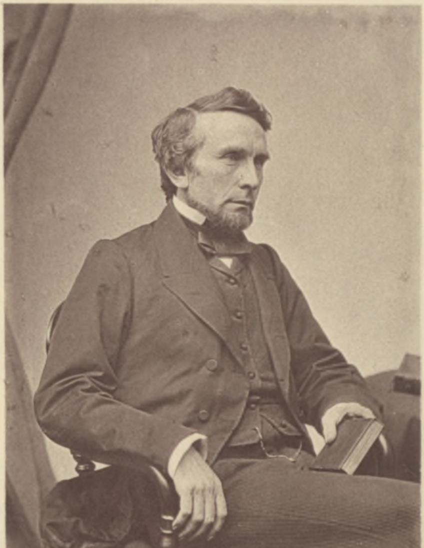

Very truly yours
Edw. H. Clarke

# VISIONS:

## A STUDY OF FALSE SIGHT

*(PSEUDOPIA.)*

BY

EDWARD H. CLARKE, M. D.

WITH AN INTRODUCTION AND MEMORIAL SKETCH

BY

OLIVER WENDELL HOLMES, M. D.

BOSTON:

HOUGHTON, OSGOOD AND COMPANY.

The Riverside Press, Cambridge.

1878.

RIVERSIDE, CAMBRIDGE:
STEREOTYPED AND PRINTED BY
H. O. HOUGHTON AND COMPANY.

"*The view of things by means of the eyes is full of deception, as also is that through the ears and the other senses: . . . . but that it is the brain which produces the perceptions of hearing, seeing, and smelling, and that from these come memory and opinion.*" — PHÆDO OF PLATO.

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## PART I.

## PART II.

# INTRODUCTION.

By OLIVER WENDELL HOLMES, M. D.

THE unfinished essay here presented to the public has a singular and quite exceptional interest. When its author had read his death sentence, and knew that the malignant disease of which he was the subject would be slow in its work and involve great suffering, he felt that he must have something to occupy his mind and turn it away in some measure from dwelling only on the tortures of his body. He therefore took up the study of a question in which he had long been interested and made it his daily occupation to write upon it. So long as his strength lasted sufficiently, he wrote with his own hand. After this he employed another to write at his dictation.

This disease had already made deep inroads upon his constitution, and he was every day becoming more dependent on the ministrations of those about him, when his wife, who had been his nurse, his amanuensis, his patient and tender companion, was seized with sudden illness which after a few days ended in her death. It is not often that a human heart is tried at once with the pangs of bodily suffering and the agony of grief as his was at this distressing period. But he bore up against it all with a courage and serenity which it seemed as if nothing could subdue. After a time he returned to his work. His mind had lost nothing of its discriminating force, his language nothing of its clearness. Again I found him busy with his manuscripts when I entered his chamber at my frequent friendly visits. He became again interested in the trains of thought he had been following. He would hand me a page or two of his manuscript for criticism, or bring up some special point for my consideration. All this time the deadly internal disease was feeding on his life, and not an hour was free from suffering except when his pains were lulled into temporary quiet by the use of narcotics. At length the pen dropped from his hand, the mind ceased from its labors, he lingered a little longer in a state of being that was divided between anguish and stupor, and the end long wished for came at last.

Throughout his long and wearing illness he had watched himself as he would have watched one of his patients. He knew what was almost certainly to be the issue of his disease, and had known it from a very early period. Yet he did not speak of himself as if he knew his case to be hopeless. It seemed to me sometimes as if he felt that it was not courteous to his visitor to appear in the attitude of a condemned man, and that he spoke of the possibility that the disease might not prove malignant in its nature rather to make his guest feel more cheerfully about him than because he himself indulged in any vain illusion.

The essay bears evidence of the philosophical state of mind in which it was written. I have been surprised to find how little correction of any kind it required. From the first page to the last it is clear, connected, without a trace of any disturbing influence.

A strange thought suggests itself, which is perhaps too fanciful to be mentioned in this connection. I cannot help being reminded of the Indian brave's death-song, in which he calmly defies his tormentors. Socrates was about to die when he discoursed in those imperishable words which the Phædo records for us, but he was not in bodily torture. This serene disquisition was written in hours of distress which were intervals of agony. No stoic of the woods, no philosopher of antiquity ever faced his doom with a more unshaken constancy and courage, with a nobler tranquillity, than the writer of this essay. Had it no other claim upon the reader, it would always have an interest as the mental legacy of one who was much honored and loved, and as a lesson of manhood too precious to be forgotten.

Although the essay is left unfinished, it should not be called a fragment. It would not be difficult to complete it by the addition of a very moderate number of pages. It was left by Dr. Clarke to my decision what disposition should be made of the manuscript. I had heard many portions of it, and discussed many points involved in it with him. But I read it all over carefully, and had no hesitation in deciding that, imperfect as it was, it should be given to the public. I did not look up the literature of the subject to see for myself just how far Dr. Clarke's ideas had been anticipated, or how far they were in opposition to those of any other physiologist or psychologist. I made no changes of any importance, and no additions whatever. The manuscript was singularly free from errors and corrections, both that portion of it written with his own hand, and the parts which were copied for him, and my work was hardly needed in addition to that of the corrector of the press.

I have made out a table of contents which will perhaps be a sufficient guide to the general and the scientific reader, in looking after what specially interests them. But I will indicate a few of the pages which will be found more particularly attractive to most of those who take up the essay.

As Dr. Clarke resolves so large a part of mental action into pure automatism, it is only fair to remember these words of his, showing that he recognized something beyond this. He is speaking of the visions of the dying.

"Probably all such visions as these are automatic. But yet, who, believing in God and personal immortality, as the writer rejoices in doing, will dare to say *absolutely all?* Will dare to assert there is no *possible* exception?" (p. 272.) It must be borne in mind, too, that he recognized the "ego" as distinct from "his engine," the bodily mechanism (p. 168), and that he speaks of the will as a *primum mobile,* — an initial force, — a cause." (p. 211.)

Ingenious and interesting as are the speculative portions of the essay, the numerous hitherto unrecorded cases will perhaps be found its most permanently valuable contribution to science. Physiological opinions, and even commonly accepted results, may be rejected as unsatisfactory by another generation of experimenters and theorists; but well recorded cases, drawn up by trustworthy witnesses, do not lose their value with the lapse of time. Such are many of these which are presented to the reader. I may venture to add that I myself knew personally the subjects of the cases recorded on pages 39, 262, and 277, and have heard a minute and circumstantial account of each of these cases from the lips of Dr. Clarke himself. With reference to the last case, Dr. Clarke mentioned a circumstance to me not alluded to in the essay. At the very instant of dissolution, it seemed to him, as he sat at the dying lady's bedside, that there arose "something"—an undefined yet perfectly apprehended somewhat, to which he could give no name, but which was like a departing presence. I should have listened to this story less receptively, it may be, but for the fact that I had heard the very same experience, almost in the very same words, from the lips of one whose evidence is eminently to be relied upon. With the last breath of the parent she was watching, she had the consciousness that "something" arose, as if the "spirit" had made itself cognizable at the moment of quitting its mortal tenement. The coincidence in every respect of these two experiences has seemed to me to justify their mention in this place.

The facts relating to the frequency of visions in children, and their power of summoning them up by an exercise of will, p. 212, also deserve special attention.

Whatever Dr. Clarke has to say concerning the action of drugs is peculiarly entitled to confidence, as he was a most diligent student of their various modes of action, and had a great experience with them, more especially in all that relates to the use and abuse of narcotics and stimulants.

But there is one case recorded which I venture to say no human being who draws the breath of life can read without profound interest. It is that which may be found on page 262. It is a deep-sea sounding of the dark abyss where each of us all is to sink out of sight sooner or later. The wise physician is on friendly terms with death. It is as much a physiological necessity as life, and though, like the visit of an officer of justice, its entrance must not be allowed without a proper warrant, yet that warrant is sure to be issued at last. The wonderful calmness of the observed and the observer, in this almost if not quite unique case, impart a perfectly scientific character to this observation of an event which is commonly yielded passively to the empire of emotion. Many, who through fear of death have been all their life-time subject to bondage, will, I believe, find more consolation in this recital than in almost any other human record.

I will only add a single remark for the scientific reader. The expressions "cell-groups," "polarizing the cells," and some other terms must be accepted, rather as a convenient form of signifying an unknown change of condition, than as intended to be taken literally. And I may say in conclusion that the whole essay must be read not with an over-critical spirit, but in the constant recollection of the mental conflict going on during the long agony in the course of which it was written.

I subjoin, at the request of his nearest relative, the obituary notice which was furnished by myself to the "Boston Daily Advertiser." A few very trifling alterations only have been made, and the reader will, I trust, overlook any repetitions of what has been said in the preceding pages.

### EDWARD HAMMOND CLARKE.

BORN, FEBRUARY 2, 1820; DIED, NOVEMBER 30, 1877.

The death of Dr. Clarke has not fallen upon our community as a surprise. It has long been known that he was suffering from a disease so nearly hopeless, as to leave scarcely a possibility of its retracing its steady progress toward a fatal issue. For the last three years he has been unable to practice his profession. A year ago he might be met occasionally walking languidly in the Public Garden; for some months he has been confined to his chamber, and for the past few weeks to his bed. The internal disease which was wasting his life was full of anguish. He was never free from pain except when under the influence of anodynes, and from time to time was racked with agony. It is a great sorrow to lose him, but all who know what he has been enduring must be thankful that he is released from his bondage to suffering. The tributes which have been rendered to his memory might seem to render unnecessary the words which can do little more than repeat what has been so well said already. I need only refer to the full and very interesting sketch of his life in the "Evening Transcript," and to the eloquent discourses delivered from the pulpit, by the Rev. Mr. Ware and the Rev. Dr. Bartol, which the public has had the privilege of reading. But as one of the friends who have seen him often and intimately during the years of his morttal illness, I cannot forbear to add my testimony to that of others, who have watched him through the course of that protracted martyrdom.

The antecedents of a man so distinguished by his high qualities will always be looked at with interest. Almost invariably some elements of the mental and moral traits which marked him will be found in the line of ancestry from which he is descended. Dr. Clarke's father, the Rev. Pitt Clarke, was one of those excellent New England clergymen, whose blood seems to carry the scholarly and personal virtues with it to their descendants, oftentimes for successive generations. From a brief account of his life, written by himself, and a sketch by his son, the late Manlius Stimson Clarke, it is easy to draw the portrait of the good pastor who, for forty-two years, ministered to the people of the pleasant village of Norton, Massachusetts. His simple, industrious habits, for he worked on his farm as well as preached to the farmers round him, his creed or "Confession of Faith," which he left as a legacy to his flock, a creed devout, humane, with a stronger flavor of Matthew's gospel than of Paul's epistles, but referring all to the "sacred volume" as "the sole rule of his faith, preaching and practice"; the love and confidence with which he was regarded in the community,— these would give the outline which the reverence and affection of his children filled up with their remembrances.

We are apt to look, perhaps, with even more interest upon the mothers of those who have become justly distinguished and honored. Dr. Clarke's mother, Mary Jones Stimson before marriage, second wife of his father, was one of those women who live and die known to but a few persons comparatively, but who are remembered by those few as more to be loved and admired than many whose names are familiar, and not undeservedly so, to the public. She was endowed with noble and attractive personal qualities, was very fond of literature, and left many poems, some of which are preserved in a small memorial volume and show a cultivated taste as well as warm affections. It is impossible to read the lines "To a Son in College," or "A Prayer," without feeling that such a mother was worthy to be rewarded with such children as God gave her.

Edward Hammond Clarke, her fourth and youngest child, was born in Norton, February 2, 1820, graduated at Harvard College in 1841, took his medical degree at Philadelphia in 1846, travelled extensively in Europe with the eldest son of the late Mr. Abbott Lawrence, and established himself at length in Boston, where he acquired and maintained a leading position among his contemporaries. In 1855 he was chosen Professor of Materia Medica in the medical school of Harvard University, succeeding to the very distinguished Dr. Jacob Bigelow. This office he resigned in 1872, and was at once chosen a member of the Board of Overseers of the University. He still continued in active practice until assailed by the disease which ended in his death on the 30th of November just past.

Returning to his early history, we find that the state of his health obliged him to leave college before the second term of the senior year, so that he could not take any part at commencement, but that he stood first in his class at the time of leaving. He had intended studying divinity, but circumstances changed his course, and he adopted the profession in which he attained great eminence, as he would have done in any other which he might have chosen. He would have been a very learned and acute theologian. Those who have heard him speak upon questions before legislative committees cannot doubt that he would have been a powerful advocate. Calm in manner as in mind, clear in statement, looking at subjects in a broad way and from many sides, yet shrewd to see on which side lay the truth he was in search of, he would have probably found his way from the bar to the bench, and left the name of a wise, if not of a great, judge upon our records.

No one ought to regret the choice which gave such a helper to lighten the burden of human infirmities. He had all the qualities which go to the making of a master in the art of healing; "science" enough, but not so much in the shape of minute, unprofitable acquisition as to make him near-sighted; very great industry; love of his profession and entire concentration of his faculties upon it, with those mental qualities already spoken of as fitting him for other duties, but which equally fitted him to form a judicial opinion in the silent court-room where nature is trying one of her difficult cases.

Such a man is pretty sure to find his place in any great centre of population. But to be recognized as standing at the head of the medical profession in a large city, or an extensive district, implies a previous long and arduous struggle, at least in one who comes unheralded and unknown. Every step of such a man's ascent must be made, like an Alpine climber's in the glacier, in the icy steep of indifference; fortunate for him if he does not slip or is not crushed before he reaches the summit, where there is hardly room for more than one at a time.

It was in such a position that Dr. Clarke stood when he felt the first symptoms of the disease to which he was to fall a victim. He cannot have been suffering very long from it when he consulted one of our most skilful surgeons, and learned the too probably malignant nature of the affection. There was a chance, perhaps, that the symptoms might be interpreted otherwise than as a certain warrant of death. For the greater part of the time, while the writer was an habitual visitor to his sick chamber, he was in the habit, if he referred to his disease at all, of speaking as if he had a chance of recovery. It was only a few weeks before his death that he spoke of the end as rapidly approaching, and then said that the trial of parting with life had been long over, even from the time when he had first sought the surgeon's opinion. One sleepless night, in which he walked his chamber alone with his fatal sentence; a letter preparing the one nearest to him for the inevitable approaching future; after that struggle he felt as if the darkest passage of the valley of the shadow of death had been left behind him, and walked serenely forward from that day to the end.

If all who knew him and leaned upon him as their cherished and trusted adviser; if all who valued him and loved him as a friend; if all who felt his importance as an active and wise and public-spirited citizen; if all whom his well-weighed and soberly stated opinions on educational and hygienic subjects have influenced, both at home and abroad; if all the pupils who have sought his guidance in the important branch which he invested with so much attraction, as well as made affluent with fresh instruction, — if all these were to record their praises and their regrets, the volume must be ample that would hold his eulogy.

There is only space for a brief notice of some of his excellences in different directions. And first of all, as a physician. It may be asked, what are the points of superiority which make the great practitioner? It is not the power of making a minute *diagnosis;* in other words, of naming and localizing a disease with the greatest nicety. It is not the power of displaying, differentiating, and describing the effects of disease as shown in the degenerated organs which once belonged to a patient. Skill in these two branches is often found in the same individuals, and is always justly and greatly to be valued; but one may be a skilful interpreter of the signs of disease, and an expert with the scalpel and the microscope, and yet very inferior as a practitioner to another who is far less instructed than himself in both of these departments. Given a fair acquaintance with the meaning of the ordinary signs and symptoms of disease, and the alterations which give rise to them, the best practitioner is the one who seizes most readily and certainly the vital conditions and constitutional tendencies of the patient, and shows most sagacity, tact, and fertility of resources in dealing with the varying states of his mind and body, whether or not he has occasion to use special remedies for special purposes, as every routine practitioner is capable of doing. Here it was that Dr. Clarke showed his mastery. He read his patient's mind as every man must who would control another; he took in the whole bodily condition and its changes by careful examinations, scrupulously recorded after his visits for the day were finished; and he knew, as very few practitioners really know, what remedies could and could not do, — but especially what they *could* do in the way of alleviating suffering and shortening or arresting curable diseases.

As an instructor Dr. Clarke was the admiration of his pupils. His plan of teaching therapeutics was his own, and he not only spoke with authority, but made a subject commonly thought among the least interesting of a medical course a great centre of attraction to the students of the medical school. In the councils of the Faculty his opinion was always listened to with respect, as coming from one of its wisest and most fair-minded members.

As a writer he published no voluminous work. He contributed various articles on the Materia Medica to the "New American Cyclopædia." In conjunction with Dr. Robert Amory, he published, in 1872, a small volume on the physiological and therapeutical action of the bromides of potassium and ammonium. In 1876 he published, under the title of "Practical Medicine," a brief and clear account of the progress of medical knowledge during the century just finished. But nothing that came from his pen has been so universally read as his essay entitled "Sex in Education." This publication was like a trumpet-call to battle, and started a contest which is not yet over. Dr. Clarke received a great number of letters and printed communications confirming his views, and was made the object of many attacks, which he bore with perfect equanimity, feeling that he had honestly given the results of his experience, having only the good of the community in view. A second essay, "The Building of a Brain," followed up the first, with various important propositions bearing on education, and was widely read, but provoked less sharp antagonism. He wrote a valuable letter on the park question, and on all subjects relating to public health his opinion was looked to as of very high authority.

During the confinement of his last illness he occupied himself much with reading, and in the later part of the time, until his strength entirely failed him, with writing, chiefly on points of psychology which particularly interested him. He seemed to enjoy discussing nice and difficult questions with some of his visitors, and it was pleasant, following his lead, to see him forget himself for a little while in the analysis of mental operations, in which he showed a power of steady and penetrating thought which would have given him a name in metaphysical speculation if he had concentrated his efforts in that direction. He had the great advantage of having studied the working of the mind under various exceptional conditions, and had many strange things to tell from his own experience, all of which he was disposed to account for without invoking any of the vulgar machinery commonly called in to explain such phenomena.

His constitution was gradually yielding to his disease. The end which he had long foreseen as probable was growing more and more certain, if possible, and, of course, coming nearer and nearer. What affection could do to help him bear his anguish was done for him tenderly and lovingly by his devoted wife and daughter, and the friends who were anxious to render their services. In this strait of a dependent, suffering, and failing life, the wife, to whom he looked for daily care and solace, who was to watch his decline and be with him in the last hour of earthly companionship, was seized with sudden illness, and died after a few days, leaving the dying husband, who had thought to have gone long before her.

Under this sudden and overwhelming grief, with pain as his constant companion, with death always in full view, he bore himself with a steadfastness, a perfect quiet of aspect and manner which showed at once his self-command and his self-submission to the orderings of that Providence in which he trusted. His rule in this world had been duty; his faith in looking forward to the future was simple, untrammelled by mechanical forms or formulæ, but having as its inmost principle the love which casteth out fear.

How many families there are in this community that feel as if they could hardly live without the counsels of this good, skilful, wise physician, or die in peace without having had all his resources called upon to keep them breathing this sweet air of life a little longer! How many will feel that no one will ever read their conditions of mind and body as he did, or give himself up so unreservedly to the exactions of their too frequently selfish suffering, or bring into the sick chamber a look so tranquillizing and assuring! Time will teach them that the art, which is long, does not perish with the fleeting life of its wisest practitioner; that others, many of them, perhaps, his own former pupils, will deserve and gain their confidence; that the affections, seeking new objects when the old are torn away, will surely find them; but to many the best eulogy of the best physician who comes after him will be so long as they live, that he recalls to their memory the skill, the wisdom, the character of Doctor Edward Clarke.

# VISIONS.

Visions have always held, and still hold, a place among the experiences of mankind. From the time that Abraham had a vision of angels in his tent, to the latest manifestation of modern spiritualism and spirit seeing; among all nations, savage, civilized, and enlightened; in all classes, whether cultivated or ignorant; and in every phase of human development, oriental and occidental, Pagan, Christian, and Mohammedan, there have been those who saw, or who pretended to see, visions. Visions have not only been recognized as a part of the mysterious phenomena of disease, but of the equally mysterious phenomena of health. The hearty and strong, as well as the morbid and ill, have been visited by them. Necromancers and charlatans, seers and prophets, enthusiasts and sober minded people, those who have deluded, and those who have inspired, the race, have, with varying degrees of earnestness and success, supported their claims to reverence or obedience, by the assertion that they could see what was hidden from the eyes of others.

When we consider that such very different personalities as Elijah and St. Paul, Buddha and Mohammed, St. Francis d' Assisi and Swedenborg, Joan of Arc, Luther and Bunyan, Indian Medicine Men and Oriental Hakems, Convulsionists of St. Médard, inmates of asylums for the insane, invalids, elevated by the ecstasies of hysteria, and persons sunk in articulo mortis, opium and hashish eaters, alcohol drinkers, and others, have all seen visions, it seems as if such phenomena must be among the commonest experiences of humanity, and of a character which ought not to produce amazement or incredulity. But such is not the case. Visions are regarded, and naturally regarded, not only by scientific and thoughtful people, but by the common sense portion of the community, very much like ghosts, as unrealities. A few exceptions may be made in the case of apostles and teachers, but the vast majority of visions are classed among the delusions, vagaries, and fancies of mankind, or among the inexplicable phenomena of disease. Yet it must be admitted, after acknowledging to their fullest extent the obscurity, mystery, and charlatanism which covers up and infects the matter we are considering, that the denial of a substantial and real foundation to the phenomena of visions must be accompanied with a certain reserve. Sometimes the incredulity of the most skeptical has been staggered by the statements of those, whose mental soundness and recognized honesty precluded the suspicion of deception or insanity; but these exceptional instances have usually been summarily disposed of, by remanding them to the region of the mysterious and unknowable. Now and then, some sanguine or philosophic hearer of such statements has returned a doubtful hope that science would yet penetrate the mystery that enveloped them, and arrive at an adequate solution of them, and perhaps has accompanied his hope with the vague assertion that —

> "There are more things in heaven and earth, Horatio,
> Than are dreamt of in your philosophy."

The persistence with which the truthfulness of visions has been affirmed, at all times, everywhere, and by such a variety of individuals, is itself a significant fact, and one that deserves consideration. It implies that below the nonsense, charlatanism, fanaticism, ignorance, and mystery, upon which visions are largely built up, there is somewhere a substratum of truth, if we could only get at it. Such a growth could never have appeared, nor would it continue to appear, if its roots did not draw their nutriment from something more invigorating than fancy or deception. It must be admitted, moreover, that the question of the possible occurrence of visions is one of great interest and importance. Its interest lies in its intimate connection with the attractive and shadowy territory — the terra incognita, and debatable ground — which stretches between the body and mind, and which connects this world with the next. Its importance lies in the fact that its solution, if a solution is possible, would not only throw light upon some of the intricate and vexed problems of psychology, but would aid materially in dissipating many popular superstitions and widely spread delusions.

That there have been, and are, many persons who solemnly assert that they have seen visions, as well as dreamed dreams, is acknowledged. The question which it is proposed to investigate here is not whether such assertions are made, but upon what they are founded. Are visions, whether occurring in the sound or unsound, excluding, of course, necromancy and cheating, pure figments of the imagination, or are they facts, resting upon a physiological basis; and if the latter, what are the conditions, and what is the mechanism of their production? If any satisfactory answer to these inquiries can be given, it must be obtained, not from psychology or theology, but from physiology and pathology; not from metaphysicians or priests, but from physicians and physiologists. Approaching the subject upon its physiological side, and supplementing physiological investigation by clinical observation, it is possible to clear away some of the obscurity which covers it, and to pick out a few grains of wheat from the mass of surrounding chaff. Fortunately, recent discoveries in physiology are of a character to throw a partial, if not a full, light upon these and similar problems, and to give reasonable assurance of a complete solution at some future period.

It is unnecessary and unwise to complicate our present inquiry with any discussion of the difference or identity of mind and matter. Whether mind is a product of matter, and so material, or an entity distinct from matter, it is admitted by all that it is manifested, so far as we know it, or can know it, in this world, only by and through matter. The materialist and immaterialist are so far agreed. Obviously, then, the rational method of studying psychological phenomena is a physiological one. The brain being an organ of the mind, knowledge of it is an indispensable prerequisite to a comprehension of the latter ;[1] consequently, visions which are mental or subjective phenomena, must be conditioned, if they occur at all, as intellection is, by the brain through which they are displayed. They can appear only under definite modifications of the circulation, nutrition, and metamorphoses of the intracranial apparatus. The states of the brain, therefore, which permit, accompany, and modify visions, and not the reports of consciousness, should be investigated, in order to arrive at any intelligent notion of

[1] Admitting that the conception of spirit or mind, as absolutely independent of matter, is unthinkable, I cannot regard them as identical. It is not from any unwillingness to affirm my belief in an ego, that there is an apparent doubt in these statements, but from a desire to avoid the introduction of side issues.

such singular occurrences. A knowledge of these states, that is, an acquaintance with the physiological conditions and mechanism of visions, would go a great way towards discovering the true character of the latter.

With the hope of contributing something to our knowledge of the natural history of visions, the following essay has been prepared. It is founded upon a series of cases, of which the majority occurred under the writer's observation. The subjects of these visions were all persons of more than ordinary intelligence and cultivation. It is possible, perhaps probable, that this fact had a more intimate connection than that of mere coincidence with the visions reported. The development of the nervous system, and especially of the cerebral portion of the nervous system, which attends cultivation and intellectual power, is more likely than the intellectual development, which is permitted by brains of coarser fibre and quality, to afford an opportunity for the display of extraordinary nervous phenomena. It will also be noticed, that all the individuals, whose cases are here presented, were themselves conscious of the subjective character of their visions. Indeed, all other cases were purposely excluded. The conditions of hallucination, illusion, and delusion can be more easily and satisfactorily studied in persons who recognize the unreality of what besets them, than in those who entertain an opposite conviction.

Before going further, it is important to be sure that a definite and precise signification is attached to the principal terms we are to use, or at least to the one by which the subject we are to investigate is designated. Accuracy and clearness of statement are essential to accuracy and clearness of ideas. Unfortunately, the terms which have just been mentioned, hallucination, illusion, and delusion, are vaguely employed, and often confounded with each other. They have not acquired definite and distinct significations; at least, not to such a degree that any one of them brings before the mind a peculiar and individual condition or notion, to the exclusion of the others. They are often used as if they were synonymous, and as if the conditions of the nervous system which they indicate were similar, or the same. This confusion undoubtedly arises from the uncertainty and inaccuracy which has existed, till recently, of our knowledge of their causes and character. Webster defines delusion, to be "false representation . . . . illusion;" illusion to be "deceptive appearance . . . . false show;" and hallucination to be "delusion, faulty sense, erroneous imagination." According to Worcester, delusion is "a false belief . . . . illusion;" illusion is "deception, as of the sight, mind, or imagination . . . . delusion;" and hallucination is "a morbid error in one or more of the senses . . . . delirium . . . . delusion." Evidently, both of these lexicographers regard the above terms as nearly synonymous. Their definitions would lead an inquirer to suppose that delusion, illusion, and hallucination, instead of being different and distinct physiological conditions, were almost identical affections. Dr. William A. Hammond, who is aware of the existing confusion of ideas and language on this subject, has endeavored to get rid of it by careful definitions. He defines [1] Illusion to be "a false perception of a real sensorial impression. Thus a person, seeing a ball roll over the floor, and imagining it to be a mouse, has an illusion of the sense of sight." Hallucination he defines to be "a false perception, without any material basis, and is centric in its origin. It is more, therefore, than an erroneous interpretation of a real object, for it is entirely formed by the mind." Delusion, according to the same author, is "a false belief." An individual, who has an illusion or hallucination, and is sensible that they are not realities, is not deluded; one who accepts them as facts is deluded. These distinctions are just and important. They are founded on the existence of three distinct classes of false perceptions, which have been discovered by physiological and clinical observation: viz. one of subjective, or as Dr. Hammond designates them, centric perceptions, which are produced solely by cerebral action, and are recognized as false by the subjects of them; a second class of objective, or

[1] *Diseases of the Nervous System*, by William A. Hammond, M. D., 6th ed., pp. 320, 321.

eccentric false perceptions, which are recognized as false by the subjects of them, and are produced by external objects, acting on the visual apparatus, *ab-extra*, that is, playing upon the individual from without, and hence the term illusion, from *in* and *ludo*, to play upon; and a third class of false perceptions, which may be subjective or objective, or both together, in the reality of which the individual believes, and so is deluded by them; hence delusion, from *de* and *ludo*, to be played upon from within, or mocked by the brain.

Nothwithstanding the justness of these distinctions, it is difficult to keep them well in mind, and use the old names. Hallucination, illusion, and delusion, as the above citations from Webster and Worcester show, are so closely allied, in their ordinary acceptation, that one not only suggests the others, but is often confounded with them, or is substituted for them. It would avoid ambiguity of language, and confusion of thought, to discard them altogether, at least, from scientific treatises, and employ new ones, if such could be found, which would describe, more accurately than these, the conditions they are intended to designate, and with which no preconceived notions are associated.

With the hope of attaining this object, the following terms are proposed, and will be used in the present essay. The normal process of vision may be appropriately called Orthopia, from ὀρθός and ὄπτομαι; and false perception, or vision, Pseudopia, from ψεῦδος and ὄπτομαι. According to this nomenclature, false perception, arising from the action of the intracranial visual apparatus, would be called subjective or centric pseudopia; that arising from disturbance of the eye alone, ophthalmic pseudopia; and that produced by the presence of external objects, objective or eccentric pseudopia. An individual, conscious of the error in his perceptions, would have conscious pseudopia; otherwise, unconscious pseudopia. One advantage of these terms over the common ones of hallucination, illusion, and delusion, is that they indicate the precise part of the visual apparatus, whose structural or functional disturbance causes the false perceptions. Conscious centric (or subjective) pseudopia; unconscious centric (or subjective) pseudopia; conscious eccentric (or objective) pseudopia; unconscious eccentric (or objective) pseudopia; conscious retinal pseudopia; unconscious retinal pseudopia, etc., etc.; all indicate, with tolerable precision, the part from which visual derangement proceeds, and, to some extent, the character of the derangement. Another and no slight advantage is, that no traditional or preconceived notions are associated with these terms.

The following cases form an appropriate introduction to a discussion of the physiological and pathological conditions of pseudopia, and they illustrate most of the important points to which reference will afterwards be made. The first case is one of conscious centric or subjective pseudopia, occurring in the course of delirium tremens, or rather during convalescence from that malady. Subjective sight-seeing is not an unusual event in that affection, but it is not of less physiological importance, because it is familiar.

### CASE I.

*Conscious centric or subjective pseudopia in a man of middle age, resulting from the action of alcohol on the brain.*

Mr. C., a man of excellent natural abilities and liberal education, unfortunately became addicted to the excessive use of alcoholic drinks. This led to the common results of intemperance, such as gastric derangement, nervous prostration, insomnia, and, at length, to attacks of delirium tremens. The latter never assumed a violent type, though they were sufficiently characteristic. The explanation of their mildness is probably to be found in the fact, that he did not live long enough for their more complete development. He died in middle life, before the age of forty, or somewhere about that time. The delirium which he exhibited was of the usual whimsical and incoherent character. When it attacked him, his attendants and the furniture in his room would assume strange and distorted forms, and he would see, moving and flitting about his chamber, all sorts of creeping and crawling things, hideous shapes, hobgoblins, griffins, and unearthly and indescribable apparitions, such as are common to the delirium of this malady. On one occasion, when he was so far convalescent from an attack as to have slept the night previous to my visit, I asked him if sleep had driven off all his spectres and unearthly companions. He replied that all were gone but one, and that one was a large black dog, which still haunted him.

"Where is he?" I inquired.

"There," he said, pointing across the room, "standing on the bureau, under the mirror."

I went to the spot, and putting my hand upon the centre of the bureau, asked, "Do I now touch the dog?"

"No;" was the answer, "he has moved aside to the right."

Carrying my hand to the right, "Where is he now?" I continued.

"Jumped down upon the floor," said the patient.

I did not attempt to pursue the animal farther, and he soon vanished. Mr. C. talked intelligently about his spectres. Generally, he said he could recognize their character as subjective phenomena, but sometimes he found it a very difficult thing to do so. For instance, he stated that his wife once assumed, in his delirium, the appearance of a burglar or a thief, when she entered his apartment, and it was with extreme difficulty that he restrained himself from knocking her down. A sort of vague and shadowy doubt as to his own condition and the correctness of his judgment, alone prevented him from inflicting violence upon her. The seeing, or rather the perception, of the animals, spirits, and other beings, of his subjective menagerie, was nearly, and sometimes quite as distinct as that of real objects when he was well.

The chief peculiarity of this case is the persistence of the apparition of the black dog, united with the distinctness with which the animal was seen. The spectres of delirium tremens are, unfortunately, only too often brought to the notice of medical men; but it is not often that the patient, who is tormented by the vagaries of his brain, is able to recognize and describe the character of his visions as clearly as Mr. C. did.

It is well known that alcohol is not the only agent which can make men and women see without eyes, and hear without ears. Opium, ether, Indian hemp, belladonna, and their congeners possess a similar power; but in what their power resides is not comprehended any better than is the cerebral mechanism by which such effects are produced.

My personal experience of the vision-producing power of opium is so slight, that it scarcely deserves to be reported; but inasmuch as it illustrates, as far as it goes, the subject of the present paper, it may not be inappropriate to record it. Among the most vivid recollections of my childhood are those of visions, which followed the administration of paregoric or of some other form of opium, a drug which was occasionally given me, especially during the season of green fruits, when colic and similar troubles are apt to occur. Soon after taking the narcotic, strange sights and grotesque forms of all sorts of known and unknown animals, among which horses predominated, sometimes in groups and sometimes singly, some with bodies and no heads, and some with heads and no bodies, some in full harness and some without bridle or saddle, and as wild as Mazeppa's steed, would fill my room, swarm about my bed, and run around and over my person. They made no noise, and never excited my fears. At first, I marvelled where they came from ; but I soon learned to associate them with opium, and enjoyed the spectacle, instead of dreading it, to such an extent, that I looked forward to a dose of opium with pleasure, and regarded the amusement which it afforded me as some compensation for a sharp stomach ache. The spectres were distinct, spirited, and life like. They were most clearly visible and most natural when my eyes were closed, and would disappear rapidly upon opening my eyelids. I often tried to summon them, after taking opium, with my eyes open, but then the spectre animals would not come. As soon as the soporific action manifested itself, they vanished, sometimes suddenly and sometimes with a lingering step, as if loath to go. The duration of their stay probably coincided with the primary stimulant action of the drug, for they rarely remained near me more than a quarter of an hour or thereabouts. With the approach of adult life, this peculiar action of opium almost entirely ceased. Whenever, of late years, I have had occasion to take opium, I have watched for the coming of the old familiar spectres, but have only caught glimpses of them. Now and then, after taking twenty or thirty drops of laudanum, I have seen a horse's head, with ears erect, peering at me through the darkness, just enough to remind me of childhood's lost visions, and that was all. This experience is probably not an unusual one; and if not, it illustrates only more fully, than if it were, the fact that the machinery of cerebral vision may be easily set agoing in a large number of persons, if we know how to touch its secret springs, without any objective stimulus. Herein may possibly be found an explanation of the visions of the enthusiasts and seers of all nations and ages, as well as of those of modern spiritualism, whenever the latter are not the result of sleight of hand, or other deception.

The next case is an instance of conscious centric or subjective pseudopia, which manifested itself during the course of an epilepsy. It occurred under the observation of Dr. S. G. Webber, of Boston, to whose courtesy I am indebted for the opportunity of presenting it here. Sounds, flashes of light, and vague, shadowy, and momentary visions, such as are described in this case, are not uncommon antecedents or consequents of an epileptic seizure. Little attention is usually paid to them by practitioners, though they are undoubtedly connected with the grave cerebral disturbances which provoke epilpsey. At present, however, we are concerned with them only as illustrations of our subject.

### CASE II.

Mr. G. an intelligent young man, came under the observation of Dr. Webber, in April, 1870, in consequence of a visitation of epilepsy. He had been suffering from the disease for four years previously. He had both the *grand mal*, with loss of consciousness, and the *petit mal.* "In the fall of 1873," according to the report of Dr. Webber, "a new feature was observed in the nature of the attacks of *petit mal.* After lying down, and hence most frequently during the night, or early in the morning, he had visionary attacks, which he spoke of as a sort of double consciousness. While knowing that he was in bed, he yet seemed to see objects out of doors. In the first attack, he saw a man on horseback, riding helter skelter over the flower beds in the garden, and the flowers seemed to be artificial, made of paper. During these attacks, he has not always seen the same objects; on one occasion, he saw a river of water, flowing along quietly, filled with the heads of seals; these changed to soldiers, marching down a street.

Twice, the attack is mentioned as occurring during the day, while lying down for a nap. Once, thousands of men leaped up over a stone wall, near which he thought he stood; also animals were seen in immense numbers, going across a marsh, keeping abreast for about a quarter of a mile; then the whole quickly faded from view. These are examples which he gave of the attacks. It was rather more common to have a large number of objects appear than solitary individuals.

This is an instance of distinct conscious centric pseudopia. The cerebral disturbance which produced it was undoubtedly the result, or a part of the condition, of the nerve centres, which was the cause of the patient's epilepsy. The support which this case lends to the doctrine, now generally accepted, that all portions of the gray matter of the hemispheres are in communication with each other, and capable, when sufficiently excited, of calling forth each other's activity, will be alluded to in another place.

The visions, which are next described, are very different in their character, of longer duration, and apparently less intimately associated with grave disease of the nerve centres, than those which have just been reported.

CASE III.

*Conscious centric or subjective pseudopia in a married woman, apparently connected with some febrile derangement of the system.*

The subject of this case, Mrs. B., is a lady nearly thirty years of age. She is the mother of several children, and though of a delicate organization, enjoys a fair degree of general health. She is of a nervous temperament, which she keeps under excellent management, but which renders her susceptible to many influences that others would feel very slightly, or not at all. She is intelligent and accomplished; and if her early education aided the development of her congenital nervous tendencies, it also aided her to acquire the mental strength by which to control them. The visions, as she calls the phenomena, which she sometimes witnesses, and which she has often described to me, are usually the forerunner or attendant of some sort of febrile attack, like a cold, or simple fever, or gastric derangement; and they disappear when the attack is fully developed. She has learned to recognize them as purely subjective phenomena, altogether independent of any objective reality, and now regards them as symptomatic of some physical derangement like those which have been just mentioned. When a child, she had the misfortune to lose her mother by drowning, and saw the corpse at a time, and under circumstances, that affected her even more profoundly than such a terrible occurrence would be sure to do, under any circumstances. She never saw visions till after this happened; and it is her belief that they are in some way connected with it, in the relation of cause and effect, though how she cannot tell.

The hallucination to which she is subject takes the form of a female figure, which commonly appears suddenly, and without warning. The figure is of natural size, dressed in white, sometimes wearing a blue ribbon, sometimes without anything of the sort, and frequently but not always carries its face averted. The form and the face are always the same, and are those of a stranger, not of an acquaintance. It comes unbidden, at any time of day or night, and is as liable to show itself in other places as in Mrs. B.'s own house. When it appears, it assumes various postures; sometimes sitting, sometimes standing, and sometimes walking. On one occasion she was going to dine out. On her way to the dinner, she felt an uncomfortable sensation in her head, like a coming headache, but was otherwise in fair condition. She did not renounce the dinner, but as she approached the table with the other guests, and was about to take the place selected for her, she noticed that the chair, appropriated to her, was already occupied. For a moment she had no doubt that a form of flesh and blood filled it, and was about to ask the hostess for another place, when she recognized her familiar spirit, which had assumed such natural proportions and color as to deceive even herself. She thrust her fan into the spectre, so as to be sure it was an airy nothing, and then sat down. The figure moved aside and vanished. On another occasion, she sent for me professionally, because, though she felt pretty well, the spectre had made its appearance that morning, and she was consequently sure that she would soon be ill. I found her with a pulse moderately accelerated, and with other symptoms of slight febrile disturbance, all of which disappeared under appropriate management, and with their disappearance the spectre departed also. She has learned by experience and observation to recognize the character of her strange visitor, and rightly regards the hallucination as

> "A false creation,
> Proceeding from the heat-oppressed brain,"

and is not disturbed by it. There are times when it presents only a vague and indistinct outline, like a shadow. At other times, its form, size, and appearance are so life-like and real, as to make its resemblance to a human being perfect; indeed, so exact has the counterfeit sometimes been, that Mrs. B. could only ascertain its unreality, by the experiment of trying to touch it. It will sometimes take a chair, and sit near where she is reading, or at work, or by her bed, by the half hour or hour together, and then vanish as suddenly, and with as little apparent cause as it came. It should be added, that, notwithstanding long familiarity with it and its freaks, she confesses to a feeling of relief at its departure.

The striking peculiarity of this case is the close similarity, amounting to identity, of the subjective perception, produced by cerebral action alone, without any external stimulus or object, with that produced in the ordinary way by the rays of light from an external object, falling upon the retina. The cerebral condition or process, which was here induced by febrile or other disturbance, was so exactly like that produced by the movement of light from a female figure, entering the eye and thence sending a motion along the nerves to the gray matter of the anterior lobes of the brain, that the objective unreality could not be recognized. In fact, under such circumstances, the brain is incompetent to discriminate between true and false perceptions, and can make the discrimination only by using its other senses as means of correction or corroboration. This Mrs. B. had learned to do, and when in doubt, she employed the sense of touch to supplement and correct that of sight. Another peculiarity is the ease and certainty with which she recognized the subjective character of the apparition. Few persons have ever been similarly affected, and few of those who have been have possessed the intelligence and temperament which enabled them to form a correct notion of such singular phenomena.

The next case differs from the preceding one in the variety of the visions described, and in the greater care with which they were observed by the subject of them. No ghosts or incorporeal visitants have ever put on a greater semblance of reality than these visual appearances.

## CASE IV.

*Conscious centric or subjective pseudopia, occurring in an unmarried woman; appearance of female figures, men, animals, and other forms.*

The subject of this case is a lady of middle age, who has long been an invalid. She has suffered most in her nervous system, though other parts of her organization have also been more or less affected. It should be added that her natural abilities and acquirements are of a high order, as the following description from her own pen of the hallucinations that at times beset her testifies. She learned very early to think for herself, and perhaps this is the reason why she recognized, so soon and so clearly as she did, the subjective character of her visions. She prepared the following description of her case at my request, and has kindly permitted me to use it, a favor which the reader will fully appreciate: —

"My earliest recollections are of a life made miserable by the daily companionship of a crowd of dreadful beings, visible, I know, only to myself. Like Madame de Staël, I did not believe in ghosts, but feared them mortally. When I was about fifteen, we went to Europe for two years, and the change of scene, and of constant external interest, broke up my invisible world, and I have only entered it since in times of excitement or great fatigue. Of late years the most distinct visions have appeared only when sharp mental pain or anxiety has been added to bodily exhaustion. My sense of hearing has never deceived me, except that during my girlhood, in frequent nervous states of mind, all sounds would strike my ears discontinuously, that is, with a time-beat as sharp and rhythmical as the movement of the bâton by an orchestral conductor.

"Several years ago one of my sisters was taken ill with typhoid fever. I was not strong enough to be of any assistance in her chamber, so I undertook to finish some work which she had commenced, and became daily more and more worn out in my endeavors to carry it on. Anxiety, added to fatigue, finally brought back the old visions, which had not troubled me continuously for some years. Animals of all kinds, men, women, glaring-eyed giants, passed before or around me, until I often felt as though I were surrounded by a circle of magic lanterns, and would sometimes place the back of my chair against a wall, that at least my ghosts should not keep me constantly turning, as they passed behind me. One evening, feeling too tired to sit up for the latest report of my sister, which my mother brought me regularly, I went to bed, leaving my door wide open, so that the gas, from the adjoining entry, sent a stream of light across one half of my little chamber, leaving the rest somewhat in shadow. Soon I saw my mother walk slowly into the room, and stop at the foot of the bed. I remember feeling surprised that I had not heard her footstep, as she came through the passage. 'Well?' I said, inquiringly. No answer, but she took, slowly, two or three steps towards the side of the bed, and stopped again. 'What is the matter?' I exclaimed. Still no reply; but again she moved slowly towards me. Thoroughly frightened by this ominous silence, I sprang up in bed, saying, 'Why *don't* you speak to me?' Until then her back had been turned to the door, but as I last spoke she turned, almost touching my arm, and the light falling on her face, showed me an entire stranger. She had heavy dark hair, and her face, quite young, was pale, and though calm, very sad. Over her shoulders was a child's woollen shawl, of a small plaid not familiar to me, which she drew closely about her, as though she were cold. Her right hand, which pressed the shawl against her side, was very white, and I was struck by the great beauty of its shape. The thought passed through my mind, 'Can she be a friend of the nurse? But *why* has she been sent so mysteriously to me?' As I stared at her in speechless amazement, she fell to the floor. I instantly stooped over the side of the bed. To my consternation there was nothing to be seen! Accustomed as I was to ghosts, if there had been anything in the least shadowy about my visitor, I should have suspected her tangibility; but so well defined was she, so vividly was her reality impressed upon me, that I could not believe that she had vanished. I looked into every corner, and glanced under the bed; it seemed even more credible, for a moment, that the floor had opened, than that my visitor had been less flesh and blood than I.

"I think that my ghost stories cannot be sufficiently remarkable to make you wish for any other than this, but if you lack illustration of any special point you wish to urge, I could probably supply you with any style of ghost or goblin that you may need. It occurs to me that the remarkable cases of nervous disturbance which you have related to me have all occurred in the evening, as did the incident which I have just described. This visitor stayed with me longer than any other of her kind that I have ever received; but usually the visions seen by sunlight have been the most distinct and deceptive, and have haunted me the most persistently. It was in the daytime, too, that I walked beside my own double; and on one bright afternoon, that I lost my way, in a country town as familiar to me as was Cambridge to your college friend. Luckily, I was driving, and not too much frightened to remember that my horse had not lost his wits also

I loosened the reins, and he brought me out safely from a very awkward dilemma."

