ART. II.—*The Physiology of Sea-sickness;* by RICHARD MEADE BACHE, Assistant U. S. Coast Survey.

(Read before the Connecticut Academy of Arts and Sciences, January 15, 1862.)

ALL that is known about sea-sickness is, that certain involuntary motions of the body produce an effect upon the nervous system. This effect results in nausea. This nausea is called sea-sickness. The question is not solved, as to the manner in which the nervous impression is produced.

It is generally supposed, that sea-sickness is produced by the mere motion of the body, and consequently of the stomach. That it is produced by motion, is not to be denied, but as wherever sea-sickness occurs, motion is the pervading concomitant of existence—the thing most patent of all that is evident to the senses, and the body is so unpleasantly subjected to it, we lose sight of the fact, that with the body are also subjected all the senses or perceptive faculties, and that these are called upon to comprehend an entirely novel state of existence.

I have said, that the mere action of motion upon the body is supposed to produce the nausea called sea-sickness. I hope to be able to overthrow this theory by the arguments and proofs of another theory, which I am about to advance.

The points which I intend to prove are—that the agreeableness of motion is a mere matter of habit—that motion however violent is not nauseating "per se" but only inasmuch as it produces an impression conflicting with its ordinary contrasted effects as pre-established in the mind, that the idea of motion is the result of concurrent testimony of the senses—and, that in novel motions, there is a violation of the conception of motion derived from the habitual concurrence of the testimony of the senses—that as the result of this violation, a conflict of impressions ensues, and the brain is affected—thence the nervous system, and nausea results. In fine, I maintain that sea-sickness is a disease of the brain, and not of the stomach, except incidentally, or as affected by the brain, although, it is true, that the stomach reacts upon the brain.

I now commence my argument in which I have attempted a procedure, which, I trust, cannot fail to bring conviction of the truth of the theory to any one who will carefully analyze it. In all statements of facts which I have introduced I have taken the experience of others, as well as my own.

The appearance of motion when the observer knows that his own body is at rest, is not nauseating. To ascertain the effect of the mere appearance of motion under these circumstances, we can take no better example, than that of a train of cars drawn by a locomotive at full speed. The more rapid motions of the

heavenly bodies are not appreciable by our senses. We have conception of them through the mind, but not through sight or hearing, therefore I have chosen the motion of railway trains for the purpose of illustrating the effect of the mere appearance of motion. Standing as near, or as far off, as one pleases, from a train of cars in rapid motion, no more nauseating effect is produced upon the spectator, than by the sight of any object at rest. Yet the appearance of motion is nauseating in *two* cases—but these are where the idea of motion of the body is involved, that is, where motion of the body of the observer is either in *debate* by the mind, or *acknowledged* by the mind and the motion is not *felt*. If this can be made to appear, it is additional proof, that the mere appearance of motion is not nauseating, or as I shall henceforth express it for convenience, the appearance of motion is not nauseating "per se." As an example of the first case—that the appearance of motion is nauseating "when motion of the body of the observer is in *debate* by the mind"—take the following: In a dimly lighted depot, two trains of cars stop side by side—presently one starts—so gently that an occupant of one of the trains cannot decide whether it is his own train which is in motion, and consequently whether it is his own *body* which is in motion or whether the motion perceived, is that of the other train. This produces a sensation of uncomfortableness—of giddiness—indicative that nausea would result if the effect were continued. At all events, it produces an impression of motion of the body, which impression is derived through the instrumentality of the sight, and which impression affects the nervous system unpleasantly—yet the body of the observer may have been at rest all the while. As an example of the second case—the assertion "that the appearance of motion is nauseating when motion of the body of the observer is *acknowledged* by the mind, and the motion is not *felt*," one illustration, as in the first case, will suffice. In the slight trembling of an earthquake, when the jar would have escaped notice, but for the faint oscillation of a chandelier which calls attention to the existence of an earthquake—this oscillation through the impression which it gives the observer, that his body is in motion, often causes the sensation of nausea. It is impossible that the motion of the body of the observer could cause the sensation, for the case spoken of is one where the existence of the earthquake would not have been known, but for the oscillation of the chandelier. The sensation could not have proceeded from the mere perception of the motion of the chandelier, because such an object can be viewed while swinging violently, without any sensation being produced, other than the perception of its swinging.

