SCIENCE

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MENTAL SCIENCE.*

WE have great reason to congratulate ourselves on the progress of psychology, not only in this country but in the world during the last quarter of a century. Not only have students, teachers, text-books, journals, societies, laboratories and monographs increased, and new fields have opened and old ones widened, but our department has been enriched by original contributions that have profoundly modified our views of mind and even of life itself. For the first time in this field American investigators have borne an important and recognized part in advancing man's knowledge of the soul. Among these we take pride even in the presence of our distinguished foreign guests in naming first of all James, who, more than any other American, has occupied and influenced the psychological thought of both experts and students here for a decade, and whose charming personality and style have done most to infect cultivated laymen in all adjacent fields with interest in psychology and to make American thought known and respected abroad; Ladd, to whom we owe the first text on physiological psychology in English and who, more than any other American, illustrates the old tradition of a system of philosophic thought large enough to embrace most of the topics from the laboratory to religion; Münsterberg, who has not only done more than any of his distinguished Teutonic predecessors from Agassiz and Lieber down to make Germany and America know and respect each other, but has been the first to lay the foundations of a new efferent system of thought which harmonized the best in Fichte and Schopenhauer with the choicest results of the laboratory; Titchener with his thorough Eng-

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lish training, whose ceaseless productivity makes him already in the widening fields he cultivates our American Wundt in a thoroughly and sometimes radically reconstructed and improved edition; Baldwin, the first here to attempt a logic of biology and sociology and evolution that should apply to genetic psychology; Dewey, who, much as he achieved in logic and general psychology, has done perhaps yet more to make these topics fruitful for education; Cattell, pioneer in founding two laboratories, the foremost editor in our ranks, who has boldly grappled the vast problem of individual psychology in a way which, if solved, must make even biography more scientific; in other related fields Royce, Ormond, Howison, Fullerton, Strong, who have done so much to restore the faltering belief in soul, freedom, God and ultimate reality; Cowles, Donaldson, Myer, Hoch, Herrick, each marking advances either in exploring the obscure psychoses of mental aberration, advancing our knowledge of the brain, correlating psychic symptoms and neural and somatic changes, and making the asylum tributary to science—these inadequate references, not to mention my own associates or even the score or two of younger men whose work already gives promise of a future richer in results than the past, and omitting, solely because I am too ignorant to speak of it, the department of sociology, bracketed with ours to-day, but which has also made advances perhaps hardly less signal—these suggest my theme, which is simply a plea for yet more differentiation and specialization between men, departments and institutions, and certain modifications of method in our rapidly widening field.

The idealist who holds that the world is man's concept and that all science is a part of psychology can hardly object to the far more modest claim that it really does properly include logic, ethics, religion, esthetics, epistemology and metaphysics, and those who with Lotze still cling to that dear old tradition of the theoretic life that its supreme joy is to attain the fullest expression of one's own personality in a comprehensive philosophical system, must not carp if one who long since abandoned the youthful hope of attaining this felicity vents his own individuality a little, as, with your kind indulgence, I beg leave to do, excused somewhat by the conviction that all systems, the most meager and the best alike, are only human documents, empirical data, votes, résumés, returns, to be used at last as empirical data for some greater synthesis of the future. If psychology is already far more than a subdepartment of physiology, anthropology and psychiatry, or a subsection in a philosophical system as of old, if we may justly reject for it the place assigned it in the hierarchy of Compte and Spencer as a link between biology and sociology and now base it no less upon the latter than upon the former, and not only claim for it an independence already achieved, but look forward to its ultimate hegemony in all the fields involving man's higher nature, or as being in a word the culmination of humanism, it follows that we must regard all that all of us have so far done as only a prelude, that much of our work must be done over again, that the history of philosophy, instead of being philosophy itself, is to be subordinated as psychological material for a truer and far more comprehensive natural history of mind, and that the best of us are only morning stars which will pale and be forgotten as day advances.

