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## APPARENT CONTROL OF THE POSITION OF THE VISUAL FIELD.

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One of my students reported that she possessed the ability of moving upwards the entire visual field. This translocation first occurred involuntarily and after noticing the phenomenon the subject found by trial that it could be repeated at will.

During several conferences and tests the following account was obtained, giving the essential facts as to the nature of the phenomenon and the circumstances of its occurrence so far as the subject had been able to notice them: The subject is afflicted with hysteria. A rather severe attack occurred seven years ago from which she is slowly recovering. The involuntary translocations were first noted shortly after this time and they have occurred rather infrequently ever since. Fatigue and a prolonged fixation seem to be the conditions under which they occur involuntarily. The phenomenon can be produced voluntarily at any time and under any circumstances. The subject has refrained from much experimentation for fear of aggravating her mental condition. An object is momentarily fixated and then slowly raised upwards. The duration of fixation necessary before movement can be effected varies from one to ten seconds. The rapidity of the movement varies. The translocation is sometimes slow and gradual and is effected only by continuous effort; at other times the movement is more rapid and comes easily. Fatigue and brightness of the visual field decrease the time of necessary fixation and increase the rapidity and ease of the translocation. The extent and duration

of the displacement is under complete control. The extent of the movement may be anywhere from one to forty degrees. The field may be held stationary at any desired position, and then be moved on upwards or be brought back to its original position. The displacement has been maintained in one position for five minutes, though the continuous strain necessary is very fatiguing. The exhaustion due to continuous effort seems to be the only limitation of the possible duration of the phenomenon. Objects do not become double during the translocation; they are perceived only in their elevated position, although the subject is conscious of their original location, for she can at any time point accurately in that direction. The entire visual field participates in the movement, and all visual objects keep their relative positions to each other. The only noticeable change in the character of the visual objects is a slight decrease in their intensity, though they remain distinct and substantial in appearance. When the field is lowered to its original position, the visual objects receive an added snap of reality the moment they reach their real position. It is by this means that the subject knows when the objects reach their true positions. Both the upward and the return movements are consciously real; objects do not merely appear now in one place and now in another, but they appear to move as well. The objects do not move relatively to the line of sight. The object originally fixated remains at the point of fixation throughout the displacement; in other words the point of fixation participates in the translocatory movement. The visual field remains perpendicular to the line of sight, as if it were undergoing a vertical rotation about the head as a center. If a person is in the visual field his voice participates in the illusion. In the preliminary tests, the subject was requested to attempt other directions of movement but she was unsuccessful. Moreover, she was successful only with binocular vision, and when the eyes were in relatively unconstrained positions in the socket during the original fixation. With monocular vision or when the eyes were rotated far to the periphery, only a very slight and momentary displacement could be effected.

At first it was supposed that the phenomenon could be explained on the basis of one of three theories: (1) The trans-

location is effected by some ocular innervation which does not involve eye movement, but which shifts the space reference of the retinae. The phenomenon would thus be similar to the well-known illusion due to the paralysis of the external rectus. This theory was put out of consideration immediately by the very obvious fact that the eyes do not remain stationary, but rotate in the direction of, and in proportion to, the visual illusion. If the illusion were slight in extent one could not be certain of this fact, but a movement of thirty degrees that may be maintained for five minutes is too obvious for the most sceptical observer. The subject was asked to point out the apparent location of the fixated object, and it always coincided with the directional position of her eyes. (2) The second theory supposes that the eyes rotate with the illusion, the space reference of the retinae remains normal, but that a refractive change, a lateral or rotary movement of the lens, occurs whereby the rays from the real positions of the objects are kept focused upon the same points of the retinae in spite of the bulbular or retinal rotation. Such a conception is conceivable though its truth is not probable according to current views of ocular physiology. There is some factual support for such a theory, because the point of fixation, that portion of the field corresponding to foveal activity, is displaced and the image of the object originally fixated is still located at the point of fixation. Foveal positive and negative after-images were induced and developed before the translocation. These after-images representing foveal activity participated in the movement and were still located at the point of fixation. Although the eye has rotated upwards forty degrees away from the object primarily fixated, yet the image of that object must be due to the foveal activity of the retinae, for it is located at the fixation point and also at the same position in space as a foveal after-image. This theory was tested by making a phakoscopic examination of the behavior of the refractive surfaces. No unusual movements were detected. The lenticular images behaved in reference to the corneal image exactly as they did during a similar normal rotation. No refractive changes were in evidence. Ophthalmoscopic tests were planned but a more satisfactory theory was evolved before they were carried out.

(3) It may be supposed that the illusion is due to some disturbance in the sense of bodily position, which illusory disturbance is projected upon, or interpreted as belonging to, the objective field, the inverse of the haunted swing illusion, etc. There is no evidence in favor of this theory. The subject does not feel dizzy in the least. Her conceptual, or ideational, space is not affected; she can point out the vertical and cardinal positions, and the real location of the displaced objects although she may not see anything in that direction. Furthermore, if the theory were true, it would be necessary to assume some secondary principle, as a refractive change, in order to compensate for the effects of the eye rotation.

