



Gustav Fechner's Observations on his Own and Others' Visual Mental Imagery

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Abstract

Gustav Fechner (1801-1887) was a German physicist, philosopher and experimental psychologist, and co-developer of the Weber-Fechner Law. In 1860, Fechner published a two-volume work, *Elemente der Psychophysik*. To date, only Volume I has appeared in English translation. This article publishes a translation of a significant part of Volume II concerning Fechner's investigations of mental imagery. The translation covers Chapter XLIV, pages 468 – 525: "Observations including Remarks on the Relation between afterimages and memory images in particular. Memory afterimages, phenomena of the sense memory, hallucinations, illusions, dreams." The translation will serve as a resource for scholars interested in the phenomenology of mental imagery, individual differences, consciousness, psychology and philosophy. The translation was prepared with the assistance of an online translation program at: <https://www.deepl.com/translator>.

Keywords: Fechner, Phenomenology, Visual Imagery, Memory Imagery, After- Imagery, Vividness, Colour, Individual Differences

XLIV. Observations and Remarks on the Relation Between Afterimages and Memory Images In Particular. Memory Afterimages, Phenomena of the Sense Memory, Hallucinations, Illusions, Dreams.

In the following I have compiled some observational material, partly my own, partly from others, on the phenomena mentioned in the heading, which can provide a useful basis for theoretical views on them, without, however, wanting to exhaust the very complex and widely branching subject matter, which would require not one chapter but a book, and without going into more than a few very general theoretical remarks, since it does not seem possible to give mine for now.

a). Memory Images and Afterimages in Relation to Each Other.

Sensory impressions once made from the outside continue to exist for a certain time after the removal of the external stimulus as after-images, after-sounds, generally as after-perceptions, which in a healthy, strong state of the senses tend to be less easily perceived, less intense and lasting than in a weakly stimutable state; and they leave behind the capacity to be reproduced in memories or more or less transformed in phantasy images. Both kinds of after-effects are to be considered here mainly, if not exclusively, in the field of facial perception, where they have been most studied; but what is valid here is more or less applicable to other fields of sense perception.

The main differences between afterimages on the one hand, and

memory and phantasy images on the other, are that the former are only ever accompanied by a feeling of receptivity [1]. The first always arise and exist only with a feeling of receptivity, only in continuity with the sensory impressions made, independent of volition and association with the imagination, and, according to the immediately preceding sensory impressions, also proceed independently of volition, legitimately, whereas the memory and phantasy images, with a feeling of lesser or greater spontaneity, can arise even a long time after preceding sensory influences, partly involuntarily through association with the imagination, partly volitionally, and can be banished and altered again.

These characteristic differences are connected with other, but generally less definite, differences that are more or less variable and give way to transitions in different persons, about which the following is disseminated.

In order to gain a starting point, I will first present the phenomena as they are found in me, who, to a certain extent, stand at the lower extreme of the scale through which memory images can be compared to sensory phenomena, such as afterimages, are able to approach. But what I have found in myself, and where I must stop after careful and often repeated observation, is by no means all found in the same way in others, as will be seen from the cases cited below.

In general, memory and fantasy images always appear to me as something lacking in corporeality, airy, breathy, in contrast to

the more material impression of the after-images.