The previous case presents several interesting points. First, the early age at which the hallucinations began is worthy of notice. Their early appearance indicates, probably, some congenital cerebral condition, which favored their manifestation. If such be the fact, it raises a question as to how far the brain, in childhood, is more susceptible than in adult life, to subjective impressions, and consequent hallucination and delusion. The screaming, and strange terrors, and frightened looks and actions, which some children exhibit, when there is no apparent cause for terror or alarm, may sometimes result from cerebral processes, which surround them with invisible objects of horror and distress. The terrors of such unfortunate children deserve the considerate treatment of practitioners, and the wise and tender watchfulness of parents, instead of ridicule and punishment. Secondly, another noteworthy circumstance is, that the visions of Miss D.'s adult life appeared only when mental pain or anxiety, added to bodily exhaustion, had prepared the way for them; a hint, that brain fatigue and bodily exhaustion favor the cerebral processes, or supply the cerebral conditions of subjective sight and hearing. A third point of interest is the close similarity of what, for want of a better expression, may be called her subjective visions to her objective sight. The important influences which flow from this will be mentioned elsewhere. A fourth point of great physiological interest, and one which her own observation led her to emphasize, is, that her visions, instead of being, as such visions usually are, shadowy and doubtful by daylight, were most distinct and deceptive in a clear and bright light. Her brain did not require shadows, twilight, and darkness, for the production of hallucinations. This is evidence, to a certain extent, that the cerebral processes by which vision is produced may not only be started in the brain itself, but that, when so started, they are identical with those set agoing by an objective stimulus in the ordinary way.

The visions of Nicolai of Berlin have been referred to, and quoted by psychologists and physiologists, for nearly a hundred years. Their intrinsic importance, as psychological phenomena, is enhanced by the fact, that he was himself the subject of them, and that, being a man of careful observation and scientific attainments, he attentively watched their various phases as they occurred in his own person, endeavored to trace the connection between them and his own physical condition, and himself recorded the result of his observations. His visions were, moreover, remarkable for presenting simultaneously false perceptions of sight and sound. He not only saw human beings, but heard them speak. He had, therefore, pseudotia (ψεῦδος and οὖς), as well as pseudopia. The rational view which he took of his visions, and his hypothetical explanation of them, show him to have been a person considerably in advance of the age in which he lived. They are such admirable illustrations of our subject, that his account of them is quoted in full.

### CASE V.

*Conscious centric or subjective pseudopia and pseudotia in a man past middle life; record of the visions, made by the subject of them.*[1]

"In the first two months of the year 1791, I was much affected in my mind by several incidents of a very disagreeable nature; and on the 24th of February a circumstance occurred which irritated me extremely. At ten o'clock in the forenoon my wife and another person came to console me; I was in a violent perturbation of mind, owing to a series of incidents which had altogether wounded my moral feelings, and from which I saw no possibility of relief; when suddenly I observed at the distance of ten paces from me a figure, — the figure of a deceased person. I pointed at it, and asked my wife whether she did not see it. She saw nothing, but being much alarmed, endeavored to compose me, and sent for the physician. The figure remained some seven

[1] *A Journal of Natural Philosophy, Chemistry, and the Arts,* by William Nicholson, vol. vi., pp. 166, etc. London, 1803.

or eight minutes, and at length I became a little more calm; and as I was extremely exhausted, I soon afterwards fell into a troubled kind of slumber, which lasted for half an hour. The vision was ascribed to the great agitation of mind in which I had been, and it was supposed I should have nothing more to apprehend from that cause; but the violent affection had put my nerves into some unnatural state; from this arose further consequences, which require a more detailed description.

"In the afternoon, a little after four o'clock, the figure which I had seen in the morning again appeared. I was alone when this happened; a circumstance which, as may be easily conceived, could not be very agreeable. I went, therefore, to the apartment of my wife, to whom I related it. But thither also the figure pursued me. Sometimes it was present, sometimes it vanished, but it was always the same standing figure. A little after six o'clock several stalking figures also appeared; but they had no connection with the standing figure. I can assign no other reason for this apparition than that, though much more composed in my mind, I had not been able so soon entirely to forget the cause of such deep and distressing vexation, and had reflected on the consequences of it, in order, if possible, to avoid them; and that this happened three hours after dinner, at the time when digestion just begins.

"At length I became more composed with respect to the disagreeable incident which had given rise to the first apparition; but though I had used very excellent medicines, and found myself in other respects perfectly well, yet the apparitions did not diminish, but on the contrary rather increased in number, and were transformed in the most extraordinary manner.

"After I had recovered from the first impression of terror, I never felt myself particularly agitated by these apparitions, as I considered them to be, what they really were, the extraordinary consequences of indisposition; on the contrary, I endeavored as much as possible to preserve my composure of mind, that I might remain distinctly conscious of what passed within me. I observed these phantoms with great accuracy, and very often reflected on my previous thoughts, with a view to discover some law in the association of ideas, by which exactly these or other figures might present themselves to the imagination. . . . .

"The figure of the deceased person never appeared to me after the first dreadful day; but several other figures showed themselves afterwards very distinctly; sometimes such as I knew; mostly, however, of persons I did not know, and amongst those known to me were the semblances of both living and deceased persons, but mostly the former; and I made the observation that acquaintance with whom I daily conversed never appeared to me as phantasms; it was always such as were at a distance. When these apparitions had continued some weeks, and I could regard them with the greatest composure, I afterwards endeavored, at my own pleasure, to call forth phantoms of several acquaintances, whom I for that reason represented to my imagination in the most lively manner, but in vain. For, however accurately I pictured to my mind the figures of such persons, I never once could succeed in my desire of seeing them *externally;* though I had some short time before seen them as phantoms, and they had perhaps afterwards unexpectedly presented themselves to me in the same manner. The phantasms appeared to me in every case involuntarily, as if they had been presented externally, like the phenomena in nature, though they certainly had their origin internally; and at the same time I was always able to distinguish with the greatest precision phantasms from phenomena. Indeed, I never once erred in this, as I was in general perfectly calm and self-collected on the occasion. I knew extremely well, when it only appeared to me that the door was opened and a phantom entered, and when the door really was opened and any person came in.

"It is also to be noted, that these figures appeared to me at all times, and under the most different circumstances, equally distinct and clear, whether I was alone or in company, by broad daylight equally as in the night-time, in my own as well as in my neighbor's house; yet when I was at another person's house, they were less frequent, and when I walked the public street they very seldom appeared. When I shut my eyes sometimes the figures disappeared, sometimes they remained even after I had closed them. If they vanished in the former case, on opening my eyes again, nearly the same figures appeared which I had seen before.

"I sometimes conversed with my physician and my wife, concerning the phantasms which at the time hovered around me; for in general the forms appeared oftener in motion than at rest. They did not always continue present; they frequently left me altogether, and again appeared for a short or longer space of time, singly or more at once; but, in general, several appeared together. For the most part I saw human figures of both sexes; they commonly passed to and fro as if they had no connection with each other, like people at a fair where all is bustle; sometimes they appeared to have business with one another. Once or twice I saw amongst them persons on horseback, and dogs and birds; these figures all appeared to me in their natural size, as distinctly as if they had existed in real life, with the several tints on the uncovered parts of the body, and with all the different kinds and colors of clothes. But I think, however, that the colors were somewhat *paler* than they are in nature.

"None of the figures had any distinguishing characteristic; they were neither terrible, ludicrous, nor repulsive; most of them were ordinary in their appearance; some were even agreeable.

"On the whole, the longer I continued in this state, the more did the number of phantasms increase, and the apparitions became more frequent. About four weeks afterwards I began to hear them speak; sometimes the phantasms spoke with one another; but for the most part they addressed themselves to me; these speeches were in general short, andnever contained anything disagreeable. Intelligent and respected friends often appeared to me, who endeavored to console me in my grief, which still left deep traces on my mind. This speaking I heard most frequently when I was alone; though I sometimes heard it in company, intermixed with the conversation of real persons; frequently in single phrases only, but sometimes even in connected discourse." . . . .

With the hope of obtaining relief M. Nicolai determined to lose blood. The result is thus described:—

"I was alone with the surgeon, but during the operation the room swarmed with human forms of every description, which crowded fast one on another; this continued till half past four o'clock, exactly the time when the digestion commences. I then observed that the figures began to move more slowly; soon afterwards the colors became gradually paler; every seven minutes they lost more and more of their intensity, without any alteration in the distinct figure of the apparitions.

At about half past six o'clock all the figures were entirely white, and moved very little; yet the forms appeared perfectly distinct; by degrees they became visibly less plain, without decreasing in number, as had often formerly been the case. The figures did not move off, neither did they vanish, which also had usually happened on other occasions. In this instance they dissolved immediately into air; of some even whole pieces remained for a length of time, which also by degrees were lost to the eye. At about eight o'clock there did not remain a vestige of any of them, and I have never since experienced any appearance of the same kind."

Besides this account of his own experience, M. Nicolai reports the case of his friend, Moses Mendelsohn, who contracted a malady, after intense application to study, in which he heard, at night, a stentorian voice repeat much that had been spoken to him during the day. Here the ear, not the eye, was disturbed so as to report inaccurately.

The comments which are naturally suggested by this extraordinary account, and the probable explanation of the visions described, will be given farther on, in connection with the discussion of the physiological conditions of pseudopia. The case which immediately follows resembles this in being an instance of the abnormal action of two senses simultaneously.

## CASE VI.

*Conscious centric or subjective pseudopia and pseudotia; in a man over eighty years of age, associated with disease of the brain, which finally proved fatal.*

Mr. A., a man of parts and education, was a retired merchant. Possessed of an ample fortune, he devoted more time to intellectual and æsthetic pursuits than to business. He was particularly fond of music, was familiar with the works of the great composers, and heard with delight the artists who interpreted them. During a long life, he was a frequent attendant at operas and concerts where the best music was produced. Early in his career he occasionally visited Europe, and when he did so, he improved the opportunities which his visit afforded, of indulging his musical taste more liberally than he could do in this country. This fact of his possessing a fine musical taste, and of his indulging and cultivating it, is emphasized in this connection, in consequence of its possible or probable relation to the phenomena which will be related presently. It should be added, that he was a man of more than ordinary intellectual ability, and was endowed with the rare gift of good common sense. Few persons could be found less likely than he to be led astray by their imagination or by superstition. Armed with an active temperament, good habits, and a strong physical organization, he enjoyed good health till after the age of eighty. He then suffered for two or three years from a cerebral malady, which at length terminated fatally. A moderate degree of deafness, persistent tinnitus aurium, occasional vertigo, and slight loss of memory, were the prominent symptoms of his condition for a year or two after he became an octogenarian. Towards the close of life, incoherence, delirium, stupor, and the like, indicated with sufficient certainty the presence of severe cerebral disease. Its precise character, however, was not ascertained by a post-mortem examination.

When about eighty years of age, and when suffering from the deafness, tinnitus aurium, etc., just alluded to, he called at my house early one morning, and gave me the following account of an extraordinary occurrence that had happened to him the previous night. He prefaced his story with the remark: "I have come to ask you, doctor, if the time has arrived for me to step out of this world." In reply to what he meant by such a question, he said that he had witnessed a most singular affair, during the previous night, of which he could give no adequate explanation, and which he thought might very likely be the forerunner of serious trouble in his brain. The account is given, as nearly as I can remember it, in his own language, with the exception of changing the first to the third person.

He had retired, on the night referred to, at his usual hour, and in his usual health. Nothing had occurred for the day previous, or for several days previous, to disturb him in any way so far as he could recollect. He had partaken of his usual diet, and followed his customary mode of life. Soon after retiring he fell asleep, and slept well till about two A. M., when he was awakened by the sound of music, which seemed to come from the street near his house. Thinking a serenade was going on, he got up to ascertain where it was, but discovered nothing. The sound ceased when he arose. On returning to bed, he heard the sound of music again, and was at the same time surprised by the appearance of three persons, standing near each other in his chamber, opposite the foot of his bed. It was his habit to sleep with the gas-light burning feebly, near the head of his bed. He turned the gas on to its full power, and inspected the intruders. They appeared to be musicians, who were humming and singing, as if in preparation for a musical performance. He rang a bell, which summoned his man servant. John soon arrived and was ordered to put the strangers out. "There is nobody here, sir," was John's reply to the order. For a moment Mr. A. was not only amazed, but alarmed. "What!" he exclaimed, "do you see no one there?" "No one," said John. "Go where those chairs are, and move them," was Mr. A.'s next direction. John did so. The strangers stepped aside, but did not go out. By this time Mr. A. had gathered his wits about him, and was satisfied that he was the victim of a hallucination; and he determined to observe its phenomena carefully. Accordingly, he bade his servant depart, and prepared to watch his visitors. But they were so life-like and human, that he was again staggered, and recalling John, told him to go for the housekeeper. She soon came, and on being interrogated, confirmed John's statements, that there were no strangers in the chamber, and no sounds to be heard. Convinced by the testimony of two witnesses, Mr. A. yielded to the decision of his reason, and again resolved to go on with the investigation of the strange phenomena. The musicians had now resumed their position, near the window and opposite the foot of the bed. Mr. A. turned the light of the gas full upon them. He looked at his watch, which marked the hour of half past two. He then arranged his pillows, so as to sit almost upright in bed, and waited for the next scene of the play. He was able to note the size, form, dress, and faces, of the performers. One was a large man, who bore some resemblance to Brignoli. The two others were of less size, and shorter stature than their companion. All were habited in dress coats, with white waistcoats, and wore white cravats and white gloves. After a little time, spent in coughing and clearing their throats, they began to sing. They sang at first a few simple airs, "Sweet Home" among others. They then attempted more difficult music, and gave selections from Beethoven and Mozart. Between the pieces, they chatted with each other in a foreign language, which Mr. A. took to be Italian, but they did not address him. Occasionally they changed their position, turned in various directions, and part of the time sat down. Mr. A. said the singing was excellent; he had rarely heard better. After the first feeling of surprise and amazement had passed away, he enjoyed the music exceedingly. The performance continued in this way for some time, when it suddenly came to an end. The singing ceased, and the singers vanished. He looked at his watch, and found that the time was four o'clock. The concert in his brain had lasted nearly an hour and a half, almost the length of an ordinary concert. He reflected for a while upon this strange occurrence, but not being able to arrive at any satisfactory explanation of it, he turned his gas down and went to sleep. The next morning he called at my office, as previously stated, to ascertain if possible what pranks his brain had been playing, and if he should regard them as a warning of his approaching departure.

Such was Mr. A.'s account of his singular vision. It occurred to me as possible that the whole might be a vivid dream, which had produced such an intense and profound impression as to deceive him with regard to its character. In order to ascertain whether such was the case or not, the two servants, to whom he referred in his report of his night's experience, were asked if Mr. A. had been ill, or if anything unusual had taken place on the night in question. The reply of each was, substantially, that he had only been a little out of his head, and nothing more, at that time, because he had called them up in the middle of the night, and told them to put some persons out of his room, when, except himself, no one was there. Evidently the vision was more than an ordinary dream.

In one respect this case is almost unique. Like that of M. Nicolai of Berlin, the only similar one that I know of, it is an instance of a hallucination involving the abnormal action of two senses, the sense of sight and the sense of hearing, simultaneously. It is not unusual for persons whose brains have been disturbed by fever, alcohol, cerebral disease, intense excitement, or overpowering emotion, to hear strange sounds, or see strange sights. This is particularly true of the ear. Noises that are altogether subjective, and of the greatest variety, such as the ringing of bells, hissing of steam, cries of animals, screams of children, chirping of locusts, and other sounds, including occasionally human voices, are so often perceived, and referred to the ear, that they are recognized as forming a distinct group of symptoms, called tinnitus aurium. In like manner, but less often, objects, such as trees, animals, and human forms, sometimes vague and sometimes distinct, have been seen by a variety of persons and under various conditions; but it is very unusual for two senses to be deceived at the same time; for the eye and the ear of a person to be both at fault, at the same moment, under the same circumstances, and with regard to the same objects. Such, however, was the fact in this case, and that of M. Nicolai, and it is this which gives to these cases a peculiar psychological and physiological interest. Fortunately, modern physiology enables us to form some notion, even if it be an imperfect one, of how such phenomena are produced. We are no longer obliged to conceal our ignorance, by calling them imaginary, or denying their occurrence. Whatever physiological explanation may be offered of these, and other hallucinations, will be found in another part of this paper.

The visions, which are recorded in the next and last case, are somewhat less definite and distinct than those previously described. It presents, however, one element or factor of great physiological significance, which none of the other cases exhibit; and that is, the presumed and apparent influence of the will in producing pseudopia.

### CASE VII.

*Conscious centric or subjective pseudopia; influence of volition upon its production; phenomena recorded by the subject of them.*

The following case deserves especial attention, not only on account of its intrinsic value, but because the subject of it, Mr. E., who is an accomplished scholar, a careful observer, and a distinguished scientist, has drawn up the present report of it himself. Consequently, we have here, as in the case of M. Nicolai, of Berlin, observations made by a careful observer and trained thinker upon himself, of the phenomena of cerebral vision. For the graphic and interesting account of them, which the following letter contains, the writer of the present essay is indebted to Mr. E. himself: —

My dear Dr. Clarke, — I have no other objections to granting your request, than that my memory may fail me as to details and dates.

In my childhood I was much tormented by faces appearing to me as soon as I closed my eyes in bed. Up to the age of fifteen, I was subject to vivid dreams and occasional walking in sleep. I mention these circumstances, because they throw light on the character of my nervous system.

In my junior year in college (my age was twenty-four in January), I not only kept up my undergraduate studies, but gave several hours a day to other mathematics, and read much in preparing and writing Bowdoin Essays. My vacations were also spent in mathematical work.

In the first term of the senior year, I began to suffer the penalties for this overwork. Sleeplessness at night, impulses by day to eccentric freaks, and the ringing of nonsense and profanity in my ears, were the most troublesome symptoms; these, however, disappeared after entire rest from mental labor for a few weeks, in October and November, 1842; while the less troublesome symptoms of visions, which began about that time, continued, I think, about two years. They were usually beautiful and pleasant, so that I was tempted to imitate Goethe, and try whether I could produce them at will. I was particularly fond of statuary; and after a few trials succeeded in producing visions of statues, by simply fixing my imagination strongly enough upon the memory of what I had seen, or upon what occurred to me as a good subject for a group. I repeated the experiment, however, but few times, fearing it might lead to some injurious result.

The spontaneous visions could generally be ascribed to some unusual fatigue or excitement. Their form I could also, usually, account for from recent visits to paintings, statuary, or gardens; but sometimes their form seemed to have been suggested by something long past. One afternoon I stood with closed eyes in the chapel, in University Hall, and was startled by the appearance of a beautiful young face, in a cloud of light. I opened my eyes, in order to disperse the vision. To my surprise the vision remained several seconds, although the sun was shining full upon the wall, by the side of the pulpit, under which (in an imaginary recess, apparently cutting off Dr. Ware's legs above the knees) this golden-haired youth showed himself. The features bore a decided likeness to Miss Sully's copy of Rembrant's Peasant Boy, which I admired very much, but had only seen once, and that some months before the vision.

One of the last visions which I had was the most troublesome. In May, 1844, I was present at a collation, where long tables were adorned with large bouquets. The next evening I was at a Sunday-school meeting at the Berry Street church, Boston, and as I came out was introduced to a lady, and requested to escort her to Old Cambridge. She proved to be rather taciturn, and as I was rather tired I finally grew sleepy; but was suddenly aroused, as we walked past the end of Inman Street, Cambridgeport, by seeing a large bouquet, in a faint cloud of light, spring out of the top of a post, on the edge of a sidewalk. From that point until I passed what is now the end of Ellery Street, every post in succession sprouted in a similar manner, as I approached within about ten feet of it. I did not dare tell my companion, but tried to talk and to draw her out to speak of other things. In nearly every bouquet I saw a flower which I did not remember ever to have seen, but which may have been in some bouquet the previous evening; I have since recognized it as cobea.

From Ellery to Quincy Street all went well except the taciturnity of the lady; but at about that point, I was unpleasantly surprised by the sudden disappearance of all fences, trees, and houses. We were on a boundless desert, a level plain of sand below us, a dull cloudy sky above, nothing else visible, except two Lombardy poplars, near together in the extreme distance in front. I managed to allow my companion unconsciously to be my guide to her house; we went past the colleges, past "the spire" and "the tower," under the Washington Elm; still I saw nothing but the desert and the two distant poplars. At length she paused, withdrew her hand from my arm, and took hold of some invisible thing before her. The latch of the gate clicked; instantly the two poplars rushed towards us, and sank into the ground at our feet; and then, to my inexpressible relief, all things took on their right appearance. I bade the lady good-night, and as soon as she had closed the door I started and ran at full speed to Divinity Hall, fearing lest some new vision might prevent my finding the way.

There seem to me three ways in which my optic nerve has given me the sense of distinct vision. First, by the normal method of light entering through the lenses. Secondly, by a somewhat abnormal way, the will holding imagination or memory to one image, until the action of that mental image has become abnormally great, and like the action of light. Thirdly, by a truly abnormal nervous excitation, spontaneously producing sensations, those sensations receiving form, or being determined into *form*, by indistinct, or, rather, unconscious memories or imaginations.

Very respectfully and truly yours.

The visions which are reported in this case are not so distinct as those described in the other cases of the present series. It is also to be noticed, that each separate hallucination or vision of Mr. C. was only momentary in its appearance, and that the figures, faces, and bouquets were more or less shadowy. But if, in these respects, this case is an imperfect illustration of subjective cerebral vision, the imperfection is more than compensated by the fact, that it presents a point of peculiar physiological interest, which none of the other cases exhibit, and which has rarely been observed, or, at least, rarely reported. This is the power or ability, which Mr. E. discovered in himself, of producing, visions, that is, of seeing objects like statues and pictures, by an act of volition, and without the aid of any objective reality. The important bearing of such a brain power, if it exists, upon the physiology of cerebral vision, and the explanation which it affords of many curious and strange phenomena that have hitherto been regarded as purely psychological or imaginary, are apparent. It will be discussed more at length elsewhere. Two other points, of less physiological interest than the one just mentioned, but still of great value, are the same as two emphasized by Miss D.: one is the proclivity which Mr. E.'s brain exhibited in early life to visions, as if it were congenitally predisposed to them; and the other is the influence which he had observed, that physical exhaustion, united with mental fatigue, exerted as a factor in the production of spectres. His explanation of the manner in which he supposed his optic apparatus gave him the sense of distinct vision, besides the ordinary method of light entering through the lenses of the eye, is ingenious and physiologically possible. It will be referred to again.

Before attempting any explanation of the visual phenomena which have been described, or making any practical application to pathology, therapeutics, metaphysics, or popular beliefs of the inferences which may be drawn from them, it is important to direct the attention of the reader to the processes and machinery of normal vision, or orthopia. When these are known and correctly interpreted, it will not be difficult to frame a satisfactory explanation of the aberrations from orthopia, which the previous cases present. We shall then, moreover, be prepared to see what service this knowledge, supplemented and interpreted by clinical observation, can render to practical medicine, and possibly to metaphysics, as well as to see how much light it may throw upon what has been called mysterious and supernatural in well authenticated and trustworthy instances of ghostly apparitions, and spirit manifestations. If the modicum of truth, hidden by the ignorance, superstition, and charlatanism which surround such occurrences, could be disinterred from its environment, a real service would be rendered to humanity. For where truth and error are united, if the truth can be discovered, error can be safely left to itself. Nothing dies so quickly as error and falsehood, when there is no truth to animate them.

It is a common, but erroneous, notion that we see with our eyes, and hear with our ears. It is true that these organs are indispensable to normal seeing and hearing, but it is also true, and a fact of great importance, that they are only conductors of the vibrations, called light and sound, to the delicate cerebral structures of the intracranial apparatus, which transform such vibrations into perceptions of sight and hearing; that is, transform them so that we see and hear. It is the brain, and not the eye or the ear, by which we see and hear.

This will be made apparent by tracing the vibrations of light from a sensible object, through the visual apparatus, to the gray matter of the cerebral hemispheres, where they become conscious and ideated vision. In order to do this, we should have a distinct notion of the character of the optical apparatus which conducts light to the brain; that is, we should acquire a clear idea of the road over which luminous vibrations travel, and of the functions of each part of the apparatus engaged in such delicate operations.

For our present purpose, the apparatus of human vision may be described as a mechanism, consisting of five organs, or sets of organs, which are closely connected, and in intimate communication with each other. They are: (1) the eye, with the iris, lenses, retina and others structures, which belong to it; (2) the tubercula quadrigemina and associated nerves; (3) the cerebral centres of vision in the hemispheres, probably the angular gyri; (4) the gray matter of the frontal convolutions; and (5) the connecting nerves of communication.

Each portion of this complicated and delicate apparatus performs a special function. To each one is assigned its own part or duty, in the labor of conveying such intelligence as light can report from the external world to the brain. Each one is supposed to do its own part or duty honestly; that is, never to send a report to a station above which it has not received from below; and in the vast majority of cases, such is the fact. The senses, and especially the sense of vision, rarely deceive any one. They are generally trusted implicitly, because they are almost always trustworthy. Nevertheless, modified by disease, disturbed by drugs, or influenced by the brain itself, they sometimes play false, manufacture news, like politicians and speculators, and send untrustworthy reports to headquarters.

Light is the stimulus or force which, like the steam that moves an engine, sets the visual machinery in motion. Without light, the apparatus in the normal condition of the system cannot work; but, as will be shown further on, and as the preceding cases of pseudopia indicate, there are abnormal conditions of the brain which are capable of making the apparatus of vision perform its function without the agency of light. When this occurs, the natural results are mental confusion, disorder, and uncertainty.

What light is in its essence we do not know. Whether the theory of emission, as held by the ancients and accepted by Newton, or that of undulation, to which physicists of the present time incline, or some other theory, be true, it is not important for the purposes of the present essay to ascertain. It is enough to know that light is either a form of motion, or produces in some ætherial medium motion of almost inconceivable rapidity. The forms of motion which light assumes, or the vibrations by which it is manifested, are recognized by the cells of the retina of the eye, which themselves vibrate in response to it. Some idea of the delicacy of the retinal machinery of vision, and of the corresponding delicacy of the whole intracranial machinery, may be formed by striving to picture to ourselves the minuteness of the wave-lengths of light to which the retina is susceptible. Fresnel states [1] that the nature of colors is determined by the number of vibrations which each color makes, just as different sounds are produced by the varying number of sonorous waves. Seven hundred and twenty-eight millions of millions of undulations a second produce what we call the violet ray; and more than four hundred and ninety-six millions of millions produce the red ray. The other rays are produced by other numbers of undulations. In like manner, differences of form and size, the varying expressions of the human countenance, the constantly changing aspects of nature, sunsets and storms, the splendor of landscapes, and the majesty of mountains and of the ocean, and all the wonderful beauty, which the faculty of vision comprehends, are telegraphed to the eye by vibrations, which differ from each other by millions in a second. This rapidity of movement and minuteness of difference is almost inconceivable. Yet this rapidity and minuteness, of which the mind fails to form an adequate notion, the retina of the eye appreciates, discriminates, and transmits to the

[1] *Traité Élémentaire de Physique Experimentale et Appliquée*, par A. Ganot. Paris. 13me ed., p. 560.

tubercula quadrigemina, and these to other parts of the brain.

In the statement which has just been made, that light is the agent which *ordinarily* produces the phenomena of vision, the expression *ordinarily* was used designedly. For, while it is true that such is the fact, it is also true, as has been already stated, that the phenomena of vision may be produced without the agency of light, and without the presence of extra-cranial objects. Such instances are rare, but that they may and do occur, and that they are susceptible of a physiological explanation, are matters of great interest and practical importance.

Such, without entering into details, is the apparatus of human vision; and such the agent, whose delicate undulations set it in motion and enable it to be the most efficient, the most important, and the most delightful means of communication between the brain and the outer world of any which the organization possesses. We owe to anatomy the discovery and demonstration of this apparatus, and of the tissues, fibres, cells, and granules, which enter into its composition, and out of which all its secret movements are constructed. We owe to physics our knowledge of the marvellous force to which it responds; and to physiology the investigation and discovery of the special function in the process of vision which is appropriated to each of its parts. Our next step is to point out these special functions, and the separate parts of the apparatus, which are charged with their performance. It has already been stated that each part of the visual apparatus has its own work to do, and that intelligent vision results from the harmonious cöoperation of the whole.

It is important to bear in mind that vision, which on account of its familiarity seems to be a simple matter, is in reality a complex process. It is called the sense of sight, but it is much more than sensation. In connection with light, it employs the most delicate operations known to physics; and in connection with the brain, the most subtle operations known to metaphysics. By a careful analysis it may be separated into its elements. When this is done, when its component parts are discriminated from each other, as clearly as the various parts of the visual apparatus have been discerned and dissected out by anatomy, it will be a comparatively easy task to assign each part, or step in the visual process, to its appropriate organ in the visual apparatus. The complicated structure of the apparatus corresponds to the complicated character of the process. Each stage of the latter is a special function of some organ of the former.

Let us now endeavor to analyze this process and discover its elements. If a drop of corrosive acid is put upon the foot of a frog, the animal instantly withdraws its foot. The observer notices that its foot has been burnt by the acid, and justly infers that the frog felt a sensation of pain, and consequently tried to remove its foot from the source of harm. This is an instance of the simplest form of sensation. Suppose, in another frog, the sciatic nerve were completely severed, and after the section a drop of the same acid were put on the foot of the limb, of which the nerve had been divided. The tissues would be burnt by the acid as before, but the animal would not withdraw its foot. In the first experiment pain was felt; there was sensation. In the second experiment no pain was felt; there was no sensation. But the acid acted in the same way in each case. The foot of the frog with the divided nerve and the foot of the frog with the undivided nerve were both alike burnt. Evidently the foot did not feel; sensation was not there, though injury was. By this example we learn that the process of sensation includes at least three elements; namely, local irritation, communication of the fact of such irritation to a nerve centre, and consciousness, which in this case was spinal consciousness.

Let us borrow another experiment from the physiologists. If a frog is suspended by its two anterior extremities, and a drop of acid is placed on the foot of one of its free, posterior extremities, the animal will withdraw its foot, rub its free extremities together, shut its eyes (a frog's expression of distress), make an effort to use its anterior extremities for relief, and endeavor in every way to get rid of the annoyance. If another frog, of which the spinal cord has been severed at a point above the junction of the nerves from the hind legs with the cord, is suspended in the same way as the former animal, and if, when thus suspended, a drop of acid is put as before on one of its feet, it will withdraw its foot, rub its two posterior extremities together, in order to push off the irritating cause, and try in every way, with the posterior half of its body, to obtain relief, as was the case with the frog in the previous experiment; but, unlike the animal of the previous experiment, it will not close its eyes, struggle with its fore legs, or make any effort with the anterior part of its body, above the point of section of the cord. Evidently, the section of the cord has eliminated from the process of sensation, in the frog of the second experiment, an element which existed in the frog of the first experiment. The first animal endeavored, with his whole body, to get rid of the irritation; the second animal made the same effort, for the same purpose, with only the posterior half of its body. In the second experiment, the anterior half did not know what was going on in the posterior half. Cerebral consciousness of disturbance did not exist. In the uninjured frog cerebral consciousness[1] of irritation existed, and was an element in the animal's sensation. This experiment discloses an element in the process of

[1] Consciousness is not used here in its metaphysical sense, but only to discriminate cerebral sensation in the frog from spinal sensation. Some persons might deny the existence of any metaphysical consciousness.

sensation, additional to those previously ascertained. Besides local irritation, intercommunication, and spinal consciousness, there is cerebral consciousness.

This does not exhaust the matter. Let us compare the condition of a frog, of which the spinal cord is sound, and of which all its nerves, running from the centre to the periphery, are uninjured, but which has been deprived of its cerebral hemispheres, with a perfectly sound animal. Such a frog will hop away, if disturbed; withdraw its foot, if the latter is irritated; croak cheerfully, if its back is gently stroked, and avoid obstacles in the way of its leap. In all these respects, it will act and appear like a sound frog. Yet there is a remarkable difference between it and a sound one. What this difference is, let Dr. Ferrier state: "The brainless frog, unless disturbed by any form of peripherical stimulus, will sit forever quiet in the same spot and become converted into a mummy. All spontaneous action is annihilated. Its past experience has been blotted out, and it exhibits no fear in circumstances which otherwise would cause it to retire or flee from danger. It will sit quite still if the hand be put forth cautiously to seize it, but will retreat if a brusque movement is made close to its eyes. Surrounded by plenty it will die of starvation; but, unlike Tantalus, it has no psychical suffering, no desire and no will to supply its physical wants."[1]

[1] *The Functions of the Brain*, by David Ferrier, M. D., F. R. S., Am. ed., p. 35.

By this experiment another element, ideation, is taken away from the process of sensation. Volition, the final cause of all sensation, is also removed.

The previous analysis shows that sensation, in its common acceptation, comprehends five distinct elements: namely, local impression, communication, spinal consciousness, cerebral consciousness, and ideation; all of which are the necessary antecedents of volition.

The process which has just been described, and which is familiar to physiologists as conscious and unconscious reflex action, is the type of the most complex, as well as of the simplest, sensations. It is the only mode of activity which science can discern, either in the spinal cord or the brain. Those who do not believe in the freedom of the will regard volition as the culmination and subtlest form of reflex action; and those who take an opposite view admit that volition can be exerted only through the machinery of reflex action.

Sight is sensation. Yet it is a much more complicated process than the one just described; and, consequently, requires for its accomplishment a much more complicated apparatus than answers for that; still it is essentially the same, and can be reduced to the same elements. In the process of visual sensation, there are the local impression of light on the eye, corresponding to the local injury of the frog's foot; communication, or telegraphing, by means of the optic nerve, to the tubercula quadrigemina, like that from the frog's foot to its spine; perception of the communication, or telegram, by the tubercula quadrigemina, corresponding to the spinal consciousness of the frog; telegraphing of the perception by the tubercula quadrigemina to a higher centre, the angular gyrus; and communication from the latter to the frontal convolutions, and consequent ideation. The two last centres and their functions, which are largely developed and distinctly differentiated in man, correspond to the cerebral hemispheres and cerebral consciousness of the frog.

This simple enumeration of the different stages in the process of vision is not sufficient for our purpose. It is necessary to examine the process more in detail; and it will contribute both to convenience and clearness of statement, to do this by describing each of its steps or stages as a distinct function of a distinct part of the visual apparatus; that is, to point out the part which is performed in the process of vision by the eye, the tubercula quadrigemina, the centres of vision in the hemispheres, the frontal convolutions, and the connecting nerve trunks.

The function of the eye naturally demands attention first. This organ receives the impression of the waves of light through the iris, and, stimulated by them, is enabled to ascertain approximately the color and varying shades of color, the form, outline, size, solidity, position, distance, direction, and movement of objects. Dr. Dalton says: "Of all the properties and functions belonging to the different structures of the eyeball the most peculiar and characteristic is the special sensibility of the retina. This sensibility is such that the retina appreciates both the intensity and the quality of the light — that is to say, its color and the different shades which this color may present. On account of the form, also, in which the retina is constructed, namely, that of a spheroidal membranous bag, with an opening in front, it becomes capable of appreciating the direction from which the rays of light have come, and, of course, the situation of the luminous body, and of its different parts. For the rays which enter through the pupil from below can reach the retina only at its upper part, while those which come in from above can reach it only at its lower part; so that in both instances the rays strike the sensitive surface perpendicularly, and thus convey the impression of their direction from above or below."[1] Form and outline are ascertained by means of the crystalline lens, which, aided by the other refracting and transparent media of the eyeball, produce a sufficient convergence of the luminous rays to accomplish this object.

"Our impressions," says the eminent physiologist just quoted, "of *distance* and *solidity*, in viewing external objects, are produced mainly by

[1] *A Treatise on Human Physiology*, by John C. Dalton, Jr., M. D., 3d ed., p. 494.

the *combined action of the two eyes.* For, as the eyes are seated a certain distance apart from each other in the head, when they are both directed toward the same object their axes meet at the point of sight, and form a certain angle with each other; and this angle varies with the distance of the object. Thus, when the object is within a short distance, the axes of the two eyes will necessarily be very convergent, and the angle which they form with each other a large one; but for remote objects, the visual axes will become more nearly parallel, and their angle consequently smaller. It is on this account that we can always distinguish whether any person at a short distance is looking at us, or at some other object in our direction; since we instinctively appreciate from the appearance of the eyes, whether their visual axes meet at the level of our own face."[1] According to the same author, "the combined action of the two eyes is also very valuable for near objects, in giving us an idea of *solidity* or *projection.* For, within a certain distance, the visual axes when directed together at a solid object are so convergent that the two eyes do not receive the same image." The ability to accommodate itself to different distances, which the eye possesses within certain limits, and which is accomplished by means of an antero-posterior movement of the crystalline lens, enables it to measure, approximately, the distance of objects. The movement

[1] Dalton, op. cit., pp. 501, 502.

of the eyeball in various directions, by which it follows a moving object, as a bird flying or a man walking, gives to it the power of recognizing and estimating motion. The sensibility and response of the retina to the almost inconceivable velocity of the waves of light, by which that membrane recognizes color and varying shades of color, has already been noticed. These, and similar important data of the motion, direction, distance, and character of external bodies, are all collected and registered by the eye, and reported through the optic nerve to the tubercula quadrigemina and the brain. In the performance of this duty the eye accomplishes a purely automatic or mechanical task, in which consciousness takes no part, and over which volition has no control. The eye receives and measures the impressions made upon it by light, as thermometers, barometers, and rain-gauges measure and register meteorological phenomena.

This then is the function of the eye, to collect the data out of which vision is constructed, but not to perform the office or be charged with the responsibility of sight.

Two questions now present themselves: What is sent through the optic nerve? and how is it sent? The ancients supposed that minute and invisible images were thrown off by sensible objects, which entered the eye and passed thence to the brain, where they were perceived. Philosophers of later times substituted for this fanciful theory an equally fanciful and unintelligible one, that ideas, which were supposed to be exact copies of objects, were the media by which the mind takes cognizance of the external world. When it was ascertained that images of objects were formed by luminous rays on the retina, as in a mirror, the theory of the intervention of ideas between the outer world and the brain was discarded, and it was believed that the retinal image was in some mysterious way transmitted to the brain. The latter conception prevails somewhat at the present time, though how the feat is accomplished no one pretends to guess. None of these theories are true. "The formation of an image on the retina is the precursor of a visual sensation; but this image is not transmitted to the brain. The oxidation of a volatile substance is the precursor to an olfactory sensation; but this oxidation is not transmitted to the brain. The destruction of tissue, which is the precursor of a sensation of a burn, is not transmitted to the brain. That which is in each case transmitted is the excited sensation."[1] When a telegraphic operator at station A sends a message to another station, B, which is connected with A by a wire, he sends no words, or hieroglyphics, or representations over the wire, but employs the current of electricity with which the wire is charged, to operate an apparatus for writing, or making sig-

[1] *The Physiology of Common Life*, by G. H. Lewes, Am. ed. vol. ii., p. 277.

nals of some sort at B; the characters produced by the apparatus at B, at the will of the operator at A, are deciphered at B, and thus a message is sent from A to B. The operator at A observes a military parade, notes the number, appearance, weapons, officers, and other characteristics of the battalion, takes the whole picture into his mind, out of which he constructs a report, which is presented at B by means of the apparatus in that station. The operator at B reconstructs from this report the picture which the reporter at A had formed, and so acquires an accurate notion of the parade. In like manner the eye takes in the picture — receives a photographic impression — of a military parade, and employs the neurility of the optic nerve, of which the special excitant is light, and to which it alone responds, to set in motion an apparatus in the tubercula quadrigemina, by the action of which a picture or notion of the parade is reproduced in the quadrigeminal station. Thus every impression which is photographed on the retina of the eye is reproduced in the tubercula quadrigemina, though it by no means follows that the same physical appearance or condition which light produces in the eye is repeated at the other extremity of the optic nerve. It is evident, on the contrary, that no such repetition can occur, for the tubercular apparatus is altogether different from the retinal apparatus, and responds to a different stimulus.

How the optic nerve behaves, when, stimulated by light at its retinal extremity, it sets in motion an apparatus at its quadrigeminal extremity, we do not know any more than we know how a wire behaves when it conducts electricity from one station to another. Any explanation of the matter must, from the nature of the case, be more or less hypothetical. Wundt says, referring to his analysis of the evidence on this point: "Nothing more can be inferred from these facts than that light is changed within the optic filaments to a form of motion, which corresponds to the velocity of the waves of light, only within limits that are yet to be ascertained." [1] The hypothesis of Herbert Spencer is, perhaps, as plausible and satisfactory as any which it is possible to offer at the present time. "He looks upon the stimulus applied to a sentient surface as molecular action issuing from the disturbing cause, and transmitted through the nerve-fibre, by means of isomeric transformation, to the nerve-cell, in which the force is augmented by the decomposition of some unstable matter, to be sent again by isomeric transformation to the muscular fibre, where it is lost in the contraction it caused. In proportion to the degree of intensity of the stimulus, this is extended to neighboring nerve-cells belonging to the same group, in which, by decomposition of their contents, more nerve-force is liberated, etc. The transmission of nerve-force he further sup-

[1] *Grundzüge der Physiologischen Psychologie*, von Wilhelm Wundt, p. 332.

poses not to take place in the form of a continuous current, but rather in separate waves of molecular change, each wave being produced by the molecules of the nerve-substance falling from one of their isomeric states to the other; and having fallen in passing, on increasing the pulse or shock, they remain incapable of doing anything more, until they have resumed their previous isomeric state. In this manner, then, innumerable waves of nervous energy, following each other in rapid succession, and constituting a nervous current, are produced." [1]

This point has been elaborated at length, on account of its importance in connection with the physiology of visions, an importance which will be apparent when that subject is discussed.

FUNCTIONS OF THE TUBERCULA QUADRIGEMINA.

The tubercula quadrigemina form the first intracranial station, on the way from the eye to the frontal lobes of the brain. They are four small but important bodies, of which the functions are obscure, and till lately have been imperfectly understood. It has long been known that they are essential to vision, but the precise office which they perform in connection with the eye remained undiscovered until recently, and now, though physiologists have cleared away a good deal of the

[1] *Transactions of the American Neurological Association*, vol. i., p. 119. *Structure of the Nervous Tissues*, by H. D. Schmidt, where H. Spencer is quoted as above.

obscurity which concealed their functions, much is to be done. Fortunately for our purpose, what has been discovered is of great service in attempting a rational explanation of the phenomena of pseudopia.

Physiology teaches that the functions of the tubercula quadrigemina may be divided into four classes: those connected with the muscular apparatus of the eye; those connected with the muscular apparatus of the whole body, and particularly with the apparatus of locomotion and equilibration; those remotely connected with emotion and intellection; and those connected directly with the sense of sight. When carefully examined it will appear that these apparently diverse functions which physiologists have localized in the tubercula quadrigemina have an intimate connection with each other, through the relation which sight bears to muscular, emotional, and intellectual action. In accordance with this generalization, it may be stated that the tubercula quadrigemina are charged with the reception and transmission of visual impressions, and with the duty of coördinating all automatic muscular movements, whether of the eye or of the whole body, or of any part of the body, which require for their initiation or perfectation the intervention of sight, and with contributing certain reflex visual elements to general cerebral activity. Thus regarded, much of the obscurity and complexity with which the tubercula quadrigemina have been invested disappears, and the mechanism of their functions becomes comparatively simple and intelligible. Dr. Dalton says, most happily, that the tubercula quadrigemina *preside*, as ganglia, over the sense of sight. They are not the centre of vision, but they *preside* over the process of vision, and over all automatic or reflex actions which require vision for their perfect performance or harmonious development. It should be borne in mind that ideated vision, or what Carpenter would call the ideo-motor action of sight, has its centre, not in this region, but higher up in the hemispheres. Wundt expresses himself thus: "We cannot doubt that the mechanism by which sight directs the muscular apparatus of our body is placed in the tubercula quadrigemina. But we should remember that muscular motions are performed under the influence of light in a twofold way: first, by the tubercula quadrigemina themselves, where visual impressions of light first set free those compound motor reactions which correspond to the quality and form of the impressions of light; and next in the cortex, where, at the central termination of the optic filaments, a sort of transference takes place. . . . The direct action of the tubercula quadrigemina is limited to an influence over locomotion, locomotion itself depending on other causes, and to the production of such movements as follow the immediate impression of light, such as reflex movements of the eye, the pupil, the eyelids, and efforts to avoid excessive light.[1] The statement of a few details will be sufficient to justify the generalization which has just been made, and will also illustrate the character of the quadrigeminal functions.

The familiar phenomenon of contraction of the pupil, under the influence of light, is a reflex action, " in which the impression," says Dalton, " received by the retina is transmitted along the optic nerve to the tubercula quadrigemina. From the tubercles a motor impulse is then sent out through the motor nerves of the eye and the filaments distributed to the iris, and a contraction of the pupil takes place in consequence." In this way the tubercles regulate the amount and intensity of light falling upon the retina. In like manner, those movements of the eyeball, which are necessary to guide and preserve the axes of the eyes in any direction required for the purposes of vision, are reflexes from the tubercula quadrigemina. When a seamstress undertakes to thread a needle, the pupils of her eyes are adjusted to the surrounding light, her eyeballs to the appropriate axis of vision, the position of her head to the requirements of her eyeballs, and the movements of her arms and fingers to the act of entering the thread into the eye of the needle. All the muscular machinery necessary to the execution of this complicated manœuvre is coördinated with light so as to accomplish the purpose, by the tubercula quadrigem-

[1] Wundt, op. cit., pp. 194, 195.

ina. It is not a difficult task to balance the body on one foot, for a few moments, with the eyes open. Let the same experiment be tried with the eyes shut, and the difficulty of steadily maintaining an equilibrium is vastly increased. In the last case, the muscles are guided and controlled in their effort to preserve a firm, upright posture by the muscular sense alone; in the former case, the muscular sense is supplemented by sight; and such aid is rendered possible by the mediation of the tubercles, which coördinate visual impressions with muscular effort. In this action, as in many others, the muscles can be trained to act without the aid of the eye, but their perfect working can be secured only in the manner indicated. It is a long and laborious process for a child to learn to walk, but after the art is acquired, walking is so far automatic, that it is accomplished with apparent unconsciousness; yet, let a person close his eyes when walking, and his gait immediately becomes insecure. Here again it is by means of the tubercula quadrigemina that a muscular effort is rendered easy and perfect, which would otherwise be difficult and imperfect.