The next conception evolved to be experimentally tested may be roughly stated as follows: During the entire period of the displacement, the retinae are insensitive to all objective stimulations, and that which the subject sees is a hallucinatory positive after-image of the objects primarily perceived. This theory was suggested by two facts: (1) The subject is an hysterical, a temporary visual anæsthesia being one of the symptoms; (2) In the preliminary tests I noted that she was extraordinarily susceptible to positive after-images. A momentary glance at an electric light in daylight is sufficient to induce a positive after-image with a duration of seven to eight minutes. This conception proved to be true in the main. The tests were made at various times of the day with different conditions of illumination. Two series were made at night in a room illumined by a shaded Welsbach lamp. The remaining tests were made on bright clear days in a well-lighted room where the brightness of the background could be varied. The various experiments will be grouped around a series of propositions.

*A. The translocations may be in any direction and may be initiated and sustained by a movement of either the eyes, head, or body.*

At first the movements had occurred in but the one direction; at my suggestion the subject attempted other directions of movement but was unsuccessful. If the translocated visual field is a positive after-image, it would seem that any direction of movement should be possible. With this idea in mind, the subject

was directed to rotate her head slowly sidewise during an upward displacement. She did so and the displaced field moved likewise. The field could now be moved in any direction by either a head or eye movement. After this experience, the subject was able to start the displacement in any direction, the preliminary upward movement not being necessary. By turning the head and body, the field may be rotated to such an extent that the objects originally perceived no longer stimulate the retina. This result did not occur with the first displacements of forty degrees. The field may be rotated the full 360 degrees if desired.

During the preliminary tests, displacements could not be effected with monocular vision, nor when the eyes were in constrained positions. After several months of experimentation, the attempt to secure displacements under these conditions was repeated with successful results. The translocation was effected, but not readily, and the period of necessary fixation was longer than in the case of binocular vision with a normal position of the eyes.

*B. All new objects introduced into the field of vision during the displacement are not perceived.*

This statement does not mean that the stimulations do not affect vision at all; it means that these objects are not perceived as objects with their proper form, color and position so as to be recognized and located in space. At first the subject was kept in ignorance of the nature of the tests, and while she occasionally knew that something had happened to the visual field, she did not have the least idea as to what had caused the perceived changes. After being informed as to the nature of the experiments, she generally knew that some object had been introduced into the visual field but she had no idea as to its nature or location.

At night, she fixated a lighted candle near the wall some eight feet distant. After a displacement of fifteen degrees, a large bright yellow paper was thrust in front of the candle; it was not perceived. The paper was now put eight inches in front of each eye in succession, and then held at the same distance in front of both eyes for a couple of minutes. The paper

was large enough (16 in. square) to intercept the entire visual field, and a Welsbach light was so situated as to shine directly upon it. In neither case was the paper seen. A long series of similar tests was performed in bright daylight, the objects being introduced at different distances from the eye and in various positions in the visual field. A few typical cases will be described: After a twenty degree displacement, a book and a lighted candle were placed at the original fixation position. The lighted candle was moved back and forth a foot in front of her eyes. A bright paper screen was placed a foot in front of both eyes so as to intercept the entire visual field. The screen was kept in this position for two minutes. Again, the field was displaced so that the subject's eyes were directed at an electric light some eight feet distant. This light consisted of three sixteen-candle incandescents. While the eyes were held in this position, the light was turned on for fifteen seconds. This test was repeated a dozen times. In one of the tests the light was kept on for a full three minutes. In none of these cases were the objects perceived. When the visual field is moved more than ninety degrees, it is projected against an entirely new background of objects and these always remain invisible.

*C. Objects introduced into the visual field during the displacement, although not perceived, may affect the brightness, color tone and distance location of the displaced images.*

The effect varies with the brightness of the field originally fixated, and the intensity, extent, and duration of the stimulation introduced. If the objects displaced be very bright, while the stimulation introduced be of small extent or of weak intensity, no effect is noticeable. If the field be weak in intensity, and the stimulation introduced be intense, large and prolonged, a maximum effect results.

When the window was displaced in bright daylight and a book or lighted candle was placed at the original fixation position at a distance of ten feet from the subject, no effect was noticed. When the screen of bright yellow paper was passed close in front of her eyes so as to intercept the vision of one or of both eyes, a very dim shadow appeared to pass over the distant displaced field. When the lighted candle was thrust close

in front of her eyes, a marked pupillary reflex was evident, and a very dim pale yellow light was suffused over the distant field. The bright window and a dull yellow wall were successively displaced in the direction of the electric lights; this stimulation produced a pale yellow glare over the field, but the effect was much more pronounced in the latter case, *i. e.*, with the less intense field. When the image of the window was displaced against the electric light, no effect was noticeable at first; after a few moments the yellow light tinged the field and gradually became more intense as the stimulation was prolonged. After a few minutes the yellow glare contracted from the periphery and became concentrated in the center of the field. Probably in time the lights would have been perceived in this case, but the subject was not able to prolong the test over three minutes. A dull wall was displaced against a blackboard as a background at the distance of three feet from the observer. A lighted candle was held near the blackboard and directly in front of her eyes. At first there appeared a dim flare of yellow light which gradually contracted in size and increased in intensity. After four minutes the image of this candle broke through the displaced field and was perceived as a candle. This was the only case in all of the tests where a distinct perception of the object occurred, and even here the percept of the candle was described as being strange, hazy, and unreal in appearance, and much less intense than in ordinary vision. Furthermore, in this test the field had been rotated more than ninety degrees, so that the objects primarily fixated no longer stimulated the retinae, and, as shall be noted later, the stimulation from the real objects is effective in maintaining their displaced images in consciousness.