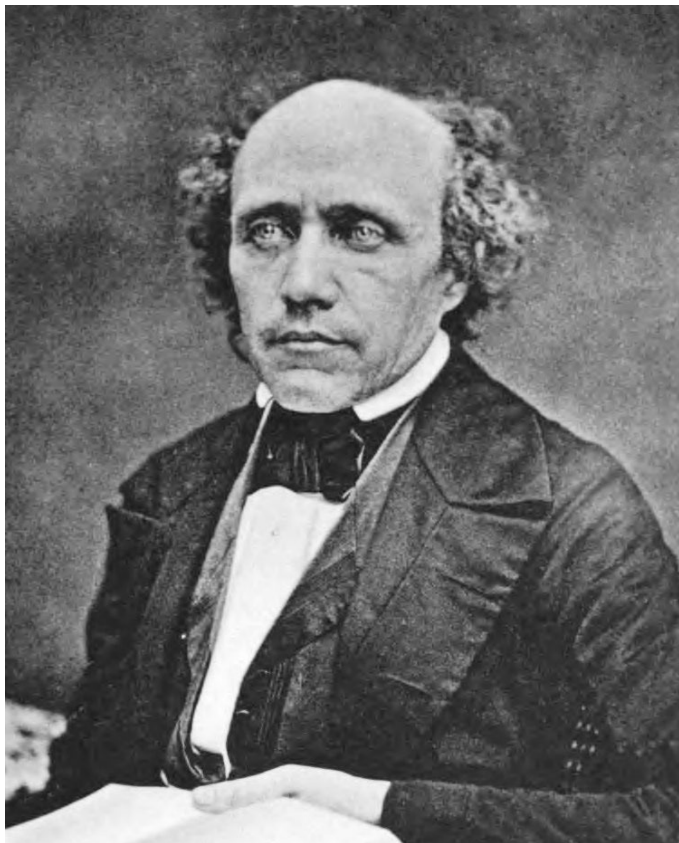


Figure 1: Gustav Theodor Fechner (1801-1887)

Thus, the drawing of the memory and fantasy images is vaguer and more blurred than that of the after-images. I am not able to obtain clear, sharp outlines even on the most familiar memory images of the objects that are daily before my eyes, while the after-images appear with corresponding sharpness as directly seen objects.

Afterimages in the closed eye are either deeper black or lighter than the surrounding ground of the eye and then the uniform black of the field of vision, depending on the brightness of the objects viewed in relation to the ground on which they appeared. Memory images, on the other hand, generally give me a weaker impression than the black itself. From white to black there is a scale of continuously graduated brightness and the deepest black is the pure black of the eye. If I now ask myself where this scale would lead if I were to think of it as continuing below black, I believe that one is led to the indistinct impression of memory and fantasy images.

With all my efforts, I cannot reproduce colours in the memory images of coloured objects, or only in fleeting, doubtful appearances when recalling very striking impressions [2]. While I receive vivid coloured afterimages in the open as well as the closed eye. I also never dream in colours, but all my experiences in dreams seem to me to proceed in a kind of twilight or night. I am not able to recall even the most familiar memory-images.

It is not possible to hold on to the image steadily, even for a short time, but in order to look at it longer, it must, so to speak, always

be recreated anew; it does not both change of its own accord and disappear again and again of its own accord. If, however, I want to reproduce it often one after the other with the same intention, it soon no longer succeeds at all, for the attention or activity of production soon dulls. This, however, is not a dulling of memory activity in general; for I am not prevented - and this seems to me worthy of attention - from immediately imagining another familiar memory image instead, as clearly as it is at all possible for me to do so, and, when attention or production activity has also exhausted itself for this one, to return to the first image where I can produce it again with the initial clarity. This is true even of quite related pictures; as, for example, I have often attempted with two portrait figures on the same photograph or portraits hanging next to each other in my living room, neither of which I can often reproduce in memory one after the other, but both in repeated alternation. If, however, I continue this alternation somewhat quickly and often one after the other, I finally find myself dulled for both pictures, but can pass on to a third picture with success.

I cannot change after-images at all by will. I can easily swap memory images with others at will, but it is much more difficult for me to change them into others gradually or to change them fantastically.

In no case do objects in the field of memory present themselves to me in relations to one another other than those that correspond to the forms of perceptions with open eyes, and in the same way my imagination with its creations cannot leave these boundaries. Thus I cannot imagine a human being both en face and from his back, although I can, as it were, walk around him with the imagination.

What was very unexpected to me, and yet I cannot find anything different in repeated observations, is that it is easier for me to produce memory images with a clarity that is always very slight, but still relatively greater, with open eyes than with closed eyes; only in doing so, I must completely divert my attention from the outside.