If the germs of soul are as old as life itself and if its types are as distinct and as persistent as those of morphology, then, though we can no more define it than we can life, must we not draw the momentous inference that consciousness alone is a very partial and inadequate organ of experience

and at best only one culminating stage, like a submarine plant's leaves and blossoms that alone reach the surface? Does not experience by its very nature tend to lapse below the threshold of consciousness, and just in proportion as it becomes complete does it not sink beyond the reach of subjective analysis? Nay, more; does it not so strongly tend to become automatic that to become perfect it must lose even the power to be transmitted by instruction, but only by heredity? If so, must we not supplement the methods of internal by those of external observation, subjective by objective, and deductive by empirical researches? Just as history is now studied more as the daily life of the average man and as the play of but half-understood economic racial and telluric forces, and less as the mere records of battles and the acts of kings and courts, so must not psychology more and more center in the study of love, pity, fear, anger, pride, conscience, beauty, love of power and wealth, sympathy and all those social instincts that make our life their sport? Should we not find helpful biological suggestion in the example of Bateson and his growing circle of followers, who would go back to facts baldly recorded to lay broader foundations for their pyramid, instead of steepening its angles to a tower or inverting it, and be content in some fields with a merely descriptive psychology that masses facts, not ignoring those that now seem most trivial, registering reflexes that, perhaps, appear but once in a lifetime, vascular and other somatic resonances that seem meaningless, in the hope that ultimately we may be able to infer something about the psychic states that once animated them and do something to restore the great volume and variety of lost soul and life that mechanism, missing links and extinct species, animal and human, have taken out of the world?

For myself, if I were challenged by some advocate of a psychology without a soul to improvise a working hypothesis of what soul may be like, I might boldly begin by assuming it to have been more potent in the past than it is in the present, but ever tending to vanish as heat, which once made the earth incandescent, does to dissipate itself; as something with which the deathless germ plasm is more instinct than are the somatic organs it evolves, even the brain where it has now taken refuge; as something no less closely related than theology once made the persons of the Trinity to be among themselves with the *nisus formitivus,* whatever that is, which when the world was young and lusty evolved all the products of natural selection, developed and then differentiated hunger and love, adapted flowers and insects to each other, made instinct and inspired all its purposive acts without the aid of any sense of purpose, was shaped by all the forces that have modified life since it began; that domesticated useful and tried to exterminate noxious animals and plants, invented thousands of languages the syntax of some of the lowest of which are the new marvels of philologists; that laid down the lines of the primeval religions and struck out all the unwritten laws and customs of social animals and tribal men, the latter more complex and perfect in many respects, as a recent English blue book on Africa insists, than any that civilized legislators have yet devised. On this view soul life when it was chiefly passion, feeling, impulse, may have been far more dominant over the body and all its processes than now. It was hot, intense, lived out close to the elements, always in sight of the edge of the fierce struggle for survival. It was more life than thought, more collective and racial than individual, shaped the world from within rather than, as science is now learning to do, perhaps, in a derived and secondary way, from without. Everything

was genetic, nothing logical, while as yet no symptom of the great paralyzer, self consciousness, had appeared. This was the great reality which our late developed and senescent, ingrowing intellect has lost and yearns for as old age yearns for its vanished youth. Its traces, fossils, remnants, still abound in our own body and soul and in life about us, but unless we can read our titles clear to this pleroma of life abounding, the psychologist will still have reason to grieve as an exile from his pristine paradise vainly seeking atonement with God, the world and self. Some type of soul life has passed out of the world with every species that became extinct, every vanished tribe, with every child that develops into maturity, with every substitution of self-consciousness and reflection for the naïve, intuitive, spontaneous, and what we call the progress of knowledge is a compound of mingled gains which we keenly feel with losses that we far less keenly realize.

When the intellect, which seems to have been developed late, as a new function of adaptation to the external world, leaves the latter and seeks to introspect its own processes and reflect upon them, it crosses some important pons. This involution is hard, slow and with many stages. Perhaps first are the half-instinctive musings on some memory-content of conduct as affecting pleasure and pain, or upon motor impulses, or the somatic stages that accompany thought are more vividly sensed. Many laboratory experiments directed to other ends have as their best result the revelation of the intricacy of the simplest psychic operations. We find a mazy network of tentative associations and impulses struggling for survival or for emergence into the narrow focus of attention, chaotic irruptions into saner sequences of perception or thought, manifold shades or elements which language is far too clumsy and conventionalized to adequately express, distractions which must be ignored by an act of the will as we ignore all that is in the indirect field of vision. From all this we select out the few and meager factors we want. But if, instead of doing so, we yield to the diverticula and seek to note all that takes place within, we soon feel that we are sane only by a small working majority of our activities, and that underneath the cosmos of habitual sequences and reasoned thought lies a vast and rank chaos of unorganized elements that defy order, analysis or even description. Some are new and some, perhaps, older than history or even than man; some strong and compelling and some so pallid and imperceptible that many experimenters hardly suspect their existence, some congruent and some diametrically opposed to each other. But the tropical sea and jungle are not more rank with life. From all this we realize in a new and deeper sense that conscious mind is only a rather superficial product of gradual and half-unconscious selection, from all this vast seething psychic activity within, of those factors that are practical or most needed for the present conduct of life. Old systems and adjustments to earlier conditions are ever disintegrating and left to lapse and ruin, although they long reverberate in the subliminal field, echo in feeling tones or on occasion have sudden resurgence in automatisms, outbreaks of passion or insistent ideas and impressions, or are injected like dikes into otherwise coherent conduct or thought. The power of survival of these rudimentary organs and processes of the past life of the soul is prodigious. Perhaps they never quite vanish even asymptotically. If the purest science is the completest description of origins and stages of development, psychology may, perhaps, never be complete.