If the tubercula quadrigemina are destroyed, leaving other parts of the brain intact, an experiment which has been performed on frogs, fishes, rabbits pigeons, dogs, and monkeys, the result is that, while with the exception of loss of sight all the senses are preserved, marked disturbances of equilibrium and loco-motor coördination are produced. "In rabbits, disorganization of the corpora quadrigemina causes blindness, with dilatation and immobility of the pupils, and also very marked disturbances of equilibrium and locomotion. While still capable of making coördinated movements of all four limbs on reflex stimulation, or when held up by the tail, they could neither stand nor walk, but rolled over from side to side."[1] The experiments of physiologists justify the assertion that the optic tubercles are not only essential to vision and to irido-ocular motion, but that they form an essential part of the central mechanism, by which visual impressions are coordinated with equilibrium, locomotion, and all muscular effort requiring light for its best results.

The relations of visual impressions to corporeal movements are not exhausted by the functions of the tubercula quadrigemina. It is probable that such impressions are still further elaborated in the thalami optici. Wundt suggests, "that the connection of visual impressions with corporeal movements, which are partly determined in the optic tubercles, may be perfected in the optic thalami, through the filaments which can be traced from the latter to the optic tract. Inasmuch as the same motor mechanism, which is regulated by the organ of tact, can also be excited by the organ of sight, it is conceivable that such an arrangement would essentially contribute to the simplification of the central function."[2] Dr. E. Tournié

[1] Ferrier's *Functions of the Brain*, p. 74, Am. ed.

[2] Wundt, op. cit., p. 201.

has been led still further in the same direction by his experiments. He destroyed the optic thalami of dogs by an injection of chloride of zinc, and inferred therefrom, that the optic thalami are the "unique centre" of perception, and of the coördination of perception with all the other senses, and with all bodily movements. His experiments do not fully bear out his conclusions, and other investigators have not confirmed his views in this respect. Nevertheless, it may be safely affirmed, that the functions of the optic thalami sustain an intimate relation to those of the tubercula quadrigemina. The two centres are anatomical neighbors and physiological partners. What the precise character and limits of their separate functions are must be left to the decision of physiologists; it is sufficient for the purpose of a rational explanation of the phenomena of pseudopia to know, that between the eye and the cerebral hemispheres, there is a region where visual impressions, proceeding from the eye, are transformed, classified, and coördinated with other sensory impressions, whence they are transmitted to the hemispheres, there to be still further elaborated, and made the basis of ideation and volition.

The relation of visual impressions to emotion and intellection are more subtle and obscure, but not less real, than those which have just been described. It is difficult, perhaps impossible, to demonstrate, experimentally, where and how such impressions are coördinated with emotion and thought, but the inference from the data afforded by physiology, pathology, and clinical observation, is conclusive, that such coördination takes place, and that the work is partially accomplished by the tubercula quadrigemina. *A priori* considerations yield a presumption, which almost amounts to a demonstration, of the truth of this statement. A world of beauty, emotion, and ideas floods the brain through the eye. Sight is the medium, by which the beauty of the human face and form, and of all external life, is presented to us; by which the varying expressions of passion and thought, of hope, joy, and pain, are discriminated; and by which we take hold of a large portion of the pleasures, sorrows, and possibilities of our mundane existence. It would be strange if a messenger, bearing such messages and laden with such treasures, were not admitted into the inmost recesses of the brain, and brought into contact with every cerebral function. It cannot be otherwise. Sight must influence all cerebral functions. Ferrier, whose caution and judicial fairness enhance the value of his conclusions, says: "The foregoing considerations on the relation between the phenomena of irritation and destruction of the corpora quadrigemina, though in many respects professedly only of a hypothetical nature, tend to support the view that these ganglia are the centres specially concerned in the reflex expression of feeling or emotion. This is rendered still more probable by the recently demonstrated influence which the corpora quadrigemina, or more properly, the deeper parts of the corpora quadrigemina, exert on the functions of circulation and respiration, modifications of which are one of the most frequent concomitants of states of feeling or emotion."[1] In another place he adds: "The feelings accompanying the more intellectual senses, sight and hearing, are the primordial elements of æsthetic emotions which are founded on harmonies of sight and sound."[2] It is as necessary that crude visual impressions should be somewhere elaborated, classified, and prepared, after leaving the eye, so as to fit them for the use of the higher cerebral centres, where ideation goes on; or in other words, so as to coördinate them with the higher centres, as that this process should be performed, in order to coördinate them with the lower centres of motor activities.

The most important function of the tubercula quadrigemina remains to be mentioned. The tubercles are the centre of the sense of sight, though not of the higher forms of conscious vision. Dalton teaches that "direct experiment also shows the close connection between the tubercula quadrigemina and the sense of sight. Section of the optic nerve at any point between the retina and the tubercles produces complete blindness; and destruction of the tubercles themselves has the same effect. But if the division be made between

[1] Ferrier, op. cit., p. 83.
[2] Ibid., p. 260.

the tubercles and the cerebrum, or if the cerebrum itself be taken away while the tubercles are left untouched, vision, as we have already seen, still remains. It is the tubercles, therefore, in which the impression of light is perceived. So long as these ganglia are uninjured, and retain their connection with the eye, vision remains. As soon as this connection is cut off, or the ganglia themselves are injured, the power of vision is destroyed."[1] Visual impressions first come within the sphere or domain of consciousness when they reach the tubercula quadrigemina. Then they are first perceived by the ego. The eye, with its lenses, membranes, tubes, and cells, silently and unconsciously performs the task of collecting visual data, which data the optic nerve with equal unconsciousness transmits to the tubercles. Arrived at that point they are recognized by consciousness.

The visual functions of the tubercula quadrigemina which have been described suggest our two next inquiries: (1.) What is the mechanism, and what the process, by which the optic tubercles, after receiving a visual telegram from the eye, transform and transmit it to the hemispheres? (2.) What kind of visual perception occurs in the tubercles? Is it the same as that which occurs in the hemispheres, or is perception in the former different from perception in the latter? A satisfactory answer to these two questions would go

[1] Dalton's *Physiology*, p. 435.

a great way towards solving the problem of pseudopia. Unfortunately, neither of these can be answered, in the present condition of physiological science, with the fulness and certainty which are desirable; but if a complete answer is impossible, a partial one can be given.

The inquiry which concerns the character of the machinery of the optic tubercles, and the manner of its action, naturally demands consideration first.

The tubercula quadrigemina are ganglia of the nervous apparatus, and resemble in their construction other ganglia, which may be found attached to the nerves in every part of the organization. In its simplest form, a ganglion is the junction, *knotenpunkte*, the Germans call it, by which an afferent nerve is connected with an efferent nerve, and is also the workshop where the effect of a sensory stimulus, carried thither by an afferent nerve, is transformed into a motor stimulus, and sent out to excite motion. The annexed diagram roughly represents this simple, but efficient and marvellous, mechanical contrivance.

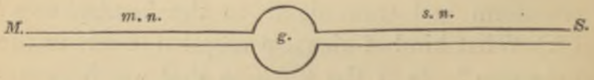



Fig. 1. Diagram of ganglionic machinery. *S.* Point of sensation. *s. n.* Sensory nerve. *g.* Ganglion or workshop. *m. n.* Motor nerve. *M.* Point of motion.

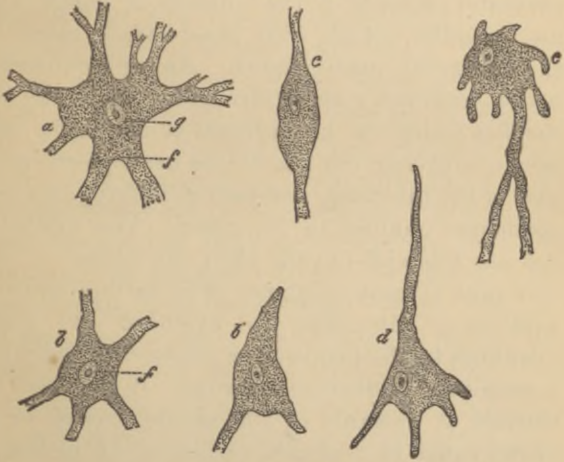
When a sensory stimulus acts at *S.* information of the occurrence is sent through the sensory nerve, *s. n.*, to the ganglion, *g.* The message, received and read at *g.*, is acknowledged by putting the ganglionic machinery in action and sending through the motor nerve, *m. n.*, a corresponding message to a motor apparatus at *M.*, where, on receipt of the message (transferred stimulus), motion is produced. The ganglion receives and deciphers a message from one direction, and prepares and dispatches a corresponding message in another direction. When the machinery acts normally, as it does in the vast majority of cases, no message is ever dispatched by the ganglion, *g.*, to *m.*, except in response to a communication from *s.* Under certain abnormal conditions, however, it is possible for a ganglion to act spontaneously, and send an order without having received one. When this occurs, the operator at *m.* is deceived, supposes a communication has been received from *s.*, and acts accordingly. It would anticipate the order of our subject to do more than allude to this important physiological fact in this connection. Its bearing upon pseudopia will be pointed out in another place.

Such is the office of a ganglion of the simplest character; and such, essentially, is the office of ganglia of the most complex character; of those charged with the highest cerebral functions. All are, of course, provided with the machinery for receiving, deciphering, and dispatching messages. The tubercula quadrigemina are no exception to this statement. They are ganglia, ganglionic workshops, placed between the eye and the hemispheres, and charged with the functions which have been described. Their apparatus, like that of other ganglia, consists of cells, fibres, blood-vessels, and connective tissue, enclosed by a protecting membrane.

Of this mechanism the cells form the most important part, and should be carefully studied. They vary in shape and size. Some are round and some oval; others oblong, spindle-shaped, triangular, or radiated. They are armed with one or more prolongations, upon which their shape largely depends, and by which the fibres connecting them with other cells and other tissues, enter and depart. The forms which occur most frequently in ganglionic and nerve tissue are represented in Fig. 2.

Cells are as variable in size as in shape. Mr. Bain tells us that nerve cells range from $\frac{1}{300}$ to $\frac{1}{3000}$ of an inch in diameter. According to the same authority, the nerve filaments, which enter and leave cells, range from $\frac{1}{1500}$ to $\frac{1}{1000000}$ of an inch in thickness. Each cell contains an eccentric, globular body, called its nucleus, enclosing a still smaller body, known as the nucleolus; one packed within the other, like a nest of boxes. The space between the investing membrane, nucleus and nucleolus, is filled with minute, albuminous granules of protoplasm, which extend into the cellular prolongations, and surround the nerve fibres and nerve filaments, entering and leaving these avenues (Fig. 2). Pigment granules are also found among the protoplasmic granules;

Fig. 2.




Varieties of Nerve Cells. *a*. Radiated cell from the anterior horn of the spinal marrow with granules of protoplasm, *f*, extending into the prolongations. *b*. Radiated and triangular cells from the cerebellum. *c*. Bipolar ganglionic cell, from the spinal ganglion of a fish. *d*. Pyramidal cell from the cortex cerebri. *e*. Central origin of a nerve filament from a cell. *f*. Granules of protoplasm. *g*. Nucleus, enclosing nucleolus (after Wundt), pp. 29, 30.

sometimes equally distributed among the latter, and sometimes collected in heaps by themselves. (Wundt). Lastly, there is that important element, the blood, which circulates with such freedom among these corpuscles, that, according to the computation of Herbert Spencer, as reported by Mr. Bain, five times as much blood flows around and among the corpuscles, as in other portions of nerve tissue.

It is difficult, perhaps impossible, to make an accurate estimate of the number of fibres, cells, and granules, which with blood-vessels make up the tubercula quadrigemina. An approximative notion, however, may be formed by computing the number which the hemispheres of the brain contain, comparing the size of the hemispheres with that of the tubercles, and then estimating the proportionate number in the latter. The tubercles are not less rich in cells than the brain. "The thin cake of gray substance surrounding the hemispheres of the brain, and extended into many doublings by the furrowed or convoluted structure, is somewhat difficult to measure. It has been estimated at upwards of 300 square inches, or as nearly equal to a square surface of 18 inches in the side. Its thickness is variable, but, on an average, it may be stated at one tenth of an inch. It is the largest accumulation of gray matter in the body. It is made up of several layers of gray substance, divided by layers of white substance. The gray substance is a nearly compact mass of corpuscles, of variable size. The large caudate nerve-cells are mingled with very small corpuscles, less than the thousandth of an inch in diameter. Allowing for intervals, we may suppose that a linear row of five hundred cells occupies an inch, for three hundred inches. If one half of the thickness of the layer is made up of fibres, the corpuscles or cells, taken by themselves, would be a mass one twentieth of an inch thick, say sixteen cells in the depth. Multiplying these numbers together, we should reach a total of twelve hundred millions of cells in the gray covering of the hemispheres. As every cell is united with at least two fibres, often many more, we may multiply this number by four, for the number of connecting fibres attached to the mass; which gives four thousand eight hundred millions of fibres."[1] According to this computation, the cerebral hemispheres contain, in round numbers, one thousand millions of corpuscles, and five thousand millions of fibres. If the optic tubercles equal in size only a thousandth part of the hemispheres, they would contain one million of corpuscles, five millions of fibres, and from five to ten millions of protoplasmic and pigmentary granules. Evidently, here is sufficient material for whatever grouping or action may be necessary to receive, register, and report the most varied visual experience of the longest human life.

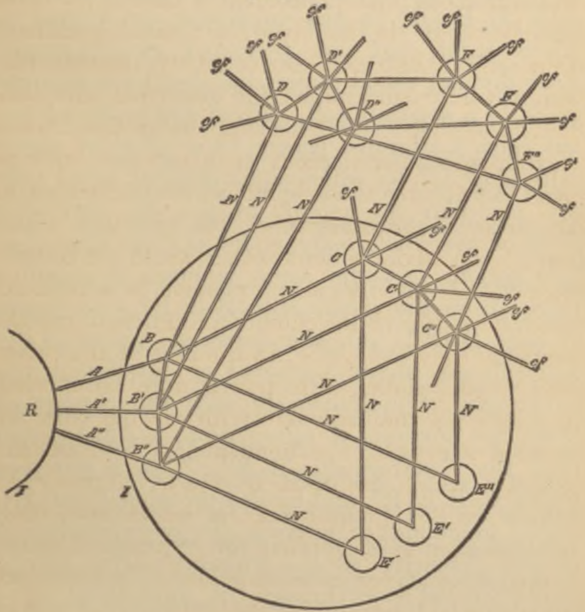
Nothing is known, and nothing probably ever will be known of the groupings, combinations, and metamorphoses of cells, corpuscles, and granules, by means of which visual impressions forwarded to the tubercula quadrigemina by the eye, are interpreted, recorded, and transmitted to the vis-

[1] *Mind and Body*, by Alexander Bain, LL. D., Am. ed., pp. 106–7.

ual centre of the hemispheres. We know, however, that the constituent elements of the optic tubercles admit of mechanical, thermal, and chemical action, and it is conceivable that all of these agencies may be employed in visual operations. Corpuscles and granules are highly unstable elements, easily decomposed and destroyed, and easily reproduced. Their decomposition liberates a certain amount of nervous energy, which may be used to reinforce the original sensory stimulus, as the relay of a battery reinforces an electric current, or to perform some other work. "Ganglionic cells," says Wundt, "possess in a high degree the power of developing and intensifying the stimulus they receive." In the case of the tubercula quadrigemina, this power may be exerted, not only for the purpose of forwarding with increased energy to the hemispheres a visual impression which has been received, but for operations within the ganglia, by which recording, coördination, and signaling are effected. The decomposition of one or more granules by the spark of a visual stimulus, like the explosion of one or more grains of gunpowder by a spark of electricity, may be the tubercular signal of a red color, or the force which groups two or more corpuscles in a form to signify a red color; or the force to induce a chemical change, which shall coördinate sight with corporeal movements.

The following diagram, Fig. 3, may serve to illustrate the conceivable action of the tubercula quadrigemina under the influence of a visual impression, — that of an uplifted dagger, for example. Let R indicate the retina of the eye, upon which

Fig. 3.




R, retina; A A′ A″ fibres of the optic nerve. I, investing membrane of the tubercula quadrigemina. B B′ B″, group of visual cells. C C′ C″ group of motor cells. D D′ D″ group of visual cells in the hemispheres. E E′ E″ group of granules. F F′ F″ volitional cells of the hemispheres. N N N, etc., connecting nerve fibres. cf cf, etc., communicating nerve fibres.

the image of a dagger, and of a hand holding it, has been impressed, as have also the data, as to the form, position, size, distance, color, and the like (of the dagger and its holder), which it is the office of the eye to collect and transmit (vide pp. 54, 64). A A′ A″ are bundles of nerve filaments of the optic nerve, by which the retina telegraphs the impressions made upon it to a group of visual cells, B B′ B″ in the tubercula quadrigemina, where sight, but not perfected vision, occurs. Each distinct visual impression goes by a separate track to a separate cell. From the group of visual cells, a stimulus passes to a group of motor cells, C C′ C″, by which sight is coördinated with the muscular movements of the eye and with those of the whole body, so far as these are called into action. At the same moment a stimulus passes from the visual cells, B B′ B″, to a group of cells D D′ D″, in the centre of vision in the hemispheres, where perfected or intelligent vision occurs. Simultaneously with the passage of these two currents of stimulation, a third passes from the visual group, B B′ B″, to a group of granules, E E′ E″, and by decomposing them, liberates an amount of nervous energy proportionate to the intensity of the stimulus. The energy thus liberated flows through the conducting nerve fibres N N N, to the motor group C C′ C″, and increases the action of that centre; it also flows back to the visual group B B′ B″, and yields force to that; and by means of anastomosing nerve fibres supplies force wherever force is needed. From D D′ D″, the centre of vision in the hemispheres, an influence passes to F F′ F″, the hypothetical centre of volition, and excites the will. The will sends down through N N N a volitional impulse to the motor-centre C C′ C″, stimulates that to increased effort, and also, by means of communicating fibres, *cf cf cf*, etc., acts on various centres of voluntary motion so as to bring the whole body into needful activity. In like manner, the impression made upon the centre of vision in the hemispheres is diffused by the nerve fibres *cf cf cf*, etc., in accordance with Bain's law of diffusion, throughout the gray matter of the brain, and arouses the intellect and the emotions as well as the will.

This scheme of visual and cerebral action is, of course, hypothetical. Whoever will take the trouble to compare it with our present knowledge of the anatomy and functions of the brain will admit, not only that it is a possible one, but that portions of it are probable, and that the truth of some of it has been demonstrated. It will serve, at any rate, to illustrate some of the recognized forms of cerebral activity, the aid of which will be invoked by and by in explanation of the phenomena of pseudopia.

Nature is always economical of her resources and delights in the distribution of labor. This is strikingly illustrated by the process of vision which we are studying. Notwithstanding the abundant preparation in the tubercula quadrigemina for operating upon visual impressions, only a portion of the work is done there. It has previously been stated that the eye is charged with the duty of ascertaining the color, form, size, distance, position, and movement of bodies, and of reporting the result to the tubercular station. The optic tubercles take up the process of vision, where the eyes leave it, and elaborate, and coördinate visual impressions, in the manner previously described, but they do not repeat, or authenticate the work of the eyes. Simple facts and combinations, which are ascertained by the eye, are themselves recompounded by the tubercles into higher combinations. "The eye, by its optical function, takes in grades of light and shade, mixtures of white and dark in the series of grays, and varieties of color. A good eye might have several hundreds of distinct optical gradations in these various effects. But the eye shows its great compass in the plurality of combinations of points or surfaces of different light, making up what are commonly called *images:* compounds of visible form (muscular) and visible groupings (optical). The multitude of these that can be distinctly embodied and remembered would seem to defy computation; yet every one must have its own track in that labyrinth of fibres and corpuscles called the brain." [1]

The millions of cells, granules, and fibres, which constitute the visual apparatus, enable every possible visual impression and gradation of impression to follow its own track to the brain, and to have its own cell, or group of cells, in which to be deposited and preserved, and from which it may be

[1] Bain, op. cit., p. 99.

derived. It is evident that this distribution of labor, in accordance with which the eyes, the optic tubercles, and the hemispheres, all perform their own part in the process of vision, and which requires each lower station, or bureau, to report only its results to a higher station, increases accuracy of work, and, by economizing conducting lines and sensory cells, affords an almost infinite opportunity for the employment of separate tracks. For the purpose of meteorological investigations, a dozen or a hundred stations collect, by means of thermometers, barometers, hygrometers, and the like, all necessary atmospheric data and report them to a central bureau, where they become the basis of comparison and coördination. The outlying stations are the eyes, and the central bureau, which collates the data, are the optic tubercles of meteorology. When we see a rose, the eye, by means of millions of retinal cells and tubes, ascertains its color and shading, form, size, position, and similar data, and reports them to the tubercles; this report is a visual impression or stimulus, which sets in motion the tubercular apparatus, and is the first intimation which consciousness receives of the presence and properties of the rose.

Entering the domain of consciousness naturally suggests the consideration of the second question already proposed: namely, what is the kind of visual perception, which consciousness takes cognizance of in the tubercula quadrigemina? What sort of conscious sight goes on there? Wherein does it differ, if it differs at all, from vision in the hemispheres?

It is only within a comparatively recent period that any attempts have been made to answer this question. Indeed, the question could not have been raised twenty years ago; for physiology had not then advanced sufficiently to admit of its being asked. Latterly it has been raised, and physiologists have undertaken to answer it by experimental researches. Let us look at the answer which their investigations give.

E. Fournié injected the optic thalami of a dog, so as to destroy the communication between them, together with the optic tubercles and the hemispheres, with one drop of a solution of chloride of zinc. The following, according to his report, was the result of his experiment: "Feeling, except the sense of vision, appeared in this animal to be uninjured. I am inclined to think, however, that if he appeared insensible to the approach of a candle, he was so, because he did not recognize the character of the object and not because he did not see it. In fact the injection had destroyed the fibres, which transmit optic perceptions to the cortical periphery, and which reciprocally transmit the excitement of the cortical periphery to the optic thalami, in order to arouse perceptions of memory in the latter. It is possible that the sense of vision was preserved; the animal saw but did not understand, and remained passive."[1]

In the following experiments, conducted by the same observer, visual impressions were limited to the tubercula quadrigemina and optic thalami by destroying the hemispheres. It will be noticed that Fournié assigns to the optic thalami some of the functions which other physiologists assign to the optic tubercles. For our present purpose, this is not important. It is sufficient to know that some sort of visual impression and visual perception occurs in one or both of these regions, and that it differs from the visual action of the hemispheres. The experiments were eight. This account of them is that they "were performed on both hemispheres; consequently they were as complete as possible. The seat of the injection was variable, though we operated regularly on the anterior, the lateral and middle, and the posterior regions. In no instance were the phenomena of simple perception abolished. The animals always smelt, felt, saw, tasted, and touched, and thus indicated that the phenomena of simple perception are manifested in the optic thalami. On the other hand, the absence of knowledge and memory was constant. The animals, for example, saw a wall, but did not recognize that it was an obstacle, and that contact with it would be painful. They permitted a lighted sulphur match to be brought

[1] *Recherches Expérimentales, sur le Fonctionnement du Cerveau.* Par le Dr. Edouard Fournié. Paris, 1873.

near them without turning the head aside, forgetting that sulphur irritates the olfactory membrane. They moved to the right or left, with the gait of animals which do not know where they are, or what they are doing; the organic reservoir of the association of acquired notions had been destroyed, and in consequence of this destruction, memory was no longer possible. They felt by all their senses, for to feel is to live, after a fashion, when the optic thalami are uninjured; but they did not unite feeling with knowledge, for in order to do this, it is necessary that the optic thalami should receive a stimulus from the cortical periphery of the brain." [1]

Dalton, who has repeated Longet's experiment of removing the hemispheres in pigeons, and confirmed Longet's results, says: "The effect of this mutilation is simply to plunge the animal into a state of profound stupor, in which he is almost entirely inattentive to surrounding objects. The bird remains sitting motionless upon his perch, or standing upon the ground, with the eyes closed and the head sunk between the shoulders. The plumage is smooth and glossy, but is uniformly expanded, by a kind of *erection* of the feathers, so that the body appears somewhat puffed out, and larger than natural. Occasionally the bird opens his eyes with a vacant stare, stretches his neck, perhaps shakes his bill once or twice, or smooths down the feathers upon his shoulders, and

[1] Fournié, *Recherches*, p. 88.

then relapses into his former apathetic condition. This state of immobility, however, is not accompanied by the loss of sight, of hearing, or of ordinary sensibility. All these functions remain, as well as that of voluntary motion. If a pistol be discharged behind the back of the animal, he at once opens his eyes, moves his head half round, and gives evident signs of having heard the report; but he immediately becomes quiet again, and pays no further attention to it. Sight is also retained, since the bird will sometimes fix its eye on a particular object, and watch it for several seconds together. Longet has even found that by moving a lighted candle before the animal's eyes, in a dark place, the head of the bird will often follow the movements of the candle from side to side, or in a circle, showing that the impression of light is actually perceived by the sensorium. Ordinary sensation also remains, after removal of the hemispheres, together with voluntary motion. If the foot be pinched with a pair of forceps, the bird becomes partially aroused, moves uneasily once or twice from side to side, and is evidently annoyed at the irritation."

"The animal is still capable, therefore, after removal of the hemispheres, of receiving sensations from external objects. But these sensations appear to make upon him no lasting impression. He is incapable of connecting with his perceptions any distinct succession of ideas. He hears, for example, the report of a pistol, but he is not alarmed by it, for the sound, though distinctly enough perceived, does not suggest any idea of danger or injury. There is accordingly no power of forming mental associations, nor of perceiving the relation between external objects. The memory, more particularly, is altogether destroyed, and the recollection of sensation is not retained from one moment to another. The limbs and muscles are still under the control of the will; but the will itself is inactive, because apparently it lacks its usual mental stimulus and direction. The powers which have been lost, therefore, by destruction of the cerebral hemispheres, are altogether of a mental or intellectual character; that is, the power of comparing with each other different ideas, and of perceiving the proper relation between them."[1]

Referring to the manifestations of intellectual power and voluntary effort in decapitated animals, Wundt, whose exhaustive researches and judicial tone entitle his views to great respect, uses the following language: "In this respect, animals which retain the tubercula quadrigemina and optic thalami uninjured, undoubtedly behave precisely as if decapitated. It is true, that as a rule they remain sitting or standing upright; but the muscular tension, which enables them to maintain such an attitude, is evidently the direct reflex result of a persistent and uninterrupted impression made upon the skin. Moreover, there

[1] Dalton, *Physiology*, pp. 421, 422.

is no hint of any movement, not referable directly to external irritation. A pigeon whose cerebral lobes have been removed, and a frog whose hemispheres have been separated from the optic tubercles, will remain for days continuously motionless on the same spot. But if, however, only a small portion of the cerebral lobes is left uninjured, all spontaneous movement is not extinguished; and in such a case spontaneous movement may be almost completely reëstablished by means of the extensive transference of function, of which the different parts of the cortex are capable. There have never been observed in complete absence of the superior portion of the brain, and of the cortex covering it, any vital manifestations which could be clearly interpreted as spontaneous, and not as movements directly dependent on external irritation. Hence, we may unhesitatingly affirm that in such animals, the reproduction of perceptions, which previously existed, is impossible; for such reproduction must necessarily lead, now and then, to corresponding movements. At the same time the conscious association of ideas by which an existing impression is referred back to antecedent perceptions, is altogether excluded. Yet here, as in the case of the spinal cord, it cannot be denied that a certain low grade of consciousness may be established, which will permit the preservation of impressions for a very short time. Only it must be remembered that such a consciousness contributes nothing to the explanation of movements. These always carry with themselves the stamp of true reflex action, produced directly by external irritation. Like all reflex action, they depend upon a simple mechanical series of antecedents, which, owing to the extraordinary perfection of constant automatic supervision, secure an appropriate adaptation of movement to impression."[1]

Ferrier's experiments on frogs have already been cited, which led him to the conclusion that so far as experiments on these animals are of value in such an inquiry, intellection, memory, and volition are functions of the hemispheres, and not of the tubercula quadrigemina. This conclusion he has strengthened by a large number of delicate and ingenious experiments on other animals, especially on monkeys, and by his investigations has confirmed the views of Fournié, Dalton, and Wundt, which have just been presented. He says: "With the exception of the greater degree of muscular paralysis and the diminished power of accommodation of movements in accordance with sensory impressions, in general, and with visual impressions in particular, the phenomena manifested by rodents deprived of their cerebral hemispheres, differ little from those already described in frogs, fishes, and birds. The power of maintaining the equilibrium is retained, coördinated locomotive actions and emotional manifestations are capable of being excited by impressions on sensory nerves,

[1] Wundt, *Physiologischen Psychologie*, p. 829, etc.

essentially, if not altogether to the same extent in all." [1]

It is a difficult matter to reason correctly from experiments on the comparatively simple mechanism of the lower animals to the functions of the higher ones; and the difficulty is increased when we ascend still higher, and endeavor to unravel the intricacies of the nervous system of man by an appeal to that of animals. Still, if due caution be employed, this method of inquiry is a legitimate one, and yields important results. Upon this point the observer just quoted, remarks: "When we pass from the consideration of the functions which the lower centres in frogs, fishes, and birds are capable of performing, independently of the cerebral hemispheres, to the effects of removal of the hemispheres in mammals, we have to deal with phenomena of a more varied character. We have seen that frogs, fishes, and birds, deprived of their cerebral hemispheres, continue to perform actions in many respects differing little, if at all, from those manifested by the same animals under absolutely normal conditions. But the results in the case of mammals, are far from exhibiting the same degree of uniformity. Differences of a marked character exist, according to the age of the animals experimented on, and the order to which they belong. If we were to draw conclusions from experiments on one order of animals, and extend them, without due qualification,

[1] Ferrier, *Functions*, etc., p. 39.

to animals in general, and particularly to man, we should be in danger of falling into serious errors. The neglect of such considerations has been a fruitful source of discrepancies and contradictions between individual physiologists, and between the facts of experimental physiology and those furnished by clinical and pathological research." [1]

This difficulty would be diminished if it were possible to subject the cerebro-spinal system of man, like that of animals, to experimental investigation; but this cannot be done. Occasionally, however, disease produces in the nerve centres a local lesion, which fulfils all the conditions of an experiment, and from which, of course, corresponding conclusions can be drawn. Whenever this has occurred under the eye of a competent observer, it has been found to confirm the results of experiments on animals. Charcot reports the case of a female, seventy-six years old, who died of a pneumonia of only two days' duration, in whom, at the post-mortem examination, the left cerebral hemisphere proved to be healthy, while the right contained a patch of softening which had destroyed the inferior, parietal lobule of the *pli courbe* (angular gyrus), the posterior half of the island of Reil, and the two first temporal convolutions. Before her pneumonia, this patient "got up every day and walked without difficulty. She even walked from her dormitory to the infirmary. While in the ward it was ascertained that the

[1] Ferrier, op. cit., p. 37.

muscular strength of her hands was equal. She did not squint, nor exhibit any notable disturbance of vision."[1] The same observer quotes from M. Baraduc the case of a man in whom the two frontal lobes were altered to a large extent by a lesion which occupied on each side the first, second, and third frontal convolutions. "The patient, whose brain presented these alterations, had been for six years in the Hospice des Ménages. He exhibited no sort of will or spontaneity. He walked every day in a hap-hazard manner, without any apparent motive, and ran against whatever objects were in his way. He died of bronchitis, and up to his last moments preserved the muscular force and sensibility of the two halves of his body."[2] The condition of this person, in whom the hemispheres had been so largely destroyed, resembled in a remarkable degree that previously described of frogs, pigeons, and monkeys, deprived of their hemispheres. Locomotion, sight, muscular powers, and coördination were preserved, but spontaneous movement, memory, and intellectual activity were absent. He saw the form of objects, but did not recognize or appreciate their relations to himself or to other objects. The process of vision was arrested before it was completed in the hemispheres. These two cases confirm, so far as they go, the trust-

[1] *Revue Mensuelle de Médecine et de Chirurgie,* January, 1877, p. 10. Art. by Charcot et Pitres.

[2] *Revue Mensuelle,* ut supra, p. 14.

worthiness of the method of studying the nervous system of man by that of animals, and consequently of the deductions, drawn in this essay, as to the visual functions of the tubercula quadrigemina and hemispheres in man, from experimental researches on animals.

It appears from the foregoing considerations, that intellection, memory, and volition must be eliminated from that part of the process of vision which resides in the optic tubercles, and which constitutes their chief function. It is not clear, however, that emotion can be so distinctly separated from them. Emotion is largely, if not exclusively instinctive, and the central mechanism of instincts is in the basal ganglia. We had occasion to observe, when describing the coördinating function of the tubercles and optic thalami (p. 73), that there were strong presumptions in favor of the hypothesis of the coördination of visual impressions with emotional, as well as with muscular action, in the tubercular region. The following experiment of Vulpian, quoted by Ferrier, illustrates and strengthens this hypothesis. Physiologists say that the rat is exceptionally emotional; that it is a peculiarly sensitive, if not sentimental creature, and therefore admirably adapted to experiments intended to bring out emotional expression. Vulpian placed one before his class in his lectures, and calling attention to its emotional characteristics, remarked: "It is very timid, very impressionable; it bounds away at the slightest touch; the slightest sound causes it to start. A whistle, or a *sharp hiss*, like the angry spit of a cat, excites in it vivid emotions. Before you is a rat, from which I have removed the cerebral hemispheres. You see it remains perfectly quiet. I now whistle with the lips, and you see the animal has made a sudden start. Each time I repeat the same sound you behold the same effect. Those of you who have studied the expression of emotion in the rat will recognize the complete identity of these with the ordinary emotional manifestations of this animal."[1] In this instance, an auditory impression, made upon the basal ganglia and prevented, by ablation of the hemispheres, from going higher, excited the emotion of fear.

These experiments and clinical and pathological observations lead inevitably to the conclusion, that the kind of visual perception, which occurs in the tubercula quadrigemina, is of a purely mechanical or automatic character. The ideas, thoughts, memories, and volitions, which visual impressions produce or awaken, form no part of the perceptive function of the tubercles. As soon as a visual telegram is received by them from the eye, the message is distributed to the various motor, visual, and emotional centres with which the tubercles are in communication, but the message is forwarded without being understood. Just as we have seen in the simplest form of ganglionic action that a ganglion, as soon as it has received

[1] Ferrier, *Functions*, etc., p. 69.

through a sensory nerve notice of a sensation, sends out a motor stimulus, without any more comprehension or perception of what it is doing than an æolian harp has of the process or power by which its strings send out music in response to the touch of the wind, so the optic tubercles receive a visual impression, and send out in various directions an appropriate response, without any intelligent perception of what has touched them, or to what issues their action tends. Consciousness recognizes the fact, whenever the tubercles receive and send forward a visual impression, by means of a telegram, that such an occurrence has taken place in that region, but it looks to the hemispheres for information as to the nature of the impression. If there is any consciousness in the tubercles, it is of that low grade to which Wundt refers as existing in all automatic centres, and as disconnected from memory and spontaneity.

The foregoing study of the functions of the tubercula quadrigemina has cleared away a good deal of the difficulty and obscurity which have hitherto enveloped them; and it indicates, perhaps it may be said that it demonstrates, the following conclusions: —

1. The tubercula quadrigemina are a visual centre, charged with the office of receiving visual impressions from the eye, and of forwarding them when received to certain motor centres and to the hemispheres.

2. The visual impressions received by the tu-

bercula quadrigemina are not physically the same as those made upon the retina of the eye, but are the result of a stimulus, which, propagated along the optic nerve, produces a peculiar molecular action in the tubercles.

3. Every object, color, and grouping of objects, capable of affecting the eye, produces in the tubercula quadrigemina a definite sort of chemical, mechanical, or thermal change, which is the hieroglyphic or cipher of that object, color, or grouping, and is the representative of no other object, color, or grouping.

4. The tubercula quadrigemina coördinate sight with irido-ocular movements, and, aided by the optic thalami, with all muscular movements, whether of locomotion or otherwise, for the perfect and harmonious performance of which sight is necessary.

5. If the tubercula quadrigemina are separated from the hemispheres by the destruction of the latter, or by interrupting the communication between these two regions, the tubercles are still capable of performing their functions independently; and, conversely, if they are destroyed, the hemispheres remaining uninjured, blindness, loss of irido-ocular coördination, and imperfect coördination of the general muscular system result.

6. Simple perception of light and of visible objects is a function of the tubercula quadrigemina, but it is perception, without memory, intellection, or volition; without any recognition of the character or relations of the objects seen.

7. The tubercula quadrigemina are essential to the process of vision, but are not centres of conscious vision.

### VISUAL CENTRE OF THE HEMISPHERES. — ANGULAR GYRUS. — PLI COURBE.

The third station on the way from the eye to the frontal lobes of the brain, from the objective world of matter to the subjective world of ideas, from the not me to the me, is the angular gyrus, or centre of vision in the hemispheres. Here seeing really takes place. Here, deep in the recesses of the brain, is the true world of vision and of visions, — the sphere where is spread before the mind all the wonder which light reveals, and where pseudopia plays its strangest freaks. The innumerable visual impressions, which, made upon the eye, are afterwards appropriately classified and variously coördinated by the tubercula quadrigemina, are sent up to this centre, here to be still further elaborated; brought into relation with the highest mental powers; made to subserve the processes of ideation; pressed into the cells of memory; and fitted to excite the will. It is with the grouping of cells in the angular gyrus that we see, and not with our eyes.

Until recently there has been a profound disagreement upon the question of the localization of motor and other functions in the cerebral lobes, between the results of experimental physiology and the facts of clinical observation. The former have affirmed that the cortical substance of the brain was an inexcitable unit, which possessed and exhibited the same properties in all its parts; the latter produced a series of cases of lesions, limited to definite localities in the cortical substance, which gave rise to definite and peculiar functional derangements. As a natural consequence of disagreement upon such an essential point, two distinct theories were put forth and defended with regard to it. One maintained the inexcitability and solidarity of the cerebral lobes, and declared that "the intellectual and perceptive faculties reside in the cerebral lobes; coördination of movements of locomotion in the cerebellum; and direct excitation of muscular contraction in the spinal cord and its nerves. . . . The organ by which an animal perceives and wills neither coördinates nor excites; the organ which coördinates does not excite; and reciprocally, the organ which excites does not coördinate."[1] The other theory, first definitely propounded by Gall, and afterwards elaborated by Spurzheim, acquired the name of phrenology, and made of the brain a sort of delicate mosaic work, divided into as many separate organs as there are cerebral functions. The facts of clinical experience and numerous physiological observations were opposed to each of these extremes. There were

[1] Flourens, *Recherches Expérimentales sur les Propriétés et les Fonctions du Système Nerveux dans les Animaux Vertébrés*, 2e ed., Paris, 1842, préface, p. xiii.

sound and philosophical students of the nervous system, who suspected that the truth lay between the two, where it would one day be discovered. One of the soundest of them, Andral, remarked years ago: "In face of so many facts, which, in alterations of the brain, continually point to its most diverse parts for an explanation of the disturbance of a single function, shall we deny that certain portions of the encephalon are specially devoted to the performance of certain acts? We have no right to do so; for it is probable, that certain points of the brain have such a mutual connection, that a lesion of one reacts in a special manner upon another; and it may be that it is this secondary alteration, inappreciable by the scalpel, which produces some special functional disorder."[1]

Within the last few years the labors of Fritsch and Hitzig in Germany, of Hughlings Jackson and Ferrier in England, of Carville and Duret and Charcot in France, have accomplished a great deal towards reconciling the result of experiment with the facts of pathology, and have shown that the brain is neither the inexcitable unit of Flourens, nor the mosaic work of Gall. They have shown that there are certain regions in the human brain, which contain centres of various motor and sensory activities; and other regions, which, even if they are charged with diverse functions, are so intimately connected with each other that they

[1] Andral, *Clinique Médicale*, tome v., p. 195.

act harmoniously as a unit.[1] The centre of vision in the hemispheres, christened by the anatomists the angular gyrus, and called by the French, on account of its shape, the *pli courbe*, is one of these recently defined regions which is of great importance in our present inquiry, and to which we must now turn our attention.

The evidence which has been adduced proves conclusively that the process of vision, which commences in the eye and is afterwards carried on by the tubercula quadrigemina, is not completed by these ganglia, but has some other organ or region for its full and final development. This has long been suspected, or rather believed, by physiologists, but it was not known till recently whether a visual impression, after leaving the optic tubercles, spreads itself for the inspection and use of the mind over the whole cortical substance of a hemisphere, or is confined to a definite centre in that substance, from which it radiates in every direction. The discovery by experimental investigation that cerebral vision is centred in the angular gyrus has put that question at rest.

[1] The speculations of the ancients upon the functions of the brain were sometimes singularly near the truth, of which the demonstration was reserved for later and in some instances for recent times. Thus Hippocrates taught that, "It is by the brain we think, understand, *see and hear*, know ugliness and beauty, evil and good, pleasure and pain; . . . . it is by the brain that insanity and delirium, fear and terror, groundless error and motiveless anxiety beset us." — *Œuvres Complètes d'Hippocrates*, traduction par É. Littré, tome vi., p. 387. Paris.

The angular gyrus, according to Ferrier, is a section of the parietal lobe of the brain, situated below the intro-parietal sulcus, and a little posterior to the horizontal branch of the fissure of Sylvius. It bends in a fold or arch, and hence its French appellation, *pli courbe*, over and around the temporo-sphenoidal convolution in which is the auditory centre. In close proximity to it are the centres of smell and taste, as well as the tactile centre. So that this region contains as near anatomical neighbors, the centres, or centric terminal stations of the five senses of sight, hearing, smell, taste, and touch. It is a region, in which these senses bring the whole external world into immediate contact with the mind ; a region, where matter assumes its most immaterial, and mind its most material condition; and where, if anywhere, mind and matter touch each other, and react on each other.

The angular gyrus is shown to be the visual centre of the hemispheres by two series of experimental investigations which supplement each other. One series presents the results following its destruction, and the other those following its stimulation in living animals. The effect of stimulating it by an electric current is to produce phenomena which "seem to be merely reflex movements, consequent on the excitation of subjective visual sensation."[1] That is, stimulation of the angular gyrus in a monkey, dog, cat, or other

[1] Ferrier, op. cit., p. 164, Am. ed.

animal, produces subjective pseudopia, which is accompanied with movements of the eyeball, contraction of the pupil, closure of the eyelids, and other efforts, indicating a desire on the part of the subject of the experiment to escape from some disagreeable visual impression. This fact of the artificial production of subjective pseudopia is one of great importance in our present inquiry. It will be referred to again by and by.

Destruction of the angular gyrus (on one side) temporarily annihilates the visual function. "The loss of vision is complete, but is not permanent if the angular gyrus of the opposite hemisphere remains intact; compensation rapidly taking place, so that vision is again possible with either eye as before. On destruction of the angular gyrus in both hemispheres, however, the loss of vision is complete and permanent, so long, at least, as it is possible to maintain the animal under observation. When the lesion is accurately circumscribed in the angular gyrus, the loss of vision is the only effect observable, all the other senses and the powers of voluntary motion remaining unaffected.[1]

There is an apparent discrepancy between this statement, that destruction of the angular gyrus in each hemisphere completely destroys vision and the statement previously made that sight may exist in the tubercula quadrigemina, after destruction of the hemispheres. Both of these

[1] Ferrier, op. cit., p. 164.

statements are correct. The experiments which have been detailed show that, in living animals, ablation of the hemispheres, which of course includes ablation of the angular gyri, leaving the lower visual centres intact, is followed by loss of vision; and, moreover, that destruction of the tubercula quadrigemina, leaving the hemispheres intact, is in like manner followed by loss of vision. They also show that visual perception persists after ablation of the hemispheres, the tubercles remaining; and that it persists after destruction of the tubercles, the hemispheres remaining. Such are the results of experimental investigation, and they are not irreconcilable with each other. The discrepancy is only apparent. It arises, to a great extent, from want of precision in the use of language; or, more exactly, from not attaching precise ideas to the language we employ.

The contradiction will disappear, and the results harmonize with each other, if we bear in mind the distinction which has been established between the various kinds of visual perception. We have endeavored to emphasize the fact, to put it in as clear a light as possible, that the process of vision consists of several stages; and that each stage has its own sort of seeing, its own sort of visual perception, of which the others do not partake. The seeing of the retina of the eye consists of impressions, unrecognized by consciousness, made upon its cells and tubes by waves of light. The seeing of the tubercula quadrigemina consists in receiving and appropriately distributing a visual message, and of doing so within the domain of consciousness, but without the domain of memory, intellect, and volition. The seeing of the angular gyrus consists in receiving, apprehending, retaining, and appropriately distributing a visual message, forwarded by the tubercula quadrigemina, and of doing this within the domains of consciousness, memory, intellect, emotion, and volition. Sight in the eye is automatic and unconscious. Sight in the tubercula quadrigemina is automatic, sensori-motor, and attended with a low grade of consciousness. Sight in the angular gyrus is intelligent, ideo-motor, partially automatic, and attended with the highest grade of consciousness.