When the screen was placed close before both eyes so as to intercept the entire visual field, some of the displaced visual objects, after some time, appeared located at the distance of the screen as though projected upon it. The screen remained invisible and the subject was ignorant as to the nature of the experiment. In the first test the subject suddenly reached out her hand in order to point out the location of the image, and was greatly surprised when her hand came in contact with a

real object in that position. Only those images foveally perceived were affected in this manner, and their size was always increased in proportion to the nearness of their location. This fact is directly contrary to the usual results as to the size of after-images when projected on backgrounds of different distances from the observer. However, in the above case it must be borne in mind that the eyes remained adapted for the distant position, instead of becoming converged upon the invisible screen.

The retinal effectiveness of these new stimulations is genuine. The pupillary reflex is indubitable proof. The screen though not perceived influences the distance of the displaced images. The diffused yellow glare is undoubtedly due to the stimulation of the lights. The subject was ignorant of the tests in the majority of the cases so that the results probably cannot be due to conscious suggestion. The absence of retinal effectiveness might be shammed by the subject, but there could be no deception when retinal effects are present, unless she had knowledge of the nature of the experiments to be performed.

*D. The objects primarily fixated, though not perceived at their real positions, effectively influence in various ways their displaced images so long as their stimulations can reach the retina.*

This influence may be tested by displacing the field more than ninety degrees, by covering one of the objects with a screen, by moving an object in the field, or by removing an object entirely from the range of possible vision.

1. A removal of an object from the range of vision was finally effective in all of the experiments. A few cases will illustrate the general nature of the results. The electric lights were fixated and displaced about twenty degrees. Shortly afterwards they were turned off. The displaced image of the light immediately exhibited a marked decrease in brightness but remained visible during the continuance of the test. The writer stood in front of the window and was fixated by the subject. After the displacement, he suddenly dropped down out of the range of vision. After a half minute his displaced image disappeared entirely from sight, though the images of the other



objects in the field remained in distinct view. The place of image was not filled in by the surrounding visual content, *i. e.*, the bright light of the window. Neither was the window back of his body now perceived. The space was filled in by a homogeneous light gray content, a light shadow silhouette effect. Upon rising up again to the original position, a rather hazy image appeared to view but still in its displaced position. The subject was ignorant of the nature of the test. A book was held before the window and fixated. After the displacement it was removed, and in a short time its image disappeared. The book was now brought back into the field of vision, but it was placed a foot below its original position. Its displaced image reappeared, but at a position a foot below that from which it had disappeared. The test was repeated a number of times, the object being introduced into the field at various positions relative to its original location. The same results obtained; the reappearing image was always displaced from the true position of the object and bore the same spatial relation to its position of disappearance as the new location of the real object did to its primary position. The object was never perceived simultaneously in the two positions. The first image always disappeared before the second image was seen in the new position. The reappearing images were much dimmer than their originals and were always perceived with some difficulty. The objects were easier to perceive when brought back to their original position than in the case where they were introduced in a new position.

Since the existence of the image of the removed object depends upon the presence or absence of that object in the field, although the other images in the displaced field remain visible, it follows that the objective stimulations must be effective in maintaining the vision of their translocated images. Ignorance of the tests disposes of the possibility of any sham or suggestion.

The removal of an intensive stimulation from the original field thus produces a decrease of brightness in its displaced image. If the stimulation is weak, its displaced image finally disappears. If the object is returned to the field, perception occurs with difficulty and the new image is much dimmer than

the original one. The new image occupies the same relative position in the displaced field as the new location of the object does in the primary field.

2. Movement of an object in the primary field may produce a change of location on the part of its image. If the movement is slow, a perception of motion may result.

At night the writer stood in the field of view. During the displacement, the arm was lifted up slowly to a horizontal position. No movement was perceived at first. After the arm had moved about half the distance, the subject noted its new position and then perceived it in motion for the remainder of the distance. The perception was very vague and difficult. The arm seemed to be a mere transparent shadow, for the subject could look through it and see the visual objects past which it moved. The experiment was repeated while standing before a bright window. No movement was perceived; the arm was finally seen in its extended position, presenting a very shadowy and unsubstantial appearance, markedly different from the remaining part of the body. The electric lights were fixated and displaced ten degrees against a dull yellow wall. The light was then set swinging, pendular fashion, quite rapidly. The arc of movement was two feet in extent. The displaced image of the light was described as quivering in a vibratory fashion as though it were rigid and had been violently jarred. In a similar test, the light was slowly moved backwards and forwards through an arc of three feet. A similar motion on the part of its displaced image was perceived, but its extent was judged to be only six inches in length. This decrease in length was not due to the subject's ignorance of linear values, for the extent of movement was represented graphically after the test. Whether the perceived motion was synchronous with the motion of the light, or lagged behind it an appreciable time, I do not know, though the latter condition probably obtained. The image of the moving object was never seen in two positions simultaneously; the image in the first position disappeared before the moving object was perceived in its second position.

These results are genuine, for I attempted to induce such movements by suggestion, often asserting that my arm was

being elevated and requesting the subject to perceive the movement if possible. Such attempts were invariably unsuccessful. When the field was displaced more than ninety degrees, the movement of an object produced no effect upon its image. In this case, the object no longer stimulated the retinae. Objects were also moved after being hidden behind a screen; this movement effected no results upon the displaced image. Consequently suggestion cannot explain the results.