I can't hold the image steadily for even a short time, but in order to observe it for a longer time, I have to recreate it again and again, so to speak; it doesn't change by itself, but it disappears again and again by itself. If, however, I want to reproduce it often one after the other with the same intention, it soon no longer succeeds at all, because the attention or production activity quickly dulls. This, however, is not a dulling of the memory activity in general; for I am not prevented - and this seems to me worthy of attention - from immediately imagining another familiar memory image instead, as clearly as it is at all possible for me to do so, and, when the attention or production activity has also exhausted itself for this, to return to the first image, where I can produce it again with the initial clarity. This is true even of completely related pictures; as, for example, I have often tried with two portrait figures on the same photograph or with portraits hanging next to each other in my living room, neither of which I can often reproduce in memory one after the other, but both in repeated alternation. If, however, I continue this alternation somewhat quickly, often one after the other, I

finally find myself dulled for both pictures, but can pass on to a third picture with success.

Afterimages I cannot change at all by will. I can easily swap memory images with others at will, but it is much more difficult to transform them into others or to change them fantastically.

In no case do objects in the field of memory present themselves to me in other relations to each other than it corresponds to the forms of the views with open eyes, and in the same way my imagination with its creations cannot leave these borders. Thus I cannot imagine a man at the same time end face and from his back side, although I can walk around him with the imagination, as it were.

What was very unexpected to me and yet I cannot find otherwise in repeated observations, is that it is easier for me to produce memory pictures with a, though always only very small, but nevertheless relatively greater clarity with open eyes, than with closed eyes; only I must thereby completely divert my attention from the outside.

The black field of vision occupies a place in this field of vision that I can change at will, and is surrounded by it in such a way that the relations of its brightness and position to it can be directly perceived and judged. On the other hand, in order to perceive a memory or fantasy image, I have to withdraw my attention from the black field of vision in the same sense as I have to withdraw it from the sphere of auditory, tactile sensations, etc., and the more I withdraw it, the more clearly a memory or fantasy image can appear to me.

Sometimes I seem to succeed in projecting a memory or fantasy image onto the black field of vision, or to paint images into it, so to speak, with my imagination. But this seems to be based only on the fact that I am most inclined to look for the memory image in front or to move it there; I do not succeed in such a way that I could become calmly aware of the relationship of the image to the field; rather, I feel a peculiar effort, which seems to be based on the attempt to transform the rapid change between the field of vision of the after-images and imaginary images into coincidence, and I never become aware of a perfect success.

This is connected with the following: I am very well able to perceive a larger memory image, which includes a majority of distinguishable parts, or also a majority of connected memory images simultaneously with consciousness, or, insofar as instead of a real simultaneity a very fast passing through should arouse the appearance of simultaneity, which is not well possible to distinguish strictly, to do the fast successive looking over with a feeling of perfect continuity of activity, as if I remain in the same field. Just as it is with memory images per se, it is with after-images per se. I can also switch very quickly between the conscious perception of after-images and memory images, but I am by no means able to consciously perceive an after-image and a memory image simultaneously or with the appearance of simultaneity, and in the transition from one to the other I do not have the same feeling of continuity as when I remain in the field of perception of the memory images or after-images by themselves.

On the occasion of the experience in my bedroom mentioned on page 473, I tried to produce the memory image, in which I think I see the bed and the stovepipe behind each other, from the after-image, in which everything appears as on one surface, by trying to transform it into it through the imagination itself; and one could think that it must be even easier to produce the memory image from the after-image than to produce it freshly. But the attempt did not succeed, but the attention had to be withdrawn completely from the afterimage in order to produce the memory image with the appearance of the front and back.

When we turn our attention from one sensory object to the other, we have at the same time a certain feeling of the changed direction, which cannot be described, but which everyone can easily reproduce in experience, and which we can call the feeling of a differently localized tension. We feel a forward tension in the eyes, a sideways tension in the ears, which increases with the degree of attention, depending on how attentively we fixate on something, how attentively we listen to something, which is why we speak of a tension of attention itself. The difference is felt most clearly when the direction of attention changes rapidly between the eye and the ear. The feeling localizes itself correspondingly differently in relation to the different sense organs, depending on whether we want to smell, taste or touch something finely.