The cause of the disagreeable sensations just described, is owing to the fact that nature requires our senses to keep pace. The sight must not proclaim what the feeling does not at once cor-

roborate and "vice versa." In the first case, nervous impression was produced by doubt in the mind of the observer as to whether his body was or was not in motion, and in the second case, by the consciousness of motion of the body, which motion was not *felt*. In neither case, did the senses keep pace, consequently the nervous impression ensued, and consequently nausea. It is evident, although the sight was the agent in these results, that it was *only* the agent, and it was the imagination which produced the effects. Sight was the intermediary. It may be safely inferred from the effect of the appearance of motion in the two cases just cited—that if a man believing himself in his senses, should see a landscape glide by, he would become nauseated, yet it is evident that the nausea would proceed from the involved idea of motion—the idea that he might be in motion without feeling it—for if he knew it was only the landscape which he saw that was in motion, he would regard it with terror, but without other sensation, and it would affect him as a passing train of cars when he knew that his own body was at rest—that is, it would not affect him at all, as far as nauseation is concerned.

We see then, that the appearance of motion "per se" does not nauseate, and we see too, how the nervous system is impressed by the imagination so as to bring about nausea.

The senses from the earliest infancy have grown up and been educated together, to act in harmony. It requires habit to render them capable of keeping pace together in a novel condition of existence. The motion communicated to the body by riding in a carriage, is by no means violent, notwithstanding which, persons in early life, frequently become nauseated while thus riding. This is merely because the sense of sight and the feeling of a certain motion have not been educated together. This I shall proceed to show. It is well known, that persons perfectly habituated to riding in a certain position in a carriage, object to riding with the back towards the direction in which they are proceeding, on the plea that it makes them sick to do so. It doubtless has that effect, but it is impossible for the effect to be produced by the mere motion in that position, for it is impossible in a carriage in motion in the dark, to decide in what position one is sitting in relation to the line of progress, unless some obstacle should interpose, or the road should be so bad as to afford an equivalent to a number of obstacles in the way, or unless the driving is of such a character, by sudden turnings and abrupt increasing or slackening of speed, as to indicate to the occupant of the carriage the position in which he must be sitting. In a word, in ordinary conditions of progress in a carriage, it is impossible in the dark to determine in what position one is sitting. This is not generally known. Experiment will prove my assertion to be true.

It has been already shown, that the appearance of motion "per se" does not nauseate. How then is a person accustomed

to riding in a carriage, nauseated by riding with the back towards the direction in which he is proceeding, for the appearance of motion "per se" does not nauseate, nor can motion "per se" nauseate in *that* instance. The effect is derived from consciousness of motion perceived by two senses at least, while at the same time, the appearance of objects violates the habitual impression produced by the sight of them. In the dark, the effect must be derived from pure imagination. If we grant then, that a particular mode of progress in a carriage can nauseate one accustomed to a carriage (and it is often seen) and we grant at the same time, that appearance of motion "per se" is not nauseating (and this I have proved) and we know also, in the case spoken of, that motion "per se" could not have produced the sensation of nausea (because the motion is the same in any position, and the person is habituated to one) we must then acknowledge that the nausea is produced neither by the motion "per se," nor by the appearance of motion "per se," but by a conflict of the two senses of feeling and sight. If this can be inferred in the case of one accustomed to the motion of a carriage, it must apply with more force to one unaccustomed to it.

So thoroughly have the senses created a conception of motion, that the exclusion of sight does not alter the idea of its appearance, nor alter the idea of the appearance of violation of preconceived effects. The mental picture is always present. If the exclusion of the sight did alter these ideas, the closing of the eyes would in one of the cases just mentioned, save from nausea a person unaccustomed to riding in a certain position, and in the other case, would secure immunity from nausea to the person unaccustomed to riding at all. But it does not save them, which shows that the mental picture of progress and of unwonted effects, takes the place of that produced by actual vision. It is immaterial whether the sight is acting or not acting. Whatever senses exist in an individual, have conjointly created a well defined idea of the contrasted effects of motion, and this conception is always evident to the mind without the continued intervention of all the authors of the conception.