3. The various results obtained by the interception of the original stimulus by the introduction of a screen are partly due to the new stimulation introduced as well as to the removal of the old one. The results due to the new object have been enumerated and described in a previous section (C, pp. 362 ff.). Certain other phenomena occur, however, which are due to the removal of the original stimulus from the retinae. In the tests at night a screen was interposed just in front of the candle originally fixated. The image of the candle did not disappear but flared out to a large size with an indeterminate contour and a marked decrease in luminosity. The image resumed its normal appearance when the screen was removed. The test was repeated several times in immediate succession with the same results. The screen was placed immediately in front of both eyes. All visual objects in the displaced field disappeared almost at once, but the subject continued to see the space between the screen and the distant wall as though nothing had happened; this space appeared light and transparent as in normal vision. The background, *i. e.*, the image of the wall, merely faded away into nothingness; the further limit of the perceived empty space was thus not blackness but a mere void. After a short time the image of the candle reappeared at the distance of the screen, though all other objects in the field remained invisible. When this image of the candle reappeared to view, vision of the empty space beyond the screen was lost. With strong illumination (fixating the window on a bright day), a screen interposed just in front of the object of fixation produced no noticeable results on the character or continuance of its image. When the screen was placed immediately before both eyes so as to intercept the entire field, certain objects in

the far distance which were perceived through the window disappeared from vision at once, but the images of the window and surrounding walls as well as of the intervening space remained visible for nearly a minute. After this period the small part of the window foveally perceived became located at the distance of the screen. The subject's attention was now attracted to this, and she did not notice whether the remaining part of the field continued to be visible at its distant position. However, the empty space beyond the screen was still perceived until the end of the experiment.

The apparent results of these tests may be stated as follows: When the original stimulation is intense and a small portion of the field is intercepted, no effect upon the duration of the displaced image is noticeable. When the stimulation is weak and the whole field is intercepted, the displaced images disappear almost immediately. Intermediary results can be obtained with mean conditions.

4. The influence of the original stimulations may be inferred from certain results obtained by a displacement of more than ninety degrees. The introduction of the electric lights before the eyes produced more marked results in case the field was displaced to such an extent that the original objects perceived no longer stimulated the retinae. Moreover, the results occurred more quickly with such extreme rotations than they did with a small displacement. The object introduced into the field was perceived as an object only in the case of such an extreme rotation.

The displaced images thus possess a greater resistance to the influence of new stimuli so long as the primary field continues to stimulate the retinae.

*E. The effect of an old stimulation is much greater than, and far different from, that of any new stimulus introduced during the displacement.*

1. An old object introduced into any part of the field after its removal is perceived as an object under conditions where the introduction of a new object would produce no visual effect whatsoever.

This general statement is derived from a comparison of the

results of the tests described in sections B, C, and D. The following test was performed to illustrate the proposition. Under conditions of weak illumination, I stood in the field of view holding an unlighted candle in my hand. The hand was fixated and a ten degree displacement of the field was secured. I now moved out of the range of possible vision and lighted the candle. After my displaced image had disappeared from view, I came back to the original position. The image of myself and candle now reappeared, but the light was not perceived save for the dim and vague luminosity suffusing the field. It would be possible to choose conditions under which even this dim luminosity would not occur.

2. The effect of a new object tends to be diffused over the visual field, while the effect of an old object tends to be definite and localized.

The first case is illustrated by the diffused luminosity of the candle and electric lights. The second statement is illustrated by a number of facts. The displaced image of the electric lights decreased in intensity the moment the light was turned off, although no effect was noted on the remaining part of the field. The removal or movement of an object in the primary field produced visual effects which were confined entirely to the displaced image of that object. When an old object was brought back into any part of the field, it was perceived as an object, *i. e.*, its visual effects were definitely localized in space.

3. The visual effects of a new object are projected in accordance with the normal laws of retinal space reference. The image of an old object re-introduced into any part of the field is perceived in a displaced position.

As illustrations of the first statement we may cite the following tests: In the case where the candle introduced into the field after a displacement was perceived as a candle, it was correctly localized. It was placed directly in front of the subject's eyes and it was perceived in that position. In the case where the eyes were directed at the electric lights for three minutes during a displacement, the diffused luminosity became concentrated in a large circle in the center of the field of vision. If this ring of light represents the stimulation of the lights, as has been

assumed, it was correctly localized. The second of the above statements represents the results given in section D, (1) and (2).

*F. This peculiar and abnormal functional condition of the eyes obtaining during the displacements may be maintained, destroyed and reinstated at will. The condition is maintained or reinstated by a mental fiat accompanied by an orbital strain, while the condition is discontinued at any time by a mental fiat and a relaxation of the orbital strain.*

1. Maintenance of the displacement. During the various tests, a careful observation was made of the subject's motor attitudes and expression in initiating and maintaining the displacements. The body generally remained quiet but exhibited a suppressed tenseness as though the whole energy of the body was being concentrated upon the task in hand. The breathing was slow, quiet and regular, but much deeper than usual. The subject appeared slightly enrapt or entranced as one does with extreme absorption in some observation involving steady fixation. The extreme concentration was due to the facts that the tests were generally of some duration, the subject's attention was directed to the observation of all changes occurring in the visual field, while many of the phenomena were novel in character. It was found on trial that the field could be displaced and maintained in a given position with a relaxed condition of the body and with normal breathing. No expression was noted other than that occurring in a case of ordinary fixation. Introspectively, the only necessary conditions for the maintenance of the displacement were a marked strain located in the head directly back of the eyeballs, and the focusing of the attention upon the images.