If a complete section of the visual apparatus is taken out, or a visual centre destroyed, all vision between the point of destruction and the frontal lobes is annihilated. No visual impression can penetrate beyond the point of destruction; a result which theoretically would be expected and which experiment has demonstrated. On the other hand, if a visual centre remains between the point of destruction and the periphery, such a centre, to which of course a visual impression can penetrate, retains, for a time at least, its own special visual powers; it retains its own sort of sight. This result, again, which theoretically would be anticipated, has been experimentally confirmed. If the eyes are taken out, no visual impression or stimulus can penetrate to the tubercula quadrigemina, angular gyrus, or frontal lobes, and arouse them to action. If the angular gyrus is destroyed, the stimulus of light can still ascend through the eye to the optic tubercles, and excite the functions of each of these organs. This can be done till they become atrophied from want of use, and then, of course, all vision is impossible. When we remember that no memory, intellection, or volition can be excited by a visual impression till it reaches the angular gyrus, we can easily understand why destruction of this centre, like ablation of the two hemispheres, should apparently produce total loss of every sort of visual perception. A function which is performed without consciousness or memory is practically abolished. An animal, which has been deprived of the angular gyrus and allowed to retain its optic tubercles, may see the same object a thousand times, in as many successive seconds, minutes, or hours, but, unfurnished with memory, it will fail to recognize the object, or comprehend its relations. Such an animal will act as if it were blind, and practically it is blind. It will look at food of which it is fond, and of which it is in need, without making any effort to get hold of the food. Its eye will follow a lighted lamp, but it will not seek to avoid the flame, unless it feels the heat. Charcot's patient, in whom disease had destroyed the angular gyrus, wandered about in a hap-hazard manner; seeing, yet acting like a blind person.

These considerations are sufficient to explain the apparent contradiction which has been mentioned, and to show that the results of experimental investigation harmonize with, and support each other. The explanation may be briefly stated thus: Each visual centre has its own sort of visual perception. The destruction of a lower centre prevents a visual impression from ascending to a higher centre, and therefore produces blindness. The destruction of a higher centre leaves to each lower centre a low grade of visual perception, which, being unaccompanied with memory, is also practical blindness.

Fournié insists upon the distinction (which we have pointed out) between the various kinds of perception. It will illustrate our subject and reinforce our argument to compare his statement with the preceding.

"In order," he says, "to comprehend the signification of these experiments, we must not lose sight of the essential distinction, which we have established, between a simple perception, produced in the optic thalami and a clear and definite perception (conception?) produced elsewhere. The latter is the result of an acquired experience, of an anterior comparison of two perceptions; it includes in a word, somewhat more than a simple perception, and has also a different character. A simple perception is produced by an exciting object, which has just affected a sensitive nerve (this is all that objective impressions can produce). A detailed perception (*i. e.*, conception) is the product of a cerebral element, which has preserved the mark or trace of an intellectual effort, by which two simple perceptions were previously compared. This element is represented by millions of cells, which are disseminated throughout the cortical periphery of the brain, where they constitute the layer of gray matter. These cells, contrary to the opinion of some physiologists, and of M. Luys in particular, perceive nothing of themselves. They represent a dynamic movement, which alone possesses the power of exciting in the optic thalami, the unique centre of perception, a peculiar perception,. or, in other words, an acquired notion. This essential distinction, which we have just established, gives us the key to memory, and enables us to point out its mechanism from a theoretical, experimental, and organic stand-point. To recollect one's self is to state, in effect, that our present impression differs from a former one, and in order to make such a statement, the brain must have preserved somewhere the trace of an anterior impression, to such an extent, that the latter can reëxcite the centre of perception.

"It is evident, if we recall the position which we have assigned to the phenomena of perception in our classification of the phenomena of life, that merely to feel is to live, but that to feel and know is to cerebrate. Cabanis was wrong, when he said, to live is to feel. It is possible to live for a time without feeling; but feeling without life is impossible.

"Acquired notions, then, are represented by the impressionable cell elements which are distributed throughout the cortical periphery of the brain. There they are organically arranged without the intervention of the will. They are associated with each other by the prolongations of cells, which are themselves so connected as to be capable of reciprocally exciting each other's activity, and of manifesting it, by exciting the centre of perception in the optic thalami. These views, deduced from a sound interpretation of the phenomena of life, and from pathological observation, throw a large amount of light upon mental operations, and on such psychical affections as hallucination, mania, etc." [1]

The angular gyrus, like the tubercula quadrigemina, is composed of groups of corpuscles, granules of protoplasm, cells, enclosing nuclei and nucleoli, interlacing nerve fibres, blood-vessels, and connecting tissue. Of the manner in which these constituent elements behave under the influence of a visual impression (telegram) from the optic tubercles, we know as little as we do of the behavior of similar elements in the tubercula quadrigemina or optic thalami under the same influence. The description which has been given of the possible grouping of cells and development of force through chemical, mechanical, thermal, or nutritive change by means of which the reception and forwarding of visual telegrams occur in the tubercula quadrigemina, applies to the angular gyri, so that it is unnecessary to rehearse the matter here. It is important to remember, however, that as the definite visual impression, which waves of light make on the retina, is not transferred to the optic tubercles, so in like manner the impression made on these organs through the optic nerve, is not transferred to the angular gyri; a visual mes-

[1] Fournié, *Recherches Expérimentales*, op. cit., p. 87, etc.

sage is received, comprehended, and forwarded. This is done by means of definite groupings of the cells, or peculiar manifestations of the chemical and other forces of each angular gyrus. The millions of cells in the gyri are amply sufficient to afford a separate cipher for every possible visual impression, and shade of impression, which can visit the most sensitive and intelligent eye during the longest life.

As we approach the higher cerebral centres we meet with several physiological laws or habitudes, which deserve consideration, and with which an acquaintance is essential to a just appreciation of the delicate and complex phenomena of the higher ganglia of the nervous system, and especially of the mechanism of orthopia and pseudopia. One of the most interesting and important of these laws is that which enables the cells of nerve centres to retain or register impressions. It may be called the law or power of cerebral registration. In accordance with it, impressions made on these cells are retained with a definiteness and permanence, proportional to the frequency and intensity of the impressions. A single, feeble impression leaves only a slight trace on the cells it reaches, and one which it is possible may be sooner or later obliterated. A single, strong impression leaves a deeper and more lasting trace. An impression, frequently repeated during a long period, leaves a deep and permanent trace. In this way the cerebral cells are modified by impressions made upon them, and the modification becomes in some unknown manner a part of the organization of the centres affected, and one which persists, in spite of the continual metamorphoses to which they are subjected. As a cicatrix upon the skin, following a burn or wound, will retain its place and structure as a part of the skin, through all the changes of growth and nutrition from childhood to old age, so a cerebral cell or group of cells retains the type, which impressions have stamped into it, through all the changes of cerebral development and action. The millions of visual impressions made on the cells of the angular gyri, by the objective world, from childhood to old age leave traces of greater or less distinctness there. Some of these are slight and shadowy, and can only be reproduced with difficulty, after the lapse of any considerable period of time; others are stamped deeply and indelibly into the cell structure, and can be easily called into renewed activity, even after many years have passed by.

The subjective cerebral action resulting from visual impressions, made upon the angular gyrus, or telegraphed to it by the tubercula quadrigemina, is one of the forms of special sensation, and involves the highest grade of consciousness. It is in fact open to the inspection of self-consciousness, and furnishes motives and stimulants to the will. Such a result does not follow the action which light produces in the optical apparatus of the eye, or of the optic tubercles. Self may be conscious that the mechanism of these organs is at work, but the subjective side of their action is not reached till the angular gyri are put in motion.

Ferrier happily says:—

"The optical apparatus without the angular gyrus may be compared to the camera without the sensitized plate. The rays of light are focussed as usual, but produce no chemical action, and leave no trace when the object is withdrawn, or the light from it shut off. The angular gyrus is like the sensitive plate. The cells undergo certain molecular modifications, which coincide with certain subjective changes constituting the consciousness of the impression, or special visual sensation. And as the sensitive plate records in certain chemical decompositions, the form of the object presented to the camera, so the angular gyrus records in cell modifications the visual characters of the object looked at. We may push the analogy still further. Just as the chemical decomposition effected by the rays of light may be fixed and form a permanent image of the object capable of being looked at, so the cell modifications which coincided with the presentation of the object to the eye, remain permanently, constituting the organic memory of the object itself. When the same cell modifications are again excited the object is re-presented or rises up in idea. It is not meant by this analogy that the objects are photographed in the angular gyrus, as objects are photographed on the plate, but merely that permanent cell modifications are induced, which are the physiological representatives of the optical characters of the object presented to the eye. The optical characters are purely light vibrations, and few objects are known by these alone. The object appeals to other senses, and perhaps to movements, and the idea of the object as a whole is the revival of the cell modifications in each of the centres concerned in the act of cognition. For what is true of the angular gyrus, or sight centre, is true, *mutatis mutandis*, of the other sensory centres. Each is the organic basis of consciousness of its own special sensory impressions, and each is the organic basis of the memory of such impressions in the form of certain cell modifications, the re-induction of which is the re-presentation or revival in idea of the individual sensory characters of the object. The organic cohesion of these elements by association renders it possible for the re-excitation of the one set of characters to recall the whole."[1]

Not only is the angular gyrus capable of registering impressions, but it can reproduce them under the influence of an appropriate and sufficient stimulus. It possesses, in other words, the power of reviving antecedent impressions, in accordance with what may be called the law of cell-reproduction. From what has been said, we should expect such a power to exist in the various ganglionic nerve centres, including the cerebral visual centre. Visual impressions, which are to a greater or less extent pictorial on the retina, become in the tubercula quadrigemina, optic thalami, and angular gyri, cell-groups, or modified cell-manifestations. Each specific group or manifestation is the cipher or hieroglyphic of a specific visual object. Such being the mechanism of sight, it is

[1] Ferrier, op. cit., pp. 257, 258.

evident that whatever will produce in any of the visual centres a cell-grouping or modification, which is the representative of any object, as a rose, a dagger, or a face, will also produce the subjective sensation or idea of the object. Ordinarily this occurs only when an object is presented externally to the eye, and the rays of light falling from it on the retina, set the whole visual apparatus in action. Sometimes, however, causes which are purely intra-cranial will revive old cell-groups or modifications, and the subjective result is the seeing of objects of which there is no external existence.

There are various intra-cranial conditions which lead to this curious result, some of which have been ascertained and others now unknown, will doubtless be discovered by and by. Two of them, habit and association, facilitate in a marked degree the revival of old impressions and contribute to the distinctness of the result.

All recognize the force of habit in rendering the performance of actions easy, which when first attempted were difficult. It enables an infant to solve the hard problem of walking with rapidity, so as to exchange in early life an uncertain, slow, and painful gait for an assured and almost unconscious step. By its aid a musician will render with accuracy and effect the most difficult music, while his conscious self is wandering among the stars, or watching the mazes of a dance. The brain of a practised orator will sometimes act so far automatically under its influence as to pour forth a strain of intelligent discourse, while the speaker's self is temporarily intent upon some occurrence in his audience, or pursuing ideas aside from his speech. The visual centres do not escape from the influence of habit. Cell-groupings and cell-modifications, which are frequently formed, acquire the power of being reproduced with constantly increasing facility. Groupings, representing the lineaments of a face which has been seen thousands of times, will re-form on the slightest visual hint that the familiar countenance is within the field of vision. Light reflected from a well-known lip, or eye, or nose, upon the retina, will not infrequently set the whole visual apparatus in motion, so as to produce in the angular gyrus a cell-group, which, being the representative of an accustomed face, will present it to our subjective vision. The more frequently the cell-groups of the visual centre have been made to assume a certain form, the more easily and accurately do they arrange themselves in that order. In this way, a single feature, resembling that of a friend, seen on a stranger's face, will polarize one or more cells of the angular gyrus, and these being part of a group which has been put together a thousand times, will cause the whole group to crystallize into shape and bring the friend before our sight.

The influence of association over the cerebral visual centre, as well as over all nerve centres, is not less potent than that of habit, and is closely allied to it. Habit enables a visual cell-group to be formed with constantly increasing facility and accuracy; association enables groups which have been associated with each other to call each other up, without any regard to mutual similarity or natural connection. Let A., B., and C., indicate the cell-groups or cell-modifications which represent respectively a man, a horse, and a rock, and which have been frequently and for a long time associated together. The man seen alone will produce in the angular gyrus the visual group, A., and its corresponding subjective sensation. The grouping of A. will lead to the more or less complete grouping of B. and C.; or A. may produce B. without C; or C. without B. It is rare that associated visual groups are completely formed in this way; if they were so the corresponding subjective sensation would be equally complete, and visions or pseudopia would be of frequent occurrence. They are, however, often imperfectly formed and bring before the mind's eye imperfect subjective visual sensations, which may be still further developed by the ideo-motor action of the cerebral cells. Such groupings and visual sensations are very apt to occur in sleep, and occasion dreams in which strange sights play a prominent part. This sort of association is an illustration of Bain's "Law of Contiguity," in accordance with which, "actions, sensations, and states of feeling, occurring together or in close succession, tend to grow together or cohere, in such a way that when any one of them is afterwards presented to the mind the others are apt to be brought up in idea."

"Pictures which memory and fantasy produce," says Wundt, "are formed by the influence of direct perception, or by that of other ideal conceptions with which they are in some way connected by the laws of association. Sometimes, indeed, it seems to us as if a definite picture arose in our consciousness without any cause. But even in such cases, the careful observer will seldom miss the link, which connects ideas with antecedent conditions. We overlook such connections easily, because re-presentation can be attached to any of the elements of perception and idea. Thus sensory and æsthetic feelings, and the affections which act upon our consciousness, and with which on account of their vagueness, association is indistinctly connected, readily serve as vehicles for reproduction. In view of the extraordinary variety of connections which are thus possible, and of the great difficulty of observing in one's self the simple, direct, internal current of our ideas, we are compelled to the conclusion, that a universal causality presides over this territory also, and that no picture of memory ever springs up over the threshold of consciousness, which did not appear there in accordance with those laws of association, which, in many cases, have been distinctly demonstrated to exist. In short, association is a psychological antecedent. Hence we may describe the essential difference between the pictures of perception and those of imagination as consisting in this: the former always have their origin in a physiological irritant; the latter in a psychological irritation. We regard psychical irritation as the originator of these ideas, which whether resulting from contemplation or self-generated, bring a picture into consciousness by means of association. Now, although an ideal picture should possess the same elements of sensation as the original perception, perhaps faded and modified in its details by the re-presentation of others, yet even here we must presuppose a physiological irritation of the central layers, which is developed in consequence of psychical irritation."[1]

It is apparent from these considerations, that the angular gyrus is the last centre or station of the apparatus, which visual impressions traverse on their way from the external world to the frontal lobes, where they are turned over to the machinery of ideation and volition. In this centre they receive their final elaboration, before being presented to the mind; here they are accurately registered and preserved for revival or reproduction. However numerous, frequent, and varied these impressions may be, it contains ample provision for receiving, forwarding, and recording them all. It recognizes, pictures, and notes every shade of visual difference. From it the mind derives all the information light can impart of the external world, and upon the accuracy of its reports the mind implicitly relies. Whatever report it sends up the mind accepts as true. In the vast majority of cases, it justifies by its truthfulness the confidence reposed in it. Were it not so, we should never be sure of anything we see.

[1] Wundt, op. cit., pp. 644, 645.

Were it apt to act of itself, without being stimulated by the eye, we should be unable to discriminate subjective from objective seeing — orthopia from pseudopia, — sights of external, from those of internal life. But, now and then, the angular gyri do act independently of the external world, and then we are amazed and confounded by their doings. Before discussing this point, however, it is important to examine the visual relations of the frontal lobes of the brain and angular gyri to each other.

## THE FRONTAL LOBES.

The cerebrum is the seat of intelligence, the home of ideas and imagination, the forum, where reason hears and decides, and from whence the will utters its mandates which issue in action. It is not intended by this statement to affirm that mind and brain are identical, but only that all mental action, however complex or subtle, is manifested through the brain. Neither is it intended to assert that the cerebrum is the sole organ of the mind; for it is probable, some physiologists would say proved, that the whole cerebro-spinal system, in varying degrees, contributes to mental force and mental processes, and aids in mental manifestations. Nevertheless, the chief seat of intelligence is the cerebrum; and of the cerebrum, the frontal lobes for all purposes of intellection, are the most important. They contain the most delicate and mysterious portions of the mind's machinery. They constitute the organic basis of the higher intellectual faculties, and intellectual power is proportional to their development.

The frontal lobes are divided by anatomists into three sections, called the superior, middle, and inferior frontal convolutions. These are situated directly behind and above the eyes, forming the anterior and highest portion of the cerebrum, a commanding position, symbolical of their watch and control over the whole nervous apparatus. Their constituent elements, like those of the tubercula quadrigemina, optic thalami, and angular gyri, are cells, containing nuclei and nucleoli, granules, interlacing fibres, investing membranes, connective tissue, and the like. Although these elements are the same as those of other nerve centres, it is evident from the functions they perform that in some way, perhaps in quality or atomic arrangement, they differ from other ganglia of the cerebrum. The difference, however, is of a character which no scalpel, lens, or analysis has been able to demonstrate, or can appreciate. In like manner, the various cell-groupings and cell-modifications, mechanical, chemical, thermal, or dynamic, which, by inducing the development or inhibition of force, enable motion, thought, and volition to be manifested, may be guessed, but cannot be traced or mapped out. What has been said with regard to the hypothetical cell-groupings and cell-modifications of the tubercula quadrigemina, under the influence of visual impressions from the eye, is applicable to similar groupings in the frontal lobes, when such impressions are transferred or reported to them from the angular gyri.

Numerous connecting nerve fibres unite the visual centres of the hemispheres with the cells of the frontal lobes, to which all visual impressions, having been elaborated, classified, and carefully arranged in these centres, are immediately reported for inspection and ideation. The nerve fibres, which connect the angular gyri with the frontal lobes, serve not only to bear visual messages from the former to the latter, but the reverse. The effects of emotion, the results of intellection, and the decisions of the will, all of which receive their final elaboration, before their manifestation in action, in the cells of the frontal lobes, are felt, when they are concerned with visible objects or visual ideas, with greater or less intensity, in the visual centres, and often aid in the revival of impressions in those centres. Messages are thus sent along the connecting fibres between the angular gyri and the frontal lobes in both directions, — to and from the gyri, and to and from the lobes. In the same way all the nerve centres of the body, and all the corporeal organs, communicate directly or indirectly with these lobes, so that not only the special senses of sight, hearing, taste, smell, and tact, but every organ and function report to these controlling ganglia. By this arrangement the frontal lobes are enabled to compare the reports from all parts of the organization with each other, and so to arrive at a sound judgment of the condition of the mechanism they govern, and of the external world with which they are thus brought into intimate and constant relation. Among these reports those from the angular gyri are of course included, and are corrected, when necessary, by comparison with the reports from other senses and organs.

Sight is perfected, as we have seen, in the angular gyrus, the cerebral termination of the visual apparatus, from which the visual impression is forwarded to the frontal lobes, where it is transformed into an idea. The cell-groupings of the gyrus, for example, being arranged into the cipher of a horse, report to the frontal lobes the presence of a horse; the latter, receiving the report, immediately produce the idea of a horse. The action of the visual cells in the visual centre is a sensation, which, transferred to the cells of the frontal lobes, becomes an idea. The sensation and the idea, however, are not identical, though one evolves the other. They are an illustration of what Mr. Bain calls the double-faced unity of mind and body. The angular gyrus presents the physical, and the frontal lobes give the mental side of a visual impression.

In order to comprehend the phenomena of orthopia and pseudopia, it is important to keep the distinction between a visual sensation and a visual idea well in mind; to remember that the idea of an object is not identical with the visual sensation of the same object; that thinking is not seeing. The cell-groupings and action of the frontal lobes, by which visual ideas are manifested, are not the same as the cell-groupings and action of the angular gyri, by which fully elaborated visual sensations are manifested; nor are the products the same. The common expression, "I can see it with my mind's eye," recognizes this distinction.

It has been stated that under the influence of habit, or association, or of both, cell-groupings may be revived in the visual centres of external objects, which are not objectively present to the eye. When this occurs, the frontal lobes receive the same visual report which they would receive if the objects were present. The lobes are deceived into the formation of visual ideas, without the presence of any objective reality. This is pseudopia. It is possible for the reverse to take place; for an idea to assume such proportions of vividness and intensity as to send an impression down to the angular gyri, and evoke there a visual cell-grouping, independently of any stimulus from the eye. In this way visual impressions may travel in a circle from the lobes to the visual centres; from the visual centres to the lobes; from idea to sensation; and back from sensation to idea: the whole being an intra-cranial process. We shall have occasion to call attention again, in another part of this essay, to this physiological and psychological phenomenon.

The existence of different grades of perception in each of the intra-cranial visual centres has already been pointed out. It has been shown that when waves of light from a visible object impinge on the retina, there is no perception of the fact; the cerebrum is not conscious of the phenomenon. When they reach the tubercula quadrigemina, perception is aroused; consciousness recognizes the approach of the visual vibrations, by which the machinery of the tubercles is set in motion, but there is no perception of the details of the visual phenomena. When they reach the angular gyri, a still higher grade of perception is attained; the details of the visual telegram are perceived; complete vision is accomplished, with a corresponding perception of its completeness. When the completed vision penetrates into the cells of the frontal lobes, and is transformed into and connected with ideas, perception recognizes both the transformation and the intellectual and emotional activity, to which the transformation gives rise. Perception in the frontal lobes, therefore, is something more than perception in the angular gyri; it is sensation and intellection. "The dynamic conditions of which the cells of the cortical periphery are capable, represent, in a sensible form, clear and definite perceptions, — in other terms, acquired notions; they represent, then, something more than simple perception; they represent this, plus intellectual work. Acquired notions are organically associated and classified in the cortical periphery of the brain; and they can, by the activity of these cells, show themselves successively in the centre of perception. Hence, when a lesion has involved any point of the cortical periphery of the brain, the association of ideas may be disturbed; and according to the nature of the lesion (congestion, inflammation, or otherwise), there may appear the phenomena of excitement, mania, hallucination, the delirium of amnesia, or stupidity. According to this view, the centre of perception is placed between two sources of excitement, both of which set going its perceiving powers; on one side, are the exciting causes which reach it along the nerves; on the other, are the exciting causes which reach it along the fibres of the white centre of the encephalon. By the first, it perceives the actual life of to-day; by the second, it perceives how it felt and lived formerly." [1]

What perception is in its essence we do not know, and from the nature of things it is not probable that the human mind ever will know. It is a vital product, but the mechanism of its production is a mystery; no more of a mystery, however, than many other vital products. Physiol-

[1] Dr. E. Fournié, *Recherches Expérimentales*, op. cit., p. 94. Though Dr. Fournié is a physiologist whose statements and opinions must be received with caution, he is a suggestive writer, and his views are often striking and original.

ogists can no more explain how the blood is transformed into a secretion like bile, or into an optical instrument like the retina, than they can how it is transformed into a cell, yielding perception. "Perception is a vital, elementary, indecomposible phenomenon; our knowledge of it does not go beyond this." Our ignorance of its nature, however, does not prevent our recognizing its existence, estimating its value, or determining its limitations. In the hemispheres, and especially in the frontal lobes of the brain, it attains its highest development and enjoys its largest range. There it becomes what Leibnitz called *apperception*, or perception that reflects upon itself. When sensory ideas, whether visual, auditory, tactile, or other, enter the domain of self consciousness, they are studied in all their relations to the external world and to the ego. Thus investigation, which is apperception, is a function of the frontal lobes. It is clearly different from the simple perception of the existence of an object, without regard to its details, such as occurs in the tubercula quadrigemina, and to which perception in that centre is limited; it is equally distinct from the perception of the existence of an object, with a comprehension of details, but without regard to the relations which the object sustains to other things, or to attendant conditions, such as occurs in the angular gyri, and to which perception in that centre is limited. Wundt illustrates this point by calling consciousness internal sight, which has, like the eye, a definite field of vision. Upon this field of vision there is at any given moment a number of objects, to one of which attention is directed to the exclusion of others. The point to which attention is directed he calls the sight point. The field of vision is the territory of perception; the sight point that of apperception. When an image enters the first territory it is perceived; when it enters the second, it is apperceived. The visual process terminates, when the angular gyri have transmitted their report from the external world to the frontal lobes. The lobes accept this report, study it in all its relations, assimilate it and act upon it. A recognition of this distinction between the visual function of the angular gyri, and that of the lobes, is essential to a comprehension of the phenomena of orthopia as well as of pseudopia. When light waves from an uplifted dagger fall on the retina, the eye records the facts of color, size, position, motion, etc., and transmits an account of them to the tubercula quadrigemina. This centre carefully adjusts the mechanism of the eye, the iris, lenses, muscular apparatus and the like, to the demands of careful observation, coördinates the general muscular system for any movement the emergency may require, and makes its visual report to the angular gyrus. The latter centre receives the report, perceives all the details of the dagger, the hand grasping it, the face and action of the owner, whatever constitutes an exact picture of the scene, and transmits a corresponding pictorial report to the frontal lobes. Upon receiving this report — this pictorial representation, — the lobes *look* at it, ascertain its significance, determine whether the uplifted dagger is raised for inspection merely, or for a threatened or real plunge, or for other purposes, communicate with the instincts and emotions, and decide the will to act.

It is evident from the foregoing statements, not only that sight is internal, or rather intracranial, being a function of the brain, not of the eye, but that internal seeing is of two kinds: one sensory, the other ideal; one evolved and conditioned by the cells of the angular gyri, the other by those of the frontal lobes; one photographing external objects without reflecting upon them, the other receiving the photographic impression and reflecting upon it; one normally preceding the other, but with the possibility of a reversed order; one being the mental vision of poets and artists, reproduced from the substrata of mental experience, the other the assured vision of seers and disordered brains, reproduced from antecedent sensory substrata; one recognized by the subjects of it as subjective, the other by the subjects of it as objective; one known to be unreal, the other believed to be real; each influencing the other; and both dependent upon and modified by cerebral and nutritive conditions.

The intimate anatomical and physiological connection of the cerebral visual centres and frontal lobes renders the reciprocal influence, just alluded to, extremely probable. Clinical and physiological observation confirms its existence, and asserts its importance. Vivid ideal pictures, painted by strong emotion or intense volitional effort on the organic structure of the frontal lobes, react on the visual centres of the hemispheres, and lead to the formation there of visual cell-groups, more or less perfect in character. These in turn visually excite the lobes, and so by action and reaction add vividness and accuracy to the ideal representations. "When we compare the *anatomical* relation of the sensorium, on the one hand, to the cortical layer of the cerebrum, and on the other to that retinal expansion of ganglionic matter which is the recipient of visual impressions, we find the two to be so precisely identical, as to suggest that its *physiological* relation to those two organs must be the same. And as we only become *conscious* of the luminous impression by which nerve-force has been excited in the retina, when the transmission of that nerve-force through the nerve of *external* sense has excited a change in the sensorium, so it would seem probable that we only become *conscious* of the further change excited in our cerebrum by the sensorial stimulus transmitted along its *ascending* fibres, when the reflection of the cerebral modification along its *descending* fibres — the nerves of the *internal* senses, — has brought it to react on the sensorium. In this point of view, the sensorium is the one centre of consciousness for visual impressions on the eye (and, by analogy, on the other organs of sense), and for ideational or emotional modifications in the cerebrum, — that is, in the one case, for *sensations*, when we become conscious of sense-impressions; and, on the other, for *ideas* and *emotions*, when our consciousness has been affected by cerebral changes. According to this view, we no more *think* or *feel* with our cerebrum, than we *see* with our eyes; but the ego becomes conscious through the same instrumentality of the retinal changes which are translated (as it were) by the sensorium into visual sensations, and of the cerebral changes which it translates into ideas or emotions. The mystery lies in the *act of translation;* and is no greater in the excitement of *ideational* or *emotional* consciousness by cerebral change, than in the excitement of *sensational* consciousness by retinal change."[1]

Numerous examples might be given in illustration of this physiological interchange and reinforcement of ideal and sensory intercranial pictures. The following is as remarkable as any. It is related by Dr. Abercrombie in his "Intellectual Powers," and quoted in Dr. Carpenter's "Mental Physiology:" "In the church of St. Peter, at Cologne, the altar-piece is a large and valuable picture by Rubens, representing the martyrdom of the apostle. This picture having been carried away by the French in 1805, to the great regret

[1] *Principles of Mental Physiology*, by Wm. B. Carpenter, M. D., LL. D., etc. Am. ed. 1874, pp. 110, 111.

of the inhabitants, a painter of that city undertook to make a copy of it from recollection; and succeeded in doing so in such a manner, that the most delicate tints of the original are preserved with the most minute accuracy. The original painting has now been restored, but the copy is preserved along with it; and even when they are rigidly compared it is scarcely possible to distinguish the one from the other."

In this case cell-groupings, representing Rubens' picture, had been frequently called together in the angular gyri of the Cologne artist by the visual stimulus of the picture; and the impressions had been stamped into them by close and careful observation of it. Habit and association conspired to facilitate the assembling of the same visual groups. As often as a sensory picture had been formed in the cerebral visual centres, a corresponding ideal picture was formed in the frontal lobes. Here, also, habit and association had facilitated the formation of the same cell-groupings. Each group had learned to appear simultaneously, and to listen to each other's call. When the Cologne artist wished to recall and reproduce the original painting, to which he was denied access, his will summoned his ideal picture, that is, the cell-groupings of his frontal lobes corresponding to it, which assembled with greater or less fidelity at the call. These, when assembled, sent down along an efferent nerve a notice of their gathering to the angular gyri. The cells of this centre, accustomed to be grouped in a form representing the desired picture, assembled automatically, and sending up a visual stimulus by an afferent nerve, reinforced the efforts at cell formation of the frontal lobes. This process went on till a grouping was formed in the angular gyri, which was the exact hieroglyphic of Rubens's painting. From this the artist reproduced the picture. He copied the copy in his brain, without the objective presence of the original work.

Habit and association, including under these terms Bain's law of contiguity and Dr. Carpenter's law of similarity, are as powerful factors in the process of reviving cell-groupings, whether visual or other, in the frontal lobes, as they are in performing a similar office in the angular gyri. Their territory extends throughout the cortical cerebral layers, and embraces the cell-manifestation of all forms of emotion, ideation, and volition, as well as the translation of special sense messages or images into ideal ones. The method of their action and the aid they render in the revival and reproduction of past impressions have been sufficiently described already; and the description may be applied, *mutatis mutandis*, as accurately to their influence over cell activity in the lobes, as in the visual centres. There are other factors than habit and association, however, which render essential service in the process of re-presenting old impressions as well as in that of intensifying the action of new ones; and which, while they exert an influence over mental manifestations in the gray matter of the whole cerebral mass, find their most important and most mysterious sphere in the frontal lobes. These are, emotion, expectant attention, automatism, blood-supply, including nutrition, drugs, disease, and volition.

Emotion, in proportion to its strength, gives vividness and intensity to every cerebral impression. Hope, fear, love, hate, desire, aversion, admiration, contempt, hunger, thirst, and the like, all in varying degrees, deepen the impression which objects, associated with these emotions, imprint upon the cells of the brain. When strong feeling is connected with any person or thing, a single look at whoever or whatever so stirs the heart is sufficient to produce an effect upon the cell-structure of the angular gyri and frontal lobes, more definite and permanent than a thousand superficial glances at indifferent objects could bring about. Emotion is the force which strikes the die deep into the cells, whereon are engraved the pictorial and other sensory records of the mind, and moulds the structure through which ideas flow and volition acts. It is the stimulus which makes the brain catch the fleeting colors, and sharp or shadowy outlines and expressions of the objective world, and the heat which burns them into the sensitized plates of the centres of special sense and corresponding tissues of the lobes.

The influence of emotion over certain parts of the organization, where its action can be recognized and is acknowledged, affords both an indication and illustration of the great influence it may exert over the delicate and mobile structures of the brain. There is apparently no part of the body, placed more completely out of the reach of the waves of emotion than the hair; yet emotion has blanched the hair in less than twenty-four hours. One of the best known and most striking instances of this phenomenon occurred in the person of the unfortunate Marie Antoinette. "Before the fatal day arrived," says M. Jules Janin, "the queen asked for a priest; the republic sent her one of its own, whom the queen refused to see and knelt alone before her God. At last the day of her deliverance came. . . . . She arranged her lovely hair for the last time, and shuddered to find it had grown perfectly white in her last twenty-four hours." The inexpressible dread and agony, attendant upon her terrible situation and approaching execution, probably induced at the base of the queen's brain a hyperæmia of some of the vaso-motor centres. As a result of this congestion, the circulation through the hairy scalp was inhibited and the hair suffered; a striking testimony to the power of intense emotion over the human organization. The blush of gratified pride and of offended modesty, the pale face of anger and the *cutis anserina* of terror, all testify to the same power.

The following instance shows that intense emotion may go so far as to change the quality of the blood and destroy life. "A young and beautiful woman in the middle rank of life, highly but self-educated, of great mental endowment, of admirable taste, and strong sensibility and attachment, was unconsciously the one by whose hand a poisonous dose was administered to her sole surviving parent, to whom she was attached with all the fervor and devotedness of a daughter's love. The phial contained an ounce and a half of laudanum; it was given by mistake for a senna draught. When presented to him by his daughter, he tasted it, and said he did not like it and would not take it. He had not been in good health; it was with much entreaty he was ever prevailed on to take the medicines prescribed. She urged him in terms the most affectionate and persuasive to take his draught; he replied, 'Dearest, you know I never can refuse you anything,' and swallowed it. Three hours passed away before she was aware of her terrible mistake. She was aroused to it by the state of stupor into which her father had fallen, when it flashed across her mind. She found the senna draught which she had intended to have given untouched; she also found the word 'poison' printed in large letters on the empty phial. The shock to her mind was terrific. She became like one insane. All possible means were employed to save the life of the poisoned man, but they were employed too late. He died profoundly comatose at the end of a few hours. From the moment of his last breath a change came over her. She was lost to all knowledge or notice of persons and occurrences around; she lay like a statue, pale and motionless. Food she never took, excepting when it was placed upon her tongue. The only sound which escaped her lips was a faint yes or no. When asked what ailed her, she would place her hand upon her heart. Her extremities were cold. She sighed and shivered frequently, and dozed brokenly and protractedly. To her, the world, and all things in it, were a blank. Tonics and stimulants were administered, air and scene were changed, kind and compassionate relatives and friends tried and tried in vain to rouse and console; she pined away, and nought but a breathing skeleton remained. She lingered on with very little variety or alteration of symptoms for ten months. Before her dissolution she became œdematous. The swelling, soft and transparent, was first perceived in the lower extremities, but gradually progressed upwards. It became apparent on the backs of the hands, along the arms, and ultimately it was universal. All the viscera, spinal, cerebral, thoracic, and abdominal, were patiently and minutely examined. No trace of organic change of structure could be detected. . . . . This poor patient, beaten down in mind and body, breathed her last without a moan or a painful struggle. The mental shock had paralyzed the vital actions, an evidence that in real life events do occur which transcend even the highest flights of fiction. An almost total suspension of nutrition, sanguification, and vascular energy characterized this case. The result was universal dropsy consisting in the thinnest serosity."[1]

Such is the influence of emotion, when intensely excited, over parts of the organization which are ordinarily very little, or not at all affected by it. If it possesses such power over organs with which it is only remotely connected, it is difficult to assign any limits to its influence over the nervous centres themselves, with which it is intimately associated. Hence we can understand how it may force the impression of a look or object, of a face or deed, seen but once, so deeply into a group of cells in the visual compartments of the brain, that half a century or more of subsequent life shall not efface it. My own experience furnishes an illustration of this statement. When a child, between two and three years old, so young that some have doubted if I could remember the event about to be recorded, a visitor at my father's house in the country committed suicide, by shooting himself through the head. He managed the matter so that the ball, entering probably by his mouth, passed out through the back of his head, and through the hat which he wore at the time. I have only an indistinct recollection of the excitement, confusion, and horror which, naturally attendant upon such an event any where, would be exaggerated in a quiet country place. My child-

[1] *Dublin Quarterly Journal of Medicine*, August 1, 1853, p. 1, etc.

ish curiosity and wonder, with a sort of nameless dread, were, of course, raised to their highest pitch; they seized hold of a single picture, and burnt it into the cell structure of my brain so deeply, that the lapse of more than fifty years have not effaced it. That picture was the hole in the victim's hat, made by the passage of the fatal ball. As I write these lines I can see the hole, with fuzz or fur sticking out around it, as if electrified, as distinctly as if the event had occurred yesterday. All other attendant circumstances, the confusion, the blood, the corpse, and the ghastliness of death, have faded away, but the hole with its fringe of projecting fur remains. There are times when that hole, unthought of and uncalled for, comes strangely before me. A black hat in a crowd, one among a thousand similar ones, will, why I know not, sometimes possess that hole. It may appear in a dream, or be seen at a dinner party or a club, where some one tells the story of a suicide; or be drawn into my field of subjective vision by a force, of which the character and source are alike undiscovered and undiscoverable. Emotion by a single blow stamped the visual record of that hole and hat indelibly into a group of cerebral cells, and the record has for half a century since occasionally obtruded itself into the sphere of consciousness, or been now and then pushed up there by some recondite association.

Emotion, which is so influential in fixing visual and other impressions on the cerebral structures, is not less efficient in facilitating the process by which old impressions are revived and reproduced. It enlarges the power and quickens the action of habit and association, so that under its stimulus both of these forces, which play so important a part in re-presenting antecedent sensory images, work with increased rapidity and accuracy. A ludicrous scene, witnessed by half a dozen individuals, will provoke a degree of laughter in each one, varying with his emotional state at the time; and upon each one's emotional state, at some subsequent period, will depend the vividness with which the original scene and corresponding laughter can be reproduced. Sir Walter Scott recognized the power of emotion over the organization, by making Brian de Bois-Guilbert fall dead from his horse, without a wound, before the lance of his enfeebled and hated rival, Ivanhoe. He also recognized its power in reviving pictures of the past, when he made Sir George Staunton recall, after years of absence and in a moment of excitement, "the Grindstone," and "the white rock in line with the steeple." "By G—, I think your honor kens the bay as weel as me," was the veteran boatman's emphatic testimony to the accuracy with which Sir George's brain rediscovered the land and water marks of the scene of his youthful follies and crimes. Who has not learned from experience how vividly some sudden emotion, joy or grief, will produce an ideal picture of the past, making the present less real

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than former scenes? A bereaved mother, looking upon a photograph, or it may be only upon a lock of hair of a deceased son or daughter, will see her loved one's face as if alive. Love and grief, reinforcing the power of association, will so stimulate her ideational and visual centres, as to revive cell-groups which represented her living child. Volition is generally intensified by emotion. The blow of an angry or terrified will is more quick and violent than that of quiet determination. Yet the opposite may be the case. Timidity, shame, and modesty may paralyze effort. In seeking for an explanation of the phenomena of pseudopia, so far as the will affords any light, the law, not the exception to it, must be borne in mind, that emotion modifies volition in the direction of intensifying the latter.

Expectant attention is volition, modified by emotion in the way just described, and is an important factor in facilitating many of the processes of perception and ideation. It does not so much initiate ideas, as it prepares the way for their evolution. It polarizes the cerebral cells in the direction of some desired result, whether sensory or ideal. Whatever the mind desires is more likely to be attained under its influence than apart from it. This is true not only of what may be called legitimate mental operations, but of illusory perceptions. Its greatest power is manifested in the revival and reproduction of cell-groups in the nervous centres, which have been previously and frequently formed there, and of the corresponding ideal and sensory pictures. When attention is exerted for the purpose, and with the expectation of seeing a familiar object, or attaining a familiar end, the object is far more likely to appear and the end to be reached, than if no such purpose existed, or no such expectation was raised.

The influence of expectant attention in facilitating certain processes of the organization, or as an assistant in the accomplishment of certain ends, has long been recognized by physicians, and applied by them in therapeutics. Its power over the body as a therapeutic agent illustrates, and to some extent explains, its action in the higher nervous centres. "Medicines," says one of the most cautious and accurate American medical writers, "as a general rule, will act with greater certainty when their legitimate effects are known and expected. An emetic will be more likely to vomit, if the patient anticipate this effect from it. The coöperation of faith with the medicine will often favor its action. This is more especially true when the nervous system is prominently concerned. The full belief in the efficacy of quinia in intermittent diseases aids considerably in the prevention of paroxysm."[1] Surgeons are familiar with the physiological fact, and act upon it, that an individual will come

[1] *A Treatise on Therapeutics and Pharmacology, or Materia Medica*, by George B. Wood, M. D., etc., etc., vol. i., p. 40.

more rapidly, pleasantly, and effectually under the anæsthetic influence of ether, if he expects to be made insensible, and gives himself up to the inhalation of the vapor, than if he is in an opposite condition. In this particular instance, expectant attention is of great practical importance. Sometimes its power over the system is such as to obtain extraordinary results from the administration of medicines. I once gave ten grains of Dover's powder to a stout hearty Irish woman at night as an anodyne. She expected a cathartic, supposed she had taken a cathartic, and was determined to have a cathartic result. Having previously taken some laxative preparation of her own prescribing, without avail, she was all the more anxious for the success of this. When I made my visit the next day, she met me with a beaming countenance, and in glowing Celtic phrase expressed her gratitude for the happy result which had been attained. The usual physiological action of Dover's powder had been antagonized by attention to an expected result.

Expectant attention involves sympathy, hope, belief, faith, and imitation ; and to a large extent achieves its results, in reviving by-gone images and ideas, by the aid of these emotions. Imagination is also an important factor in this process, and is intimately connected with emotional states, though very different from them. Combined with them, it adds extraordinary energy to the power of expectant attention, and enables it to attain its greatest and most mysterious marvels. "When a person on swallowing a bread-pill, in the belief that it possesses aperient properties, is purged, it is said to be through his imagination; the mental condition present yielding, on analysis, a definite direction of thought to the intestinal canal; such leading idea exciting the same peristaltic action as would have been induced by castor-oil. The force of this current of thought is augmented by expectation. The other day a lady nurse at the Plymouth Hospital told me of a patient in one of the female wards, who was much disconcerted at the doctor having left the hospital without ordering an aperient pill, as he had intended to do. The nurse procured a bread-pill, and satisfied her mind. Next day she found, on inquiry, that it had answered its purpose satisfactorily. Again, I hold a ruler in my hand, and point it to a painful region of the body of a patient who entertains the opinion that I am about to relieve the pain. The patient imagining that the ruler will be the means of curing her, believes in a force which does not exist, — a curative power passing from the ruler to the body, — and is relieved. That she is relieved is no imagination. What cured her? Merely to say it was the imagination is no solution of the problem. What really happened was that her attention was arrested and forcibly directed to the part, the prominent idea being the firm conviction that the morbid symptoms would pass away. In other cases the fixed idea may be, on the contrary, that certain phenomena will occur; that there will be pain, or redness of the skin, or loss of muscular power, and should these supervene, we say, as before, it was due to the imagination. This medical use of the term has for its basis that thinking upon an object which, as Dugald Stewart points out, is used by Shakespeare as synonymous with the imagination, when he speaks of 'thinking' on the frosty Caucasus, the 'apprehension' of the good, and the 'imagination' of a feast."[1]

From this account of the power of expectant attention over organs and functions, which lie remote from the cerebral nerve centres, we can form some notion of its influence over these centres themselves. Indeed, it is probably through its influence over these, that it produces the effects which have been described. It would exceed the limits of the present essay to describe the full extent of this influence; for our purpose it is sufficient, here, to emphasize the fact and character of its action upon the visual, auditory, and ideational centres; upon these, it acts efficiently, aiding the force of habit, association, and emotion in the revival of old cell-groupings, and the consequent reproduction of past images and ideas. One who expects to see the face of a departed friend or child, around which are clustered the deepest and tenderest emotions of the human heart, and with

[1] *Influence of the Mind on the Body*, by Daniel Hack Tuke, M. D., etc., etc. Am. ed. 1872, pp. 19, 20.

which are associated life's hopes and disappointments and deeds, is placed in the most favorable condition for the formation of cell-groups, capable of bringing the familiar face within the field of subjective vision. Under such circumstances the most remote suggestions and shadowy traces of resemblance are sometimes sufficient to produce an ideal vision, or even a sensory representation. When Polonius, at Hamlet's bidding, saw a cloud assume the likeness of a whale, he illustrated a profound physiological law as well as the obsequious subservience of a courtier.

Automatism, that is, automatic or reflex action, has been described in the earlier part of this monograph as a contrivance of the nervous system, by means of which most of the phenomena of life are accomplished. Some physiologists assert that even the highest functions of the cerebrum are performed through its agency. Without accepting the latter statement to its full extent, it is clear that all the ganglia, spinal, sympathetic, cerebellar, and cerebral, are subject to its power, and that it is difficult, perhaps impossible, to define or limit its jurisdiction. It is unnecessary to repeat the description, previously given, of reflex action; but without doing so, it is important, in this connection, to call attention to what may be called acquired automatism, or the power, which the nervous apparatus gains, after persistent effort in any given direction, of doing that easily, automatically, and almost unconsciously, which, at first, was difficult, volitional, and conscious. The facility which the human mechanism acquires of performing, with apparent spontaneity, the complex acts of walking, talking, handicraft, and the like, are familiar illustrations of this fact. Our hands and feet, when instructed and trained, acquire the power of acting as if they were independent beings; so do our eyes and ears, though we are less accustomed to recognize the automatic action of the latter than of the former. An eye, trained to watch and guide the movements of a shuttle or needle, acquires a marvellous facility of automatic action in doing so. The cells of the motor centres, which coördinate and govern locomotion, are so frequently grouped together for that object, that they assemble on the slightest hint, and when assembled possess an acquired power of acting automatically. In like manner, certain cells of the visual centres are often grouped together by the frequent presentation of the same object to the eye, and the visual groups thus formed acquire, at length, the power of transmitting a visual message to the frontal lobes, automatically, that is, with very little regard, or possibly no regard, to the objective presentation. If it should so happen, as it sometimes will, that a particular visual group, the hieroglyphic of a familiar face, for example, should be called together by some remote association or intense emotion, in the way previously described, the group would act automatically by virtue of its acquired automatism, and spontaneously send up a visual report to a higher station. Under such circumstances, an individual, like the Cologne artist, would have subjective but not objective vision.

