweat pours down and a trembling seizes all my body; I am paler than grass, and seem in my madness little better than one dead."[1] Such a description would indicate that tonic-type motor discharge (" sweat ", etc.) is present, but that the motor self proper is progressively weakened (" little better than one dead ").

[1] Second Sapphic fragment, H. T. Wharton, *Sappho*, London, Reprint of Fourth Edition, 1907, p. 65.

Moreover, systolic blood pressure records taken during love excitement sometimes show a progressive and extensive drop at a short interval prior to the sexual orgasm. Such drops in systolic blood pressure perhaps indicate that the strength of the heart beat, which is tonically maintained, has been diminished not by inhibition but by general diminution of the tonic outflow of motor self.

However such cardio-vascular phenomena may be interpreted, the decrease of muscular tonicity all over the body seems unmistakably symptomatic of lessening of tonic discharge. This decrease of the motor self does not occur immediately upon initiation of love excitement, nor does it occur very frequently with male subjects, or even with extremely passionate women subjects, except under maximally favourable conditions. The phenomenon seems to depend upon the passing of a certain threshold in the volume of phasic motor discharge produced by the entire love situation stimulus. When this volume of motor stimuli has become sufficiently great, the symptoms of decrease in the motor self interest themselves, sometimes rather suddenly. May it not be the case that this phenomenon occurs at the time that the total volume of sexual motor discharge exceeds the volume of allied tonic impulses ?

If our foregoing analysis is correct, then we find that *the motor self follows a general principle of increasing its volume of intensity in response to a motor stimulus of less strength than itself regardless of whether the motor stimulus be allied or antagonistic to the motor self,* and that *the motor self decreases its volume of intensity when reacting to a motor stimulus of greater strength than itself, regardless of whether the motor stimulus be allied or antagonistic to the motor self.*

Differences Between Psychonic Relationships of Motor Self to Allied and to Antagonistic Stimuli

It should be noted at this point, however, that the actual phenomena occuring upon the motor psychons where the increase or decrease of the motor self is integrated, must be thought of quite differently when the increase or decrease is accompanied by facilitation, than in the case where the change in volume or intensity is coupled with mutual antagonism between motor self and motor stimulus. When the motor stimulus is antagonistic to the motor self, the victor in the

conflict wins a right of way across the disputed psychon into the final common path, but there seems to be no neurological evidence that the victor in such a conflict possesses power to compel the vanquished impulse to change its rhythm or impulse rate in such a way as to conform to and facilitate the impulse rate of the victorious antagonist. In the conflict under discussion, however, the motor self attains almost precisely the same result because it reinforces itself in the process of winning its victory by an increment as great as the strength of the vanquished opponent. Thus, although the weaker antagonist is not actually made over into the nature and pattern of its conqueror, the victor is increased in strength or volume in its own nature or pattern by an increment identical in strength with the vanquished stimulus.

The result which occurs when the motor stimulus is the victor is not precisely the same as in the case just considered. When the motor stimulus wins through into the disputed common path, it has no mechanism for self reinforcement[1] and remains, therefore, of exactly the same strength it was in the first place. The diminution of the motor self in this case rather represents a readjustment of tonic discharge to permit the victorious phasic impulse to hold its own, specific course, than a general defeat of the motor self proportionate to the victory of the stimulus. In short, there is a conceded victory for the motor stimulus without any enhancement of the latter. This is followed by a readjustment of the motor self which, if the integration is completed, restores harmony to the entire integrative picture. By means of this adjustment, all parts of the motor self save that interrupted, and also the motor stimulus may follow their own paths without mutual interference.

In the case of a real alliance between the motor self and the motor stimulus, however, each continues in union with the other, no matter which ally is in quantitative supremacy. When the motor self decreases in reaction to an allied motor stimulus of superior volume, it does not step aside, as it were, and permit the victorious motor stimulus to continue on its way unimpeded. The decreased motor self, even though made smaller by the presence of the victorious motor stimulus,

[1] According to a recent statement by Sherrington, during the lecture referred to above, the flexor muscle of the knee, an anti-tonic muscle, possesses no mechanism for progressive self reinforcement.