2. The discontinuance of the state. We found that it was not necessary to move the field back to its original position in order to discontinue the state. The subject generally shook her head, moved her eyes, blinked several times and relaxed her bodily tension. The subject was asked to give an account of her method of discontinuing the state at will, but was unable to do so with the exception that she had noted that it was not necessary to move the field back to its primary position. This method was made an object of study in a number of experi-

ments. It was found that a sudden head or eye movement generally caused the field to disappear momentarily during the movement. The movements, blinkings and the bodily relaxation were not necessary to discontinue the phenomenon though they were of some service. The only necessary concomitants of the mental decision were the release of the attention from the images, and a relaxation of the orbital strain mentioned above. The displaced field does not disappear immediately, but fades away gradually. The time necessary for the disappearance of the images seemed to vary slightly in the different tests. Probably, the time is proportional to the intensity of the original stimulations. The average duration necessary was from three to five seconds. The recovery of normal vision does not occur immediately after the disappearance of the displaced images. There is an intermediary period in which the visual field presents a uniform gray hazy appearance. The images of the real objects now before the eyes break through this hazy mist and gradually become distinct. The whole process involving the disappearance of the displaced field and the recovery of normal vision lasts from four to seven seconds.

3. The reinstatement of the displaced field after its disappearance. After normal vision has been recovered, the displaced field may be brought back to consciousness at will without the necessity of again subjecting the eyes to the original stimulations. A mental decision involving a thought of the objects and the reinstatement of the orbicular strain is the only condition necessary to effect this result. Merely thinking of the objects is not sufficient to produce the reinstatement. The displaced field does not come back gradually but *instantaneously*. The subject had not been aware of her ability to recall these positive after-images at will and first attempted it at my suggestion. The results were so immediate and pronounced as to startle her. The phenomenon is best described in the subject's own words: "No sooner had I willed than the displaced images burst upon me in full bloom as though they had been hidden behind a screen and this screen had been suddenly jerked away." With the return of the displaced images, the eyes were subjected to the various tests described above in order to deter-

mine their sensitivity. The eyes are now in exactly the same condition of sensitivity as they were during the original displacement. This voluntary alternation of the abnormal condition of the eyes and of normal vision may be successively produced in the same experiment apparently as many times as desired. In one experiment the field was displaced more than ninety degrees and projected against a background of new objects. The subject was directed to hold the eyes as motionless as possible, to allow the displaced field to disappear until distinct vision of the new background was secured, to call back the displaced field so as to hide all vision of the new background of objects and to alternate the two states as long as possible. The two conditions were alternated six times in succession, when the subject was compelled to stop through fatigue. Apparently, fatigue is the only limitation on the possible duration of the phenomenon. In every case normal vision was effected gradually while the abnormal condition was reinstated immediately.

*G. The visual field may be moved at will in a third dimensional direction. The backward movement is effected by an 'effortful feeling of expansion' within the eyeball, while a 'feeling of contraction and relaxation' in the same locality accompanies a forward direction of movement. During these movements the same abnormal condition of sensitivity obtains as in the case of the lateral displacements<sup>1</sup> already described.*

At the time when the lateral displacements were first noted (seven years ago), third dimensional movements of the field sometimes occurred involuntarily, especially under conditions of fatigue or of prolonged fixation. By trial, it was found that these movements were also subject to voluntary control. They can be produced voluntarily much more easily and after a shorter period of fixation than can the lateral displacements.

The field cannot be moved forward to a distance nearer than five feet from the subject, but it can be removed to the apparent distance of the horizon. Within these limits, the field can be

<sup>1</sup>The translocatory movements already described in the previous sections will be termed hereafter 'lateral displacements,' in order to distinguish them from these third dimensional movements.



moved and located at will. The images do not become double; but are blurred to some extent and are rather confused in outline. With the backward direction of movement, the images become slightly smaller, but the decrease in size does not seem to be proportionate to the increase of distance according to the laws of perspective. The decrease in size seems to be due to a 'melting away of the edges' of the various images. In the return movement, the field is judged to have reached its real position when the images attain to their maximum distinctness of outline.

The movement can be effected with monocular vision, but it occurs much more readily with the left eye than with the right. On the return movement with the right eye, the field does not move forward gradually but jumps back quickly in an involuntary manner. The images grow less distinct and a trifle smaller with the backward movements. The decrease in size seems to be due to a 'fading away of the edges.'

When the field is moved backward toward the horizon, the subject experiences a 'feeling of expansion' which is located inside of the eyeballs directly back of the cornea. The forward movements are accompanied by a 'feeling of contraction' in the same locality. The feeling of expansion is described as effortful, while the contractile feeling is accompanied by a sense of relaxation.