Association utters a call for the assembling of a cerebral cell-group; habit enables it to form with facility; emotion imparts distinctness to it; expectant attention anticipates and urges its appearance; automatism gives it power to act; and the ideational centres welcome and utilize the result.

The laws or modes of cerebral activity, which have hitherto been considered on account of their intimate connection with the phenomena of pseudopia, are some of the laws, perhaps the principal ones, which the brain exhibits in its normal condition. They are necessarily more or less modified in their operation, by any abnormal condition of that organ. Any change of nerve structure, or alteration of the quantity or quality of blood circulating through the cerebral tissues, and consequently of their nutrition, involves a corresponding change in the manifestations of cell-power. Any or all of these manifestations may be increased or diminished or abolished, by organic or functional cerebral changes. Hence it becomes necessary to describe, as briefly as the object before us will permit, the mutual relations of blood and brain. The subject is a large and important one. Only a few salient points, which bear directly upon our purpose, can be touched upon here.

A most interesting anatomical fact arrests our attention, as soon as we glance at the relation of blood and brain to each other. That fact is the enormous amount of blood, furnished to the brain and consumed there, in comparison with the amount sent to the rest of the body. "In the case of man, although the brain has not ordinarily more than about one fortieth of the weight of the body, yet it is estimated to receive from one sixth to one fifth of the whole circulating blood."[1] There is, of course, an object in supplying the brain with such a wealth of blood, the costliest compound of the organization, and that object is apparent, when we reflect that the blood is the life of the body, and consequently of every organ in the body. Wherever the largest amount of blood is present and consumed, *there* will always be found the greatest functional and organic activity. Vital manifestations are proportional to blood consumption. In the brain, where the highest forms of such manifestations, sensation, ideation, and volition are exhibited, the most blood is consumed. The cell-groupings and cell-modifications, the organization and destruction of protoplasmic material for the evolution of force, the transmission of visual reports from one visual centre to another, the transformation of sensory pictures into ideas, and all the complicated phenomena, attending the process of vision from objective to subjective sight, to which such constant

[1] *Principles of Mental Physiology*, by W. B. Carpenter, p. 38.

reference has been made in these pages, all depend on the blood as their source and supply of energy. Sensation, ideation, and volition are as dependent on the quantity and quality of cerebral blood supply, as electricity is upon the quantity and quality of the fluid which supplies the battery generating it.

Blood performs a triple function in the development of nerve force. It affords to nerve structures material for the metamorphosis which goes on in them unceasingly while life continues; it supplies oxygen, by the action of which on nerve structures force is developed; and it removes the waste which metamorphosis of tissue and utilization of force necessitate. A diminished quantity of blood passing through the ganglionic nerve centres, visual and others, produces as a rule an inactive condition in them, so that they respond less readily than usual to their appropriate stimuli. An increased quantity, passing through their capillaries — hyperæmia — is followed or accompanied by greater nerve-activity and corresponding augmentation of susceptibility to stimuli. When the abstraction of blood is carried so far as to drain it all, or nearly all away, complete abolition of nerve power — of sensation, thought, and volition — is produced; and the same result follows an excessive flow of blood into the intra-cranial capillaries, leading to congestion with pressure or extravasation. If either the abstraction of blood from the cerebral nerve centres, or its flow into them, passes certain tolerably well defined limits, all manifestations of nerve force are suspended or rendered impossible. Within these limits, an abnormal diminution of blood circulating through the brain, excepting in some diseased states, represses, and the opposite augments these manifestations.

The mysterious physiological process of metamorphosis of tissue, goes on in the brain as well as in all other parts of the organization, and therefore measures correlated mental activity, as accurately as it measures the secretion of bile in the liver, or muscular effort in the muscles. Cerebral, like muscular metamorphosis, requires oxygen for its performance. Metamorphosis results from combustion. Hence if the blood, without being deficient in quantity, is poor in oxygen, there will be diminished metamorphosis, and corresponding inactivity of the cerebral ganglia. The visual centres are not exempt from this law. The due performance of their functions depends upon the destructive and constructive metamorphosis of their peculiar structures, and this upon the oxygen which they derive from the blood. Called ganglia, they are delicate furnaces of marvellous construction, constantly supplied with combustible matter, which, kindled by rays or waves of light, reaching them from visible objects through the burning retina, furnish heat, by means of which the process of vision is rendered possible, sensory impressions are transformed into ideal images, and the latter made the substrata of thought and volition. For all these purposes, a continual supply of oxygen from the blood is as essential as the oxygen of the atmosphere is to the sparkling of a fire-fly, the combustion of coal, or the flash of artillery. The curious change of force from waves of light to those of thought, by the aid of oxygen, has many analogies in the transformations of the world about us, especially in the changes resulting from the correlation of force. Mr. W. R. Grove devised an ingenious and elegant experiment which illustrates this statement. He arranged a box filled with water, in which was enclosed a prepared daguerreotype plate, a gridiron of silver wire, a galvanometer coil, a Brequet's helix, and a set of needles, in such a way that as soon as light, by raising the shutter of the box, was allowed to impinge on the plate, there was produced, light being the initiating force, "*chemical action* on the plate, *electricity* circulating through the wires, *magnetism* in the coil, *heat* in the helix, and *motion* in the needles."[1] What began as an image on the plate became motion in the needles. So in the process of vision, what begins as an image, initiated by light on the retina, results as thought in the frontal ganglia. We know as little of the precise nature of the process in the one case as in the other. We see the phenomena, but not the working of the mechanism by which the results are attained. If, in Mr. Grove's experiment, the

[1] *Correlation and Conservation of Forces*, by E. L. Youmans, M. D., p. 117.

initial force had been electricity in the wires, or heat in the helix, instead of light on the plate, the result — motion of the needles — would have been the same. In the mechanism of vision, if, by some abnormal condition of the cerebral structures or circulation, or by some action on the delicate elements of the brain of the modifying influences just described, or by some subtle change in oxygenation, the initial force, instead of being the ordinary one of light impinging on the retina, should be one producing a visual group in the tubercula quadrigemina or angular gyri, the result of ideation in the frontal lobes would be the same. The ego would not be cognizant of the initial point.

"Thus, then, the dependence of nervous power and of mental activity upon the physical changes kept up by the circulation of oxygenated blood through the brain, can be shown experimentally to be just as direct and immediate, as is the dependence of the electric activity of a galvanic battery upon the analogous changes taking place between its metals and its exciting liquid. And if we say that electricity is the *expression* of chemical change in the one case, how can we refuse to regard thought as the *expression* of chemical change in the other? This view is not here advanced as *explaining* any mental phenomenon. No physicist would say that he can 'explain' how it is that electricity is generated by chemical change; but he knows that such a relation of cause and effect exists between the two orders of phenomena, that every chemical change is accompanied by a disturbance of electricity; and thus, whenever he witnesses electric disturbance, he is led to look for some chemical change as its physical cause. And in precisely the same sense, and no other, the physiologist *must* regard some change in the substance of the brain as the immediate physical antecedent of all *automatic* mental action. It is the attribute of the Will to utilize this automatic power of the brain, as it utilizes that of the muscles; and thus to make the ego, in proportion as he has acquired the mastery over it, a free agent."[1]

Inasmuch as the greater includes the less, it follows that what Dr. Carpenter, in the above extract, has asserted of the whole brain must be equally true of the visual centres, which are component parts of it. And this is in accordance with the whole doctrine of the preceding pages.

Besides supplying material for constructive metamorphosis, and oxygen to enable metamorphosis to go on, the blood performs the third office of removing from the cerebral ganglia the waste products of their labor. It keeps the visual workshops of the retina, the tubercula quadrigemina, angular gyri, and frontal lobes, as well as all other cerebral laboratories, clean, so that they are always in good working order. The refuse is the result of the transformation of cell-contents, granules, protoplasmic stuff, and whatever other elements enter into the formation of visual cell-groups, and are necessary to the generation of force, utilized in the transmission of visual reports to all parts of the nervous system with which

[1] *Mental Physiology*, by W. B. Carpenter, p. 40.

vision is associated. This waste is represented by various oxy-compounds of carbon, hydrogen, phosphorus, and the like, which replace in the veins returning from the brain free oxygen, carried thither by the arteries. The effect on the brain of the retention of these waste products by the cerebral circulation is well shown in certain forms of disease producing mental torpor, insensibility, and, in extreme cases, death by asphyxia. It is possible, — and perhaps clinical observation would warrant the statement without reservation, — that what thus occurs as a general affection of the whole brain, may, under favorable conditions, occur as a local affection of a limited portion of the cerebral mass, like one of the sensory or ideational centres. Local cerebral affections, the result of local cerebral causes, are of not infrequent occurrence. A tumor pressing on the tubercula quadrigemina will cause blindness. Inflammation, limited to the same territory, may lead to the same result, without deranging the mental faculties, or the functions of the sensory ganglia. A poison in the blood, resulting from the retention of waste products, may spend its morbid force chiefly upon one of the encephalic organs. Excessive use of one or more of the visual workshops, by which their working capital is consumed more rapidly than it is supplied, and more rapidly than the waste is removed, may gradually lead to deterioration of their power; or may induce conditions which will enable them to fabricate and transmit false visual reports. This point will be more fully discussed in another place.

Attention has already been called to the anatomical fact that the brain is not, as it was formerly supposed to be, a single organ, but on the contrary a congeries of organs. "The encephalon," says Charcot, "does not represent one homogeneous organ, but rather an association or, if you prefer the term, a federation, composed of a certain number of diverse organs. To each of these organs there are physiologically attached certain characteristics, functions, and distinct faculties. Now the physiological characteristics of each of these parts being known, it would be possible to deduce from them the conditions of their pathological state, the latter being only a modification, more or less pronounced, of their normal state, without the intervention of new laws."[1] Such being the architecture of the brain, it is easy to understand that the circulation of blood through it, and especially through its capillaries, would naturally be proportioned, as it is in other parts of the body, to the size and functional importance of the organs to which it is distributed. In fact the brain is not only furnished, as we have seen, with a larger proportional amount of blood than any other part of the body, but its different organs receive different proportional amounts. The distribution is unequal. The gray cerebral matter

[1] *Leçons sur les Localisations dans les Maladies du Cerveau,* par J. M. Charcot, Professeur, etc., p. 3. Paris, 1876.

is richer in blood than the white; the ganglionic nerve centres are richer than the commissures. Moreover, the natural inequality of distribution is increased by exercise. Just as the exercise of a particular muscle, or set of muscles, attracts more blood to them than circulates through the rest of the muscular system, so mental exercise causes more blood to flow through the cerebral organs exercised, than through other parts of the brain. And as the continued use of a set of muscles for months and years, within due physiological limits, hypertrophies and strengthens them by increasing their vascularity and nutrition, so the continued physiological use of one or more intra-cranial organs develops them, by endowing them with a larger number, or greater size, or better quality of elements composing them. The biceps of a carpenter, blacksmith, or athlete, at the end of ten or twenty years of bicipital exercise is a different, stronger, and more obedient muscle than it was before its training began, or than the biceps of a student or clerk is apt to be; in like manner, the angular gyri and ideational cells of one trained to visual effort, are different organs, because more developed and of a higher power, than are the visual ganglia of artisans and farmers. The visual apparatus of an expert microscopist will discern, through an objective of a $\frac{1}{25}$ or $\frac{1}{50}$ power, symmetrical forms and harmonious movements, where an unskilled observer's eye will see only an unmeaning or chaotic mass. A person who has trained his visual ganglia to act under the influence of the subjective stimuli of volition, association, habit, expectant attention, automatism, and the like, will sometimes succeed in producing what may be called a local visual hyperæmia, and so attain surprising results — results which inexpert experimenters cannot accomplish, and which to the uninitiated seem to partake of the supernatural.

In the physical, as in the moral world, whatever is capable of good is equally capable of evil. The germs of blessing and cursing are wrapped up in the same cell, and each may be developed after its kind. Strychnia, which, appropriately administered, will lead the nervous system to healthy issues more kindly and rapidly than any other drug, and without leaving a trace of ill behind, possesses a deadly power, which makes its name a sound of terror. Opium, one of the great blessings of the human race, and one without which medical art would be almost impossible, — an agent so useful that its chief active principle well deserves its name, derived from that of an ancient divinity, — is endowed with poisonous properties, equal to its sanative virtues. It can protect, or it can cut life's silver cord. So in the human system: training and exercise can render an organ, or a set of organs, equally capable of good and evil; of health and disease; of honest and of dishonest work. As a microscopist may train his retina to photograph, his tubercula quadrigemina to classify, his angular gyri to perceive, and his frontal lobes to apperceive an objective world, invisible to others; so a visionist may train his angular gyri and frontal lobes to act independently of the retina and tubercula quadrigemina, and form visual cell-groups, which, composed of old cell-groups and modifications, will enable him to perceive and apperceive a subjective world, real to him alone. Thus the visual apparatus of the human brain, a mechanism of which the delicacy and power has only been imperfectly portrayed in the foregoing pages, intended to report with wonderful accuracy and minuteness the external world to the Ego, may be trained to do dishonest work with equal faithfulness, so as to turn objective into subjective sight, orthopia into pseudopia, and to make the Ego the fool of the brain.

It appears from these statements that blood supplies material, which enables the cerebral machinery to act, or, to use an expressive French term for which there is no English equivalent, — to functionate. Blood is not the mechanism, but it is the mechanism's working force. As an engineer, by turning a stream of water upon the wheel of a mill, or a current of steam upon the piston of an engine, puts the whole machinery in action, so when light from a visible object stimulates the visual ganglia, and turns or draws a current of blood upon them, or, possibly, when volition, representing the Ego, or association, or emotion, or some other cerebral force, performs the same office, the visual apparatus is set in motion and sight results. The relation, then, of blood to brain, and of course to each organ which goes to make up the brain, is that of force to mechanism; and if the force, however initiated, is properly applied, the mechanism will functionate. Blood flowing through a set of ganglia, however, like those of the visual apparatus, is more than the force of water turning a mill-wheel, or than that of steam moving a piston: it not only moves the machinery, but it keeps the machinery in repair. Nutrition is therefore included in the relations of blood and brain, and is so intimately associated with the circulation, that the former cannot be disconnected from the latter. Such being the case, it is unnecessary to refer to the influence of nutrition upon the process or mechanism of vision. Its influence has already been sufficiently described, in describing that of the blood.

The authority of Charcot, a neuro-physiologist, whose statements few will be inclined to question, may be invoked in support of this view of the dominant importance of the cerebral circulation over other intra-cranial factors. He says:—

"The encephalon is placed, if I may use the expression, under a pathological régime, unlike that of other portions of the neural axis. In fact, the general statement may be made that in the encephalon, and especially in the brain, the vascular system (arteries, veins, capillaries) controls the situation." [1]

[1] *Leçons*, etc., par J. M. Charcot, p. 46.

The action of drugs on the nerve-centres of the human system, and particularly on the visual apparatus of that system, forms one of the most interesting chapters of physiological materia medica. Moreover, there is no department of physiological or pathological research, in which the scientific progress of the last quarter of a century has been greater or more satisfactory than in this. Something like accuracy, or at least something which promises to attain accuracy in the future, has been reached in our knowledge of the action of certain drugs upon the nervous system, and of the methods of administration by which to attain that action. Perhaps, also, there is nothing which illustrates more clearly and convincingly the mechanical structure and working of the entire nervous system, cerebral as well as spinal, than the facility and certainty with which it is possible, by means of these drugs, to play upon it. By their aid its power can be increased or diminished, all its functions modified, and indirectly the action of the whole organization affected.

Digitalis in appropriate doses influences the ganglionic nerve-centres of the heart and capillaries in such a way as to impart steadiness and force to the muscular fibres of the former, and improved elasticity to those of the latter; thus causing the streams of the circulation to move with an equable and natural current, into and out of every organ. Calling this power to his aid, a skilful practitioner is able, in certain forms of congestion of the brain, to relieve that organ from the burden of excess of blood, and, sometimes, in the opposite condition of anemia, to send thither a needed supply. By this regulation of the cerebral circulation, various functional disturbances of the brain, ideational as well as sensory, like delirium, pseudopia, tinnitus aurium, and the like, are not infrequently removed. When strange sights and sounds, accompanying congestion or anæmia of the brain, or of certain localities in the brain, disappear under the influence of an agent which relieves the pathological condition, the inference is a fair one, to say the least, that the ideational or sensory derangement is produced by that condition.

Quinine, if the dose is large enough, acts on the auditory nerve centres, producing tinnitus aurium, — subjective sounds of an irregular and indefinite character, it is true, but still sounds. The music of a church bell is not more unmistakably heard by those in its neighborhood, than is the ringing of quinine by those who have taken a ringing dose of the drug. The subjective sound is the result of quinine, acting in some unknown way upon the circulation of the cerebral auditory centres.

Frequent reference has been made in the course of this essay to the reflex action of the nervous system, as being one of its most important features, — perhaps the most important, as well as the most curious and ingenious feature of that system. It has been shown that all parts of the nervous apparatus are endowed with a power, commonly called reflex, but which physiologists have also designated as excito-motory, affero-efferent, centripeto-centrifugal, and the like; hoping thereby to describe with precision the responsive character of the ganglia, distributed throughout the organization, and presiding alike over its simple and its complex functions. There are drugs, unlike in their physiological action those just mentioned, which exert a remarkable influence over reflex action, and which enable a physiological engineer to call it forth, or to repress it, almost as readily and freely as the engineer of a locomotive, by the pressure of his thumb on a valve, can increase or diminish the force of steam in his engine. This action of drugs illustrates the mechanical nature of the nervous system, not less clearly than the pressure of an engineer's thumb does that of his engine. It is worthy of note, however, that the *ego* of the human system, whose volition enables the prescribed drug to be taken, is no more to be confounded with his engine, than the engineer, the pressure of whose thumb lets on the force of steam, is to be confounded with his.

By means of strychnia the reflex action of the nervous system, and especially of the spinal nerve centres, may be augmented indefinitely. They can be rendered so sensitive by it, that they will respond by convulsive muscular twitchings to the slightest contact of a single hair, to the touch of a feather, or to the wave of a breath of air; and the convulsive action may be increased, by increase of dose, till rapid death follows. The ideational centres of the frontal lobes, and the cerebral sensory centres of sight and hearing, are less amenable to the influence of strychnia than the spinal cord and lower nerve centres: an indication or hint that the higher functions require for their performance less reflex or automatic power than the lower. How it is that strychnia accomplishes the result of increasing reflex sensibility is still an unsolved problem. Possibly, as some suppose, by a process of oxygenation in the nerve centres themselves; or perhaps, as an ingenious experiment of Brown-Séquard implies, by the local irritation of direct contact with nerve tissue.[1]

The bromide of potassium, bromide of sodium, bromide of ammonium, bromide of lithium, and their congeners, exert upon reflex action an influence, the opposite of that induced by strychnia. They repress it, and in sufficiently large doses nearly, if not quite abolish it. Their repressive action, however, is by no means limited to the spinal cord, but extends up to the sensory and

[1] Professor Brown-Séquard, as he himself informed the author, succeeded in laying bare a section of a frog's nerve without destroying its central or peripheral connections, depriving it completely of blood, and preventing the access of blood to it. He then applied strychnia to it with the result of producing twitching in the muscles innervated by it.

ideational centres. It is possible by an appropriate administration of these agents to dull, without destroying, the general reflex sensibility of the nervous system, and to act on the cerebrum in such a way as to produce a degree of hebetude simulating imbecility. Ideation is not abolished, but rendered sluggish. The visual and auditory centres perceive sights and sounds, and report them to the frontal lobes, where they are received with indifference. Apperception is more dulled than perception. It is a curious and interesting fact that a bromized individual, in spite of the inhibitory influence to which he is subjected, can, by a strong volitional effort, arouse his sleepy attention and blunted faculties, and compel them to work effectively, showing, that manifestation of power, not power itself, is interfered with by the bromides. Another phenomenon following the administration of bromidal preparations is sleep. This occurs so constantly, that they are now very generally employed for the relief of certain forms of insomnia. Physiologists have shown that bromides, by means of the vaso-motor nerves, produce contraction of the capillaries, and especially of those of the brain. The quantity and mode of administration, necessary to produce this effect, are the quantity and mode of administration necessary to produce the phenomena above described; indicating clearly that the mental hebetude, sluggish movement, and somnolent condition, are the results of diminished circulation of blood through the capillaries of the nerve centres; an additional proof of the dependence of cerebral phenomena upon the circulation through the cerebral structures.

The drugs, hitherto considered, illustrate the mechanical machinery of the nervous system as a whole. It is possible to pursue the illustration still further, and to show that by means of drugs one portion of the nervous system can be called into activity, and another portion, intimately associated with the one affected and apparently a component part of it, be left quiescent. Many, perhaps all the centres of motion and sensation are constructed so that they seem to be a unit. The sensation of pain, for example, following a wound upon the finger, is carried along a sensory nerve to a nervous centre, where the sensation is translated, as we have previously seen, into motion, and reflected along a motor nerve to a set of muscles, by which the finger is removed from the place of danger. Commonly when a sensori-motor centre is paralyzed, or destroyed by disease or other cause, both motion and sensation are taken away. An individual so affected can neither feel the injury, nor move the injured part; he does not know that his finger is wounded, nor possess the power of escape. Sensation and motion, which the mind easily recognizes as distinct from each other, and which consciousness perceives and acts upon as separate and dissimilar factors, have their distinct organic representatives in the cell structures of the nerve centres; and yet it is impossible to distinguish and isolate by chemical analysis, anatomical dissection, or microscopical exploration, a cell which recognizes sensation, from one which determines motion. This difference, which the mind perceives, but of which our gross means of investigation cannot discover the mechanism and into which no scalpel, laboratory, or lens has hitherto penetrated, drugs have made clear. The physostigma venenosum, a kidney-shaped bean from Calabar in Africa, which the natives of that region have long employed as an ordeal test for criminals, possesses the property of diminishing, and in sufficient doses of annihilating all reflex power, so that complete muscular flaccidity follows its administration. At the same time sensibility persists, as long as it is possible to obtain any evidence of it. Motion is taken away, but sensation remains. The pain of heat and cold and injury is still reported to the ganglionic nerve centres, but their ability to remove the body from the offending spot, or to expel the offending cause, no longer exists. The drug acts on the nerve cells of motion, and leaves those of sensation unaffected. The central translation of sensation into motion is abolished — that link in the mechanism is broken, — a demonstration, that the difference between sensation and motion, which the mind accepts, is organically represented in the nervous apparatus. In the age of martyrdom, martyrs were fastened to the stake beyond escape, and so compelled to suffer the utmost torture of the flames. What the church and the law inflicted as a punishment for heresy and crime, by means of cords and chains which compelled muscular inactivity, modern physiology has accomplished by a harmless looking alkaloid. How the old torturers would have rejoiced in the possession of an article, the administration of which would have enabled them to tie their victim to the fire by an invisible force, capable of preventing all escape and preserving all the agony ; and so to roast him alive, enforcing, with fiendish ingenuity, a nightmare of awful suffering and impossible escape!

In addition to the drugs just cited as agents, capable, by their physiological action, of illustrating the division of the nervous system into various and distinct faculties, and which exhibit this division, chiefly by their influence over its reflex mechanism and spinal centres, there are others which bring the same fact into clear light by their action on the higher sensory ganglia, and their influence over the cerebral functions of emotion, ideation, and volition. The principal medicinal agents of this class are opium, Indian hemp, alcohol, ether, chloroform, and belladonna with its congeners. These are among the most important articles of the materia medica. They derive their therapeutic position, to a large extent, from their power to select for their action certain important parts of the nervous system in preference to others, and to act efficiently upon the selected portions. A brief allusion to their physiological behavior in this respect will be sufficient for the object before us.

Opium is so generally known as an anodyne, soporific, and poison, that its power to stimulate the frontal half of the brain is often overlooked or depreciated; and yet its action, in this respect, is not less important than its power over other portions of the nervous system. A great variety of symptoms, many of them apparently conflicting with each other, have been reported by different physiologists, as the result of its administration to men and animals. Without undertaking to reconcile these differences, an effort foreign to our present purpose, it may be safely asserted, as Dr. H. C. Wood, Jr., has shown, that after a careful survey of the symptoms, two classes of phenomena, one spinal, the other cerebral, stand out prominently, as the physiological result of opium. To this should be added the statement that in ascending the scale of being from the lowest to the highest forms of animal life, the spinal phenomena predominate in the lowest, and the cerebral in the highest. The brain of man is more actively and peculiarly affected by opium, than that of the lower animals; and of his brain, the higher and most complex ganglia are more susceptible to its action than the lower and less complex. This varying action of opium on different individuals, and on different parts of the brain in the same individual, is of course less evident in lethal than in non-lethal doses. De Quincey's description of the pains and pleasures of opium, which must be taken *cum grano salis*, for it has the flavor of an opium-eater's imagination, is correct, in so far as it paints the influence of the article on the emotions, the imagination, the intellect, and the will. His personal experience was a vivid illustration of the elective action of opium on the intra-cranial apparatus.

A stimulus or irritant, applied to a nerve, will call into greater or less activity the special function of the ganglionic nerve centre with which that nerve is connected, and of the force of which it is a conductor; and it will not develop any other sensation or force, than that which is the special property of the part stimulated. Irritation of a nerve of sensation causes pain, and except by a reflex act, does not cause motion. Irritation of a motor nerve will cause motion, not pain. Irritation of the auditory nerve gives rise to sound, and not to pain or motion. Cutting or pinching the optic nerve produces a flash of light, and not pain, movement, or sound. Irritation of the salivary nerves excites a flow of saliva, without exciting pain, motion, light, or sound. The same law pervades the whole nervous system. Each organic centre can be stimulated to do its own work, but not that of its neighbors or connections; and each will act normally only under its own appropriate stimulus. The auditory ganglia respond to waves of sound, not to those of light; the optic ganglia to waves of light, not to those of sound. The converse of this is equally true. When a stimulus succeeds in arousing an organ into activity, the action produced is that organ's function. If opium, by stimulating the frontal lobes, produces ideation, it is because ideation is the function of those lobes. Hence the value of the following graphic account, by De Quincey, of the movement of his brain under opium. It also illustrates the power which the brain possesses, and which has previously been dwelt upon, of reviving past impressions.

"The minutest incidents of childhood," says the brilliant essayist, "or forgotten scenes of later years, were often revived. I could not be said to recollect them; for if I had been told of them when waking, I should not have been able to acknowledge them as parts of my past experience. But placed as they were before me, in dreams like intuitions, and clothed in all their evanescent circumstances and accompanying feelings, I *recognized* them instantaneously. I was once told by a near relative of mine, that having in her childhood fallen into a river, and being on the very verge of death, but for the critical assistance which reached her, she saw in a moment her whole life, in its minutest incidents, arrayed before her simultaneously as in a mirror; and she had a faculty developed as suddenly for comprehending the whole and every part. This, from some opium experiences of mine, I can believe; I have, indeed, seen the same thing asserted twice in modern books, and accompanied by a remark which I am convinced is true, namely, that the dread book of account, which the Scriptures speak of, is, in fact, the mind itself of each individual. Of this, at least, I feel assured, that there is no such thing as *forgetting* possible to the mind; a thousand accidents may and will interpose a veil between our present consciousness and the secret inscriptions on the mind. Accidents of the same sort will also rend away this veil; but alike, whether veiled or unveiled, the inscription remains forever; just as the stars seem to withdraw before the common light of day, whereas, in fact, we all know that it is the light which is drawn over them as a veil; and that they are waiting to be revealed, when the obscuring daylight shall have withdrawn."[1]

This, so far as a single case can be of value, is a psychological confirmation of the physiological inference from the experiments of Ferrier and others, that the frontal lobes of the brain contain a large portion, if not all, of the mechanism of ideation and volition. Stimulated by opium, De Quincey's brain not only reproduced cell-groupings, which were organic foundations of ideal pictures — memories — of long past scenes, but also effected organic modifications, which enabled him to reason about them. He saw the past; satisfied himself that it was *his* past, and drew therefrom certain corollaries as to the working of his own brain. It does not appear that he saw, even in his opiated dreams, sensory pictures, but only ideational ones. The mechanical explanation of

[1] *Confessions of an English Opium-Eater*, by Thomas De Quincey, Am. ed., 8vo, 1869, pp. 110, 111.

his psychological experience in this respect is this. In childhood, vivid sensory pictures were painted on the visual centres of his brain. These were telegraphed to the ideational visual centres of his frontal lobes, where correspondingly vivid ideational pictures were produced. In adult life, these lobes, excited by opium carried thither by the blood, reproduced the visual cell-groupings of his childhood, and the emotions and ideas corresponding to them. The angular gyri were less affected than the visual centres higher up. This is, in fact, what would be expected from the physiological action of opium, an agent which produces subjective, rather than objective visions. The testimony of an acute observer, like De Quincey, to the existence within his personal experience of intra-cranial pictorial representations, is peculiarly valuable, though he did not recognize the distinction between cerebral sensory, and cerebral ideal pictures; a distinction essential to a just comprehension of the phenomena of pseudopia.

Both Calabar bean and opium possess the power of causing iridal contraction; and this they do in virtue of their influence over the visual apparatus, independently of their action on the cerebral tissues in general. This power is another instance of the elective affinity of these agents for certain ganglionic nerve centres in preference to others, and lends additional confirmation to the doctrine, that the process of vision is not confided to the eye alone, but to a complex apparatus extending well into the brain. It is a curious and suggestive circumstance, to say the least, that an article, like opium, capable of exciting the cerebral hemispheres to the production of ideational pictures, should also be able to excite to contraction that part of the visual mechanism, which serves as the original gateway for the entrance into the brain of photographic pictures of the outer world. Doubtless, by and by, something more than coincidence or simultaneousness of action will be discerned between these two phenomena.

Cannabis Indica, called haschisch in its native country, Indian hemp in Europe and America, is a worthy member of the materia medica, though its therapeutic virtues are much less valuable than those of opium. It possesses great interest, however, for the psychological physiologist, on account of its peculiar and extraordinary power over the brain; exerting upon some of the ganglia a singular influence, and affecting them all more or less. It does not lead the brain to revive past experiences, so much as to pervert and distort existing ones. Its vulgar East Indian appellation of hashisch, from which some derive the English term assassin, is said to be indicative of its influence over the brain of those who chew it, and who often commit, under its delirium-producing action, all sorts of excesses, even the assassination of those they meet. It is a moderate anodyne and soporific, incapable of inducing either the profound anæsthesia or sleep characteristic of the cerebral action of opium; on the other hand, it exerts over parts of the brain a more marked influence than that drug. Its physiological action is, therefore, a forcible illustration of the functional independence of those nerve centres upon which its energy is expended. Every instance of this sort renders more probable, if it does not demonstrate, the existence of distinct organic centres in the anterior lobes for the perception, analysis, and reproduction of impressions like ideational pictures.

Ideas of time and space have always afforded to metaphysicians a large opportunity for a great deal of subtle discussion and useless speculation. Without taking part in their metaphysical gymnastics, it may be justly observed that it is important, both for physiologists and psychologists, to recognize the probable existence in the brain of an organ concerned with the manifestation of notions of time and space, and perhaps exclusively devoted to the apperception of such ideas. Independently, however, of all abstract and *a priori* considerations, the physiological fact appears — let the metaphysician interpret it as he can, — that cannabis Indica, taken in sufficient quantity, possesses the power of imparting to conceptions of time and space a singular degree of magnitude or extension. In accordance with the physiological law, that a ganglionic nerve centre can only be made to exhibit a power of which the manifestation is confided to its organization, it is fair to infer, that if an artificial stimulus can be applied so as to develop or exaggerate ideas of time and space, there must be an organic provision in the brain for that purpose. It is an established physiological phenomenon that cannabis Indica is capable of exciting and strangely developing these ideas. De Quincey fancied that he discovered the same virtues in opium from the character of his dreams after taking laudanum. His statements in this respect have not been confirmed by other observers, and are undoubtedly fanciful; but even if they are not true of the dreams of opium, they are a graphic description of the time-and-space-magnifying properties of Indian hemp; a description, the accuracy of which I have repeatedly been able to verify by the experience of those who have taken the drug under my professional care. "The sense of space," says the brilliant Opium-lover, "and in the end the sense of time, were both powerfully affected. Buildings, landscapes, etc., were exhibited in proportions so vast as the bodily eye is not fitted to receive. Space swelled, and was amplified to an extent of unutterable infinity. This, however, did not disturb me so much as the vast expansion of time. I sometimes seemed to have lived for seventy or one hundred years in one night; nay, sometimes had feelings representative of a millennium, passed in that time, or, however, of a duration far beyond the limits of any human experience."[1] One of my medical friends noticed

[1] *Confessions*, etc., p. 110.

a similar effect in his own person after taking cannabis Indica. Ascending a flight of stairs, from his sitting-room to his bedchamber, seemed to occupy time enough for a journey from Boston to Washington and back. It required a century for the winding up of his watch.

The following case happily illustrates the power of cannabis Indica to play with the human brain, and to act on the visual apparatus, as well as on the higher ideo-motor centres.

Three members of the medical class of Harvard University, after one of my lectures on the physiological action of cannabis Indica, determined to test the accuracy of the statements to which they had listened, by experiments with the article upon themselves. They accordingly procured some of it, and each took a portion. After taking it they remained together about an hour. At the end of this period, the whole party began to feel "queer," and thought their wisest course was to go, each to his own home. Before separating they agreed to meet each other the next day and report and compare experiences. Two of the number found it necessary to exercise a moderate degree of self control, in order to get home without exciting observation. On reaching home they were garrulous and uneasy, had a quick pulse and were sleepy; so sleepy, that they went immediately to bed and to sleep. Their sleep was sound. On the next morning they awoke in their usual condition. Such was their experience.

The third experimenter did not get off so easily as his companions. Older than most medical students and more fortunate, he was a married man, and possessed a house of his own. It was two miles or more from the place of parting with his companions to his home, and he shortened the way by getting into a car or omnibus. Soon after taking his seat he was strongly impressed with a sense of his own importance, with the size, symmetry, and beauty of his person, and with the comparative insignificance of those about him. This impression became so strong that he felt compelled to speak of it. Accordingly, calling the conductor to his side, he expatiated upon his personal attractions, and especially dwelt upon the size and shape of his arms and thighs, and did not fail to comment upon the excellence of his general make-up. He likewise remarked upon the lilliputian aspect of his fellow passengers. He, himself, was not an Apollo. The conductor attempted no reply to these criticisms. Presently the student, who may be called Mr. K., again addressed the conductor, and rehearsing the matter in a loud tone, advised him to put the passengers out of the carriage, as persons unfit to ride there; and as especially unfit to be in the neighborhood of so august a personage as Mr. K. By this time he was near his residence. The car stopped. The conductor, charitably supposing liquor had provoked such odd behavior, kindly offered to assist Mr. K. to the sidewalk.

All offers of aid were refused with imperial dignity and decision. He soon reached home. The ideas of grandeur and importance with which his own person had inspired him, attached themselves to his house; he stopped before entering, to admire the magnificence of its portal and its palatial façade. He entered. The hall was imposing; the stairway grand. His library equalled the Bodleian. His wife was a princess; and so on through all his belongings. Suddenly the scene changed. He acquired double consciousness, and became two persons, — two distinct individualities. One was a notable physician, the other an indigent patient. He proceeded, in the character of a physician, to examine himself in the character of a patient. Consciousness No. 1 discovered a serious affection in the body of consciousness No. 2. No. 1 went into his office and obtained some surgical instruments, with which he undertook to operate on No. 2; having stretched the latter for the purpose on a sofa. These singular doings alarmed Mrs. K., who, fearing for her husband's sanity, sent for a physician. In the mean time, consciousness No. 1 had dismissed consciousness No. 2, and recognized instead a criminal, who on account of some misdemeanor in prison had been condemned to the punishment of a shower bath. Obedient to this notion, consciousness No. 1 administered a shower bath to consciousness No. 2. The physician who had been summoned by Mrs. K. arrived in the midst of the bath. The result of his investigation was the conclusion, not an unnatural one under the circumstances, that Mr. K. was drunk. By this time the soporific influence of the drug began to assert itself, so that only a little urgency was necessary in order to induce Mr. K. to go to bed. A sleep of about twelve hours put an end to further extravagances.

On the next day Mr. K. retained a vivid recollection of the various phases through which he had passed. He remembered distinctly the conviction he entertained, while under the power of cannabis Indica, of the reality of each scene he witnessed, and of the part he played in it. The fact of double consciousness stood out in his memory with peculiar prominence. He did not experience the amplification of time and space like De Quincey, but the idea of size which he attached to his person and belongings, and the presumed length of time which he spent in his various operations, require a similar amplification of those conceptions. The pictures of grandeur and beauty which his own person, that of his wife, and his house exhibited, in all the reality of actual presentation, indicated unequivocal derangement of his visual apparatus. It is evident that no new ideas or pictures were produced by the action of his brain in its novel condition. Old ones in part or in whole were reproduced, amplified, jumbled together, or otherwise perverted. In physiological terms, the cell-groupings and cell-modifications, which had previously been formed, were partially reproduced in greater or less disorder, with a corresponding disorder of ideas. Like the explosion of a shell in the midst of a battalion, which throws the troops into strange combinations of confusion and rout, or the violent unrhythmical striking of the keys of a piano, yielding sound without music, the passage of cannabis Indica through the cells of Mr. K.'s brain produced singularly disordered cell combinations, and ideas without reason.

Alcohol has probably caused more visions, such as they are, than all other drugs combined. It also has been, and still is, a prolific source of discussion and bone of contention. Even its physiological action, a purely scientific matter, has become a question of popular debate; and those who are ignorant alike of the rudiments of physiological chemistry and of experimental research, discuss the relation of alcohol to the system, and criticize the results of modern investigation with regard to it, as if they were profound experts. Fortunately it is not necessary for the purpose of this essay, to discuss any of the questions, scientific or moral, which teetotallers, their opponents, or reformers of any sort, have raised with regard to alcohol. The visions of alcohol are matters, about the existence of which there is no doubt.

Alcohol is the active principle of all sorts of ardent spirits, wines, ales, beers, and the like. They differ from each other in various ingredients, as acids, etherial oils, flavoring and coloring substances, which render them more or less agreeable to the palate, the stomach, and the constitution of different individuals, and which give to them a varying therapeutic value; but after all, that to which they owe their chief importance is alcohol. Without that constituent, they would do very little good or harm in the world. Alcohol is the devil or angel, always lurking at the bottom of the cup. It hides in the rich man's bottle, and in the poor man's dram. Any of these liquors, taken in sufficient quantity, and for a sufficient length of time, will disturb the nervous system, peculiarly affect the visual apparatus, and lead to dreams and visions.

As might be expected, the pseudopia of alcohol has a character of its own. The visions of opium, however distinct and fascinating, are subjective, soothing to the general nervous system, and stimulating to the imagination. The opium-eater loves to retire into a corner, away from a crowd, wrap himself up in revery, and gaze on his pictures in silence. The visions of cannabis Indica are objective, magnificent, and commanding. He who takes it projects the disordered figments of his own brain into space, makes them imperial, and becomes the autocrat of his imperial world. The visions of alcohol are objective, confused, and turbulent. Less imaginative than those of opium, less royal than those of Indian hemp, they endow ordinary scenes and objects with life, and with life which is often ridiculous, sometimes tragic, and always vulgar. Lying on his bed, the victim of delirium tremens converts the rude pictures of his papered walls into a living and active panorama, transforming its irregular lines into crawling snakes and creeping things, its shadows into hobgoblins, and all about him into strange shapes. In the movement of his bedclothes, he sees the plunging of unnatural animals; giants in busts and plaster casts; and the face of a devil in the countenance of his wife; he hears the cries of the damned in the voices of his children; and surrounds himself with scenes of unutterable horror, the distortions or caricatures of his surroundings. Commonly the emotion of fear is excited by the shapes and horrors which alcohol evokes, or at least simultaneously with them. The drunkard is timid. He tries to conceal himself in his bedclothes from his tormentors, or to run from them, or in despair and self-defence to kill them. Often bombastic and vain, he rarely manifests true courage.

Irregular muscular action is characteristic of alcoholic intoxication. The tottering gait of the drunkard is unfortunately too well known; but it is not so well known that occasionally incoördination of muscular action affects the ocular muscles, generally the internal rectus, thereby producing double vision. This is another instance of an agent, which, to the power of inducing cerebral pseudopia, joins that of affecting the ocular apparatus. Opium and cannabis Indica, as already stated, contract the iris; belladonna, as will be mentioned presently, dilates it; alcohol disturbs the action of the eye-ball. Perhaps it might be expected that agents, which act decidedly on one part of the visual machinery, would affect other parts also. A drug, which has the power of deranging the irides, might extend its influence a little farther up, and take hold of the cells of the visual ganglia, giving rise to motion in the iris, and visions above.

Alcohol does not produce pseudopia so readily as opium, cannabis Indica, belladonna, and the like. A single dose, or a few doses of these agents is often sufficient to excite the visual apparatus to activity. One dose of alcohol may intoxicate the person who ventures to take it, and lead to a great deal of nervous disorder, but will rarely if ever call up visions. They occur only after it has been taken long enough to bring about an organic change in cerebral nerve tissue; and then they appear as one of the results of that change, rather than as a direct effect of alcohol. The organic changes which alcoholic liquids induce in the visual ganglia, deprive those centres of their normal accuracy of perception. Probably the angular gyri and ideational centres are more profoundly affected than the tubercula quadrigemina and ocular apparatus. In like manner the same agent gradually deprives the motor ganglia of locomotive perception and action, and hence general muscular tremor and incoördinated gait. There is an analogy between a drunkard's visions and his step. Occasionally, however, his visions instead of being absurd and confused embrace distinct and intelligible objects. Thus in the first of the previous series of cases, the black dog which appeared to the patient was neither a caricature nor a monster, but bore a normal canine shape and expression. The cerebral cell-groups, which were the hieroglyphic of that dog, were reproduced by the alcoholized brain, excited by some unknown stimulus.

The visions caused by ether and chloroform resemble those of hysteria and ordinary febrile delirium, rather than those which follow opium or cannabis Indica. In some respects they are like those of an alcoholized brain. During profound anæsthesia, ideational as well as sensory action is abolished. When the system is put under the influence of the inhalation of ether, there are first a sense of exhilaration and fulness in the head, combined generally with tinnitus aurium. "These are soon succeeded by a feeling of the immediate surroundings being afar off, and this soon fades into semi-unconsciousness with visions and illusions. These are of various characters, and are often accompanied by a species of delirium. Some patients weep, others laugh; some shout, some pray, some rave, and some become exceedingly pugnacious."[1] Etherization admira-

[1] *Therapeutics, Materia Medica*, etc., by G. C. Wood, Jr., p. 242.

bly brings out the anatomical arrangement of the nervous system in distinct centres, and their corresponding separate functional action. According to Flourens, "the order of the involvement of the nerve-centres (by inhalation of ether) in man and animals, is first, the cerebrum, next the sensory centres of the cord, next the motor centres of the cord, next the sensory centres of the medulla oblongata, and finally, the motor centres of the medulla oblongata."[3] If the anatomist had not discovered the distinct centres or stations of the cerebro-spinal system, the physiologist would be warranted in asserting their existence from the phenomena of etherization. Ether puts to sleep one function of the nervous system after another. Step by step, it ascends from the lowest to the highest — from the simplest to the most complex — parts of the mechanism of life, destroying the power of each part as it mounts, till all vital manifestation is annihilated. The functions cease separately and in a certain regular order. The inference is inevitable that each function disappears, because the organ to which the function is attached is controlled by ether, and prevented from functionating. So, by parity of reasoning, if an ideational function of vision can be called into activity or abolished by artificial means, like opium or alcohol, which act on the frontal lobes, the existence of an organic centre in those lobes, above the angular gyri, may be fairly inferred. Bella-

[1] *Therapeutics, Materia Medica*, etc., by G. C. Wood, Jr., p. 243.

donna, hyoscyamus, and stramonium add their testimony to that of the drugs already quoted. All of these, in sufficient doses, give rise to a peculiar, whimsical and muttering sort of delirium, accompanied with visual disturbance, showing their power to call into action the ideo-motor and visual centres. All of them also possess the power, whether administered locally or internally, of dilating the pupil, and are used by oculists for that purpose: an additional illustration of the fact, that medicinal agents which affect one part of the mechanism of vision affect other parts of it also.

The doctrine of these pages, that the process of vision is confided to a mechanism consisting of distinct parts, each part being under the control of a centre or ganglion, the whole united, however, so as to form a unit, is confirmed, as our statements have indicated, by the teachings of physiology, and the results of experimental investigation. It has also been shown that this process, ordinarily and normally called into action by external objects, as living beings and natural scenes, may also be called into action, subjectively, by such factors as emotion, association, habit, expectant attention, automatism, blood supply, drugs, and influences which accompany these forces. It remains to examine the relation of disease and volition to the process under consideration.

Unfortunately our knowledge of the pathology of the nervous system, and especially of the brain, is yet in its infancy. Nor is this all. Recent investigations, both clinical and experimental, show that much which was supposed to be knowledge in this direction is largely mixed with error; and that consequently the whole territory of nervous pathology must be restudied, — a labor which some of the ablest medical scientists of the present day have undertaken. Such being the case, it is scarcely to be expected that so minute a portion of this territory as that appropriated to the mechanism of vision should have received much attention as yet. Something, however, has been accomplished in the way of unravelling the mysteries of nervous affections, and what has been done throws considerable light upon the subject of our present inquiry. The phenomena of disease sometimes point the way to an explanation of the phenomena of health.

The eye itself is frequently attacked by disease. Its pathology as well as its physiology has been carefully explored, and it may be safely asserted that, at the present time, ophthalmology approaches nearer to an exact science than any other branch of medicine. But the eye is only one part of the machinery of vision; and being the most external part, is more easily studied, and its diseases are more readily recognized than is the case with the deeper seated portions of the same machinery. The intra-cranial sections of the visual apparatus, hid in the recesses of the brain, are not readily accessible to investigation, and have been studied chiefly as a part of the general cerebral mass. A knowledge of them and their diseases is not less necessary to a comprehension of all the phenomena of orthopia and pseudopia than an acquaintance with those of the eye itself. But the diseases of this obscure region are not better known, to say the least, than affections of the brain, of which it forms a part.