Now, however, I have a quite analogous feeling of tension as when I want to perceive something quite sharply with the face or the ear, when I want to visualize a memory or fantasy image as clearly as possible; and this quite analogous feeling is localized quite differently. While in the case of the sharpest possible perception of objective visible objects, as well as of after-images, the tension goes clearly forward, and when the attention is turned to other sensory spheres, only the direction between the outer sense organs changes, while the rest of the head is tensionless according to the feeling, in the case of the occupation of the memory or phantasy activity, the tension is withdrawn completely from the outer sense organs according to the feeling, and rather seems to affect the part of the head, which the brain uses so that it disappears from my mind, which is not difficult in itself and succeeds all the more easily when I put my eyes down and point them towards the ground as if in a dream. It seems to me as if, when the eyes are completely closed, the light material were lacking to weave the images out of them, as if the black of the eyes gave nothing for it, and had a more disturbing effect on their perception than the gentle brightness of the day. - On the other hand, I am never in a better mood for abstract thinking than in bed in the dark early in the morning.

Afterimages seem to move in the same direction when one moves one's head or eyes; whether the same is the case with memory images is difficult for me to judge because of their great weakness and the difficulty of keeping anything of them present at all if I am simultaneously conscious of something else. But it has always seemed to me that, for example, a tower, a tree, the moon in the sky, if I only imagine them stationary (whether with open or closed eyes), also retain their position in the imagination unchanged while I move my head or eyes back and forth. How it is with memory images that are not deliberately fixed by

imagination, I am not able to say; they disappear with every movement of the head or the eyes, if at the same time I want to pay attention to whether they appear to be moved or not, since they do not tolerate this division of attention.

The field of vision in which the afterimages are inscribed and the apparent field of vision of the memory images present the following differences in appearance. The field of the afterimages with closed eyes, the black field of vision, seems to me to be of very limited size, without any depth, directly in front of my eyes or coinciding with the vertical plane of the eyes themselves. Even if I have the after-images of very different distant objects in my closed eye at the same time, they still appear to me as if on a surface next to each other, and their size is determined only by the angle of vision at which the objects that gave the after-image appeared, so that the illusion that has become a different nature to us with our eyes open, that objects of the same size and at different distances are also of the same size, is no longer possible.

In all these respects, the appearance of the field of memory and fantasy images is quite different for me. Since we always see the objects in front of us, I am naturally inclined to imagine the objects I remember as being in front of me rather than behind me; but I can imagine them not only as far in front of me as I like, but also behind me, to the side, above me, below me; I can imagine a tower in front of me and a tower behind me at the same time or in rapid alternation; I can imagine the objects in front of me behind each other as well as beside each other.

When I am still lying in bed early in the morning after the day has dawned, and close my calmly held open eyes about once, the black after-image of the white bed immediately in front of me and the white after-image of the black stovepipe on the opposite, quite distant wall of the long chamber in which I sleep, usually present themselves to me simultaneously with great intensity. Both appear to me as if on a surface next to each other, and while with open eyes I think I see the whole length of the white bed, in the after-image with closed eyes I see only a relatively narrow black strip instead, in view of the great foreshortening in which I saw the bed. Instead, the memory image reproduces the whole illusion of the appearance with open eyes.

In short, while the black field of vision with its content of afterimages seems to me to have only two dimensions without depth, the field of vision of the memory images seems to me to have three dimensions with depth like the field of vision with open eyes. At least this is true insofar as I imagine a whole region, a part of a city, a room or the like at once.

In order to perceive the afterimage of a limited object, e.g. a flame of light, in the closed eye, I must direct my attention to the black field of vision of the closed eye. The after-image takes on a certain, not arbitrary, shape.

If, for example, I want to visualize a region or person before me quite vividly, it will appear before me all the more vividly, not the more I draw my attention forward, but the more I withdraw it behind it, so to speak. More about this below.

Hallucinations before falling asleep, as so many people have them, do not occur with me; and the vivid flickering of light, which I always have in the closed eye because of the pathological condition of my eyes, never forms itself into certain figures, nor can I form it into them by imaginative activity.

After all, the memory and fantasy images present themselves to me in a weakness, as it seems to be rare with others, even if I try the memory and fantasy activity as much as possible, although afterimages appear to me with the greatest ease and great intensity, often annoyingly; and I have no reason to consider my sense of colour with open eyes less developed than that of other persons.