Leaving these, must we not hence infer that the conscious soul we know was evolved solely as an organ to regulate practical life;

that there is no criterion of truth, save its value as a guide to conduct; that the sciences of nature and of mind are, can be and mean only a system of rules for right living and thinking; that to ask what the world and soul are *per se* is an extravasation of the intellect which was kindled only to shed light upon the supreme problem of how to feel and act aright and to which it is subordinate as means to end; that to ask what mind and nature are *per se* and apart from all use by heart and will is paranoiac or a new scholastic entity cult, because the end of science as well as the only real essence of mind is service? Thus the quest of absolute reality must always end in the solipsistic involucre, which is only a new definition of zero, and pure thought purged of will, feeling and sense can not be an object of psychological study, for it does not exist.

Mathematics, which is a formulation of the properties of time and space in the sensory, applies at most only to motion and force in time and space, and its objects are at the bottom, where those of psychology are at the top of the scale of evolution and complexity. From Pythagoras down to Herbart, Fechner, the hedonistic calculus in ethics which the vilest wretch may master without feeling the faintest impulsion to virtue, the Boolean and even common deductive logic which never yet discovered anything, and, indeed, I think, every attempted application of mathematics to psychology, save only for the simple algebraic or other treatment of statistical data, have later proved an illusion if not a mere affectation, and we owe to-day no more to any concept susceptible of mathematical formulation than modern physiology does to the old iatric school that so elaborately treated the bones as levers, the muscles as pulleys, circulation as hydrodynamics, digestion as trituration, and insisted, as Plato did for philosophy, that geometry was the best preparation for the study of medicine. Perhaps no two types of mind have less in common than the mathematical and the psychological or help each other less and may hurt each other more. The former has given us hosts of defunct definitions, categories and dogmas, and has constructed world-bestriding systems by concatenations of the high *a priori* kind in a way that must raise the query in every candid and impartial mind whether in the field of mind the precept 'truth for truth's sake' is not as dangerous as the dictum 'art for art's sake' has proven in its, and whether, beside the old injunction 'physics, beware of metaphysics,' we should not erect the warning 'psychology, beware of mathematics,' and make due purgation of both its methods and its ideals.

Thus, the first and, perhaps, the chief danger to psychology as a science to-day seems to me to be its tendency, as by an iron law, to gravitate to methods that are too abstract, deductive, speculative and affectively exact. Other sciences long since threw off the influence of the old systems, many of which had dominated them, but psychology is still permeated by them. It still feels the charm of the old insolubilities of ultimate reality, of the relation of mind and body, parallelism or interaction, the primacy of feeling or somatic changes, and is dominated more than it knows by interests in the soul's future, by teleology, freedom *versus* necessity, all of which, so far as we see, can never be problems of scientific psychology because they can not be answered. The modern psychologist, too, can be neither materialist, idealist, positivist, dogmatist, gnostic or agnostic, or, rather, is at the same time all of these in some way or degree. Such problems have a large and very important place in the history of philosophic thought. Their culture value as disciplines is very great, but they belong to a stage of mentation now passing

away and doomed perhaps ultimately to become as *ueberwundene Standpuncte,* as those of vortexes, the plenum or vacuum, the Plutonic *versus* the Neptunic theories, have become for science. The ethical bearings of many of these questions once thought so great are rapidly becoming insignificant, but they still bulk large wherever psychologists are dominated by theological interests, or even accept, as far more do, their problems at the hands of metaphysics. Our science is still, like Milton's tawny lion, pawing to get free from the soil in which it is just being born. Many text-books and treatises modulate from the latest science to the oldest speculative surds and speak in two alternating registers, while others evaluate new results by their bearings upon antique problems wrongly put in a pre-scientific age, but made venerable and most significant for history by the accretions of the best and most ingenious thought of ages. Thus, the second danger that besets our work is that it is not sufficiently emancipated from the now conventionalized criteria of past systems of thought, and has not subordinated these as it should to be used not as finalities or solutions, but only as empirical data for larger generalizations that transcend them. But if it is the philosophy of philosophy, it comes to many of these problems not to destroy, but fulfil.