Another and serious difficulty in the way of obtaining from the study of cerebral diseases the light which they might be naturally expected to throw upon the process and phenomena of vision, is to be found in the fact that they are rarely limited to the visual territory, but commonly extend beyond it. A clot of blood, effused into the angular gyri, is not often confined there, but involves, by its size or by the morbid action it sets up, the auditory centre and more or less of the neighboring motor centres. A lesion affecting the tubercula quadrigemina is rarely limited to the tubercles, but takes hold of the surrounding region also. In such cases it is always difficult, often impossible, to discriminate between symptoms produced by a lesion of a visual centre alone, and those produced by derangement of a considerable tract, of which the centre forms a part. In spite of these difficulties, a careful study of cases of cerebral disease, involving a part or the whole of the machinery of vision, and a comparison of them with the results of direct experiment, have already led to many new and valuable conclusions. When, as now and then happens, a lesion is limited to one or more parts of the visual apparatus, the investigation of it, correspondingly simplified, yields results of the highest importance to physiology and pathology. These pages have been enriched by two or three such cases, reported by Charcot. Clinical observation yields, moreover, a large number of cases of non-fatal diseases of the brain, which illustrate and to some extent explain the subject of visions. Fevers of all sorts, many cerebral affections, accidents involving the brain, intemperance, insanities, and other derangements give rise to a plentiful crop of visions, many of which admit of being observed with tolerable ease, and amply repay the physician for the necessary time and trouble of observation. It is, in fact, upon a series of such cases that the present paper is founded, and from which it derives its principal value. Cases of visions are not unusual. They enter into the experience of most practitioners. It is not difficult, therefore, for the clinical observer to obtain facts, illustrating the abnormal action of the visual apparatus; the difficulty lies in the correct interpretation of the facts observed.

Anatomy describes the raw material and organization of the brain. Physiology describes the cerebral functions and their modes of action. Clinical observation tests the accuracy of anatomical and physiological teaching, and supplements them both by pathological research. The brain must be approached by all these avenues, and must be studied in action during life, as well as by the microscope and scalpel after death, in order to comprehend its power. The most careful examination and exact knowledge of the structure and parts of a steam engine would fail to reveal its force or final cause. A study of it in action would disclose its normal but not its abnormal capacities. An acquaintance with the whole varied experience of an engine's life; with its efforts and fractures; its handling by different engineers, good and bad, drunk and sober; its exposures, illnesses and recoveries, would reveal in it capacities, eccentricities, and idiosyncracies which, without such observation, would never be brought to light. So with the visual apparatus. The anatomist can take it to pieces, and show its parts like those of a telescope; the physiologist can exhibit its power and working and field of vision; but from the clinical observer must be obtained not only the authentication of every physiological law concerning it, but whatever knowledge it is possible to obtain with regard to its abnormal action, and the modifications impressed upon its functions by the varied experience of the cerebral life of which it forms a part.

Notwithstanding all the difficulties attending it, and they are many and great, medical science owes a large portion of its present knowledge of cerebral affections to clinical observation. Among its contributions are to be found some of especial value to the student of visions.

The first of these in importance is the confirmation, perhaps it would be more just to say, the demonstration of the fact, that visions may and do occur; that subjective seeing being more than fancy, and more than a mere possibility, is an occasional reality. Clinical observation asserts the existence of the phenomena of pseudopia, as a symptom of cerebral disease, with as much certainty as it does that of paralysis or pain, as symptomatic of nervous derangement. The full significance of the existence of such phenomena has not been hitherto duly appreciated. Visions have been and are commonly regarded, even by medical men, as figments of the imagination — airy nothings — rather than as manifestations of abnormal brain action. From the age of Hippocrates till now, clinicians have recognized the occurrence of various sorts of pseudopia, in connection with a variety of maladies, and, content with regarding them as a part of delirium or kind of hallucination, have neglected to inquire further. This neglect only enhances the value of their testimony to the fact, that the visual apparatus is capable of being thrown into action by intracranial causes. It was stated in the earlier part of this essay that we do not see with our eyes, or hear with our ears. Clinical observation, in confirmation of this physiological statement, asserts that it has met at the bedside those whose brains, under the influence of disease, saw, though their eyes were blind; and conversely, has met with those, who, with eyes capable of vision, had brains which were not.

This physiological fact, the demonstration of which is largely due to clinical observation, is emphasized in this connection, on account of its great importance. By subjective sight is, of course, meant the seeing of objects and scenes, by the reproduction of cell groups, without the stimulus of any external object. This fact, which has long been known as one of the results of cerebral disease, and which has stood prominently out before the eyes of clinical observers, has received very little attention, in comparison with that bestowed on the visions of charlatan spiritualists, prophets, enthusiasts, and others, who have excited the wonder and awe of the world. The brain of a drunkard, who sees a black dog in an image on his mantel, or a burglar in the form of his wife, may be in a condition, so far as its visual cell groups are concerned, not unlike that of some rapt votary, who sees the countenance of his patron saint, beaming from his crucifix; or from that of an excited soldier, who, on the eve of a battle is blessed by the appearance of his mother's face in the midst of his prayers and tears. The fact being accepted, which clinical observation has chiefly substantiated, that morbid states of the intracranial apparatus may lead to the establishment of visions, the foundation is laid for the rational explanation of many phenomena, hitherto regarded as inexplicable. It is singular that this important fact, which disease has for a long period clearly revealed, should have received so little attention. Physicians are so familiar with visions as symptoms in febrile and nervous derangements that they have overlooked the physiological importance of such symptoms in other and psychological relations. One of the most important contributions, then, towards an accurate knowledge of visions has come from a study of disease; namely, the demonstration of the fact of their subjective existence.

It should be noticed, in the second place, that a knowledge of the conditions necessary to the production of visions can be obtained only or chiefly by a study of diseases in which they occur. This point was discussed when speaking of blood supply, including nutrition, and other agencies, which influence the grouping of nerve cells and modify nerve tissue. It is therefore unnecessary to dwell upon it again now. Habit, association, attention, and other modes of cerebral activity are intensified in their action by many diseases, and produce visual effects, which without the underlying morbid state, could not be brought about. Hyperæmia or anæmia of a visual centre may set the visual telegraph in operation, and notify a higher centre subjectively of the presence of a dog, or child, or angel, or devil, just as the same condition, in a motor centre, may set the motor apparatus at work, and produce convulsions; or in a centre of sensation, may produce neuralgia. It is not intended by this statement to affirm that all visions rest upon disease as their basis; but it is intended to affirm that visions do not occur, unless some abnormal state of the visual nerve mechanism is produced, through which they are manifested, and which condition their manifestation. Disease contributes the conditions necessary to the production of subjective visions, and so leads the way to an investigation of their pathology. It does not militate against this view of the etiology of pseudopia, that cerebral morbid states, producing visions, may be artificially induced. Changes in the quantity and quality of the blood, circulating through the visual nerve centres, are doubtless the most frequent causes of inducing those cell-groups and cell modifications which are the hieroglyphics of visions. Such changes undoubtedly occur in fevers, starvation, delirium tremens, and other affections, among the symptoms of which are subjective sights and sounds.

The third point to be mentioned has, like the previous one, been already touched upon. It is this: Physiology obtains from the clinical observation of disease the final and complete demonstration, that the visual function is localized in a special intracranial apparatus. Experiments, like those of Hitzig and Ferrier, may render the localization more than probable; but such experiments were performed on animals, and the results cannot be transferred absolutely from animals to man. Neither is it justifiable, if it were desirable, to experiment on men as on animals, in order to decide the question. Disease, however, performs what experiment would not dare to undertake. By its mysterious processes it attacks different parts of the brain, producing all sorts of cerebral lesions and cerebral blood changes. Sometimes these lesions or changes are limited to one or more visual centres, thus enabling the clinical observer to test the accuracy of the physiologist's statements with regard to the function of those parts.

It thus appears that disease reveals the fact of the existence of subjective vision; secondly, that it occasionally facilitates the appearance of visions, and by many of its processes affords an opportunity for a study of the character and conditions of cerebral seeing; and, thirdly, that it confirms the recent assertion of physiology, as to the localization of the visual function in a special part of the brain, and in a peculiar apparatus.

The last influence or factor, which it is necessary to mention in this connection, as capable of facilitating the appearance of visions, and in rare instances of initiating them, is Volition.

If there were a locomotive running over our railroads, stopping at one station to take passengers in, and at another to let them out, slowing its speed around a curve and over a bridge, and hurrying its pace on a straight and level road, cautiously feeling its way through a tunnel or into a city, putting forth all its power to surmount an ascending grade, and with equal effort holding back on a descending one, advertising with a shrill cry the careless and halt and blind to avoid its path, starting at a fixed moment and reaching its various goals with exactness, and doing this and all its labor intelligently, with the *engineer invisible;* if such a locomotive could be found, there would at once spring up around it two classes of philosophers; of whom, one class would attribute to the engine itself, including its mechanism, and aided perhaps by the reaction of its surroundings on its wheels and springs, the power of self guidance; while the other class maintaining an opposite view, would assert the existence and constant presence of an invisible engineer. The human brain, an engine more delicate, wonderful, and powerful than any of which man has conceived, started on life's devious way some thousands of years ago, has been running over it since and is running still. Its engineer is invisible, and because invisible, many have doubted if there is one. This essay is based on the hypothesis, the author believes on the fact, that a cerebral engineer exists, who, within certain definite physiological limits, guides and controls his engine; an engineer who is a self acting cause. Whatever name may be given to him, Soul, Ego, the Me, or other title, he is known only by his volitions, impressed on his engine. Hence the importance, in this discussion, of ascertaining as definitely as possible the relation of volition to the visual function. However much the engine may act automatically, or be trained to act so, the cerebral engineer, by touching some secret nerve centre or cell, as the engineer of a locomotive touches a protected spring, modifies, more or less, the movements of the mechanism intrusted to his care. It is not probable that there is a nerve centre, cell, or fibre, removed from his supervision or beyond his reach. Even the centres of special sense, those of sight, hearing, taste, and smell, which are charged with the duty of reporting the outer world to him, are influenced by his commands, and sometimes controlled by his volition.

It is not intended, by these statements, to assert that physiology has discovered the point of contact between Mind and Brain, or that the existence of an Ego — an engineer — has been demonstrated, in the sense that three angles of a simple triangle have been demonstrated to be equal to two right angles; but it is intended to assert that these statements, if a cerebral engineer exists, are logically true.

This brings us to the question, how far does volition influence vision; — how far does the will control sight. It is admitted by all physiologists that the will controls, or at least modifies all the functions. Even the processes of disease are affected, and sometimes initiated by the will. The proverb that "the mind can kill and the mind can cure" not only illustrates a popular belief, but a physiological truth. When the will directs the power of attention to any object, it has already been shown that all the senses are sharpened in their attempt to carry out the directions of the will. Objects are seen and impressions recognized, which would not otherwise be noticed. In like manner, whatever is performed under the cognizance of the will, and especially whatever is performed in obedience to an express act of volition, is done with enhanced energy.

If physiology has not succeeded in exposing the process by which the will communicates with the body and secures obedience, it has succeeded in establishing the fact, that the results of the will are attained by indirect, and not by direct action. The will does not move the hand or the eye by directly communicating a force or stimulus to them, but by playing upon the ganglia, which automatically call into action the necessary nervo-muscular combinations. "No better illustration of this doctrine could be adduced, than that which is furnished by the act of *Vocalization;* either in articulate Speech, or in the production of musical tones. In each of these acts, the coördination of a large number of muscular movements is required; and so complex are their combinations, that the professed anatomist would be unable, without careful study, to determine what is the precise state of each of the muscles concerned in the production of a given musical note, or the enunciation of a particular syllable. Yet we simply *conceive* the tone or the syllable we wish to utter, and say to our automatic self 'Do this:' and the well-trained automaton does it. The delicate gradations in the action of each individual muscle, and the harmonious combination of the whole, are effected under the guidance of the Ear, without (save in exceptional cases) the smallest knowledge on our own part of the nature of the mechanism we are putting in action. In fact, the most perfect acquaintance with that mechanism would scarcely afford the least assistance in the acquirement of the power to use it. The 'training' which develops the inarticulate Cry of the infant into articulate Speech or melodious Song, mainly consists in the fixation of the Attention on the *audible result*, the *selection* of that one of the imitative efforts to produce it which is most nearly successful, and the *repetition* of this until it has become habitual or *secondarily automatic.* The Will can thenceforwards reproduce any sound once acquired, by calling upon the Automatic apparatus for the particular combination of movements which it has *grown into* the power of executing in respondence to each preconception; provided, at least, that the apparatus has not been allowed to become rusty by disuse, or been stiffened by training into a different mode of action."[1]

This illustration of Dr. Carpenter is an admirable description of the method by which the will influences, and perhaps operates the human

[1] *Mental Physiology*, by W. B. Carpenter, pp. 20, 21.

mechanism. Disease furnishes many illustrations of the same sort. The following incident, which came under the observation of the late Dr. John Ware of Boston, and was related by him to the author, as happily illustrates the power of the will over morbid processes, as that of Dr. Carpenter does its power over healthy ones. Miss X., a bright intelligent girl, eighteen or twenty years old, had an attack of bronchitis which involved not only the bronchi, but her larynx and vocal apparatus. The attack was not severe or dangerous, but prolonged, and refused to yield readily to treatment. After a time she lost her voice. At length the bronchitis improved, but the aphonia obstinately persisted, without any indication of relief. While Miss X. was suffering in this way, a notorious charlatan appeared in Boston, who cured diseases in the old ecclesiastical way, by laying of hands on the affected region. Multitudes followed him. His fame was great, and spread through all the region in the neighborhood of Boston. Numerous stories were told of his healing gifts, and of the wonderful cures he wrought. As generally happens in such cases, not only the common people and uneducated sought relief from him, but many intelligent persons were attracted to him. Some visited him, doubtless, from curiosity alone, but others were led by hope and faith as well. It was said that his hall was full of the crutches and canes of the rheumatic and infirm, who went thither stiff and lame, but who, cured by a touch and a word, left their artificial supports behind, as trophies of the healer's power, and walked away rejoicing and sound. The fame of the therapist reached the ears of Miss X. and her family, and excited in them the hope that he might restore her voice. After due deliberation, the consent of Dr. Ware was asked. This was readily given, and Miss X. repaired to the bureau of the dealer in cures. He heard her story, passed his hands somewhat roughly over her throat, told her to speak, and she spoke. Not long after she reported herself to Dr. Ware, who expressed much pleasure at the recovery of her voice, but did not seem to be surprised at the result. Miss X. was disappointed, perhaps a little nettled, by the Doctor's indifference. The aphonia, which was hysterical, did not return at once. Some time later, she called again upon Dr. Ware, and said to him: "Doctor, I wish to know the secret of the recovery of my voice. At our last interview, you did not look or speak as if you thought the laying on of hands had much to do with it." "I did not think so," was the Doctor's reply. He then endeavored to explain to her the physiological process, by which her will, stimulated by novelty and hope and faith, had acted almost with electric energy upon the affected nerves, and secured the fortunate result. A year passed by and then Miss X. had a return of bronchitis and aphonia. She again put herself under the care of Dr. Ware, who, again finding the treatment he employed ineffectual, himself proposed that recourse should be had to the charlatan. This was done. Miss X. repaired to the therapeutic bureau. The old process was repeated, and the old order given, but in vain. Her voice refused to return. The aphonia would not be exorcised. Once more she sought Dr. Ware, who, suspecting the real cause of failure, told her that in consequence of his previous physiological explanation, she had less faith than before, and had not on this occasion made sufficient effort. "Now," continued the Doctor, "if you choose, as you sit in that chair, to put all your will into the effort, and try with intense determination to speak, you will speak. Try it." "I will try," said Miss X. Determined, if will could do it, that there should be will enough, and reddening her cheeks in the struggle, she did her utmost to speak, and her voice returned and remained with her. In this instance, the will, playing upon the nervo-muscular centres of the complex vocal apparatus, acted as a powerful stimulant, and initiated the process of recovery.

Many other instances might be adduced of the power of the will to influence the causation and progress of disease, but those just given are sufficient to show its power, not only over the nerve centres in general, but also over those which are apparently quite out of its reach. There is probably no part of the body, which cannot be affected somewhat by volition. Even the lungs acknowledge its sway to a limited degree. Every one knows that he can accelerate or slow his respiration by a voluntary effort, though he cannot compel his lungs to cease from breathing permanently. The heart, which is rendered turbulent by emotion, sometimes and in some persons is obedient to the will. The familiar and celebrated case of Colonel Townshend is an illustration of the last statement. It is hardly necessary to quote the details of a case which is so well known. The Colonel, it will be remembered, told his physician, Dr. Cheyne, that he could stop the beating of his heart for a time and cause it to beat again whenever he chose to do so. Dr. Cheyne seeming astonished, perhaps incredulous, at such a statement, the Colonel proceeded to demonstrate its truth. He was sick and in bed, and the Doctor at his bedside. Presently the experiment began; the Colonel's breathing became slow, and the beating of his heart slow also. Both respiration and cardiac pulsation grew slower and slower, till they ceased altogether. No pulsation could be felt over the heart or radial pulse. A dry watch glass, held over the Colonel's mouth, gave no evidence of moisture. The Doctor thought that his patient was really dead. After remaining nearly half an hour in this condition, the Colonel's heart began to beat, his lungs to act, and he was alive again. Dr. Cheyne, who reported this extraordinary phenomenon, was in his day a physician of repute and knowledge, and one not likely to be deceived. Mr. Skrine, an

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apothecary, who was present, witnessed the occurrence and confirmed the accuracy of Dr. Cheyne's observation.[1] By the light which physiology has recently thrown upon the functions and power of the nervous system, it appears to be by no means impossible that now and then an individual might be found, whose heart could be controlled by the will, even to the extent of stopping its apparent pulsation.

These illustrations, and they might be multiplied indefinitely, are enough to show that the force of volition extends, with varying degrees of power, throughout the whole organization. The will, or Ego, who is only known by his volitions, is a constitutional monarch, whose authority within certain limits is acknowledged throughout the sytem. If he chooses, like most monarchs, to extend his dominions and enlarge his power, he can do so. By a judicious exercise of his authority, employing direct rather than indirect measures, he can make every organ his cheerful subject. If on the other hand, he is careless of his position, sluggish and weary of constant vigilance and labor, he will find his authority slipping from him, and himself the slave of his ganglia. It would be singular, if in a system so admirably arranged and harmoniously adjusted as this, the visual ganglia should be the only ones withdrawn from the influence and authority of the will. Or

[1] It should be remembered that, in England, an apothecary is not a druggist, but a general practitioner.

to change the figure, it would be singular, if in a mechanism of such harmony and perfection as the nervous system, the only part, withdrawn from the supervision of its engineer, should be a part so important as the visual apparatus. Such cannot be the case. On the contrary, the influence of the will guarded by appropriate limitations must extend beyond the eye to the tubercula quadrigemina, the angular gyri, and the ideational visual centres of the frontal lobes. That the Ego, who is known to us only as will or volition, can influence the process of vision is an inference from the preceding considerations which amounts to demonstration. This inference is not weakened, because the will sometimes or generally employs indirect, rather than direct measures for the accomplishment of its ends. If in order to produce an ideational picture in the frontal lobes, the will excites emotion, calls in the aid of association, and fixes attention and by these means compels the brain cells into forms which represent a picture, it is as much a factor in the visual operation, as if it did all the work itself. Under these circumstances it is the *primum mobile* — an initial force — a cause.

Evidence is not altogether wanting, not of an inferential character, that the will acts on the intracranial visual apparatus. From the nature of the case, the evidence cannot be of the experimental character, upon which the physiologist relies, nor of the pathological character, upon which the pathologist relies; yet it possesses a value, second only to that of physiological experiment and pathological investigation. The weight which should be attached to it depends in every instance upon the individual who gives it — upon its quality, and not upon its quantity. It is the assertion of individuals that they can produce subjective vision by their own volition and have done so. Such evidence can of course, be received only after the most careful scrutiny.

Two classes of persons make this assertion; children and adults. The evidence derived from the first class is the most valuable, so far as it goes, for children are unprejudiced in this matter, and have no theories to uphold. They tell their story unaware of its value or bearing. The evidence derived from the second class must be received with great caution. Adults have theories and love to be the subject of marvels.

Many children, especially very young children, possess the power, when they have closed their eyes in the dark, of surrounding themselves, by a simple act of volition, with a panorama of odd sights. The objects and persons evoked are not of a definite character, and are commonly queer and strange. They come in a throng, tumultuously, and disappear on opening the eyes. Most children who possess this power like to exercise it, and see the show, which they can call up in the darkness. Others are unwilling to exercise it, and are often afraid of going to bed in a dark room, on account of the crowd of ugly beings which come floating in the air around them as they try to go to sleep. De Quincey, who was aware of this peculiarity in children, speaks of it in connection with the effects of opium upon himself: "The first notice," he says, "I had of any important change going on in this part of my physical economy, was from the reawaking of a state of eye generally incident to childhood or exalted states of irritability. I know not whether my reader is aware that many children, perhaps most, have a power of painting as it were upon the darkness, all sorts of phantoms: in some that power is simply a mechanic affection of the eye; others have a voluntary or semi-voluntary power to dismiss or summon them; or, as a child once said to me, when I questioned him on this matter, 'I can tell them to go, and they go; but sometimes they come when I don't tell them to come.' Whereupon I told him that he had almost as unlimited a command over apparitions as a Roman centurion over his soldiers."[1] An acquaintance of the author, who is now between fifty and sixty years of age, says that in his childhood, after closing his eyes at night he could and often did, by an act of volition, call troops of queer forms around him. As years passed on and manhood approached, he lost the power of subjective vision, and though he has frequently tried since childhood, to people the darkness in the old way, he has never been able to do so. The subject of the fourth case of

[1] *Confessions*, etc., p. 109.

the preceding series, a most intelligent observer, says in her account: "My earliest recollections are of a life made miserable by the daily companionship of a crowd of dreadful beings, visible, I knew, only to myself." In her case the cerebral condition, which induces visions, was so pronounced that her childhood's atmosphere was inhabited with phantoms, whether her eyelids were lifted or closed. I retain myself at the present time, a vivid recollection of the sights which I was able to conjure up in childhood, in the darkness of evening or night, by shutting my eyes. I did not learn till after pseudopia had been produced by opium, in the manner previously described, that I possessed the power of voluntarily summoning such companions about me. It was only on rare occasions that I could do so by an act of volition. Generally, after closing my eyes, I was obliged to wait for the phantoms to come of themselves. Since childhood I have frequently endeavored to produce the same result, in the same way, but in vain. A lady now over seventy years of age, informs the writer that she was greatly troubled at night, during her childhood, with involuntary pseudopia. For a long time she believed the phantoms were realities, and sought to escape from them by pressing her hands firmly over both eyes, as the ostrich is said to avoid his enemies by hiding his head in the sand. As years passed on her phantom power disappeared, and now it exists only in her memory.

It will be noticed that this form of pseudopia, which may be appropriately called the pseudopia of childhood, is of two kinds, voluntary and involuntary, and that the latter predominates very largely over the former. The involuntary sort is doubtless what De Quincey calls "mechanic" in its character, that is, produced, as muscæ volitantes are, by changes in the contents of the globe of the eye, or by automatic cerebro-visual action. The voluntary sort is, of course, independent of any mechanical disturbance of the eyeball, and results chiefly from changes in the cerebral circulation. Both show how easily the delicate nerve centres of children may be disturbed; and, what is of more importance to our present purpose, both show that the brain can be made, without great difficulty, to put together the organic cell-representatives of pictorial ideas: for, although the objects seen are always of an odd, strange, indefinite, and perhaps frightful character, it is not to be denied that they are pictorial and that the brain produces them. It is also shewn by the evidence adduced that while the most of them are produced by a process of automatic cerebral action, others are the result of a process, into the initiation of which volition enters as a factor.

It is a matter of surprise that this phantom power of childhood has not excited more interest than it has done, among psychologists and physiologists. Its appearance in childhood, when the nerve centres are delicate, imperfectly developed, mobile, and impressible; its disappearance in mature years, when the nerve tissues are developed, harder, less mobile, and less impressible; and its reappearance at the very close of life, when, as dissolution approaches, the nerve centres are exceptionally disturbed, often producing visions of the dying; these phenomena are all curious, significant, and worthy of study.

Evidence derived from the second class of persons, or adults, as to the power of the will to produce objective pseudopia, is not easily obtained. Few possess any such power, though there may be multitudes who pretend to it; and those who possess it are neither fond of exercising it, nor of being questioned with regard to it. The subject of Case VII., a man whose large scientific attainments and careful intellectual training entitle his testimony to great weight, says, in his report of his own visions, that he was tempted to ascertain if he could not produce them by an act of volition, and adds: —

"I was particularly fond of statuary, and, after a few trials, succeeded in producing visions of statues by simply fixing my imagination strongly upon the memory of what I had seen, or upon what occurred to me, as a good subject for groups. I repeated the experiment, however, but few times, fearing it might lead to some injurious result."

Goethe could at will produce, for his own study and examination, subjective copies of pictures and works of art which he had seen. He describes his faculty of doing this in the following language: —

"As I entered my sister's house for dinner, I could scarcely trust my eyes, for I believed I saw before me a picture by Ostade so distinctly that it might have been hanging in a gallery. I saw here actualized the position of objects, the light and shade and brownish tints and exquisite harmony, and all which is so much admired in his pictures. This was the first time that I discovered, in so high a degree, the gift, which I afterwards used with more complete consciousness, of bringing before me the characteristics of this or that artist, to whose works I had devoted great attention. This faculty has given me great enjoyment, but it has also increased the desire of zealously indulging, from time to time, the exercise of a talent, which nature seems to have promised me." [1]

Nicolai of Berlin strenuously endeavored to induce pseudopia by an act of volition, but never succeeded in doing more than to bring before himself what he called phantoms; that is, he produced ideational cerebral pictures, but could not, as Goethe did, project them into space before him. Nevertheless, the testimony of so accurate an observer as Nicolai to the fact that he could, by voluntary effort, excite or modify to any extent, however little, his visual cerebral apparatus, is important.

The evidence presented, that volition is a factor in the production of pseudopia, and may initiate pseudopia, is cumulative, and not easily set aside. It is threefold. First: the inference, that as voli-

[1] *Aus meinem Leben Wahrheit und Dichtung*, Achtes Buch, Goethe's sämmtliche Werke, Stuttgart, 1863.

tion influences, directly or indirectly, by means of communicating nerves, every part of the organization where its action can be traced, it must also be connected with the intracranial mechanism of vision, and have some influence over that, though its action cannot be traced there directly. Second: the pseudopia of children demonstrates in them an influence over it of volition; and third: the assertion of two careful and unprejudiced persons that they could produce, and had produced, pseudopia in themselves by an act of volition. These facts warrant the conclusion that the will can influence the production of visions.

Before making any practical application of the physiological and other principles, which have hitherto occupied our attention, it would be well to present a brief summary of the course of thought which has been followed. The argument is this.

1. Such a number and variety of persons, everywhere and in all ages, have asserted their belief in visions, and have maintained, with every reasonable appearance and proof of sincerity, their ability to see visions, and the fact of having done so, that a presumption is raised in favor of the truth of their assertion; and, consequently, science is obliged either to disprove the appearance of visions altogether, or to give a rational explanation of such phenomena.

2. Eight cases of pseudopia, occurring in persons of education and intelligence, carefully ob-

served and recognized by the subjects of them as pseudopia, and recorded in this essay, confirm the presumption raised by the experience of mankind, and demonstrate the fact that visions occur.

3. The key to the explanation of pseudopia, or visions, is to be found by studying and comprehending orthopia, or the process of normal vision. Sight is not a function of the eye alone, but of a complex and delicate apparatus of which the greater part is lodged within the cranium.

4. This apparatus is composed of sections, each having its own centre, and being connected with the other centres by inter-communicating fibres, and in correspondence with the higher cerebral centres of perception, ideation, and volition.

5. Perception of visible objects, or consciousness of seeing, does not take place in the eye. This begins in the lowest of the intracranial visual centres; and in each ascending centre becomes of a higher character. Perception varies with the perceiving centre, and is highest in the frontal lobes, where it becomes apperception or thought.

6. Some account of the reflex or automatic action of the nervous system is given, so as to show how each ganglionic nerve centre is capable of independent action, and has its own consciousness without self consciousness.

7. The visual apparatus is normally operated by the stimulus of rays of light, falling on the retina from a visible object, and propagating an

action to each centre above, till the frontal lobes are reached.

8. In abnormal conditions, stimuli originating in the brain, without the presence of any external object, may excite any of the centres of the visual apparatus, and set the process of vision going from that point.

9. Every object, making an impression on the brain or visual apparatus, leaves an organic trace there, which may be reproduced at an indefinite period afterwards by cerebral action.

10. Pictures of external objects are not transmitted from the eye to the brain, but only visual reports of such objects. These reports are transmitted from centre to centre (telegrams), each centre employing for that purpose its own cell-groups and other contents.

11. Visual sensory impressions are carried up to the frontal lobes, and there translated into ideas. In rare instances, ideas may send down an influence, and be translated into sensory impressions in a lower centre.

12. Hence seeing is a matter of the brain, and not of the eye; the eye only transmits impressions.

13. The brain cells, acting under subjective stimuli, may arrange themselves in such a way as to represent a vision, that is sight, when no external object, corresponding to it, exists.

14. Various influences, as habit, association, attention, emotion, disease, blood changes, and voli-

tion may put the visual apparatus in motion and produce visions.

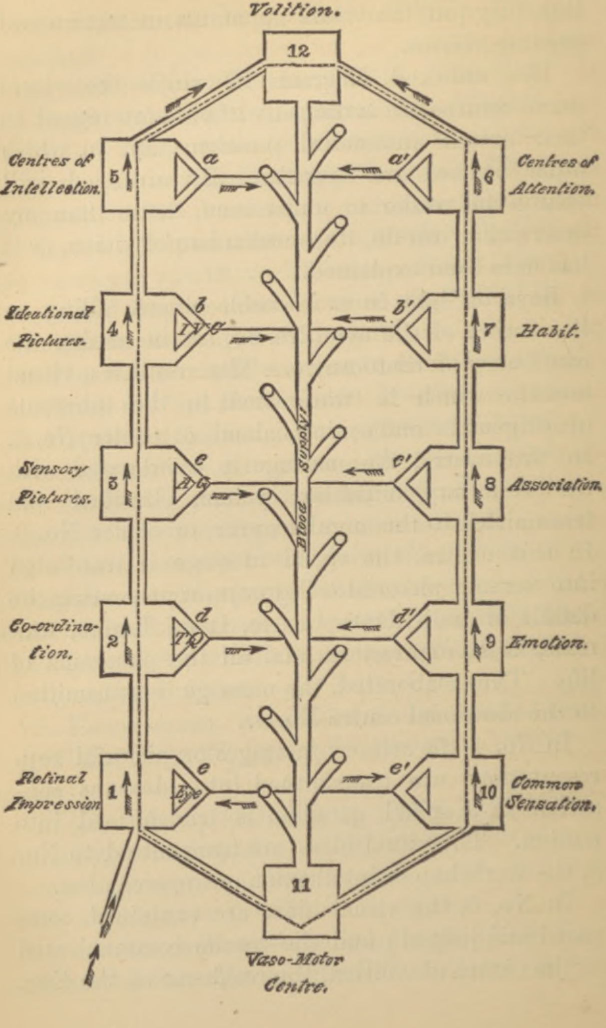
The annexed diagram, in which the visual nerve centres are arranged without any regard to their actual anatomical position, and in which other centres are hypothetically arranged, will enable the reader to understand, better than any description can do, the mechanism of vision, as it has here been explained.

Rays of light from a visible object, falling on the retina of the eye (No. 1), set in motion the machinery of that centre. The result is a visual message which is transmitted to the tubercula quadrigemina and optic thalami, or centre No. 2. In this centre, the message is coördinated with the voluntary muscular system, classified and transmitted to the angular gyrus, or centre No. 3. In this centre, the visual message is translated into sensory pictorial cell-groups, representing the details of individuals, houses, trees, flowers, animals, faces, expressions, and all the panorama of life. Thus elaborated, the message is transmitted to the ideational centre No. 4.

In No. 4 the sensory messages or pictorial representations are transformed into ideas, as sensation in a spinal ganglion is transformed into motion. The visual ideas are transmitted to No. 5, the workshop of intellection or apperception.

In No. 5, the visual ideas are examined, compared and judged; and the results communicated to the centre of volition, the residence of the Ego.

Fig. 4.


Volition.
12
Centres of Intellection.
5
a
a'
6
Centres of Attention.
Ideational Pictures.
4
b
b'
7
Habit.
Sensory Pictures.
3
c
c'
8
Association.
Blood Supply.
Co-ordination.
2
d
d'
9
Emotion.
Retinal Impression
1
e
Eye
e'
10
Common Sensation.
11
Vaso-Motor Centre.

The hypothetical centres of attention, habit, association, emotion, and sensation, numbered on the diagram 6, 7, 8, 9, and 10, are in constant and close communication with each other, with the centres of the visual apparatus, and with all the cerebral centres. Avenues of reciprocal communication are thus opened between all parts of the brain, by means of internuncial nerve fibres.

The vaso-motor-centre, No. 11, by its control of the calibre of the arterioles, regulates the supply of blood, so that more or less blood is furnished on demand to any one of the centres, or to all of them, or to the whole brain.

No special centre is assigned to memory, for each organ, or centre, or faculty, to use a metaphysical term, has its own memory. Each cell makes and keeps its own record.

The centre of volition, No. 12, is in connection with every organ, centre and cell, of the cerebro-spinal system. All report to it. It acts with greater or less energy on all.

**Explanation of Diagram.—1, The Eye. 2, Tubercula Quadrigemina. 3, Angular Gyrus. 4, Ideational Visual Centre. 5, Centre of Intellection or Apperception. 6, 7, 8, 9, 10, are the Hypothetical centres of attention, habit, association, emotion, and common sensation (sensorium commune). 11, Vaso-motor centre of cerebral blood supply. 12, Centre of Volition. The dotted line indicates the connection of all the centres with volition. The arrows indicate the course of visual rays. aa′, bb′, cc′, dd′, ee′, nerve fibres connecting the centres with each other.**

## PART II.

The considerations presented in the first part of this essay have prepared the way for a rational and satisfactory explanation of all forms of pseudopia, and to some extent have anticipated that explanation. They have also prepared the way for an application of the principles here expounded, to medicine, legal medicine, and psychology, and to some of the demands upon the faith of mankind, made by religion and spiritualism and individual enthusiasts — visionists.

The key to an explanation of pseudòpia is the fact, which has been repeatedly stated and emphasized in these pages, that sight is not a function of the eyes but of the brain. Human sight is not accomplished till sensory impressions are transformed into ideas, and this is done in the hemispheres. When this is done — when the organic basis of visual ideas is formed there, seeing takes place, whether there is any corresponding external object or not. A vision is produced whenever the cell groups, indicating that vision — its hieroglyphic or cipher — are formed in the brain, whether they are formed normally, by the stimulus of light waves from an external object, or abnormally, by a stimulus initiated intracranially.

There appear to be four ways by which visions may be induced, of which three are pointed out by the philosophic observer, who, himself the subject of one of the preceding cases, derived his conclusions from his own experience. The four ways are these. First, the normal and ordinary way, by which waves of light from a visible object falling on the retina of the eye (Fig. 4, No. 1) set the whole visual apparatus in motion, in the manner already described, producing sensory vision in the angular gyri, and ideated vision higher up. The movements of the visual apparatus, vibrating along the nerve fibres, as roughly indicated by arrows in the same figure, act simultaneously on the centres of attention, association, habit, emotion, volition, and the like. Second, an abnormal and simple automatic way by which a stimulus from without (objective), as a shadow, or a stimulus from within (subjective), as opium, striking when objective, the retina of the eye, when subjective, one or more of the intracranial centres (Fig. 4, Nos. 2, 3, or 4), initiates a customary sort of motion in the visual apparatus, which determines the apparatus to produce of itself, automatically, the cell-groups and modifications, that is to go through an habitual action, representing some external object. By this process a vision is produced. The process is like the automatic walking of a somnambulist, when a sound, or movement, or dream, has started him upon his unconscious peregrinations. Third, an abnormal and complex automatic way, by which attention, association, habit, emotion, volition, and cognate forces (Fig. 4, Nos. 6, 7, 8, 9, 10, 11, and 12), stimulated subjectively or objectively, play upon the visual apparatus, till they compel one or more of its centres into activity. When this is accomplished, the automatic action of the visual apparatus reinforces the automatic action of the forces just mentioned, and under their combined influence, cell-groups and modifications are finally formed, which, being the organic basis of a previously known object, person, or scene, vision is produced. As soon as the subjective vision is produced the object or person represented is projected into space, and seen as if present there. In this way, intense emotion brings out under favorable conditions and before impressible persons, the faces and forms of the dead. Fourth, an abnormal and volitional way, by which volition (Fig. 4, No. 12), stimulated to the highest degree, and summoning to its aid fixed attention, association, habit, emotion, and all other forces at its command, plays with its utmost energy upon the angular gyrus (Fig. 4, No. 3), or some other centre, and drives its machinery into operation. If this can be accomplished, vision is accomplished. The gift which Goethe said nature bestowed upon him, by which he was able to reproduce, voluntarily, familiar pictures and project them into space before his eyes, is an illustration of this rare form of pseudopia. These four sorts of visions may be appropriately designated as follows: (1.) orthopia; (2.) simple automatic pseudopia; (3.) complex automatic pseudopia; (4.) volitional pseudopia.

The first of the preceding series of cases, the one in which pseudopia occurred in connection with delirium tremens, belongs to the class of complex, automatic pseudopia. The subject of it saw, it will be remembered, during convalescence, in the daytime, and in the presence of the writer, a black dog, which, standing on a bureau, leaped upon the floor and disappeared. At another time, he mistook his wife for a burglar. On both occasions, he recognized the subjective character of his visions. So natural were the appearances, however, that if his previous experience had not convinced him of the untrustworthiness of his eyes, he would have entertained no doubt as to the presence of a dog at one time, and a burglar at another.

The physiological explanation of his visions is not difficult. He had taken alcoholic drinks sufficiently long, and in sufficient quantity to produce delirium tremens. This affection does not come on after one potation, however large, or after several potations. It appears only after alcohol has been taken continuously for a considerable period, and when, as a result of thus soaking the brain in spirits, an organic change has taken place in the cerebral tissues. All the nerve cells are affected. The derangement of the motor centres is shown by tremors, muscular weakness, and locomotor disturbance ; that of the auditory centres, by unearthly noises and strange cries, which beset the victim; that of the olfactory and gustatory centres, by whims of smell and taste; that of the ideo-motor centres, by phantasies ; and that of the visual centres, by subjective visions. Groups of cells and cell modifications, with which the brain has long been familiar, are thrown confusedly together in the brain of the drunkard, upon the least hint afforded by the character of his surroundings, and become the organic representatives of visions, which are as confused, unmeaning, and strange, as the cell groups themselves. "The perceptions," says Hammond, "the emotions, the intellect, and the will are all implicated to a greater or less extent."[1] Such was the condition of Mr. C.'s brain. In this condition, rays of light from some ornament on his bureau, falling on the retina, called out in one of his visual centres, probably in the angular gyri, cells which were part of a sensory group, stowed away in his brain, as the representative of a familiar black dog. These cells, aided by habit and association, called around them other cells, accustomed to cluster together, whenever the black dog appeared. Soon, by action and reaction, the representative group was formed, and consequently the appearance of a dog telegraphed to the centres above, which accepted

[1] *Diseases of the Nervous System*, p. 851.

the report as correct. The picture of the animal was then projected into space, and the vision accomplished. By a similar process, his wife became a burglar. He had been a soldier, and had commanded troops in active service for years. Life of the camp, the march, and the battle had stored away in the recesses of his brain numerous sensory cell groups, the organic souvenirs of ugly faces, rascals, and villains. Something about his wife's dress started up the first cell, or cell group, belonging to some scamp he had seen; that cell started up a companion one, and soon the whole thing went of itself, so that the vision of the burglar was complete. The elements of Mr. C.'s alcoholized brain were in an unstable condition readily thrown into strange and unnatural groups, which were as readily dissolved again. His will had as little control over them as over his locomotor apparatus. His sensory and ideational and volitional cells were as weak and shaky as his motor ones.

The pseudopia of Mr. C., due to poisoning of his brain by alcohol, not only illustrates one of the results of alcoholic poisoning, but may be taken as an illustration of a similar cerebral condition, induced by the illegitimate use of a number of other drugs. The visions of opium, ether, chloroform, cannabis Indica, belladonna, and kindred articles, of which the cerebral action has been noticed, belong to the class of complex automatic pseudopia. Although these agents possess an elective action for one part or function of the intra-cranial mass in preference to other parts or functions, yet they affect all parts somewhat. They appear to act with peculiar energy on the visual and ideational centres, and also to disturb other parts, so that the force with which volition, attention, sensation, habit, association, and emotion play upon the visual mechanism and frontal lobes is sometimes increased, sometimes diminished, and always irregular.

There are two or three points with regard to the vision power of these drugs, which were not mentioned when they were previously considered, and which may be appropriately described here.

The physiological action of opium is properly divided by those who have investigated it, into two stages; a primary stage of stimulation, and a secondary stage of depression. In the primary stage, the functions of the nervous system, and especially those of the cerebrum, are exalted; in the secondary stage the same functions are depressed. The primary stage is the delight of the opium eater; the secondary stage is the one chiefly employed by therapeutists. During the period of exaltation, the visual machinery and ideo-motor apparatus are stimulated to extraordinary activity, and sometimes produce extraordinary results. The action is so clearly automatic, that the opium lover seeks to retire alone, by himself, and watch and enjoy the shifting movements of his cerebral panorama, as if they were the scenes of a play. The writer's opium experience in childhood, to which reference was made in connection with the report of Mr. C.'s case, confirms this statement. He recalls distinctly the passive condition in which he used to lie and wait for the show, as if he were only a spectator. De Quincey, whose account of the action of opium should not, as was previously hinted, be trusted too implicitly, vividly and accurately describes, in the following language, the power of opium to reproduce, automatically, the past: —

"As the creative state of the eye increased, a sympathy seemed to arise between the waking and the dreaming states of the brain in one point, — that whatsoever I happened to call up and to trace by a voluntary act upon the darkness was very apt to transfer itself to my dreams; so that I feared to exercise this faculty; for, as Midas turned all things to gold, that yet baffled his hopes and defrauded his human desires, so whatsoever things capable of being visually represented I did but think of in the darkness, immediately shaped themselves into phantoms of the eye; and, by a process apparently no less inevitable, when thus once traced in faint and visionary colors, like writings in sympathetic ink, they were drawn out, by the fierce chemistry of my dreams, into insufferable splendor that fretted my heart."

From this exaltation, the primary stage of the action of opium, he passed to the secondary one of depression, which is thus described: —

"For this, and all other changes in my dreams, were accompanied by deep-seated anxiety and gloomy melancholy, such as are wholly incommunicable by words.

I seemed every night to descend — not metaphorically, but literally to descend — into chasms and sunless abysses, depths below depths, from which it seemed hopeless that I could ever reascend. Nor did I, by waking, feel that I *had* reascended. This I do not dwell upon; because the state of gloom which attended these gorgeous spectacles, amounting at least to utter darkness, as of some suicidal despondency, cannot be approached by words."[1]

The importance of this statement consists in the distinctness with which it brings into view the automatic action of the visual and ideational apparatus, and so far confirms the explanation which has been given, of Mr. C.'s vision of the dog and burglar, an explanation applicable to all similar visions.

The explanation of the intense enjoyment which some derive from opium eating may be found in its stimulating the creative power of the brain. F. W. Faber says, in one of his letters, "The greatest pleasure of life arises from the felt sense of power: the greatest intellectual pleasure is the sense of intellectual power: for creative energy is clearly the most luxurious, and it is power solely." This is not the language of exaggeration. The creative force which opium stimulates is that of re-creating the past; and in doing so, it yields a pleasure second only to that which attends the exercise of original creative energy. Let no one im-

[1] *Confessions, etc.*, pp. 109–10.
[2] *Life and Letters of F. W. Faber*, p. 45.

agine, however, that by means of opium he can extract from his brain anything beyond what is native to it, a fact which did not escape the notice of the brilliant author of the "Confessions." A butcher, who takes to opium, will probably dream of oxen, and see pictures of beef; a poet will be transported to the dreamy splendors of Xanadu and Kubla Khan. Wind touching an Æolian harp will call forth, not the notes of an organ, flute, or viol, but the strains of a harp. Blood charged with opium, and flowing through the delicate chords of the brain, will not make them vibrate with the ideas of Plato, Shakespeare, Goethe, or Emerson, but only with those of the experimenter.

The reason for dwelling at considerable length, in the first part of this essay, upon the reflex, or automatic power of the nervous system is now apparent. It was necessary to acquire a clear and definite notion of that power, and its modus operandi, before it could be shown that the visual centre and other centres of special sense are obedient to it, and that it is capable of explaining the appearance and mechanism of visions. The whole visual apparatus may be regarded, from this point of view, as a single ganglionic nerve centre. In orthopia, a visual stimulus, consisting of the motion of waves of light, impinges upon it from without, through the eye, objectively, and is transformed into sensory and ideational pictures; and these into ideas, a reflex action, automatic, just as sensation, transformed by a spinal ganglion into motion, is a reflex action. In pseudopia the only difference is that the visual stimulus, which impinges on the visual apparatus, and causes the transformation of sensory into ideational action, comes from within the head. In both cases, reflex machinery is put into operation, and is worked by ganglionic nerve power. In Mr. C.'s case, his alcoholized visual centre, catching a shadowy hint, as previously described, from without, and aided by an alcoholized brain, transformed the hint by reflex action into a black dog.