Having shown that a certain motion is nauseating, but is not nauseating "per se," we may fairly infer that no motion is nauseating "per se." Perhaps in very violent motions, there may be some mechanical effect produced by the movement of the stomach—this is not a primary cause of sea-sickness, but an aggravation of it. Otherwise, it must be supposed that the stomach of a sailor becomes entirely changed in its nature.

The law to be deduced from what I have attempted to demonstrate is this—that the violation of the habitual conception of contrasted effects of motion, is the cause of the nauseation which occurs during novel motions—and the cause is not motion "per se," nor the appearance of motion "per se."

If such effects as those just described in the case of riding in a carriage can nauseate, when they are produced by comparatively slight changes in "the habitual conception of contrasted effects of motion" it is not surprising, that the effect of motion at sea should bring the great and continuous nausea called sea-sickness. The motions of a ship vary infinitely. As soon as a certain kind of motion has lasted for a long time, the voyager becomes accustomed to it, and he has no more tendency to become nauseated, than has the man accustomed to a carriage. He may, however, become sick again, if the motion should vary, and yet not be increased. A person habituated to the sea, may remain ashore for a long time, but his senses readily accommodate themselves again to conditions once understood. It is true, that even old sea captains are sometimes afflicted by sea-sickness, but this does not invalidate the theory which I have advanced. There are temperaments so predisposed to sea-sickness, that the inuring process has to be perpetually renewed. I do not assert, that the same amount of experience at sea, gives the same immunity to each person. The causes which I have mentioned as superinducing sea sickness affect every one, but the capability of resisting it varies with every temperament. There are individuals who never become sea-sick—that is to the extent of succumbing to nausea—but they undergo the same process of education of the senses. The difference between these persons and those who do succumb, is that their organizations in physique and temperament enable them to resist the inclination to nausea and the education of the senses is completed before nausea has been able to overcome them, although it always attacks. There is no one, who in a first experience at sea, is not disposed to nausea, but there are some few persons, who possess such organizations, that with the aid of a firm determination to resist an attack of sea-sickness they are enabled to escape it, and to pass the ordeal of the novel motion at sea without manifest inconvenience.

At sea, motion immediately nauseates, even when it is much less than may be experienced in a swing without the slightest impression. In a swing, motion is comparatively regular. It requires little education of the senses to enable them to keep pace with each other. The evidence of the sight is nearly the same as that of the feeling. If a person in a swing is blind, or keeps the eyes shut, there are still measures of the extent of motion. These measures are firstly the points of highest elevation and greatest depression—secondly, the corresponding intervals of time—thirdly, the perception of the rush in progressing through the atmosphere, for not only does the cessation of the rush indicate the points of greatest elevation, but its increase or diminution, indicates continuously all other points. Hearing may also be mentioned, as it contributes to the conviction of the mind as to

the uniformity of the motion to which the body is subjected when swinging. All these certainly give a most accurate idea of the segment of a circle which the body is describing in the air. Nausea can be produced in a swing, but it requires very little education of the senses to enable a person to bear the motion.

I have been told by a person who attempted to prepare himself for a sea voyage by using a swing, that the process was entirely unavailing—yet I doubt very much, whether the motion to which one is subjected at sea, is often greater than can be attained in a well constructed swing. But the motion of a swing is quite uniform—that at sea far from it, and the failure of the swing to inure a person to unequal motion, shows that it is not motion which affects us, but inequality of motion, and that it is not the mere mass of flesh and digestive organs which are alone concerned, but other elements as appurtenances of the body demand our consideration, and as I hope to prove, merit it, far more than the mere body and stomach, which becoming diseased only react. If it be said, that animals, such as horses and dogs, become sea-sick, and yet have no such nice senses as we have, excepting perhaps scent;—I answer by saying, that a horse is always terrified at movement in which he does not see the cause, even terrified at perfectly noiseless movement. What is it which prompts a young dog to jump at all hazards from a vehicle in rapid motion, even when driven by his own master, and what makes him eventually delight in riding? Preconceived ideas of motion when violated bring terror to both horse and dog. The conditions of novel motion, once accepted, the senses are reconciled and habit is the result. If then we allow these animals to possess habitual conception of motion, they must be affected at sea as human beings are—in the same manner if not in the same degree. The tumbler pigeon precipitates itself with a revolving motion towards the earth, but does not appear to be at all affected by the motion which its body has undergone. If the same bird is taken in the hand and its head placed under one of its wings and it is then whirled around, it may be placed on a table, and during a few moments it will appear lifeless. Aquatic birds of the greatest vigor in flight, and habituated to floating on stormy waves, often become nauseated on the decks of vessels.