The third source of danger to psychology arises from the theory of knowledge or epistemology. The human soul inherits the result of a vast experience acquired by the race but innate in the individual, but the latter can not validate much of it in his own restricted life. He is so surcharged with paleoatavistic traces, tendencies, instincts, from back, perhaps, to the amphioxus or even the amœba, that he often seems to himself to live and move in a world that is both within and without unrealized, alien and afar. What we inherit is so much better organized than what we acquire, it is so dominant and, perhaps, so unmodifiable and unaccountable, that the world and self seem shadowy, and our unreflecting confidence in these is thus easily shocked out of its poise by Berkeley and Hume till some come to feel that a life so unexplained is hardly worth living. When, in addition to these predisposing causes which for some diatheses may become a neurosis, the thinker leads a pallid, anæmic life in academic isolation from the great, throbbing, struggling world, and in the study devotes himself to passionless contemplation pampered by the second-hand knowledge of life derived from books, it is not strange in a precocious and over-civilized age with more knowledge forced upon the mind than it can digest, that the veil of Maya sometimes settles fold on fold over the soul till it almost feels the panic of the claustraphobiac and must break out and away to find reality or smother. It feels that, like the Holy Grail, removed from the sight of carnal men, it can be sought only by those purged from all defilement of the world of sense, but it must be found and quaffed or the soul be lost to truth. For those paranoiac minds sitting thus in prison, whose constitutional malady is aggravated by the doctrine of the ideality of space, the greatest philosophic delusion of modern times, it is well to have highways of escape opened up out of agnosticism. For many, if not most, too, a touch of it but not too much of it is, perhaps, a necessary part of the complex initiation of youth into its world, but the severer types of this discipline seem more suited to senescent than to adolescent men and races. For the psychologist, however, in pursuit of his legitimate vocation, to be liable to be held up at any time to prove that the soul has a brain or a body, that the self or the objects of sense exist, that other people and animals with similar organs to his own

have similar subjective states, is just as irrelevant and as paralyzing as it would be for the physicist, chemist and astronomer, and any old answer makes just as little real practical difference of any conceivable kind in the one field as in the other. Yet the need of such a cult and all its symptoms, how they came to arise and how very real they sometimes are, and their forms of documentation in both the oriental and the modern world, constitute not only a very important but a fascinating problem for inductive psychology, while the ways of meeting these needs are legitimate and now even pressing questions of the higher individual pedagogy.

Finally, as to the field and methods of scientific psychology, the present speaker feels profoundly limitations that prevent him from rising to the height of the great argument for unification so wisely proposed in the plan of this congress, and can only briefly indicate a view perhaps yet more personal than what has preceded, recognizing that very different ones are held by many if not most of his wiser colleagues. First, no trace of sentiency, even the faintest, down to and perhaps even into the plant world, should be alien to our interest. If in doubt between Wasmann and Forel, on one hand, and the mechanical interpretations of the tropisms and taxies as held by Loeb, Bethe and Uexkull, we should recall and profit by the fate of Descarte's conception that even the higher animals were only automata. In experimenting on these, under the controlled conditions of the laboratory, we should not neglect the observations of the field naturalists nor ignore even the more valuable of the contributions of our agricultural stations, economic zoology, the stock farm and the menagerie, men hunters, etc. Studies here need sympathy as well as controlled conditions. We also want compends of what is known of each of the important animals and birds nearest to man, and to make contact with dynamic or functional biology in its efforts to pass beyond morphology and investigate life, histories, habits and causes of variation, postulating that the manifestations of instinct are just as differentiated and as persistent as those of morphology itself. No philosophic prejudice should make us forget that animals have the same will to live, love of offspring, fear, anger, jealousy, individual attachments, memory, attention, knowledge of locality, home-making instincts and senses that we do. Nor should we deny that empirical methods, whether they have yet done so or not, are quite capable of giving sufficient evidence for the existence of psychic powers as radically different from our own as those claimed for photodermatism or the topochemical sense of the antennæ of ants. Not only, then, might the old maxim, 'Psychologus nemo nisi physiologus' be now also with much propriety reversed, but physiological psychology is now expanding both ways toward a larger biological philosophy, and studies of life and mind will henceforth be more and more inseparable just in proportion as genetic or evolutionary conceptions pervade our field.