At first it was supposed that these depth movements were entirely distinct in nature from the displacement phenomenon, and that they were another instance of that voluntary control of the depth location of the visual field possessed by Miss Allen.<sup>1</sup> This inference was not wholly correct. During a depth displacement, the visual field may be displaced laterally, or it may be moved in a third dimensional direction during a lateral translocation. During the prolonged tests on the lateral displacements, the subject often lost control of the distance location of the displaced field and it would suddenly recede from five to ten feet. A series of experiments was performed in order to test the sensitivity of the eye during the depth movements. If anything, the eye is more insensitive during this phenomenon

<sup>1</sup> PSYCHOLOGICAL REVIEW, Vol. XIII., No. 4, pp. 258-275.

than it is with the lateral displacements. Various objects were introduced into the range of possible vision, but they were not perceived, nor did they affect the visual field in any way. A lighted candle held at a distance of three feet directly in front of the eyes did not even suffuse the distant field with a luminous glow. When objects were removed from the field, the period necessary for the disappearance of their images was longer than in the case of the previous phenomenon. The movement of an object in the field was not perceived, though the object was finally seen in its new position. Objects re-introduced into the field were perceived with extreme difficulty unless they were brought back to their original positions. In the latter case the image of the object is more intense and realistic, and it appears to view in less time after the introduction of the stimulus.

The fact, however, that the moving visual field is of the nature of a hallucinatory positive after-image, does not explain the mechanism of its distance location. The lateral displacements are due to head or eye movements, and the depth changes must likewise be attributed to some factors just as in the case of the distance location of any after-image, either positive or negative. Moreover, the changes must be due to factors over which the subject has direct voluntary control. While this phenomenon is essentially different from that exhibited by Miss Allen so far as the retinal sensitivity is concerned, yet it is possible that the two cases are similar in respect to the mechanism involved in this voluntary control over the depth location of the visual imagery. In the case of Miss Allen, the depth movements were conditioned by lenticular adjustments which involved no convergent changes of the eyes. With the present subject, no convergent movements occurred. This fact supports the proposition previously enunciated as to the retinal effectiveness of the stimulations from a primary field, for if the eyes were totally free from the influence of the objects primarily fixated, it is inconceivable that the convergence should remain unaltered while the visual images are subject to such marked changes in respect to depth location. As to the presence of lenticular adjustments, no confident assertions can be made. I was under the impression that lens changes occurred, but the

movements were so slight in extent that I could feel no absolute confidence in the validity of the observations. The movements were so small that it was impossible to detect whether a particular kind of adjustment was invariably correlated with each direction of image movement. The small extent of the movements present, in case the observed results are valid, is explicable from the fact that the possible extent of the third dimensional movements of the visual field was greatly diminished in the dim illumination necessary to a phakoscopic examination. The lack of clear-cut definite results, as in the case of Miss Allen, does not disprove the lenticular theory; neither do the observations furnish indubitable proof that the depth displacements are conditioned by appropriate adjustments of the lenses, though they do support that theory to some extent. During the displacements pupillary changes occur, but they are spasmodic and irregular in character, no definite change being invariably correlated with each direction of image movement. The fact that the displaced images become blurred and confused in outline in the third dimensional movements, but do not do so during the lateral displacements, indicates the presence of lenticular disturbances in the former case. The presence of muscular feelings inside the eyeballs in the region of the lens may likewise be interpreted in favor of the theory. On the whole the writer is disposed to believe that lenticular changes do occur and condition the movements to some extent, though they may not constitute the sole explanation of the phenomenon. The possibility of other conditioning factors is a matter of speculation and any such discussion is beyond the range of this paper.

The preceding account has purported to be as much as possible a factual statement of the various experimental results with little comment or theoretical digression. Some peculiar aspects of the case deserve further consideration.

Such visual anæsthesias, wherein objective stimulations are retinally effective and may indirectly influence consciousness, occur with hysteria and may be induced by suggestion. So far as the writer is aware, however, such anæsthetic retinal areas do not subserve any objectified visual consciousness, as

with the present subject, unless hallucinatory images are induced by suggestion. The hallucination and the insensitivity seem to be a single phenomenon rather than two independent events, for they invariably occur together. This is seen from the fact that there is no stage of a total lack of visual sense content intervening between normal vision and the abnormal condition. When the displaced field is caused to disappear, there is, it is true, an intermediary stage wherein the visual field presents a uniform undifferentiated appearance. But this is not a total blindness, for an objectified visual sense content is present. When objects were removed from the field and their displaced images were allowed to fade from view, no gap was left devoid of all sense content. This close relation between the presence of the hallucinatory field and the insensitivity, and their relation to volition are matters for discussion. Three theories may be conceived as to the relations involved :

1. The anæsthesia may be assumed to be directly subject to volitional control, while the hallucination is an effect of the anæsthesia. The first relation is conceivable for such anæsthesias can be induced by suggestion, but the second causal nexus is hard to conceive and some facts contradict the assumption of any such invariable connection. An involuntary semi-trance, involving a visual anæsthesia and a complete aboulia has frequently occurred throughout the subject's life. This visual anæsthesia generally involved a complete loss of all sense content, *i. e.*, it did not produce an hallucination.

2. It may be supposed that the two phenomena are independent events and are controlled by separate volitional processes, but, since the two results cannot be separately initiated, it must be assumed that each event is due to a particular process within the whole volitional act, but that the two processes are so associated that they cannot be even consciously separated. This theory may be true for all that is known to the contrary, but it is needlessly complex.