Allusion has been frequently made throughout these pages to sensory and ideational pictures. They are not the same, and it is important to acquire a distinct notion of the difference between them. The following incident will illustrate the difference better than a formal description. Some months ago, I had occasion to take an average dose of laudanum, at night, for the relief of pain. The desired relief was obtained. I was surprised the next morning, however, to see, on awaking, hanging up on the wall of my chamber, near the ceiling, a mask or masked face of very large proportions. After a moment's amazement I remembered the previous night's dose of laudanum, and my childhood's paregoric visions, and recognized in the mask one of the pranks of opium, but I had not time to get more than one good look at the object before it vanished. During the day I tried in vain to make out what the mask was which opium had picked out of my past experience. I could not remember ever to have seen its like. Reflecting upon the pseudopia the next day, I endeavored to recall it in all its details. I could remember how it looked, and bring before me a clear idea of it, but I could not project it into space. While doing this, it suddenly flashed upon me that it was the Greek mask of Tragedy which had obtruded itself into my field of subjective vision, and so it clearly was. The first picture — the pseudopia — was a sensory one; the second, which memory gathered up, was an ideational one. The organic basis of the first was doubtless a group of long disused cells in the angular gyri ; the organic basis of the second, a group of cells in the frontal lobes. The sensory picture was projected into space ; the ideational one remained an idea. The probable explanation of this pseudopia is, that in the early morning light, the brain still muddled and unstable in consequence of exposure to opium, a ray of light shot from a figure on the wall paper to the retina, which stimulated the visual apparatus to reproduce the cell group of a mask, seen in a theatre or elsewhere, and that group automatically called out cells enough to complete the picture.

Subjective sights and sounds, flashes of light and strange noises, often occur in epilepsy. They commonly immediately precede an approaching paroxysm, and give warning of it. In rare instances true pseudopia is manifested, and when such is the case, the patient can only be persuaded with great difficulty to distrust his own eyes. It is not long since an epileptic was found in England, quietly sleeping off a convulsive paroxysm on a public road, by the side of a man he had killed. Why the crime was committed could not be ascertained, but it is probable that the murderer was deceived by pseudopia, preceding a convulsion, into the commission of the deed. The visions of epilepsy, like those of delirium tremens, evidently belong to the class of complex automatic pseudopia. They are well illustrated by the second of the preceding series of cases, in which there were visions of a man on horseback in a flower garden, of flowing water, soldiers, flocks of animals, and other objects. The process by which these visions were produced is not so apparent as in the first case, but a shrewd guess may be made with regard to it.

The pathology of epilepsy is not yet well ascertained. Sometimes it results from the reflex disturbance of eccentric irritation, like teething, or the presence of foreign matters in the alimentary canal; sometimes, from an irritant within the cranium, as a spiculum of bone; and sometimes from disease of the highest nerve centres. It frequently occurs, however, when nothing can be discovered after death to account for it. Recent researches indicate, if they do not demonstrate, that the vaso-motor nerves, by their influence in suddenly and temporarily producing anæmia, or hyperæmia, of the sensorium, lead to epileptic convulsions. Such sudden disturbance of the sensorial circulation would be sufficient to account for the visions of epilepsy, as well as for epilepsy itself. Irritation of the vaso-motor centre, by producing contraction of the arterioles, would induce anæmia of the sensorium, congestion, or sufficient pressure upon the same centre would lead to an opposite state of the arterioles, and consequently to hyperæmia of the sensorium. In both cases the blood supply, the vast importance of which has been pointed out, would be suddenly and seriously changed. The influence of this can be scarcely overestimated. The intimate anatomical connection of the visual apparatus with the sensorium is such that whatever affects the circulation of the latter, reacts at once upon that of the former. It would be strange, when any such disturbance occurs, if now and then a group of old visual cells should not be thrown up into the field of subjective vision, and attract to itself associated groups, which would excite the automatic action of the visual machinery to produce a complete vision. In this case, sensory pictures rather than ideational ones would be formed, and would be likely to appear and disappear with changes in the circulation.

The doctrine that perception is centric, and not eccentric, which is here applied to the visual apparatus in explanation of the appearance of visions, is not confined in its application to that apparatus. On the contrary, it is the application of a general physiological law to the process of vision. It is not unusual, for example, for an individual to complain, weeks, months, or years after the amputation of a limb, foot, or hand, of pain in the amputated part. The sensation has been so strong in some instances, that a foot or hand which had been laid peacefully away has been dug up, in order to ascertain if there were not something torturing it. The accepted and demonstrated explanation of this physiological phenomenon is the same as the preceding one of pseudopia. When pain occurs in a toe or finger, the fact is telegraphed to the spinal centre of the affected member, and from thence to the appropriate cerebral centre. Perception of the pain takes place in the brain and is projected to the periphery. Let T., S., and C. represent the toe, its spinal centre and cerebral centre respectively. Pain occurring in T. is telegraphed to S., and thence to C. The office of S. is to send telegrams from T. to C. In case of the destruction of T., by amputation of the foot, pain may be felt in S. or in C., in consequence of irritation in those centres, at any indefinite period after the operation. When felt in either of those centres it will be referred to T., whether the latter is attached to the body or lies at the bottom of the ocean. The general law is that in a certain class of cases, pain perceived at the centre is referred to some point in the circumference. The analogy between this and the previous explanation of pseudopia is evident, and it lends additional confirmation to the truth of the explanation.

The third case, that of Mrs. B., is remarkable for the distinctness of the vision, for its appearance by daylight, and for the sort of personal identity which the phantom sustained. From the fact that it appeared only in connection with some general febrile disturbance, it is evident that it belonged to the class of complex automatic pseudopia, and admits of the same explanation as others of that class. It should not be forgotten that headache frequently acompanied Mrs. B.'s febrile attacks, and sometimes proved to be a warning of the approach of her ghostly friend. It is impossible to gather from her account the details of the process, by which old and disused cell groups were so completely revived. All the conditions, however, for the production of pseudopia were present. She was naturally endowed with an excitable and nervous temperament. She witnessed in childhood an occurrence — a death — under circumstances of distress and horror, such as are seen by few, and which made a profound and permanent impression upon her. Her emotions were excited, at the time, to such a degree, that she could never afterwards allude to the event without distress. Later in life she became subject to the febrile attacks just mentioned, which were attended with slight cerebral congestion. At such periods the brain cells, including those of the visual apparatus, were temporarily flushed with blood, and therefore just in the state to be called into activity by the slightest stimulus. It is probable that her pseudopia was, in some recondite way, connected with the terrible occurrence she witnessed in childhood, though she could never make out the chain of connection. However that may be, it is apparent that whenever the current of blood poured freely through the machinery of vision, cell-groups, which had been deeply stamped by some scene of which the phantom figure was the outcome, were revived; and as soon as this was accomplished, association, habit, and allied influences, playing on the visual apparatus, would set its automatic machinery at work, and produce her customary pseudopia.

The next case, which is reported by Miss ——, the subject of it, is an illustration of what may be called a pseudopic habit. Pseudopia occurred with her in childhood, to such an extent as to torment her; then ceased for a while; and later in life returned. Her case, like the previous ones, is an instance of complex automatic pseudopia, not only the visual apparatus, but the whole cerebrum being implicated. It is not difficult to give a satisfactory physiological explanation of her visions. She was congenitally endowed with a sensitive nervous organization, and in childhood exhibited an unusual proclivity to the pseudopia of that age. The hard experience of anxiety, long illnesses, sorrow, and bereavement, to which she was exposed in later years, had a tendency to develop, rather than repress the idiosyncrasies of her nervous system. Her emotional nature was sorely exercised, and sorely tried. Great anxiety and exhaustion predisposes to visions, just as starvation makes its victims dream of savory repasts, and tables loaded with food. Miss —— was often exposed both to anxiety and exhaustion, and she herself notices in her report that visions beset her only or chiefly when she was anxious or exhausted. The cells of her visual and other nerve centres were then in their most mobile and sensitive state, readily gathered into groups, by any stimulus however slight, and became the basis of sensory and ideational conceptions. Under such circumstances, automatic action would exercise its largest, and volition its least control. The frontal lobes would partake of the disorder, so that her power of analysis and correct interpretation would be weakened, if not temporarily destroyed. In this condition, a shadow from the wall, or from a curtain fold, or group of clothes, or from almost anything would be sufficient, reaching a visual centre, to stimulate it into activity, and pseudopia would result. The figure which Miss —— saw was undoubtedly formed in this way. Some slight stimulus acted on her visual apparatus, the automatic action of which produced the sensory cell-groups of the figure and projected it into space. It was actualized. She saw it though it did not exist. Sir Walter Scott, in his "Demonology and Witchcraft," describes a vision of Lord Byron, initiated in this way, with which he was favored, and which he had the insight and good sense to explain correctly: —

"Passing from his sitting-room into the entrance-hall, fitted up with the skins of wild beasts, armor, etc., he saw right before him, and in a standing posture, the exact representation of his departed friend, whose recollection had been so strongly brought to his imagination. He stopped for a single moment, so as to notice the wonderful accuracy with which fancy had impressed upon the bodily eye the peculiarities of dress and posture of the illustrious poet. Sensible, however, of the delusion, he felt no sentiment save that of wonder at the extraordinary accuracy of the resemblance, and stepped onwards towards the figure, which resolved itself, as he approached, into the various materials of which it was composed. These were merely a screen occupied by great coats, shawls, plaids, and such other articles as are usually found in a country entrance-hall. Sir Walter returned to the spot from which he had seen this product of what may be called imagination proper, and tried with all his might to recall it by the force of his will, *but in vain*."

Dr. Tuke, in his "Mind and Body," reports an instance in which, by virtue of what he called sympathetic emotion and attention, a number of persons were made the victims, in spite of their eyes, of the same deception, at the same time, and from the same cause: —

"During the conflagration at the Crystal Palace in the

[1] Quoted by W. B. Carpenter, *Mental Physiology*, p. 207.

winter of 1866–1867, when the animals were destroyed by the fire, it was supposed that the chimpanzee had succeeded in escaping from his cage. Attracted to the roof, with this expectation in full force, men saw the unhappy animal holding on to it, and writhing in agony to get astride one of the iron ribs. It need not be said that its struggles were watched by those below with breathless suspense, and, as the newspapers informed us, "with sickening dread." But there was no animal whatever there; and all this feeling was thrown away upon a tattered piece of blind, so torn as to resemble, to the eye of fancy, the body, arms, and legs of an ape."[1]

It is worthy of notice, that in this case and the preceding one, the pseudopia was distinct by daylight, showing how closely it may imitate orthopia. The imitation may be so exact as to render it impossible to distinguish one from the other except by applying the correction of another sense, or by comparison with the sight of others. The instance just quoted from Dr. Tuke shows that the later form of correction will not always detect the error. As a rule, however, it is not difficult to detect pseudopia, whenever an intelligent and honest effort is made to do so.

The next case of the series is the celebrated one of Nicolai, of Berlin, quoted from his own report. It presents several points of great interest, alike to the psychologist and physiologist. It is one of the rare instances, in which both the eye and the

[1] *Mind and Body*, Am. ed.

ear were deceived simultaneously. Nicolai saw human forms projected into space before him, and heard them speak. Thus two senses conspired to deceive their owner at the same time. Notwithstanding this, he was not duped. He recognized the error of his eyes and ears, carefully observed the pseudopia, and recorded his observations. This occurred more than one hundred years ago, and indicates a degree of physiological sagacity, philosophic thought, and absence of superstition, remarkable for the age in which he lived. His explanation of his visions is far in advance of the science, and, it may be added, of the theology of the last century. The persistence of the pseudopia and pseudotia, and their evident connection, as in the case of Mrs. B., are important physiological facts. They show that the cells of the sensorium, and of the higher nerve centres, may acquire a chronic facility for grouping themselves into old forms. At the present time, aided by the light of modern physiology, his visions admit of a satisfactory solution. Without any doubt, Nicolai saw and heard what he described, but his seeing and hearing were all purely subjective.

It appears that Nicolai's emotional nature had been stirred to its lowest depths, not long before he was visited by the visions he describes. As the inevitable result of such violent perturbation his sensorial and ideational nerve centres were thrown into a disturbed, excitable, and sensitive state. As a cause or consequence of this, the vaso-motor centre dilated the blood-vessels confided to its care, and let in an unusual flow of blood. A group of cells was formed, probably in the angular gyri, which, influenced by association, emotion, habit, and the like, stimulated the automatic action of the visual apparatus to such a degree, that it revived other cell-groups, accustomed to appear together, till at length the cipher or hieroglyphic of his deceased friend was revived. As soon as this was accomplished, pseudopia was produced. Under the same influences, acting now with increased power, and to which was added undoubtedly the force of expectant attention, the vision was projected into space, and the phantom stood forth before the amazed observer, in human shape. The auditory centres, according to the experiments of Ferrier and others, are anatomically near the visual centres. Sound, like light, is a form of motion, and its perception, like the perception of light, is subjective, not objective. Wherever human forms are seen, human speech is commonly heard. The human voice goes with the human form. And so in the brain, when visual cell-groups which represent human forms are called together by orthopia, cell-groups which represent human speech are apt to be called together, at the same time, in the neighboring auditory centres. In the case of Nicolai, habit, association, and expectant attention, intensified by emotion, would unite, as his vision continued to appear, to act energetically on the automatic machinery of hearing. At length, their influence was such as to set the auditory apparatus in motion. Auditory cell-groups were formed, and speech was heard, which was inevitably projected out to the figures before him. Thus the united automatic action of his visual and auditory apparatus completed the vision. He saw distinctly, but there was no form. He heard, but there was no voice.

The voice which Nicolai's friend, Mendelssohn, heard after the experience of intense emotion, is of course to be explained by these physiological principles. His auditory cells assumed automatically the shape corresponding to sound.

Nicolai's cerebral congestion was apparently relieved by depletion; and after the congestion was removed his visions ceased. Such was probably the order of occurrences. Hyperæmia and anæmia of the brain will produce almost any sort of functional derangement of the intracranial organs.

The following case, which, like that of Nicolai, illustrates a condition of the brain, probably a state of congestion, capable of producing pseudopia, was kindly communicated to the author by Dr. S. Weir Mitchell of Philadelphia, the distinguished physiologist and neurologist. The subject of the case was a lady, and the report, given in her own language, is in answer to a request for it from Dr. Mitchell, who vouches for the unquestioned trustworthiness of the reporter. "After a long interval," says Mrs. ——, "an interval indeed of years, I recall the 'visions' of the illness you refer to as vividly as though but a few hours had passed since I was first conscious of them. It hardly needs even an effort of memory to see again with startling distinctness the endless procession of tiny men, who floated across the upper part of the wall of my bedroom opposite the bed where I lay. They entered the room by the transom above the door in couples, perfect little men, tiny in form, with cheery bright faces; long fair hair hanging about their brows and down their shoulders; they were dressed all alike in vivid green short-clothes, with long straight waistcoats and deep cuffs; they came from the time when I saw them first until I slept; and even sometimes in sleep I dreamed of them carrying, as they always did, each one, a heavy pickaxe, — and a coffin, covered with crimson cloth. The coffins were borne between two of the tiny men, who walked always with their bright little faces turned smilingly toward me, but carrying their strange burden with exceeding care. Endless as this procession seemed, as it entered on one side and passed through the end of the wall on the other side of the room, as on the stage of a theatre figures disappear behind a side scene, I had one means, but only one, of arresting their movement and staying the numerous little figures in their wearying march. When I counted them *they stood still*, and just so long as I continued to count them, audibly, which I would do day after day until strength and utterance failed me, they remained motionless, resuming their movement the moment the voice ceased to repeat the numbers. They were never affected by conversation, no matter how much I might myself be interested in it. The drift of the procession swept on and on, until I once said, wearied almost to death by the persistent pressure of its members, to my physician, 'I believe I am going mad.' But one day when my illness had increased, and I was worn by the long continuance of pain and wearisome sleeplessness, I saw a sudden change sweep with startling swiftness over the faces and dress and burdens of my tiny visitors. Looking steadily at me as they always did, the bright cheery faces suddenly changed and shrivelled, growing sad and worn and colorless, like the faces of old men. There was a sudden eagerness and hurry in their movements, contrasting strangely with their former steadiness, if not absolute repose, as each one setting down hurriedly the coffin he held, — drew over his bright green clothes a heavy overcoat of dark brown cloth. The coffins, so tiny but so distinct, seemed to grow suddenly heavy, and changed from vivid red to black. The movement of the procession, when at last it was resumed, was no longer rhythmical, but jolting and hurried and confused. This condition of my little visitors lasted through the entire day and night. I hailed it as a welcome change, when on the next morning I found my little men once more in their original clothing, their ruffled hair all smooth and shining, the little faces cheery and bright, and once more the crimson coffins carried by them in serious but rapid procession as at first. This 'vision' remained with me long after I left my sick-room, returning with any undue exertion or fatigue, dying out with intermissions of hours, then of days, and at last ceasing altogether."

The following comments were made by the reporter herself: "1. I had seen this vision many times before I was willing to speak of it to my physician. 2. I have said that the figures *floated across my room.* I think this is slightly inaccurate, they moved as though on a firm but hilly road, marching steadily, but following the wall in its rise or fall. 3. When I lay with my eyes shut, I still saw the procession as through the eyelids. 4. In *dreaming* of them, I saw them as one sees objects in ordinary dreams, not with the sense of *creating* the objects but simply enumerating them."

The next case, that of Mr. A., is as interesting and peculiar as that of Nicolai, and formerly would have been as inexplicable. Mr. A. saw three figures in his chamber at night, and heard them sing a number of songs, for about an hour and a half, when his servants could not hear or see any one. Here again two senses, seeing and hearing, were deceived simultaneously. This is unusual; but the marvel is not, when visions occur, that this sort of double deception should be rare, but that it should not occur oftener. *A priori*, it would seem, if subjective vision created a human form, that subjective hearing should endow it with speech. The physiological principles, which have been here discussed, afford a rational explanation of Mr. A.'s vision also. He was an ardent lover of music, and a frequenter of concerts and musical entertainments. During a long life his brain cells had been often grouped together at the sound of music, and at the sight of musical performers. The same groups must have been formed repeatedly, both in his visual and auditory apparatus. For some time before his vision, he began to suffer from cerebral difficulties, of which one of the prominent symptoms was a sense of pressure in the head. There was more or less cerebral congestion, and he finally died of disease of the brain. All these conditions were favorable to functional derangement of his nerve centres. It is conceivable that any sort of cell-groupings, or cell modifications, might occur under these circumstances. The slightest stimulus would be sufficient to put in motion the whole, or a part of his intracranial machinery. He went to bed and fell asleep. While sleeping, the notes of a serenade, or the whistling of a boy in the street, or the vibration of distant music, or even the excitement of a dream, would be enough to rouse his automatic cerebral apparatus into musical activity. Just as the pricking of a finger will rouse that finger's appropriate spinal ganglion sufficiently to move the wounded member, automatically transforming sensation into motion, so a rhythmical vibration, touching Mr. A's. auditory ganglia, roused them into activity, transforming sensation into ideation. His visual and auditory centres had acquired the habit, in musical matters, of acting together. Like a pair of old family horses, which had trotted in each other's company for a lifetime, till each had acquired the habit of starting out with the other, without much regard to the coachman's call, so Mr. A.'s sight and hearing were trained to the mutual enjoyment of music. One had accompanied the other, for a long life, to concerts and musical gatherings, and each expected to be employed when the other was. As soon, therefore, as some stimulus, however slight, had set the chords of his auditory apparatus into automatic action, producing subjective sound, his visual nerve centres were sympathetically aroused, and soon produced subjective vision. It will be remembered that he heard sounds, apparently in the street, before he saw any one. His auditory apparatus functionated first, and it was not until after the lapse of a considerable interval, that his visual apparatus followed its example. As soon as this was done, the two processes went on harmoniously together. It should be observed that Mr. A.'s vision resembled, in many respects, concerts with which he was familiar. There were performers, dressed after the orthodox fashion of musical artists, who cleared their throats, and got up and sat down in the most approved way, and seemed to do all the little nothings, necessary to occupy the interludes. The time occupied was about the length of an ordinary concert, and the selections were familiar to him. It is not probable that any particular concert was rehearsed before him, but that bits of one concert followed bits of another, — a composition, not a copy, — just as the revival of one set of musically stamped cells led to the revival of another. The pseudopia was not repeated, and in Mr. A.'s condition it was not likely to be. The congestion, which yielded blood enough to the visual and auditory apparatus to enable them to go through these abnormal performances, increased. Stupor supervened, and Mr. A. died. His suspicions were correct that his vision, a compound of pseudopia and pseudotia, was a warning for him to "step out." During this singular occurrence, and after it, he was so little moved, emotionally and intellectually, that the vision should be classed as simple automatic pseudotia. His visual and auditory mechanism seemed to act, as far as possible, independently. Groups of old visual and auditory cells moved in and out of his field of seeing and hearing, and were telegraphed to his ideational centres, as honest reporters of objective sights and sounds.

The last case of the series is that of Mr. E., which illustrates two forms of pseudotia, — the complex automatic form, and the volitional form. It possesses an especial value on account of the intellectual training and large attainments of its subject. His childhood's experience indicated a nervous organization predisposed to pseudotia. Previous to his visions, prolonged and unwise mental application had, by inducing excess of nervous expenditure over repair, of destructive over constructive metamorphosis, weakened his nerve centres, rendering their nerve cells and cell contents abnormally sensitive and unstable. The power of correctly interpreting sensorial impressions was impaired, as well as their dependence upon the will. They were liable to start into almost any sort of abnormal action, upon the slightest stimulus. This condition was increased by mental excitement, great bodily fatigue, and prolonged abstinence from food. Thus prepared, his brain transformed rays of light, from gas-lamps on the street, into bouquets, caused trees to disappear before him, and arid plains to take their place. A fair-haired youth, the reminiscence of a statue, looked at him from underneath a pulpit, and other forms of pseudopia amazed him. When the state of his nervous system is considered, none of these phenomena can be called strange: they were a sort of lofty delirium. If he had starved and illtreated his brain somewhat more severely, he would have had mania, instead of pseudopia, and been carried to a hospital instead of reaching his college apartment. He was wise in abstaining from the exercise of a power, which he found by experiment he possessed, — that of producing pseudopia by an act of volition. It is probable that if he had exercised this power to any great extent, he would have injured his nervous system. Goethe might do it, but Goethes are not often found.

In connection with these clinical observations it is interesting to know that some persons, apparently in excellent health, and among them some of the greatest minds, have been visited and puzzled by visions. Spinoza, — one of the world's intellectual giants, who, insensible to prejudice and superstition, never shrunk, in his speculations with regard to man and God, from any conclusions to which his inexorable logic carried him, —has recorded the fact of being visited by a vision. No one would accuse him of being led astray by fancy, emotion, or any of the false lights, which mislead lesser folk. It appears that "His friend Peter Balling had heard in the night certain groanings. Afterwards, his child fell ill, gave utterance to groanings which Balling recognized as identical with those he had before heard in the night, and died. Balling wrote to be instructed whether the groanings he had heard were 'omens.' Spinoza replied at some length in a very curious letter. He considered that the groanings heard by Balling were 'imaginations.' It had happened to himself, he related, that, waking up one morning, the images of which his dreams had been composed remained obstinately before his eyes, as vivid as though they had been real things. Amongst these was the image of a 'certain black and filthy Ethiopian' whom he had never before seen.

This image in great part disappeared when he directed his eyes *with attention* to a book or other object; but returned with the same vividness as it at first possessed, so soon as he allowed his eyes to fall anywhere *carelessly* (*sine attentione*). The image at length disappeared from the head downwards. His description of the phenomenon may be interesting to students of the psychology of dreams."[1]

It is evident that Spinoza, without comprehending the physiology of the phenomenon, justly regarded the Ethiopian as a construction of his own brain, and not as a supernatural person, or as possessing an objective existence.

The thought of the poet, overleaping the limits of the age into which he is born, by the insight or rather the far-sight of genius, sometimes detects the secrets of the future with marvellous accuracy. In this respect, Shakespeare always has been, and always will be, the mystery of the ages. Into what science did his eye not penetrate? Even the physiology of visions did not escape him. He has illustrated and explained them in a few choice words, which excite not less wonder and admiration by their physiological accuracy, than by the singular knowledge they display of a subject, about which little or nothing was known two hundred years ago. It is worth while to turn aside a moment from the hard path of our dry discus-

[1] *Contemporary Review*, reprinted in *Littell's Living Age*, No. 1714, April 21, 1877, p. 143.

sion, and see how Shakespeare regarded pseudopia. He has admirably interpreted it. In the dagger scene of Macbeth, the murderer, on his way to the king's chamber, is confronted by a vision in the air of a bloody dagger. Amazed, he exclaims, —

> "Is this a dagger which I see before me,
> The handle towards my hand ?"

Doubting the testimony of his eyes, he proceeds, justifying by so doing his freedom from superstition and fear, to test and correct their evidence by his sense of touch : —

> "Come, let me clutch thee.
> I have thee not, and yet I see thee still.
> Art thou not, fatal vision, sensible
> To feeling as to sight ?"

Finding that the testimony of the sense of touch confirmed that of sight, he tried another expedient by which to prove the vision, and submitted the dagger in the air to a careful comparison with his own :—

> "I see thee yet, in form as palpable
> As this which now I draw."

By these various tests Macbeth is convinced of the reality of the vision he has encountered. Now what is Shakespeare's explanation ? He does not make Macbeth deny the vision, or call it fancy, or a supernatural visitation, or give any of the theories of that age. He gives the exact physiological explanation, in language which, for accuracy and brevity, cannot be surpassed. He calls it : —

> "A dagger of the mind: a false creation,
> Proceeding from the heat-oppressed brain."

In Macbeth's mental state, intense emotion, driving the blood to the brain, would heat and oppress the nerve centres, producing "a heat-oppressed brain," and by a brain so pressed, subjective daggers — daggers of the mind — would be created and projected into space more readily than Goethe could revive a picture by an effort of his will. Shakespeare does not stop here. Macbeth examines the dagger more closely: —

> "I see thee still.
> And on thy blade and dudgeon gouts of blood,
> Which was not so before."

Satisfied that the vision was a creation of his own brain, not the messenger of any God or devil, and denying its objective, but not its subjective existence, he next demanded the cause of this singular appearance, and says: —

> "It is the bloody business which informs
> Thus to mine eyes."

Could any physiologist of to-day, assisted by lenses, laboratories, and all the appliances of scientific investigation, give any better explanation! Whence such knowledge, in the age of Queen Elizabeth?

## VISIONS OF THE INSANE.

The visions of the insane present an interesting and instructive field of study, and one allied to the proceeding; but any attempt to explore it would scarcely be in harmony with the design of this essay. Moreover, the insane are a peculiar people, possessing peculiar and extraordinary features, and demanding peculiar aptitudes on the part of those who study and manage them. That insanity is a disease of the brain, and not of the soul or mind, independent of the brain, is now admitted by all alienists. Such being the case, it follows necessarily that the organic changes and modifications, which underlie insanity, whether discoverable or not by our present means of investigation, must modify the development of its visions, as well as of its other symptoms. The visions of the insane naturally partake of the peculiarities of their condition, and although the physiological principles, which have been here enforced are applicable, *mutatis mutandis*, to them, yet the discussion of these principles, in their application to insane visionists, properly belongs to those who are charged with their care, and will not be examined here.

### VISIONS OF THE DYING.

The previous study of the visions of childhood, of adult life, and of disease, naturally lead to an examination of the visions of the dying, — to the pseudopia of the death bed. The subject is a sacred one, and is indissolubly bound up with our holiest and tenderest feelings. We love, and not unnaturally, to hope and believe, when the silver cord is loosed which has bound those we love to earth, that, at the moment of the loosing, there may come a glimpse of heaven, which for an instant shall clothe the dying features with angelic brightness, and perhaps give to the departing one a momentary recognition of those who have gone before. Such is the conviction of some, the faith of many, and the hope of most. The superstitions and traditions of the past encourage this belief, and the private and public history of mankind furnish innumerable examples which apparently illustrate it. There is scarcely a family in the land, some one of whose members has not died with a glorified expression on the features, or exclamation on the lips, which, to the standers by, was a token of a beatific vision. History is full of the detailed accounts of the death-beds of great men, — warriors, statesmen, martyrs, confessors, monarchs, enthusiasts, and others, to whom, at the moment of dissolution, visions of congenial spirits, or of heavenly glories were vouchsafed.

It seems unnecessary to examine the foundation of such hopes, and almost cruel to destroy them. Yet it is better to know the truth than to adopt a counterfeit of it, or to nourish a faith built on error. Moreover, when the truth which replaces a misconception is comprehended, it yields greater satisfaction and brighter hopes than the old error. Visions of the dying are no exception to this statement. It is better to know what they are, and how they are produced, than to leave them shrouded in mystery. Could this be accomplished, much of the terror, with which the act of dissolution is now invested, would disappear, and a serene faith, born of knowledge, take its place.

Dissolution is a natural event in the course of life, not life's end. It does not close a career, but marks an epoch. Without it the world and life would come to an end, for life is born of death. Being a natural process, death should not be more mysterious, or more painful than other natural processes, and the closest observation shows that it is not so. The mystery which shrouds it is not greater than that which shrouds birth, or thought, or volition; and yet instinct, fear, hope, imagination, superstition, and religion, have all conspired to misinterpret its attendant phenomena, distort its character, and crown it King of Terrors, transforming an angel into a devil, a blessing into a curse. It is time these false notions were dissipated, and death seen in its true nature. It would still be clothed with mystery enough to command the utmost awe and reverence, and be the harbinger of sorrow enough to melt and discipline mankind, and to call for all the resources of philosophy and religion.

One of the most common of these errors is the notion, that pain and dying are inseparable companions. The truth is they rarely go together. Occasionally, the act of dissolution is a painful one, but this is an exception, and a rare exception, to the general rule. The rule is that unconsciousness, not pain, attends the final act. To the subject of it, death is no more painful than birth. Painlessly we come; whence we know not. Painlessly we go; whither we know not. Nature kindly provides an anæsthetic for the body when the spirit leaves it. Previous to that moment, and in preparation for it, respiration becomes feeble, generally slow and short, often accomplished by long inspirations and short, sudden expirations, so that the blood is steadily less and less oxygenated. At the same time, the heart acts with corresponding debility, producing a slow, feeble, and often irregular pulse. As this process goes on, the blood is not only driven to the brain with diminished force, and in less quantity, but what flows there is loaded more and more with carbonic acid gas, a powerful anæsthetic, the same as that derived from charcoal. Subjected to its influence, the nerve centres lose consciousness and sensibility; apparent sleep creeps over the system; then comes stupor, and then the end. Thus nature, depriving death of pain,

"Gently slopes the way"

from this world to that. The process resembles the asphyxia of drowning, to which allusion was made, when speaking of the revival of past images, thoughts, and memories, said to crowd the brain of a drowning person. Convulsive twitchings, livid features, gurgling in the throat, and similar ghastly symptoms, which mark the last moment, are only exhibitions of unconscious automatic action.

The testimony of the dying, so long as they are able to give any testimony, is that their sufferings do not increase as the termination of life approaches, but on the contrary grow less. The following incident illustrates the truth of this remark, and, so far as a single instance is of value, confirms what has been said as to the painlessness of dissolution. A medical friend, whom I attended professionally in his last illness, was the victim of a most painful disease. He was aware of its incurable character. Supported by an intelligent faith in God and immortality, he prepared himself with admirable courage and unfaltering trust for the final change. In consequence of continual and severe pain, he was obliged during the last few months of his life to take opium daily. He sent for me one night soon after midnight. A brief examination was sufficient to show that the end was near.

"Do these symptoms mean perforation?" asked Dr. ——

"They do," was the reply.

"Then I have reached the end of the chapter," he quietly remarked, and added, "how long shall I probably last?"

"That you know," I said, "as well as any one: perhaps twenty-four, or thirty-six hours."

Scarcely heeding the reply, he continued, —

"I am ready; but promise me this: that I shall not suffer pain, if you can prevent it."

The promise was, of course, given, and I agreed to see him every hour or two as long as he lived. This being done, I said to him, "One thing remains; how shall I communicate with you when, at the very close, the time comes that you cannot indicate whether you suffer or not?"

After a little talk the following signals were agreed upon: He was to indicate a negative answer, or No, by raising the forefinger; and an affirmative answer, or Yes, by raising the forefinger and the one next to it also. One finger was No; two fingers Yes. Having arranged this matter, he took rather more than his habitual dose of opium, and was soon comparatively quiet. *The pain did not return.* For twelve or fifteen hours he appeared much as usual; conversed with his family and friends, and was cheerful and serene. Then, as nature's anæsthetic began to act, he became dull and heavy. In answer to repeated inquiries as to pain, he constantly replied in the negative. At length, he answered less readily. For an hour or so before death he answered only by the signal of his fingers which had been agreed upon, and by that signal he replied quickly and intelligently. Fifteen minutes before dissolution, I asked him, "Do you suffer pain?" He instantly made the negative signal by raising his forefinger. After this he made no sign, but slept peacefully to the end.

Another erroneous notion is that a momentary glow on the countenance, opening and apparent fixing of the eyes upon some object, or person, or upon vacancy, a certain earnestness of expression, and similar signs, betoken intelligence. All such phenomena as these are automatic. They are analogous to those produced by etherization. An etherized person loses volition, consciousness, and sensibility, but is not deprived of the functions of organic life. And so a person asphyxiated by natural death loses volition, consciousness, and intelligence, before automatic action and the functions of involuntary life depart. The glowing cheek, and fixed or rolling eye, are indications of mechanical action after the higher centres have ceased to functionate.

Deprived of volition and intelligence, and given over, for a brief period, to automatic power, it is to be expected that the intracranial apparatus, and especially the sensory portion of it, would occasionally exhibit singular phenomena. The wonder is, not that they do so at all, but that they do not do so oftener. A steam-engine, shattered by a blow and deserted by its engineer, will for a few seconds make a singular exhibition of power, leaping obstacles, running up ascents, plunging into rivers, and illustrating, in a variety of ways, the action of blind force. So the ganglia of the brain, just before dissolution, sometimes show their automatic power by phenomena, which are unusual, and often regarded as supernatural. This is particularly true of the visual apparatus. Not only is the brain released, at this time, from its usual controlling force, and oppressed by an anæsthetic, but its cells, cell-contents, nerve fibres, and all its tissues must be in a peculiar organic condition, the direct or indirect result of disease. Old sensitized plates (cells) of memory, emotion, thought, sight, and the like, the accumulated stores of a lifetime, must partake of the general commotion, and oftentimes be brought into conditions which permit their being easily called into functional activity. Their dynamic state may be temporarily exalted. Should a bright ray of light, falling from some object in the chamber, on the retina of a dying person, excite the visual apparatus, and cells, the hieroglyphic of a departed child, husband, lover, or friend, be brought into the field of subjective sight, the beloved one would be reproduced, and at once projected into space. Intense emotion, engendered by such a sight, would for an instant break through the stupefying power of nature's anæsthetic, as the surgeon's knife sometimes momentarily breaks the spell of ether, and the dying individual springing, with eyes intent, features transfigured, and arms outstretched, toward the vision, would naturally pronounce the long remembered name, and then fall back and die. Such scenes have occurred. Few could witness them without an overwhelming sense of awe, oppressed

"With thoughts beyond the reaches of our souls."

at beholding for a moment, the apparent lifting of the veil and the glory within. To the dying, such a vision would not be false. It would not be imagination. It would be real to him. The well-known features would be there, and yet they would be a creation, or reproduction of a dissolving brain, and not a messenger from the opened heavens. The vision would be a physiological effect, not a supernatural intervention.

The following incident illustrates the power of the brain to revive past memories at the moment of dissolution: —

"I was watching one night beside a poor man dying of consumption; his case was hopeless, but there was no appearance of the end being very near; he was in full possession of his senses, able to talk with a strong voice, and not in the least drowsy. He had slept through the day and was so wakeful that I had been conversing with him on ordinary subjects to while away the long hours. Suddenly, while we were thus talking quietly together, he became silent, and fixed his eyes on one particular spot in the room, which was entirely vacant, even of furniture; at the same time a look of the greatest delight changed the whole expression of his face, and after a moment of what seemed to be intense scrutiny of some object invisible to me, he said to me in a joyous tone, 'There is Jim.' Jim was a little son whom he had lost the year before, and whom I had known well, but the dying man had a son still living, named John, for whom we had sent, and I concluded it was of John he was speaking, and that he thought he heard him arriving; so I answered, — 'No. John has not been able to come.' The man turned to me impatiently and said, 'I do not mean John; I know he is not here;

it is Jim, my little lame Jim; surely you remember him?' 'Yes,' I said, 'I remember dear little Jim, who died last year, quite well.' 'Don't you see him there? There he is,' said the man, pointing to the vacant space on which his eyes were fixed; and when I did not answer, he repeated almost fretfully, 'Don't you see him standing there?' I answered that I could not see him, though I felt perfectly convinced that something was visible to the sick man, which I could not perceive. When I gave him this answer he seemed quite amazed, and turned round to look at me with a glance almost of indignation. As his eyes met mine, I saw that a film seemed to pass over them, the light of intelligence died away, he gave a gentle sigh, and expired. He did not live five minutes from the time he first said, 'There is Jim,' although there had been no sign of approaching death previous to that moment."[1]

The similarity of this vision to some of those forming the basis of our present investigation is obvious. The appearance of this for a single instant only, and of those for a considerable period, constitute no essential difference between them. All saw a human form, distinctly, when others could not do so. A similar cerebral condition, not necessarily the same condition, must have existed in all of them, probably a condition characterized by more or less hyperæmia. If there had been anything supernatural about this case, — as the reporter of it is inclined to believe, — there should be a supernatural element in the others

[1] *New Quarterly Review*, reprinted in *Littell's Living Age*, August 11, 1877 ("The Riddle of Death").

also. But if physiology can give an adequate and rational explanation of them, the same explanation should be applied to this. Wherever natural forces supply a sufficient cause, it is unnecessary and unphilosophical to seek for any other.

It is stated in this case that the patient was not drowsy before the appearance of his vision, or before his death. He died suddenly, so that there was no opportunity or necessity for nature to provide an anæsthetic. This does not militate against the fact that dissolution is ordinarily painless, or against nature's method of securing euthanasia. When death occurs suddenly from disease of the heart or brain, or from nervous exhaustion or other cause, it must obviously be painless, and the combined action of the heart and lungs, by which nature provides a painless departure in the slower and more common ways of dying, would be unnecessary. It happens not infrequently that a patient, exhausted by long illness, dies suddenly from exhaustion, and if so, without pain.

It is conceivable that, under the conditions which have been described, almost any sort of pseudopia might occur. Sometimes one of the nerve centres is affected, sometimes another, and sometimes all of them are. Perhaps those most commonly called into activity at the time of dissolution are the motor centres, the irritation or excitement of which is apt to produce general or partial convulsions. These are always expected. They are the recognized attendants of the death-bed, regarded by the ignorant as an effort of the spirit to free itself from its prison, and christened the death struggle. They are strictly automatic and painless, and physiologically are analogous to visions. At that moment of cerebral cell confusion and disintegration, a stimulus, impinging on a motor centre, excites convulsions; on a visual centre, visions; on an auditory centre, sounds, and so on. Automatism rules for a brief period before death closes the scene.

This cerebral commotion, and the pseudopia which now and then accompanies it, belong to the moment of dissolution. The condition of the cerebral tissues, preceding the final breaking up by some hours or days, is, of course, somewhat different from their condition at that time. Stupor and anæsthesia, so characteristic of the final stage in most cases, do not appear till an individual is moribund. Antecedent to that stage, the sufferer may be heavy, oppressed, and dull, wretched and worn out by the discomforts and agony of disease, but still retain an unclouded intellect, unfaltering courage, and serene faith. In this state, when disease, if acute, has been making rapid inroads upon the system; if chronic, has been slowly undermining it, the nerve centres are, of course, more or less involved. Waste predominates over repair. Weakness characterizes the nervous system as well as the rest of the organization. All the nerves are unnaturally sensitive, or irritable, even when there is apparent torpidity.

The eye is easily disturbed by light, and the ear by sounds. The presence of near friends is pleasant, of half friends offensive. The gentle pressure of a loving hand is more grateful than speech; light friction of the skin than gossip; quiet and solitude than excitement and company. All this betrays irritability of the higher nerve centres, and is a state in which they are as sensitive to internal or subjective impressions as to objective ones. The memories of childhood, of youthful friends and early scenes, are revived with extraordinary vividness. Tears come readily. Emotions of all sorts are intensified. Cells and cell-groups, which have been associated by the habits and occupations of a life, perhaps of a long life, are easily revived and stimulated into reflex activity through the brain, and excite its sensory, motor, and ideo-motor centres. These are precisely the conditions which favor the production of subjective pseudopia, and particularly of ideational pictures or visions. Thus, Napoleon, enfeebled by sickness, not moribund, but soon to be so, recalling, perhaps subjectively looking upon, scenes of past slaughter and glory, startled his attendant with the cry, "*Tête d' armée.*" Thus, victims of the Inquisition, starved and tortured into weakness and disease, were often cheered and consoled, on the eve of their *auto-da-fé*, by visions of their sainted predecessors beckoning them to follow. Thus, hospital patients, strangers, poor and friendless, have amazed their companions by stories of glorified visitors, bringing hopes of release which were soon verified. Tennyson's "May Queen" illustrated one of these states of quiet thanatopsis, when shortly before her departure, she heard voices of angels calling her to join them. Pages, or rather volumes, could be filled with histories of visions of this sort, if the records and traditions of the past, and especially if the biographies of devout Catholics, were searched for them. Saints, who have mortified the flesh till their anæmic brains, rapidly disintegrating and highly sensitive, are brought to the eve of dissolution, present the most favorable conditions for the production of subjective, ante-mortem pseudopia. With volition at its minimum, reflex activity at its maximum, their nerve-cells wasted and dried into tinder, is it marvellous that their brains should sometimes burn with unwonted light?

These and similar manifestations are of peculiar interest to the physiologist, as illustrations of automatic cerebral activity, and to the psychologist, as illustrations of the power of the brain to produce results, which have hitherto been regarded as purely mental. They exhibit not only the power of the sensory and motor apparatus, but indicate the effects which the sensori-motor and ideo-motor apparatus are capable of producing, when, deprived of a coördinating centre, they act independently. Emotions, subjective sensations, pictorial representations, ideational pictures, ideas, hieroglyphics of the past, and distortions of the present, flow, a confused medley, through the sensorium; flame up there for a moment, with a strange, unearthly light, to disappear, so far as the body is concerned, forever. If this be so, — and what physiologist can doubt it, — the stories of heaven opening over death-beds, upon which angels ascend and descend, and of friends gone before, waiting to welcome the new comer, must be referred, not to supernatural agencies, or to the imagination, but simply to the automatic action of the brains of the dying. They are, however much our hopes may wish they were not, the last flickering of life's taper; the occasional flashing of cerebral fires, burning the brain's accumulated stores of experience.