Let us now consider the motions at sea. A ship rolls, plunges, seems to pause, then dart, and every movement brings the passenger increased uneasiness. There is no precedent in his experience for such movement. If he possesses sight, the view of objects is at variance with all that he has been habituated to in other motions. If he is blind, his mental conception—the picture in his mind—is equally at variance with his habitual conception. In a few days, in either case, the person would be indifferent to the motion. He will have learned, in the mean-

time, to reconcile the evidence of his senses. If he possesses sight, it will have been educated in conformity with unequal motions, just as it was educated from childhood to comparatively equal ones, or if he is blind, his conception of the appearance of motion, will have been reconciled with motion experienced. In either case, it is the conception of the appearance of motion, as contrasted with the feeling, which conception will have reconciled itself with existing conditions. Both those who see, and the blind possess this habitual conception, which is never shut out from the mind as has been shown. Closing the eyes will not discard it. If it did, every one subjected to unusual motion could in that way, secure immunity from nausea. This has been shown not to be the case.

Let us now consider the peculiar effect of unequal motions upon the human body. It is my conviction that motion is nauseating whenever the estimate of its extent does not correctly precede it. The mind mechanically calculates what is to take place while it is taking place.

I shall now endeavor to show, that "motion is nauseating whenever the estimate of its extent does not correctly precede it." I have already shown that motion is not nauseating "per se." I have also shown, that when it does nauseate, it is when the brain is impressed. The question naturally suggests itself here, as to what there is in the impression produced on the brain which affects us unpleasantly and produces nausea. It is the idea of undefined movement of the body of the observer. Back of this I do not pretend to go. Nature has so constituted us, that undefined motion is repugnant to our organizations. Nauseation from motion proceeds from the idea present to the imagination, that the body is the subject of undefined motion. The nauseation of sea-sickness, of course, eminently proceeds from undefined motion. But to the proof—an experiment which any one can make. I have often lain awake at night in the cabin of some great ship at sea, and guaged the motion and calculated the capability of the passengers to resist an access of nausea. Choose a time, when there is a regular sea and wind, when the ship ploughs along pretty evenly. Now and then, seas will rise somewhat higher than the rest. Sea-sick passengers habituated to uniform motion—at the intervals when the ship has been accustomed to rise or to fall, feel that they rise still higher or fall still lower. The difference in motion is not perceptible in violence, and yet causes many to give involuntary evidence of the occupancy of their state rooms. The strain of fancy is ever exerted and *solicitous* to imagine and attain the turning point, although after it is gained, the motion, as in a descent, may be still more rapid. Let any one who has been at sea, recall how trying was a continuous movement in one direction, even a long rise upon a wave, when the motion is certainly not as swift as in

a descent, and at the same time remember, how small the motion of a long gliding rise or descent is, as compared to much that one is subjected to at sea—how much less violent. The effect upon the observer is produced simply by the difference of motion —by ignorance of the extent to which it is going—by the idea of undefined motion. When one's senses are educated in the novel condition of existence at sea, the motion is no longer undefined. A ship could make no movement which would not be accompanied by a corresponding idea of space passed through. There is no motion at sea which by habit will not cease to appear undefined, but if it were possible for a ship to mount heavenwards, and to sink rapidly near to the bottom of the sea in alternate movements, it is my belief, that the hardiest sailor would become sea-sick.