3. We may assume that the hallucination is volitionally controlled, but that the presence of the hallucinatory images is the cause of the anæsthesia. The second relation may be illustrated by the following phenomenon: Let the light from a bright

window be reflected into the left eye by one's glasses. The image of the window is now projected against the wall of the room. If the right eye is closed, the wall back of the projected image remains invisible in spite of all efforts to perceive it. The stimulations from the wall enter the eye and reach the retina, but vision is so dominated by the image of the bright window that the stimulations from the wall fail to influence it effectively. Likewise, it may be conceived that the hallucinatory activities so dominate the visual centers that these latter are impervious to the objective stimulations. The phenomenon is thus a matter of visual rivalry. This conception is supported by the general result enunciated in section C that the visual effect of any new stimulation introduced varies with its intensity, extent, and duration, and also according to the brightness of the primary field, *i. e.*, the intensity of the hallucinatory field. In the volition her attention is positively directed toward the visual images in the reinstatement and maintenance of the hallucination, and it neglects them in order to discontinue the state. This fact supports the view that volition deals directly with the hallucination and that the insensitivity is a secondary by-product. The supposition may be further supported by the fact that the stimulation of an old object is more effective when it is brought back to its original location than when it is introduced into the field in some new position. In the former case the image is more vivid and realistic and is perceived in a shorter time after the object is returned to the field. This result may be conceived as due to the fact that the stimulation in any secondary position comes into rivalry with a hallucinatory image of some other object.

There is a real spatial translocation of the effects of retinal stimulation in certain cases. This is illustrated in Fig. 1. Suppose that the eye momentarily fixates the object  $F$ , while  $C$  is perceived in indirect vision. The points  $f$  and  $c$  are the retinal areas stimulated by these objects. The eye is now rotated upward until the optic axis is directed toward  $F'$ . The stimulations from the objects  $F$  and  $C$  now meet the retina at the points  $b$  and  $a$  respectively, while the images of those objects are perceived in the positions  $F'$  and  $C'$ . These periph-

eral stimulations at *a* and *b* influence the brightness, duration, location and existence of the visual images *F'* and *C'* which should normally correspond to the retinal activity of the areas *f* and *c* respectively. It is as if the effects of the stimulations of *a* and *b* were transferred to the points *c* and *f* respectively. What is true of these two stimulated areas is also true for all retinal points. Thus every retinal area, *c* for example, transfers the effects of its own stimulation to another area *d*, and in

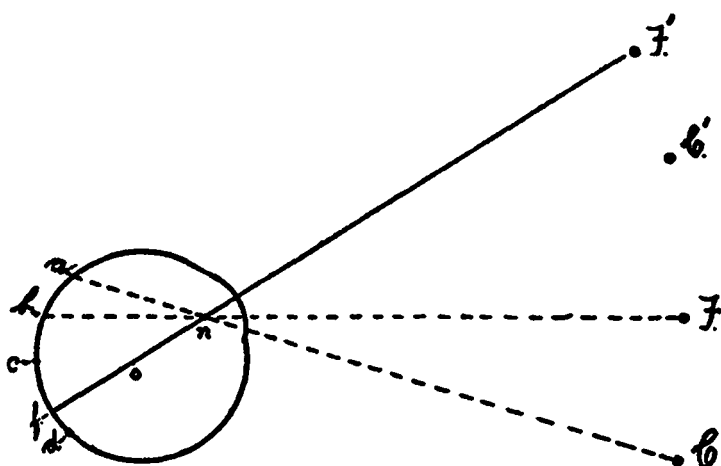


FIG. 1. *F* and *C*, objects in the field of vision; *F'* and *C'*, displaced images of the objects *F* and *C* after the eye rotation; *n*, nodal point; *o*, center of rotation; *f*, fovea; *f-o-n-F'*, optic axis after the rotation; *a*, *b*, *c*, *d*, retinal points.

return it receives the effects of the stimulation of the area *a*. However this apparent 'transference' of the stimulation of one area to a second retinal area occurs only for 'primary stimulations,' *i. e.*, only for those objects occupying the original field of vision. In the case of 'secondary stimulations'—those resulting from new objects introduced into the field of vision after the displacement—there is at first an apparent retinal 'diffusion'; the results of the stimulation are diffused so as to tinge appropriately the entire visual field. This diffusion is minimized in extent in proportion to the duration and intensity of the secondary stimulation.

As to the nature and mechanism of this 'transference' and

'diffusion' several possibilities are open. It may be supposed that the retinal space reference has been altered. Ordinarily the image corresponding to the stimulation of a point *b* on the retina is localized along a line running through this point and the nodal point *n*, but this spatial reference of the retina may be altered in certain conditions, *e. g.*, the partial paralysis of an eye muscle. This conception is disproved by the fact that the retina localizes normally in the case of a prolonged and intensive secondary stimulation, although the transference of the primary stimulations still obtains. While the conception might explain the 'transference phenomenon,' yet it is inadequate to account for the 'diffusion of secondary stimulations.'

The phenomena may be supposed to be either retinal or central affairs. In fact, they have been couched above in retinal terms, but this was done merely for descriptive and not explanatory purposes. Analogous results have been obtained in experimental psychology. The irradiation phenomenon, simultaneous contrast, etc., indicate that in normal experiences the conscious effects of any retinal stimulation are not confined wholly to the corresponding part of the visual field, but it is not known whether this diffusion of results is centrally or retinally conditioned. The question is further involved with the general problem of the seat of hallucinatory activities, as to which there is no unanimity of opinion. Consequently, there is no positive evidence to be derived from other sources in favor of either conception. So far as anatomical possibilities are concerned a central location is preferable. The fact of voluntary control over the existence and duration of the transference is more explicable in central terms. A statement of the facts, however, in either retinal or central terms would do little but localize the phenomenon. The mechanism and *raison d'être* of the process would still remain unintelligible.