Child-study, which began so crudely and has long since silenced many, though not yet all, of the objections raised against it, has already demonstrated its practical value for education, and is acquiring a place of its own in the literature of other departments, especially pathology, philology and criminology, and is beginning to prove itself a key of unsuspected value in unlocking problems connected with the prehistoric development of the race, supplementing studies of the adult mind somewhat as embryology does anatomy and histology. It has not only made new connections between our work and the above departments, but is steadily developing a logic which, though as yet unwritten, is

destined in my own fond belief to become an instrument of great value in reinterpreting the bionomic law of recapitulation, shedding new light upon early developmental stages, and thus giving psychology a genetic perspective which it has so sadly lacked in the past. Students in this field are impregnating insignificant and transient acts, expressions and feeling with new meanings. This work still suffers from the fact that, like the Renaissance, the Reformation and to some extent Darwinism itself, it had to begin outside academic circles, which are now so rapidly opening to it, and develop popular interest and momentum before it could attain scientific methods. It has thus survived and profited by a volume of honest criticism which would have swamped a less vital movement, and that too by many of the very ablest of our craft who did not at first fully understand its scope and value. Now, although we might point with justifiable pride to its books, journals, chairs, its body of results that all accept, we believe that far greater results lie in the near future, and sometimes some of us indulge in dreams of a new dispensation of psychology doctrine with evolution more evolved as its center.

Again, a new alliance is now cemented with the psychological side of anthropology and even ethnology. With almost no academic representation or support, it is our government that has developed a body of scholars that in the study of the Indian have, in the language of another, 'set the world its best example of gathering and recording the myths, customs, rites, occupations and modes of life, thought and feeling of the decadent, yet the most representative of all the races of the stone age.' Psychologists are learning to profit by this work and also to extend their interest to every such record of the sentiments, habits, social organizations and superstitions of primal man. As a naturalist delights in new species, so we more and more both need and desire to profit by every new account that sheds light on how the remotest aborigine thinks, feels and acts, and we do it with a psychic tension and exhilaration as if some great correlation with other allied fields impended. We feel a closer bond with sociology because it, too, is coming rapidly into rapport with anthropology and finding the key to so many of its problems in tribal and other consanguineous forms of early society. The reciprocal suggestiveness of this department with psychogenesis is already beginning to bear fruit.

So in mental and moral alienation we have a few precious and detached studies of psychic symptoms in individuals that are almost classic. The older epoch-making interpretations of epilepsy by Hughlings-Jackson, new views of hysteria, paranoia, a choice fresh little literature on *dementia præcox*, a large collection of records of delusions, hallucinations, automatisms and other phenomena of the borderland between sanity and insanity, gathered at the behoof of an obsolescent hypothesis, but interpreted in a way that has happily called attention to subliminal processes and also the methods of their exploitation by hypnotism. Many of these phenomena are devolutionary; others are normal states magnified by disease as if it were a microscope. Criminology, meanwhile, has shown us feral man in our midst and given a copious anthology of facts about degeneration and perversion, many of which could now be used to make the teaching of practical ethics more interesting and effective. It is high time that mental perversions should be represented by chairs in our medical schools, especially if they are to make headway against quacks and mind-curists, save the profession from some of the tragic experiences just recorded so vividly in the confessions of Veresaeft, teach the medical

student that there is something to be learned outside bacteriology and anatomy, and qualify him to dominate the mind as well as the body of his patient, particularly in a land and age when psychic and nervous complications are more and more involved in diseases. We should not forget the old adage of Hypocrates, 'Godlike is the doctor who is also a philosopher,' which will also bear reversing, and if the psychologist does not study very much anatomy, save the brain and its general structure, the new conception of which he should know, he must give much attention to physiology and have its latest results accessible. At least the psychiatric clinic where nature performs her tragic experiments should always supplement those of the laboratory.

All religions tend to decay, and must be incessantly revived and newly dispensed lest they become raucous and weazened in dogma, conventionalized in rites and rituals, and lose power over individuals, communities and nations, and become divorced from science and life. The multiform symptom-groups of religious pathology are a sad but fascinating chapter only just beginning to be written. Sacrifice and totemism, the faith and prayer states of mind, asceticism, renunciation, miracles of healing, psychology of sects, Sabbath, saints, vows and oaths, the conviction of sin, confession, ecstatic states, worship, the God idea in its many forms, the relations between religion and morals—these and many more old problems, as they begin to be restated in psychological terms, beam with a new light like the cherub faces in old canvases awaiting reincarnation, which they must have if religion is ever to be again made interesting and influential for cultivated men. These themes demand a treatment quite apart from any problems of historicity and should especially be represented in our theological schools, whose pupils ought to have some conception of what the soul they try to save is. Even the so-called philosophy of religion represented by Ritschl and his divergent pupils has not got beyond the restatement of judgments of worth as suggested by Kant's practical critique.