The summary of what I have attempted to demonstrate is this, that sea-sickness is not the result of motion "per se," nor of the appearance of motion "per se," but is the result of the senses "violating the habitual conception of contrasted effects of motion" and producing on the brain the idea of undefined motion. When the senses are educated to form coöperating and agreeing measures of the novel condition of existence at sea, nausea ends. If they never formed these measures nausea would never end.

For another proof of this theory, take the case of an infant. Instances of children in arms being sea-sick are very rare.* A child certainly feels the motion, that is to say its body is subject to the motion equally with that of the oldest passenger. But a child undergoes motion without *feeling* it. It sees too, without *perceiving*. In its case nothing conflicts. It is as ready to be rocked on the billows as in its cradle. Its youth precludes the possibility of its having any habitual conception of motion from the education of the senses, and if it feels any sensation, that sensation is at variance with nothing. As soon as children begin to "take notice," as it is called, the education of the senses begins, and thus we find, that children shortly afterwards, at the age of two and three years, are attacked by sea-sickness, but they recover long before adults are secure from it. The case of a blind man, because he cannot see, and consequently cannot perceive, is not

* A medical friend has handed us the following note on a case of his own observation.—Eds.

While I was surgeon on the emigrant packet ship "Webster," (1861,) I recollect a case of a girl (an infant) at the breast dying of sea-sickness. The child was perfectly healthy when passed by the Inspecting Medical Officer in Liverpool, and continued to be so, apparently till after we discharged our Pilot at Holy Head. On the evening of the first day out, it was very rough and blowing hard, and consequently a large number of passengers, both adults and children, were afflicted with sea-sickness (Morbus Nauticus). They all eventually recovered with the exception of this child. It had all the symptoms of sea-sickness, such as loss of appetite, vomiting, a cool clammy skin, tongue thickly coated in the middle, and a weak feeble pulse. In spite of good medical treatment, it continued to fail rapidly with debility, till we arrived in long. 27° when it died. Dr. E. S. Bissell.

in any respect similar to that of an infant, for I have shown, that the mental picture may conflict with reality, and the blind man has the mental picture—the idea of space—motion—speed—everything—excepting color. Not only are babies not usually afflicted with sea-sickness, but just in proportion to the youth of children, are they exempt from it. Since my own observation indicated what has been asserted in regard to the immunity of babies from sea-sickness, I have enquired of persons of experience, whether their observation tended in the same direction, and I have been confirmed in my belief.*

It has been asked by a friend, to whom I communicated this theory of sea-sickness, whether the insane are sea-sick, and an answer in the negative would certainly seem to corroborate the theory. Thus far, however, I have been unable to ascertain, as the insane are so rarely allowed to go to sea, that it would require long and patient investigation to determine the point. Immunity from sea sickness in a very few cases might be a mere coincidence. As far as the answer has been made to my enquiries, I shall give the result. I know of two persons, who, there is every reason to believe never had been at sea until a voyage, when they labored under the "mania à potu." These persons did not become sea-sick. Another case of which I have reliable information, is that of a young girl, who was insane, and who was taken

* Among the latest testimony which I have received, is a letter written by Captain R. P. Manson of Bath, Maine. This letter is subjoined. Much other testimony has been received verbally, or is my own testimony derived from close observation and comparison during a series of years. The remark that it is impossible, in a carriage in motion in the dark for the occupant to decide in what direction he is sitting in relation to the direction of progress, is one which I heard made by my father many years ago, at a period when I was but a child. Memory treasured this alleged fact, and not suspecting for a moment, that the determination of its truth would ever be of any service, beyond the mere verification of a curious fact, I was able subsequently to investigate it, and to ascertain its entire correctness, and now it forms a very important link in the chain of evidence which I have adduced in support of my theory of sea-sickness. I have often received the testimony of others on various points, by merely listening to their descriptions of certain sensations, and thus I was generally enabled to avoid what might prove leading questions.

Letter of Capt. R. P. Manson.

Bath, Oct. 14th, 1861.

R. M. Bache, Esq.,

"*Dear Sir:*—Your letter regarding sea-sickness has been received, and I most cheerfully comply with your request—offering any information (which has come under my observation during thirty years actual services as shipmaster mostly in the European business) which you may deem relative or interesting to that subject.