The conception which seems most satisfactory to the writer involves several propositions: (1) For all points *a, b, c* on the retina there are corresponding cortical areas *A, B, C*. The habitual pathway of a retinal impulse from any point is to its corresponding cortical area (Fig. 2). The course of any impulse may be varied under certain conditions. It is not neces-

sary to assume that the spatial arrangement of the cortical areas is in any way similar to that of their corresponding retinal points although they have been represented in that manner in the figure (2). The hallucinatory images of the displaced field are due

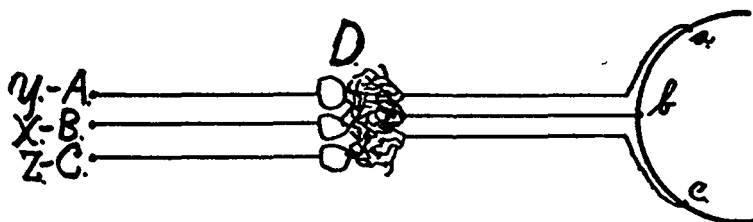


FIG. 2. *a, b, c*, retinal points; *A, B, C*, cortical areas corresponding respectively to *a, b, c*; *Y, X, Z*, displaced images due to activity of *A, B, C*, respectively; *D*, subcortical center.

mainly to cortical activities, and (3) these cortical activities are so intensive and dominating that they interfere with the habitual behavior of the incoming retinal impulses. These impulses become blocked at the subcortical center *D*.

We will suppose that the eye perceives three objects, *X, Y* and *Z*, corresponding to the three neural processes represented in the figure. The images of these objects are now displaced by an eye movement, and a new object, *V*, is introduced into the field so as to stimulate the retina at *b*. This retinal impulse is checked at *D*, and hence a diffusion of the impulse occurs. If the stimulation is weak, the effects are drafted off to lower centers without conscious effect. A greater intensity of stimulation gives a diffused effect over the entire visual areas. In case the stimulation is very intense and prolonged, the retinal impulse becomes strong enough to supplant some one of the cortical activities. The impulse will traverse the line of least resistance, and this will be along the habitual pathway *b-D-B*. The object *V* will thus be localized in a normal manner. The displacement of the images *Y* and *Z* and the correct localization of the new object *V* are thus possible.

As a result of the eye movement, the object *Y* now stimulates the retina at *c* instead of at *a*. This retinal impulse becomes blocked at *D* because of the cortical activity of *C* involved in the displaced image *Z*. This impulse will finally



break through the hallucinatory field at the point of least resistance. With primary stimulations this point of least resistance is not along the habitual pathway *D-C*, but it is at the cortical area *A* involved in the displaced image *Y*. This area *A*, being strongly excited centrally, forms an apperceptive center highly susceptible to an appropriate stimulation. The impulse from *c* is transferred to *A* by the subcortical center *D*. This theory assumes that a psycho-cortical activity will block an habitual path to impulses which would arouse qualitative dissimilar responses in that center, while it will markedly increase the susceptibility of that area to appropriate impulses. This conception involves no new doctrine, for the same principle is used to explain the selective character of apperceptive attention; central activities increase the mind's sensitivity to stimulations of an appropriate character but decrease its susceptibility to all other stimulations. Thus it is not necessary to posit the existence of a subconscious mind in order to explain the subject's ability to react differently to the two kinds of stimulations.

The volitional control over the existence and duration of the hallucinatory images is a noteworthy fact, for generally such experiences possess all of the involuntary characteristics of percepts. What causal relation the orbital strain bears to the existence of the abnormal state is a subject concerning which it is idle to speculate. It is also rather curious that this abnormal condition does not seem to be subject to suggestion in any way, although it is so susceptible to volitional influences.

The subject of these experiences was under the writer's observation for six months and the experimental work covered a period of three months. Owing to the subject's susceptibility to fatigue, it was impossible in this time to investigate the phenomenon as thoroughly as desired. The case deserves further study, as many interesting problems came up during the experiments whose solution would certainly give a more comprehensive insight into the phenomenon.

The subject comes of a well-to-do and cultured family. She is an only child and was reared in comparative isolation from those of her own age. She has been much addicted to day dreaming and she possesses an artistic, idealistic and sensitive

temperament. Her physical health has always been good. She is physically well-developed, and her appearance gives every indication of healthful bodily functioning. She has been subject all her life to short attacks involving visual anæsthesia and aboulia. These attacks are congenital on the mother's side of the family. She has often experienced other seizures involving faintness and extreme physical weakness, with the presence of only a dim vague consciousness. These attacks often leave the subject in a very weak condition for some hours. Shortly before the phenomenon described in this paper was first noticed, she experienced a more profound attack resulting in some permanent amnesias. The complete loss of auditory musical memory incapacitated her for her vocation as a music teacher. Her retentiveness for academic subjects was much impaired. She is now extremely susceptible to fatigue. Her case was diagnosed by a competent nervous specialist who found that she was unable to converge upon objects at a distance of less than eight feet. She has been using a set of prisms to strengthen the internal recti muscles and finds that their constant use has had a beneficial effect upon her mental ability.<sup>1</sup>

<sup>1</sup> The MS. of this article was received October 15, 1907.