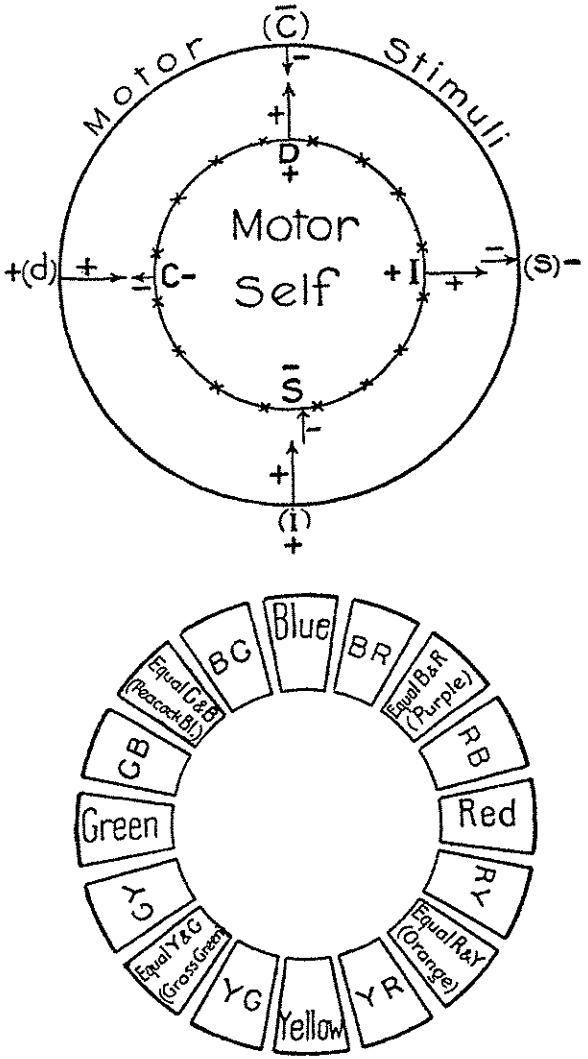


FIGURE 3

"The Emotion Circle and the Colour Circle"[1]

[1] Note: These terms for intermediate colours are from Munsell. (See A. H. Munsell, *A Colour Notation*, p. 35).

FIGURE 3.—The capital letters D, I, S, C, indicate responses of the motor self. A plus (+) sign near one of these letters, inside the Motor Self, indicates an *increase* of the Self during response; while a minus (—) sign indicates a *decrease*.

Arrows between Motor Self and Motor Stimuli indicate relationship between these two elements during response. Relative length of arrows indicates preponderance of one or other element, (also indicated by plus or minus sign near arrow). Arrows pointing in opposed directions indicate antagonism between Self and Stimulus; arrows pointing in parallel directions indicate alliance.

The small letters (c), (s), (i), (d), indicate the type of Stimulus adequate to evoke each response; the Stimulus (c) being in the same relationship to the Self as the Self is to its stimulus at C, etc. A minus (—) sign near a small letter indicates a *decrease* of the Stimulus as a result of the Self's action upon it; while a plus (+) sign indicates an *Increase*.

The Colour Circle is placed with the four nodal points of colour, blue, red, yellow, and green, in positions corresponding to the four nodal points of emotion, dominance, inducement, submission, and compliance. An identity of integrative principles has been suggested by preliminary research in naive associations between primary colours and primary emotions (see *Psyche*, October, 1927, p. 4).

The points marked " × " on the Motor Self circle suggest just-distinguishable differences of response, in between nodal points D, I, S, C, comparable to violet, purple, carmine, etc., on the colour circle.

motor self. As we proceed clockwise toward the point I, this antagonism may be thought of as becoming continuously less, until at I an alliance relationship appears. But at this same point, I, the inferiority of motor stimulus strength and the corresponding increase of motor self energy reaches its maximum, and begins to change toward the opposite relationship, which first appears decisively at S. At this lowest nodal point, S, the alliance relationship between motor stimulus and motor self has reached its maximum, and begins to fall off as we proceed upward toward C, where alliance has disappeared altogether and antagonism relationship has reappeared. At the point C, again, the decrease of motor self intensity and response to superior stimulus strength has reached its maximal value, changing again to the opposite relationship by the time our starting point, D, is again reached.

Starting at the nodal point, C, which is the point at the extreme left of the diagram, we may summarize the relationships and reactions at the nodal or primary points of the diagram as follows:—

C

Motor stimulus.....	(a)	Antagonistic to motor self.
	(b)	Superior strength to motor self.
Reaction of motor self	(a)	Antagonistic to motor stimulus.
	(b)	Decrease of strength.

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To

MY TEACHERS AND COLLABORATORS

My Mother
Claribel Moulton Waterman
Elizabeth Holloway Marston
Marjorie Wilkes Huntley
Olive Byrne