In answer to your questions regarding children—I have never known an infant, nursing—sea-sick, and children from the age of two and a half up to four or five years, are not often sea-sick, when so, the attack is but short, slight, and seldom returns. Such, I believe, is in conformity with your own views: it is what I have invariably observed with many hundred emigrant families.

I will mention I once knew one of the worst cases of sea-sickness completely and almost instantly cured by fear. Respectfully your ob't serv't,

R. P. Manson."

to sea by her father, who was the captain of the ship. She too was not sea-sick. I should be very sorry to mar a strong case of evidence in favor of the theory which I have advanced, by an assertion of the truth of which I am not positive, even if I were willing to state any thing of which I am not absolutely certain. I give my investigation of this subject, for what it is worth in the thoughts of those who may read this article. I shall not support my theory in any measure whatever upon the result of that slight investigation. Therefore I do not assert, that the insane are not liable to sea-sickness.

I think it sufficiently clear from all that has been said, that impression of the brain is the cause of nausea on the ocean, since I have shown, that it is not motion "per se" nor the appearance of motion "per se" which causes it, but an *idea*, which I have termed one of undefined motion, derived when the body is subjected to motion in an unusual manner, from the "violation of the habitual conception of contrasted effects of motion." There are minor causes of sea-sickness, or rather, not so much causes as aggravations of it. These are close cabins, smell of bilge-water, unusual food, and as I have said, the stomach reacts upon the brain.

A precaution frequently taken by people about to commence a sea-voyage, is to eat nothing or scarcely any thing. Another precaution taken, is to get immediately into a berth. Neither plan is good. Neptune is the most insatiable highwayman on the globe, and attempts to levy toll on all. The traveller who comes totally unprovided, fares badly, if he cannot successfully resist. In plain English, the stomach is weakened by want of food, and is therefore more liable to be acted upon in the production of nausea, and if nausea should ensue, retching is probably more distressing without than with food. Lying down is an excellent plan to adopt for the purpose of avoiding nausea, but when the posture is assumed in a berth with the nauseous smell of bilge water around and as is often the case, with a tin vessel of questionable nicety, hooked on the edge of the berth, the plan is no better than the first.

Persons frequently imagine that some particular article of food cured their sea-sickness. It is a general rule, that whatever a sea-sick person is able to eat at all while sick, or convalescent, gets the credit of the cure. The most heterogeneous articles are spoken of as specifics. The best preparation to avoid sea-sickness, is to go aboard ship with the stomach supplied with its accustomed amount of food. It is best, as far as possible, to maintain the habits of shore.

Many reasons combine to render the deck of a vessel in any thing like fair weather, the proper place to remain, either to avoid sea-sickness, or to recover from it. It is there, that the

sight can be more quickly educated to the movement, than it can be in the cabin. The crests and troughs of the seas can be observed, and thus it can be seen, just how far one has to rise—just how far to fall. Persons will frequently find, that the view of the waves has a beneficial effect in stilling nausea, suffered more severely in the cabin. This is not only on account of the fresh air on deck, but because in the cabin, the idea of motion is more undefined. The view of the horizon also, has a most beneficial effect. The horizon is the only object which has the appearance of remaining stationary, and the motions of a ship are readily graduated by keeping the gaze directed to it. On deck the miserable sea-sick passenger can breath the fresh air, in lieu of the conglomerate smells in a cabin aboard ship. He can also choose a position amid-ships, where there is the least motion of any place on deck. Then there are more agreeable objects to look at on deck, and beyond, than in the cabin, and it is very important that the mind should be distracted from the passing scene—or, what is disagreeable or most so in it. In a foot-note, I have adverted by a quotation to a case, where a woman who had been prostrated for some days by sea-sickness, was immediately and completely cured, owing to the action of terror on her mind, resulting from the belief that the ship was foundering, and this case is by no means isolated.

If in addition to what has been recommended, the passenger will spread a mattress, and put himself in a recumbent posture, all will then have been done, that can be done, to prevent, to cure, or to alleviate sea-sickness, until the education of the senses is completed.