In fine, revolutionizing as the thesis may seem to many, I believe psychology should now be dominantly inductive and practical. Even the old systems, grand as they were, must, as I said, be treated as data of a higher order, whose makers thought they were doing one thing but turned out to have done something very different. Instead of laying bare the constitution of the universe they were only documenting their own souls with unusual fulness for the benefit of the future generalizer. Their work, suggestive as it is, was precocious, and their conclusions premature, and about all of it must be done over again on a larger basis of facts, and our watchword must be not merely back to Kant or even Aristotle, but back to a reexamination of the primitive events of soul life, gathered by the most systematic outer and inner observation, and even from history, literature, experience and wherever psychic life is most voluminous and intense, pain, misery, famine, war, revolutions, shame, revivals, every passional state in which Despine says all vice and crime originate; love, fervid as Dante knew it, crowds, the struggles of the individual soul with besetting sin, which is the original form of dualism as experienced from Paul and Augustine down to poor Weininger, who lately shot himself because he could not overcome the evil within which his almost Manichean system set over against his ideals of goodness. Especially as we advance from the study of sense and intellect to that of the will and feelings, the anæmic thinker, who can realize in his own person so little of the stormy life of man, must seek every possible contact with it. He must live where

he can among animals, children, defectives, the insane, criminals, paupers, saints, sinners, the sick, the well; must know grief and joy—these, as well as the clinic and the laboratory, for here he fronts the bottom facts of the world. Next, he must supplement his at best meager first-hand experience with the proxy experience of others as recorded in books. Psychology lives not merely in the study, but where doubt and belief, sanity and inherited insanity, struggle together; where temptation and conscience wage their wars, in the mob, the cloister; where rage, terror and pity become convulsive and sweep all before them, and where love of the lie usurps that of the truth. Once it was thought that the study of pure should precede that of applied science, but we are now coming to almost reverse this maxim in education. So psychology, especially in our practical age and land, must first study and teach how to live, love, learn, labor; must have something to say to all who reflect on reproduction, disease, health, and thus must first serve man well if it would later rule him wisely. If this view be correct we must abandon many supposed certainties and finalities, and with faith in a future far greater than the past has been, devote ourselves to severe and unremitting toil perhaps for generations; must often practise that hardest of all forms of self restraint in our field—the suspense of judgment—assured that in the end psychology is to become queen of those sciences that deal with man, and reign among all the humanities somewhat as chemistry and physics are coming to do over the material world, with a method, perhaps, sometimes no less exact and certain than these already have. So we shall at last attain a true metaphysics of realities behind sense and feeling which is the necessary crown of all science when it becomes complete.

G. Stanley Hall.

*PRESENT PROBLEMS OF ORGANIC CHEMISTRY.**

There is a strong tendency on the part of some chemists, at the present time, to claim that chemical science in the true sense includes only such portions of our knowledge as can be stated in accurate mathematical terms. One distinguished representative of this school of chemistry has said, 'It is not in the province of science to explain phenomena,' and another has written, 'It is not a part of its ultimate object (*i. e.*, of natural science) to acquire knowledge in regard to mentally conceived existences, such as the atoms of matter, or the particles of luminiferous ether, which are of such a magnitude and character as to lie far beyond the limits of human perception.' I think that nearly all of those now actively engaged in working over the problems of organic chemistry would dissent strongly from these statements. Long experience in dealing with the cumulative, non-mathematical evidence upon which our knowledge of chemical structure is founded has led to a very firm conviction that human knowledge is not bounded by the limits of sense-perception. We are inclined rather to the view that, while there are, undoubtedly, many things which will always remain beyond any direct cognizance of our senses, yet, so far as these have a real existence we may in the end secure, regarding them, very practical and positive knowledge. It is impossible to conceive that those theories with regard to structure which have guided the work of thousands of chemists for the last fifty years do not in some measure express the actual truth with regard to atoms and their relation to each other in organic compounds.

Let us follow, for a few moments, in very brief outline, the steps which have led to the present standpoint. So far as the mat-

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