Probably all such visions as these are automatic. But yet, who, believing in God and personal immortality, as the writer rejoices in doing, will dare to say *absolutely all?* Will dare to assert there is no *possible* exception? If life is continuous, heaven beyond, and death the portal, is it philosophical to affirm that no one entering that portal has ever caught a glimpse, or can ever catch a glimpse, before he is utterly freed from the flesh, of the glory beyond? May not the golden bowl, just as it is shattered, "be touched by rays from a light that is above it," and flash with a glory no language can describe? The pure materialist, sad disciple of nihilism, may dispute this, but no theist or Christian will be bold enough to deny it. Frances

Power Cobbe, in a recent article from which the last case was quoted, has given utterance to the above thought. "Assuming," she says, "that we are individually already convinced that the quasi-universal creed of the human race is not erroneous, and that the 'soul of a man never dies' we may not unreasonably turn to the solemn scene of dissolution, and ask, Whether there do not sometimes occur, under one or two perhaps of its hundred forms, some incidents which point in the direction of the great Fact, which we believe to be actually in process of realization? According to our common conviction, there is a moment of time, when the man whom we have known in his garb of flesh, casts it aside, actually, so to speak, before our eyes, and 'this mortal puts on immortality.' . . . . Of course, it is quite possible that the natural law of death may be that the departed always sink into a state of unconsciousness, and rather dip beneath a Lethe than leap a Rubicon. It is likewise possible that the faculties of a disembodied soul, whatever they may be, may need time and use, like those of an infant, before they can be practically employed. But there is also at least a *possibility* that consciousness is not always lost, but is continuous through the passage from one life to another, and that it expands, rather than closes, at the moment when the bonds of the flesh are broken, and the man enters into possession of his higher powers and vaster faculties, symbolled by the beautiful old emblem of

Psyche's emancipated butterfly quitting the shell of the chrysalis. In this latter case there is a certain *primâ facie* presumption that close observation ought to permit us occasionally to obtain some brief glimpse, some glance, though but of lightning swiftness and evanescence, revealing partially this transcendent change."[1]

With the hope of throwing some light upon this interesting question, competent persons were asked by the authoress of the "Riddle of Death," if they had ever observed any phenomena, at the moment of dissolution, indicating that the Ego — mind or soul — was conscious of a new phase of existence before leaving this. Nine observations are reported, the character of which was believed to justify such a notion. Judged by the principles forming the basis of our present study of visions, it is unnecessary to go beyond the physiological action of the brain for a rational and satisfactory explanation of most of them. Two or three of the cases, however, present phenomena, of which, to say the least, it is difficult to give an adequate physiological solution. The following incident, the subject of which was an intelligent boy about fourteen years of age, dying of "decline" illustrates this remark: —

"He was a refined, highly educated child, who throughout his long illness had looked forward with much hope and longing to the unknown life to which he believed

[1] *The Riddle of Death*, by Frances Power Cobbe. *Littell's Living Age* and *New Quarterly Review*.

he was hastening. On a bright summer morning it became evident that he had reached his last hour. He lost the power of speech, chiefly from weakness, but he was perfectly sensible, and made his wishes known to us by his intelligent looks. He was sitting propped up in bed, and had been looking rather sadly at the bright sunshine playing on the trees outside his open window for some time. He had turned away from this scene, however, and was facing the end of the room, where there was nothing whatever but a closed door, when all in a moment the whole expression of his face changed to one of the most wondering rapture, which made his half-closed eyes open to their utmost extent, while his lips parted with a smile of perfect ecstasy; it was impossible to doubt that some glorious sight was visible to him, and from the movement of his eyes it was plain that it was not one but many objects on which he gazed, for his look passed slowly from end to end of what seemed to be vacant wall before him, going back and forward with ever-increasing delight manifested in his whole aspect. His mother then asked him if what he saw was some wonderful sight beyond the confines of this world, to give her a token that it was so by pressing her hand. He at once took her hand, and pressed it meaningly, giving thereby an intelligent affirmative to her question, though unable to speak. As he did so a change passed over his face, his eyes closed, and in a few minutes he was gone." [1]

Here is another instance in which it is difficult to trace the action of automatism. An elderly man was dying of a painful disease, which, however, did not obscure his mental faculties. Al-

[1] *The Riddle of Death.*

though it was known to be incurable, he had been told that he might live some months, when somewhat suddenly the summons came on a dark January morning. It had been seen in the course of the night that he was sinking, but for some time he had been perfectly silent and motionless, apparently in a state of stupor; his eyes closed and his breathing scarcely perceptible. As the tardy dawn of the winter morning revealed the rigid features of the countenance from which life and intelligence seemed to have quite departed, those who watched him felt uncertain whether he still lived; but suddenly, while they bent over him to ascertain the truth, he opened his eyes wide, and gazed eagerly upward with such an unmistakable expression of wonder and joy, that a thrill of awe passed through all who witnessed it. His whole face grew bright with a strange gladness, while the eloquent eyes seemed literally to shine as if reflecting some light on which they gazed; he remained in this attitude of delighted surprise for some minutes, then in a moment the eyelids fell, the head drooped forward, and with one long breath the spirit departed.[1]

From the observation of death beds for more than a quarter of a century, during which period I have often witnessed the dissolution of persons of all ages and conditions, I can recall only a single instance of which the phenomena admitted the possibility of any other interpretation than a

[1] *The Riddle of Death.*

physiological one. It was night. The departing one was a lady of middle age. Her death, though momentarily expected from cardiac disease, was not announced or preceded by the usual anæsthesia of the dying. During the night, when awake, her mental action was perfect. She conversed, a few minutes before dying, as pleasantly and intelligently as ever. There was no stupor, *delirium, strangeness, or moribund symptom* indicating cerebral disturbance. Her cardiac symptoms alone foreshadowed the great change. After saying a few words, she turned her head upon her pillow as if to sleep, then unexpectedly turning it back, a glow, brilliant and beautiful exceedingly, came into her features; her eyes, opening, sparkled with singular vivacity; at the same moment, with a tone of emphatic surprise and delight, she pronounced the name of the earthly being nearest and dearest to her; and then, dropping her head upon her pillow, as unexpectedly as she had looked up, her spirit departed to God who gave it. The conviction, forced upon my mind, that something departed from her body, at that instant rupturing the bonds of flesh, was stronger than language can express.

There is an important difference, in one respect, between the last three cases and the previous ones. In the previous cases a definite object, like a human face, or form, was seen; sometimes more than one individual appeared. Moreover, those who made themselves visible were departed friends, and bore familiar faces. Their hieroglyphics had been laid away in the cerebral cells of the dying individual, and were consequently capable of being revived with greater or less fidelity. In the last three cases, no definite object, form, or face, was apparently seen. The departing person seemed to gaze with intense interest and delight, and a transfigured countenance, upon something, whether some strange beauty, as of a radiant glory, or an angelic group, or sainted friends, no one present could tell, and there was no revealing sign. Silence, surprise, wonder, and rapt gazing would be natural to any one, even at the moment of dying, upon whose view such a scene should burst. There would be no revival of brain-cells, stamped with earthly memories and scenes, but something seen, of which the brain had received no antecedent impression, and of which the Ego had formed no conception.

It is in some such direction as this, if in any, the departing spirit would indicate, just as the old is dropping off, that the new is seen. Entranced by a glimpse of what eye hath not seen, nor ear heard, and of which man has formed no conception, his gaze would be riveted upon a glory, invisible to his earthly companions. His features would be transfigured, and those around would be amazed, perhaps appalled at the sight, as some fishermen were, two thousand years ago, upon a mountain in Galilee by the transcendent glory of a familiar face. In Correggio's "Notte," the light which illuminates the group around the infant Jesus proceeds from the face of the Christ-child, who, reposing on his mother's lap, unconsciously baptizes all with heavenly beauty. Such should, and such must be, the ineffable expression of transfigured humanity upon the features of whoever gets a sight of heaven, before he has left the earth. If ever a scene like this occurs, who will dare say that the explanation of it may not come from a height inaccessible to our imperfect physiology?

### VISIONS OF SLEEP.

Visions and dreams are near relatives. They are produced by similar causes, depend on similar conditions, and are subject to similar laws. Both inhabit the intracranial territory, manifest themselves by means of the ganglionic machinery of the higher nerve-centres, and not infrequently delude those they visit into the notion, that their subjective movements are objective realities. Both claim an antiquity equal to that of the human race, and continue at the present day, with greater or less success, to excite superstition, ridicule, or fear, and to mock or strengthen the faith of mankind. Hence, a study of visions naturally and almost necessarily leads to a study of dreams, the visions of sleep. These are a part of those; the latter are included in the former.

There are two important differences, however, between pseudopia and dreams, which should be clearly recognized. One is that the mechanism of pseudopia is limited to that of the visual apparatus. Vision, as its name implies, belongs to seeing, and is concerned with other functions only so far as it may be influenced by them. The mechanism of dreams, on the contrary, embraces all the mechanism of sensation and thought. All the higher centres contribute to the evolution, and enhance the complexity of dreams. Pseudopia cheats its victims by the employment of a special apparatus in the abnormal production of false pictorial representations. Dreams aim at the same end, and sometimes attain it by utilizing any part of the nervous machinery of which they can get hold. Pseudopia is limited to a comparatively small section of the cerebral system. Dreams occupy the whole. A second distinction between dreams and pseudopia is that the occurrence of dreams is confined to the period of sleep, while pseudopia acknowledges no such limitation. A vision may appear and excite the wonder, disturb the thoughts, and perplex the judgment at midday as well as at midnight. A dream creeps stealthily into the brain, displaying its operations when reason and volition are off their guard, and sleep has shorn judgment of its power.

Sleep, then, is a fundamental condition of dreaming. Revery and abstraction may occupy our waking hours and lead to self forgetfulness, but between them and dreams there is a great gulf, which must be passed before the land of dreams is reached. If it were possible to comprehend the phenomena of sleep, there would be less difficulty in comprehending those of dreaming. As it is dreams admit of a more satisfactory explanation than sleep. What a mystery sleep is! So like life and so like death, that it is difficult to say which of the two it resembles most. Under its influence the system exhibits the repose, unconsciousness, and torpor of death, but retains the color, pulse, and breath of life. If we should witness sleep for the first time to-day, we should look upon the subject of its spell with wonder and anxiety, if not with terror, and feel unspeakable relief as we saw movement, intelligence, and speech return. Now, accustomed to its mystery, as we are to that of life, we commit ourselves and our dear ones to its care with thankfulness, not with fear, assured that it will carry us and them, each separately but safely, through the dark and silent valley of unconsciousness to renewed life. In this it is like death, which leads us, each separately and alone, through a passage of equal, perhaps not of greater, darkness and unconsciousness to renewed existence. Socrates was right in saying that whoever does not fear sleep should not fear death.

The mechanism of sleep is not perfectly made out, but the observations of Mr. A. Durham of England, and of Dr. W. A. Hammond of New York, on the brain, and those of Dr. J. Hughlings Jackson on the retina, show that during sleep the activity of the circulation of the blood through a part of the brain is considerably diminished. The physiological action of a continued dose of the bromide of potash, which simultaneously produces sleep and diminished activity of the cerebral blood circulation, points in the same direction. So does the following case: —

"M. Perquin observed in the hospital of Montpellier, in 1821, a case which throws considerable light upon the actual condition of the brain in profound sleep, and in that in which dreams occur. A female, aged 26, had lost a portion of her scalp, skull bone, and dura mater, under an attack of malignant disease, by means of which a portion of the brain was exposed in such a manner as admitted of inspection. When this patient was in a dreamless state, or in profound sleep, her brain was motionless, and lay within the cranium. When the sleep was imperfect, and the mind was agitated by dreams, her brain moved and protruded from the cranium, forming a cerebral hernia. This protrusion was still greater whenever the dreams, as reported by herself, were most active, and when she was perfectly awake, especially if engaged in active or sprightly conversation, it attained its fullest development, nor did this protrusion occur in jerks, alternating with recessions, as if caused by arterial blood, but remained permanent while the conversation continued." [1]

On the other hand section of the sympathetic nerve in dogs produces congestion of the brain, and does not interfere with sleep. From these various observations it may be inferred with reasonable

[1] *New Am. Cyclopedia*, art. "Dreams."

certainty that sleep, and a diminished supply of blood to a part of the brain, and congestion of another part, bear an important and definite relation to each other, but it does not appear from them which is cause and which effect. Sleep may be the cause of a retarded cerebral circulation, though the reverse is probably the case; a conclusion, strengthened by Dr. A. Fleming's experiments on compression of the carotid arteries in the neck. Fortunately it is not necessary to decide this question, in order to arrive at a rational explanation of dreams. It is important, however, for such a purpose to know that derangement of the cerebral circulation is a constant accompaniment or co-efficient of sleep. Dreams are manifested only by a sleeping brain, and such a brain carries less blood in one part and more in another than a waking one.

During sleep the process of nutrition is at its maximum. This is especially true of the nutrition of the nervous system. Its ganglionic centres, having supplied force for the day's labor, take advantage of the repose of sleep to repair their cells, and obtain fresh supplies of the elements of force. Then the brain is busy, discharging its decomposed products, the *débris* of effort, thought, and volition, into the blood, and selecting from the constituents of the same fluid the elements of its own power. There is probably some occult connection between this process, and sleep, and a diminished blood supply. It would be strange if the contemporaneous action of these three factors were fortuitous. Wundt has put forth the ingenious hypothesis that the automatic cerebral excitations of sleep are due to a retardation of the intracranial circulation, and consequent retention in the blood of the products of decomposition. He says: —

"It is in the highest degree probable that the automatic excitement of sleep has its origin in the innervating centres of the medulla oblongata. Retardation of respiration is a frequent accompaniment of sleep. The tendency of the blood, thereby induced, to produce dyspnœa probably acts as an irritant upon the vaso-motor nerve centres and so as to cause retardation of the circulation of blood within the cranium, and consequent irritation of the central parts, and especially of the cortex. This notion is strengthened by the fact that other forms of automatic irritation, like respiratory convulsions and epileptic spasms, are most easily excited during sleep." [1]

If we could look in upon the brain during sleep, and watch the behavior of its minute constituents, millions upon millions of cells and cell contents, there would be presented to our view not a scene of repose and inactivity, but one of incessant work. There would be no congestion or pressure of blood through the capillaries, whereby the manifestation of volition, intellection, ideation, and similar nerve action is rendered possible. The sort of tissue change, which the day

[1] *Physiologische Psychologie*, p. 189.

had witnessed, would be replaced by the labor of repair, and the genesis of cells, granules, protoplasmic stuff, and all the raw material of cerebration. Everywhere there would be displayed activity, in preparation for the next day's labor. The workman and the tools would be microscopic, almost infinitesimal, it is true, but still they would be there and at work, and they would be all automata. In health all this work is performed in silence. We are utterly unconscious of it. Few, however, enjoy such perfect health, and sleep so normal and profound as to get no hint of the cerebral action which sleep covers; and when any such hints are received they are apt to become the origin of dreams. What profusion of stuff for dreams is here!

Another characteristic condition of the brain during sleep, and one of great importance in its relations to dreams, is the predominance of automatic over volitional action. In this respect, the resemblance of sleep to death again appears. As the system approaches dissolution it is surrendered, more or less unreservedly, to automatic power, and in the act of dying, the surrender is complete. In sleep a similar condition prevails, but the surrender is incomplete, and the power of volition, never entirely gone, can always be recalled. The difference is one of degree. In sleep not only is the superintendence of volition practically removed, but the light of reason is substantially extinguished, the guidance of judgment absent, and the moral sense obliterated. All the highest faculties, those in most intimate relations with the Ego, and which some suppose to constitute the Ego, are in temporary abeyance, and the work of the brain is carried on automatically. At the same time the sensory and reflex centres retain their organic consciousness and activity undiminished. If a finger is pricked, the sensation is felt, converted into motion, and the finger withdrawn, without awaking the sleeper. The imperfect digestion of a cold potato, or a Welsh rabbit, may produce the extremity of uneasiness, almost convulsive thrashing of the limbs, and even screams without opening the eyelids. The same holds true of innumerable other sensations, which are transformed into motion during sleep. Not only is this the case, but the delicacy and extent of reflex action sometimes seems to be increased by sleep. Of this the firm and courageous step of a somnambulist along the edge of precipices, or on exposed and dizzy heights, is an example. Emotion is often increased in intensity by sleep, and a sleeper will scream with fear at trifles which he would scarcely notice when awake. Any friction of the cerebral machinery is felt and extravagantly magnified. When awake, ideas, or groups of ideas, produced by impressions on sensory or ideational cells, are recognized as subjective; when asleep, reason and judgment being absent, the same impression on the same cells, is apt to be regarded as objective. When the Greek mask of tragedy appeared on the ceiling of my chamber, after opium, I was awake and instantly recognized its subjective character. In sleep its subjective nature would not have been recognized, and it would have been a dream.

Such are some of the conditions and characteristics of sleep, a physical state, which affords an opportunity for a display of the phenomena of dreams, without which dreams would be impossible, and which deserves a careful study by all who are interested in them. It is doubtful if in normal sleep dreams ever occur, notwithstanding the opinion of many eminent observers to the contrary. The characteristics of sleep, favorable to dreams, which have been mentioned, are first, and most important, the predominance in the cerebral machinery of automatic over volitional control; second, the process of repair, by which cell activity is produced and kept up; third, a tendency to exaggerate sensations, emotions, and ideas; and fourth, the inactivity of reason and judgment, supplemented by the activity of unreason and misrule.

This brief survey of the conditions of sleep forms a natural introduction to an examination of the visions of sleep. Most of the current definitions of dreams have been framed by psychologists, from a psychological standpoint, and are of course of very little value to a physiologist, or to any one else. They are chiefly interesting as curious illustrations of the different notions entertained by philosophers and metaphysicians, with regard to them, and of the loose ideas floating on the public mind concerning the whole subject. Even Sir William Hamilton's definition is inaccurate and obscure. Approached from the physiological side, it is less difficult than from any other to get a distinct view of dreams, and consequently less difficult from that standpoint to form a tolerably accurate notion of their character. Examined from that point, dreams appear to be the automatic and generally irregular revival of impressions made upon antecedently sensitized cerebral cell-groups, or elements, whether sensory, emotional, motor, ideational, or all combined, and the ideation produced by such a reproduction. The cell-groups, thus revived, may be those stamped by the previous day's experience, or those stamped by the experience of years long gone by, or a medley of recent and old impressions, attracted to each other by associations which admit of no explanation.

In ancient times dreams were supposed to be prophetic. Such was the character of Joseph's dream of sheaves; Pharaoh's dream of fat and lean kine; Calpurnia's dream of the Ides of March, which, ridiculed by Cæsar, was supposed to be confirmed by the dagger of Brutus; and numberless other dreams, of which history and tradition have preserved the record. Tertullian regarded dreams as messages, sometimes from God and sometimes from the devil. A belief in the prophetic or ominous character of dreams has not yet disappeared. How many persons are there, who, visited on Monday night by a vivid and detailed dream of the death by drowning of a son, on the next day, Tuesday, as one of a projected sailing party, would not use every effort to keep him away from the excursion, or, if this were impossible, feel greatly relieved at his safe return? As with the visions of the dying, so with the visions of sleep, the human mind is strongly tempted to believe that dreams open the door for supernatural communications.

The characteristics of dreams curiously correspond to the conditions of sleep. They fit into, or, to use a carpenter's phrase, dovetail into each other. The opportunities afforded by sleep for a brain to play all sorts of pranks with its cells, granules, and elements is taken advantage of, and dreams are the outcome of its unguarded or morbid action.

One of the marked characteristics of dreams is their independence of volition, reason, and judgment, a cerebral condition similar to that which occurs in sleep. It is a curious and suggestive fact that the retirement of the blood from the frontal lobes, and from the periphery of the hemispheres, which is coincident with the retirement of volition, reason, and judgment from activity, is also coincident with congestion of the base of the brain, with unrestrained if not with augmented activity of sensory, motor, emotional, and automatic action, *and with sleep and dreams.* It seems as if the undiscovered power which introduces sleep and permits dreams, while doing so, plays upon one part of the brain in such a way as to inhibit blood supply and the action of the Ego, and at the same time plays upon another part so as to increase blood supply, and, regardless of the Ego, set free automatic action. At any rate, without pushing our speculations further in this attractive direction, it is clear that there is a suspension of volitional control over the higher and lower cerebral ganglia when dreaming. Then the Ego becomes a passive spectator, and generally an indifferent one, of whatever scenes automatic action produces. It should be remembered, however, that the abdication of volition in dreams is never absolute and final. Dreamers are sometimes conscious of attempting to watch and guide their dreams, and not infrequently of an effort to regain self-control. If a dream is so vivid as to make the excitement it produces intense, the dreamer is apt to awake, when volition, reason, and judgment resume their functions. This, however, occurs rarely. The rule is that dreams are characterized by an absence of volition from the field of cerebral activity.

Automatism is another characteristic of dreams, as well as of sleep. It has already been stated that the repair of nerve tissue is most actively carried on during sleep. It is scarcely necessary to add that this repair is exclusively an automatic process, which implies, at that period, not only unusual activity, but unusual sensitiveness of the automatic machinery of the brain. Cells and cell elements of all sorts are in commotion, and in greater or less numbers are brought within the sphere of automatic influence. Cell groups associated by near and easily recognized ties, and those united by distant, obscure, and forgotten links, are pushed or drawn up into the field of intra-cranial observation, and stimulate the visual, auditory, motor, or other cerebral centre. Thus excited, these nerve centres begin to functionate by their own inherent automatic power as actively as if the whole brain were awake. The cell groups thus brought together form the organic basis, or hieroglyphics, of dreams. Groups, or elements, which at any time during the dreamer's past life may have been brought together within the range of subjective vision, hearing, motion, sensation, or ideation may be and often are drawn within the circle of automatic action, and made the subject of a sort of automatic contemplation. A corpse seen yesterday may enter into last night's dream. When the cell groups representing that corpse are collected, they might readily attract to themselves, under the influence of automatism, another set of groups representing the first corpse seen in childhood, and the scene of its burial. A stranger from India, who mingled with the funeral cortège, might be recalled, by the revival of the elements representing him, and with him would come all the "splendor and havoc" of the East with which the dreamer was acquainted, and so on indefinitely.

Incongruity and incoherence are characteristics of dreams which few have failed to recognize, and which dreams would, a priori, be expected to exhibit. Volition absent and automatism supreme, congruity and coherence could not be anticipated from the fortuitous revival of antecedently stamped cells and cell elements. Children have a game for the playing of which cards, inscribed with a single letter, word, or part of a phrase, are thrown together into a common receptacle. The wit of the game consists in withdrawing the cards one by one, placing them in a line, in juxtaposition, and reading the result. Generally only a meaningless jumble appears; sometimes a familiar word is formed, and rarely, very rarely, an intelligible phrase crops out of the confusion. When this occurs, the wonder of the players reaches the highest degree of amazement. Something like this occurs in dreams. Sensitized cells, of which some are inscribed with a single event or individual, others with complex scenes or actions, some belonging to the near, others to the remote past, and possessing no apparent bond of union, are thrown into the sensorium commune, a sort of common receptacle and there they are arranged together, with the result of obtaining grotesque, incoherent, incongruous, and unexpected forms, and of exciting a correspondingly unexpected and unintelligible kind of ideation. It has already been intimated that in normal sleep no such by-play of our cerebral machinery takes place. All is quiet, then. The automatic cell revival is frequently sufficient to make the dreamer remember that there have been visions in his sleep, but not sufficient to enable him to recall them. Occasionally, the revived impressions are so vivid and natural as to arouse and fix the attention of the Ego, and be remembered in detail on awaking. In rare instances, the vividness and artistic presentation become startling, and the dreamer is almost persuaded, perhaps is really convinced, that his visions had an objective basis, and that he was visited by a supernatural message or messenger.

From this brief examination of some of the characteristics of dreams it is evident that common sense takes no part in the visions of sleep. Where volition is wanting, where reason and judgment are in abeyance, and no regard is paid to incoherence of thought or incongruity of action, common sense cannot be expected to appear. And such, as we have intimated, is the fact. A dreamer regards the strangest jumble of events, the most singular confusion of thought, and the most unnatural ordering of life, with as much complacency and satisfaction as he derives from the contemplation of the noblest actions, or the manifestations of supreme order and beauty. He is not disturbed because a man in Boston converses with his wife in Calcutta; or a corpse drives itself to the grave, instead of being driven there; or a mosquito assumes the proportions of an elephant; or a child of five reasons with the wisdom of Solomon. To him all this is credible and natural. But still more surprising than the absence of common sense from dreams is the entire absence of the moral sense from them. This too is to be expected, for a mechanism has no soul. Automatism will yield order and perfection of workmanship, but it can never breed love of goodness or hatred of evil. The dreamer regards virtue and vice, an act of violence and a deed of love, fiends and angels, all that is good and all that is evil, with an equal eye. It is recorded by a recent writer that a certain Mr. D. of Edinburgh dreamed he ran his best friend through with a sword. In his account of the dream, Mr. D. states that he was not at all disturbed by his commission of the deed, or the death of his friend. On the contrary, he was pleased with his own expertness as a swordsman, and watched with simple curiosity the effect of his blow, and was delighted to see how accurately the point of his sword came out from the body of his friend, almost precisely opposite the point at which he had caused it to enter. His delight was that of a marksman who hits his mark. Similar illustrations might be multiplied indefinitely, but it is unnecessary to give any more of them. The reader's own experience and reflection will be sufficient to confirm the truth of the statement that the moral sense does not enter into dream life. A troubled conscience may produce dreams, but dreams themselves are not troubled by a conscience of any sort.

By the statement that the visions of sleep lack the guidance of volition, and are independent of reason, judgment, common sense, and the moral sense, it is not intended to assert that they are independent of intellection also. So far is this from being the case that, within certain limits, the opposite of it is true. The dreamer reasons, not as he would do if he were awake, but in a way satisfactory to himself. Moreover, his conclusions always seem to him to be valid. He is never surprised at any result at which he may arrive. Indeed, it is one of the characteristics of dreams to be free from the element of surprise. If a dreamer, who feels a pain in his toe, infers, possibly stimulated to the inference by the heat of his room, that Mount Ætna is pressing upon his foot, he is not disturbed by the conclusion, but readily accepts it. One of the chief difficulties in the way of comprehending the natural history and physiology of dreams is found in the fact that reason is absent from dreams, and yet that the dreamer reasons. A portion of the difficulty would disappear if it were borne in mind that reason and reasoning are not the same things. Reason is a faculty of the mind, or, if a different phrase is preferred, an attribute of the Ego, gifted with the divine power and privilege of recognizing truth, of discriminating good from evil, and so of acting as a guide to humanity, through the mazes of error to the loftiest heights of truth. This faculty takes no part in dreams. Reasoning, on the contrary, is a process, not a faculty; and it may be good or bad, logical or illogical, sound or absurd. It is altogether independent of reason. Hence, there is no contradiction in asserting that a dreamer reasons, but does not use his reason. Reasoning enters largely into the texture of dreams, but is not in them subjected to the test of reason. Bearing this distinction in mind, it is not difficult to conceive that in dreams, where reason is absent, the most absurd reasoning should be carried on. Moreover, if physiology should demonstrate, by and by, as it probably will, that reasoning is a mechanical process, performed in our waking hours under the guidance of the Ego, by the machinery of the brain, and therefore automatic, it will then be evident that the reasoning of dreams is only a part of the automatic action which is their chief characteristic. There are some remarkable instances on record of great intellectual effort in dreams. Condillac's composition of a part of his *Cours d'Études* is an illustration in point. The writer is acquainted with a gentleman who performed a long and difficult piece of intellectual work with accuracy, in a dream. He was in college at the time and harassed by work. On one occasion, he was surprised at finding himself sitting up, in his nightclothes, at his study table, an hour or two after midnight, with a task accomplished which, on the evening previous, he was unable to comprehend. Carpenter calls such labor unconscious cerebration. By using such a term he indicates its automatic character.

Dreamers have been compared to children, and dreams to children's fancies. The comparison is not a fortunate one. For children possess the germs of all the faculties of adult life, none being in abeyance. It would be more accurate to say that dreamers resemble animals, who exhibit the force of automatic action, with little or no interference from other sources. It is worthy of remark in this connection, that in regard to the absence of moral sense from dreams, to which allusion has already been made, dreamers and animals are alike. Perhaps the best distinction between man and the animal creation below him, is the fact, that man is the only animal that calls himself to account for his own actions. When a dog worries a cat, there is no evidence that he retires, after his amusement is over, to consider whether he has been engaged in a good or an evil action, and to call himself to an account, accordingly. There is no evidence that any of the lower animals ever enter into this sort of self-examination. Man alone does this. Man alone calls himself to account for his own deeds, irrespective of the fear of punishment, or the hope of reward. In dreams this distinction is obliterated, and the dreamer, losing the moral sense, is assimilated to a lower order of beings. It is possible that this fact gives us a hint of what animals sometimes seem to be thinking of. Who that has watched a horse, gazing intently upon some passing show; or a cow, quietly ruminating in the shade of a tree; or a dog, watching a body of laborers at work; or a cat musing before the fire; or a canary bird, intently listening to the gossip of a family breakfast near its cage, has not wondered what these animals were thinking of? Possibly like dreamers they are simply watching, without any regard to the quality of the action, how the thing will come out. Often stimulated by what they see to the most strange and fantastic actions, their fancies, like a dreamer's ideation, are strange, grotesque, and meaningless; and so are dreams.

It has been stated by some observers, that dreams are not wholly deprived of the guidance of volition, or of a certain amount of judgment. The evident attempts at harmony of combination and selection of objects of attention, which dreams have sometimes exhibited, have been regarded as evidence that reason, judgment, and volition are not always and wholly excluded from the visions of sleep. This conclusion is not warranted by the facts of physiology. On the contrary, the amount and sort of volition which appear in dreams and the apparent exercise of choice which they put forth are evidences, not of the action of the Ego, but of automatic power. The thorough materialist resolves all volition into reflex or automatic action, pretty good evidence, not of the correctness of his conclusions, but of the fact that a large amount of what has been regarded hitherto as belonging to the function of the mind and the will is really automatic. Probably no physiologist at the present day would refer the small amount of spontaneous action and attention which dreams exhibit, to any other source than automatism. The character of the reflex function of the nervous system was so fully explained and illustrated in the first part of this essay, that it is only necessary to refer to it here as a chief factor in the production of that sort of movement in dreams, which seems to be the result of volition and attention. The highest and most delicate operations of automatic action are so like spontaneity and conscious attention, that this sort of automatism is sometimes called automatic volition and automatic attention. No kind of selection is so exact, and apparently intelligent as that which is automatic. Put a dozen bits of iron filings and a dozen grains of broken granite together on a table, hold over and near them a magnet, and the magnet will select and pick up the iron with unerring certainty. If a dog is following his lost master over a public highway, and comes to a place where the road divides into several paths, all of which bear the impress of innumerable human foot-prints, inextricably blended together, the dog will unhesitatingly select and follow his master's foot-print. In the case of the magnet there is simply selection; in the case of the dog, there are both selection and volition. The dog selects his master's foot-print and determines to follow it. In both cases the actions are automatic. And so in the visions of sleep a cell-group, drawn within the circle of automatic influence, may be so sensitized that like the magnet it attracts certain other cell-groups, thus exercising what seems to be intelligent selection. And as a dog, after receiving the impression of a special odor, determines to follow the foot-print which exhales it, so a nerve ganglion, after receiving the impression of a pain in the foot, decides to send a motor influence down to the motor apparatus of the foot and remove the suffering part. This act, which is apparently volitional, is automatic. Cells, or cell-groups, which possess an affinity for each other, attract each other; and this they do irrespective of volition. Throw a handful of sand upon a drum-head, and let a person play an instrument of music near by, and the sand will arrange itself in orderly lines and harmonious groups; let a number of brain cells, impressed, like the negative of a photograph, with past individuals, events, scenes, men, rivers, trees, all that makes up the scenery of life, be present in the brain, as they are in the silence of the night, and then let some strain of music strike the ear, or a cool blast of air sweep over the face, or a crack in the woodwork go off like a pistol, or a child scream in a neighboring room, or the colic from an undigested potato send up a sudden pain into the brain, and the brain cells lying there, unstable and unexcited, will arrange themselves into some sort of grouping in harmony with the strain of music, the scream, or the colic, just as the sand heaps arrange themselves on a drum-head in harmony with the note of a flute, or a strain from Nilsson's throat. This combination, with the ideas it produces, is a dream. This harmony of adjustment seems to indicate intelligence and volition, while in reality it is no more so than the harmonious jumping about of sand on the drum-head.

Another characteristic of dreams, and one by no means to be neglected, is the apparent rapidity of action which they exhibit. Events, which in our waking life require years for their occurrence, take place in the course of a few days, hours, or minutes. A child may grow in our dreams from infancy to manhood in a few moments. A dream may witness the beginning and end of a civil war. A dreamer, regardless of the difference of time which separates Cæsar from General Grant, would place himself at a dinner table between the two, and chat with them as contemporaries. A friend, who called upon the writer yesterday, dreamed the night previous that he took a walk with the Reverend Lyman Beecher, and the elder Josiah Quincy of Boston, and was not at all surprised at their simultaneous appearance as his companions. Space is annihilated in dreams as well as time. The world is dwarfed to the compass of a dreamer's arms. B. in Boston talks with C. in Calcutta as easily as if they sat in chairs that touched each other. An allusion was made a little way back to the fact, that sleep resembles death; and it is the best counterfeit of the great mystery that we know anything of. It is a curious and suggestive thought that dreams, which occur only in sleep, and so occur only in a state which bears the likeness of death, should be characterized by a fact which, if there be any future life, can only be realized in that future existence. The fact to which we refer is the characteristic just mentioned, that dreams are free from the limitations of time and space. The dreamer, partially escaped from the fetters of the flesh, roams like a disembodied spirit, without time or space to hinder him. In the future life there can be no such thing as time. A thousand years are as one day, and one day as a thousand years. In the future life there can be no such thing as space. New England, Australia, in that existence, are neighbors to the mountains in the moon, to Arcturus and the Milky Way. This must be so, or there is no future life. A child dies in Yokohama, and the instant the soul leaps from the body, it can talk to its earthly parent in Boston, as if the Pacific and the Rocky Mountains and the prairies did not intervene. And thus it happens that one of the strangest facts of dream life — a life that exists only in sleep, and comes and goes like a flash, — hints at a life which has neither beginning nor end, and is bounded by no limits which human thought can compass.

These are some of the characteristics of dreams. Others might be mentioned, but these are enough to show how singularly and curiously they harmonize with the conditions of sleep. They are simply the unconscious cerebration of that portion of the brain, over which sleep has no power. Sleep affords the opportunity, within certain limits, for the brain to act of itself, and dreams are the result.

Dreams exhibit every possible variety. They may be roughly classified thus: first, simple dreams; second, medleys; and third, artistic dreams.

Simple dreams consist of a single event or scene. Sometimes they are concerned only with a single individual, as when one dreams of seeing the face or form of a relative or friend, without any attendant circumstances; sometimes they are concerned with a single occurrence, like falling down a precipice, or breaking one's nose, or swallowing a snake, or starting on a journey, or receiving or giving an injury, or a benefit, or in some way being the subject or the spectator of some common or strange, expected or unforeseen, pleasant or horrible, occurrence. They are a play in a single act. The second class of dreams or medleys are perhaps the most common of all. They consist of several individuals or events, mixed up in a strange and incongruous way. Oftentimes they are composed of a series of disconnected events or scenes, the details of which are filled with animals, and objects, and human beings, fairies, grotesque creations and equally grotesque combinations, and all the odd stuff with which dreamers are familiar. Sometimes it is possible to trace the threads of connection which draw such a medley together, but more commonly they escape the most careful scrutiny. That there is some secret attraction, which draws these images into the field of automatic cerebral activity during sleep, when the higher centres of the brain are quiet, cannot be doubted. Such visions of sleep are plays in several acts, of which the various parts are thrown confusedly together, and the actors drawn from the past experience of the dreamer's life. Artistic dreams are of occasional though not of frequent occurrence. They are made up of individuals, events, and scenes, which form more or less of an harmonious combination. Like pictures which artists call compositions, they are made up of details, taken like the details of a medley from life's varied experience, and harmoniously blended, so that the whole forms a scene, or a series of scenes, which are startling on account of their appearance of vivid reality. Such dreams do not often take place, but when they do they are regarded by some persons with a sort of superstitious awe, as prophecies of the future, or interpreters of the present. Examples are better than description; and therefore let us endeavor to use the doctrine of the preceding pages as a key to the explanation of a few dreams, given as illustrations of the visions of sleep.

A young medical gentleman, busy with his professional studies, had occasion to spend the night at the house of a stranger. His host was an invalid. The house as well as its occupants were unfamiliar to the guest. Before retiring the visitor, whom we will call Mr. H., called upon his host and bade him good-night in his bed. Mr. H. was then conducted to his own chamber by the daughter of his host and a female servant. Sometime during the night he dreamed that he was in a strange place. Where it was, and what he was there for, he did not know. Presently he saw a bed in his room and apparently somebody in the bed. He got up to find out who had intruded upon him, when he found that a bed was really there, and that there lay stretched at full length upon it a female, covered with a sort of drapery, and having an extremely pale countenance. A closer examination showed that she was dead, and laid out like a corpse. Not fancying a neighbor of that sort, he was about to remonstrate with his host for being put into a chamber thus occupied, when he awoke, and it was a dream. This belongs to the class of simple dreams, and happens to admit of an easy explanation. Its chief interest lies in the fact that it illustrates the principles which have here been enforced. Mr. H. was a medical student. He was, of course, a good deal occupied with the labor and occupants of the dissecting-room. Corpses of both sexes and all ages, placed in all sorts of positions, and wearing all sorts of expressions, were familiar to him. Groups of brain cells and cell elements, the hieroglyphic representatives of these ghastly beings, were latent in his brain, ready at any time to be evoked. With this sort of furniture in his brain, he spent the night at a strange house among strange people. One of the last things he saw before retiring was a sick man stretched upon a bed. Among the very last objects pictured upon his brain, before going to sleep, were two females who conducted him to his chamber. Moreover, it happened that the few minutes conversation which he held with his host as he bade him good-night, were about death and dying. From this it appears that Mr. H., having a brain furnished with dissecting room pictures, went to bed in a strange house, among strange people, having just before going to sleep talked about death, seen a sick man stretched upon a couch and looked upon two females who ushered him into his chamber. After he got to sleep, a slight attack of indigestion, enough to make him grit his teeth and groan faintly, stimulated the automatic activity of his brain; and his brain, thus stimulated, produced the dream, which was in reality a reproduction of what was familiar to him. Sleeping in a strange place made him dream that he was transported to some mysterious locality. Talking about dying brought death into his dream. Associated with death came the familiar corpses of the dissecting room. His host sick on a bed, brought the sick bed and reclining figure into his room, while the females who bade him good-night turned the figure from a man into a woman. Thus it appears that all the stuff of his dream was in the cells of his brain, and indigestion set the machinery at work which combined them into a picture.

The following incident, which is a curious illustration of the automatic dream power of the brain, occurred to Lord Brougham, and is given here in his own language: —

"Tired with the cold of yesterday, I was glad to take advantage of a hot bath before I turned in. And here a most remarkable thing happened to me — so remarkable that I must tell the story from the beginning. After I left the High School, I went with G——, my most intimate friend, to attend the classes in the University. There was no divinity class, but we frequently in our walks discussed and speculated upon many grave subjects, among others, on the immortality of the soul, and on a future state. This question and the possibility, I will not say of ghosts walking, but of the dead appearing to the living, were subjects of much speculation; and we actually committed the folly of drawing up an agreement, *written with our blood*, to the effect that whichever of us died the first should appear to the other, and thus solve any doubts we had entertained of the "life after death." After we had finished our classes at the college, G—— went to India, having got an appointment there in the civil service. He seldom wrote to me, and after the lapse of a few years I had almost forgotten him: moreover, his family having little connection with Edinburgh, I seldom saw or heard anything of them, or of him through them, so that all the old school-boy intimacy had died out, and I had nearly forgotten his existence. I had taken, as I have said, a warm bath; and while lying in it and enjoying the comfort of the heat after the late freezing I had undergone, I turned my head round, looking toward the chair on which I had deposited my clothes, as I was about to get up out of the bath. On the chair sat G—— looking calmly at me. How I got out of the bath I knew not, but on recovering my senses I found myself sprawling on the floor. The apparition, or whatever it was, that had taken the likeness of G——, had disappeared; the vision produced such a shock that I had no inclination to talk about it, or to speak about it even to Stuart, but the impression it made upon me was too vivid to be easily forgotten; and so strongly was I affected by it, that I have here written down the whole history, with the date, 19th December, and all the particulars as they are now fresh before me. No doubt I had fallen asleep; and that the appearance presented so distinctly to my eyes was a dream, I cannot for a moment doubt; yet for years I had no communication with G——, nor had there been anything to recall him to my recollection; nothing had taken place during our Swedish travels either connected with G——, or with India, or with anything relating to him, or to any member of his family." . . . .

More that half a century later Lord Brougham supplemented the preceding account by the following note: —

"E. BROUGHAM, *Oct.* 16, 1862.

I have just been copying out from my journal the account of this strange dream: Certissima mortis imago! And now to finish the story begun about sixty years since. Soon after my return to Edinburgh there arrived a letter from India announcing G.'s death! and stating that he had died on the 19th of December!!" [1]

Many of the data necessary to a satisfactory explanation of this singular vision, are not to be found in Lord Brougham's account of it; but enough are given, however, to enable a physiologist to frame a probable and reasonable explanation. It will be noticed that this description gives an account of two entirely different phenomena. One is the vision which appeared to Lord Brougham in his bath; the other, the death of his friend G. in India. These two phenomena, the vision in England, and the death in India, should not be confounded together. They are not necessarily parts of the same event, and we must not hastily assume that they bear the relation to each other of cause and effect because the vision and the death occurred simultaneously. Let the fact of G.'s death, at the time of the vision, be laid aside for the present and the vision alone considered.

The facts are these. When Lord Brougham was a young man, gifted, as the world knows he was, with intellectual power of the highest order, he became intimate with another young man of

[1] *The Life and Letters of Henry Lord Brougham, written by himself.* New York, 1871. Vol. i., p. 146.

congenial tastes, and undoubtedly of considerable intellectual force. As fellow students they discussed, it appears, some of the greatest themes with which the human mind ever grapples, such as immortality, God, the problems of human life, and similar themes ; some of which Lord Brougham has since studied and expounded with singular ability. It is difficult to conceive of circumstances, better calculated than these to impress, powerfully and profoundly, the mind of one so gifted as Lord Brougham. Impressions naturally made by such discussions as have been described, were deepened by a compact, made with all the folly and enthusiasm of which genius is capable, and consecrated and sealed with the blood of those who made it. Like the oath of Grutli, the compact was intended to be sacred and inviolate, reaching beyond this life into the next. The cells of young Brougham's brain must have been stamped, more deeply than ever before by any other event, with the features of his friend G.'s face, and with the ideas and hopes and resolutions which the compact they had entered into inspired. G. disappeared from the orbit of Brougham's life. The brain cells which had been thus stamped, sensitized like a photographic plate, were laid away in the recesses of Brougham's brain. There they were deposited, the hieroglyphic representations of G.'s face and form and of the compact and the attendant ideas, like a portrait in a garret, or a manuscript in a drawer, ready to be brought out, whenever anything should occur, capable of dragging them into the light. The cells remained latent in Brougham's brain for a long period, without anything to call them into the region of perception. Still the cells were there; they were deeply stamped and were in a condition to be called into activity at any time. With a brain containing the cell-group referred to, Lord Brougham got a chill, while travelling in Sweden, and after the chill refreshed himself, with what he says was a warm bath. It is evident from the result of the bath, that the water was hot rather than warm. Lord Brougham got from the heat to which he exposed himself a congestion of the brain. The congestion clearly was not apoplexy, yet it was near being so, for he says that he fell asleep but still contrived to get out of his bath-tub, and then fell upon the floor, unconscious.

It will be remembered that a moderate anæmia of the periphery of the brain, and a moderate hyperæmia of the base of the brain are among the conditions of sleep, and consequently of dreams which occur only in sleep. The congestion produced by the bath naturally intensified these conditions. What Lord Brougham had been talking about with his friend, Stuart, shortly before the bath, does not appear from the description; but it would be strange if the subjects of God and a future life did not enter into their conversation, when we reflect that such subjects occupied a very large share of Lord Brougham's attention and study during his whole life. We know from his account of the case, that he examined and discussed them with G. Such a discussion, added to the stimulus of a warm bath, would be sufficient to bring within the sphere of automatic activity the latent cell-groups which were the representatives of G. The groups appeared; subjective vision was accomplished; and Lord Brougham saw the friend of his youth apparently projected into space before him.

The connection between the death of G. in India, and the vision in Brougham's brain, is probably only that of coincidence. At any rate, physiology has no explanation to offer of such a phenomenon. Those who believe that it is more than coincidence must seek for an explanation by means which science cannot employ, and in a region into which physiology cannot enter. And, moreover, such persons must not forget the fact previously mentioned, that the future life is not conditioned by time or space; so that when G. died in India he was as near Brougham in England as if they were in the same room. Hence, looking at the vision from the spiritual side, we can conceive how G., having no limits of space between him and Brougham at the moment of death, should at that moment instantly be near him. But how G. could communicate with Lord Brougham is again a matter about which we are utterly ignorant. In reality, we do not know how we communicate with each other. The lips open, the tongue moves, and the air vibrates, but I do not know how that makes an idea pass from me to you, or from you to me. Still less can we guess how a disembodied spirit can communicate with flesh and blood.

One other suggestion may be made. God never employs a new method, that is, a supernatural one, when an old method, that is, a natural one, will accomplish the object he has in view. He loves to employ the simplest measures. The same mathematical curve, which governs the growth of a violet, guides the stars in their courses. Following this law, we should expect that G., if he wished to appear to Brougham, would not reclothe himself with our miserable habiliments of flesh, but would simply act upon Brougham's brain in a way to produce subjective vision. So God may act upon the human brain, so as to indicate his presence and become a working force in it, without ever assuming a gross anthropomorphic objective form.

The following dream resembles in some respects the preceding one, and illustrates even better than that the method which the brain pursues in producing dreams: —

"The most frequent general organic condition of the sensory apparatus during the existence of hallucinations would appear to be one of congestion, or fulness of blood. A circumstance directly illustrative of this is related in the 'Psychological Journal' for April, 1857, as occurring to the writer himself. He says: 'We have known cases of *ghost-seeing* when wide awake, which have been cured by leeches at the front of the forehead, — evidently indicating that they have resulted from a congestive state of the perceptive faculties. . . . . We were on a visit in ——, and had taken more wine than usual. It was the summer-time, and the weather very hot and dry, which combined sensations rendered us feverish and uncomfortable. . . . . We went to bed, but not to sleep, and tossed and tumbled, changing our position every moment, but were too restless to repose; at length we turned towards the window and perceived between it and the bed a short, thick-set, burly figure, with a huge head, staring us in the face. Certainly nothing could appear more real or substantial, and after gazing on this monstrous creature, we put out our hand, when he opened his ponderous jaws and bit at us. We tried various experiments with the creature, — such as putting our hand before his face, which seemed to cover a part of it. The longer we contemplated it, the more palpable was this figure, and the more wrathful were its features. Struck with the apparent reality of the apparition, we mechanically felt our pulse; it was throbbing at a fearful rate; our skin was hot and dry, and the temporal arteries were throbbing at railway speed. This physical condition had produced the phantom. We then jumped out of bed, when the spectre seemed to be nearer and of more gigantic proportions. We then threw open the window to admit a little more air, sponged our head and body, and thus, by removing the cause, the monster disappeared.'"[1]

The second class of dreams or medleys is illustrated by the following dream taken from Wundt.

[1] *A Physician's Problems.* Elam, p. 284.

"I am able to illustrate by some examples this interweaving of various causes which may work together in such a way. I dreamt that a funeral procession in which I was to take part stopped before my house; it was the burial of a friend who had died a short time previously. The wife of the deceased invited me and other friends to place ourselves upon the other side of the street in order to take part in the procession. As we went out an acquaintance remarked she only said that because there was cholera on that side of the street and she wished to retain this side for herself. Now the dream suddenly changed into the open air. I found myself in long and irregular by-ways in order to shun the places where cholera prevailed. When I finally, after straining every nerve in running, had reached the house, the funeral procession had departed. But still numerous bouquets of roses were strewed about the street, and a number of stragglers, who appeared to me in my dream as attendants upon the funeral, were all like myself in haste to rejoin the procession. These funeral attendants formed a motley crowd, especially some who were clad in red clothing. Whilst I hastened it occurred to me that I had forgotten a wreath which I had intended to lay upon the coffin. Thereupon, I awakened with palpitation of the heart."

THE END.