Where possible even more difficult than in the field of the sense of sight I produce memories in the field of other senses. Thus, I am even less able to reproduce the sound of my wife's voice or that of other persons with whom I interact daily with any clarity in my memory than I am to reproduce their face, even though I would recognize the same persons among thousands if I really heard their voice in the dark. I do not succeed at all in reproducing smell and taste sensations. However, I can remember simple melodies after hearing them several times and facilitate their recollection by singing them softly or by soft movements of the larynx as if I were singing. The local feeling of recollection of sensations in other sensory areas than that of the face seems to me to agree with the local feeling in the face; however, without recollection I believe to hear some rushing music in the memory more than with the ears.

So much for my own observations. With these I found the perceptions of others, whom I induced to self-observation, in general the more they agreed with me in the weakness of the memory and fantasy images, but thereby I easily found the more these phenomena approach sensual phenomena as well as afterimages in strength, the more the other stated differences between them fade away, so that finally only the essential difference of spontaneous and non-spontaneous generation and alteration seems to remain between the two.

It would be of interest to work on this object statistically, and I regret to have neglected the earlier really intended such pursuit of the object nevertheless over other objects, so that at present no so extended material for comparison is at my disposal as I myself wished. Perhaps, however, not much more could be learned from a larger number of cases than from the relatively few that I have collected recently. By the way, it is obvious that it is difficult to get exact, reliable data in this field, since it is already difficult to give such data and to find the right expressions. A careful and repeated self-observation with prevention of self-deceptions, and a certain questioning, if one demands information from others, with caution not to put answers into their mouths, is presupposed. Also, an objective guarantee that one has been understood correctly when questioning others and that one has understood correctly, and that everywhere quite comparable circumstances of the inner observation have taken place, can hardly be given concerning some points.

It is indisputable that in the last respect it is necessary to refer to comparable objects of memory in order to be able to expect comparable answers, without it seeming useful to me to stick to quite specific objects. Only one has to distinguish whether it is about familiar or unfamiliar memories, about limited memory images, as of a rose, a face, a tower, which I usually use as examples, or unlimited ones, as of a whole region, and whether the memories are gained by using these or those means of association. In order not to begin with complications, it seems to me expedient, first of all, to give reminiscences.

It is not possible to exclude the memory of impressions that are obtained with the help of one's own activity, the memory of which then interacts with that of the object viewed, as when a painter thinks of himself painting, or a walker thinks of himself walking through the area he is picturing. A further continuation of these observations would, by the way, probably still lead to some considerations and distinctions that are to be made and have not yet presented themselves in this first attempt to subject this area to a more precise observation.

I will now first give the specific data of some more or less extensively interviewed persons, then some general remarks about the subject. Hopefully, one will not regret too much the space that these statements take up; since detailed information about the behaviour of the phenomena in different persons is the only way that can lead to something at all, and so far there has been an almost complete lack of this basis of experience. For almost only the cases, where the memory images approach hallucinations or turn into such, have attracted attention so far; indisputably, however, it is necessary first of all to see how the phenomena behave in normal cases.

The following cases are arranged according to the ascending degree of approximation to sensual phenomena, which they seem to have according to the description.

1) Ch H Weisse, professor of philosophy, of the same age as me (59 years), seems to be on a very similar level as I am with regard to memory images; in that he can produce just as little clear colour or drawing on them. When he closes his eyes, he has just as little as I do a purely black visual field, but all kinds of colourless light in it, from which, however, the longer he keeps his eyes closed, the more distinctly formed phantoms weave themselves, which is not the case with me. In order to observe them, he must direct his attention in the same way as if he wanted to observe external objects with open eyes; in this respect, they completely take the place of them (just as the flickering of light does with me); whereas, in order to receive memory images, he must, just as I do, withdraw his attention completely from this field, and absolutely cannot grasp the memory images with those sensual images at the same time, or paint them into the field of them, which is so decidedly the case with him, that he has to observe the following opposing phantoms.

The court was inclined to regard the information provided by others as being based on an incorrect view of the facts.

2) A. W. Volkmann, professor of anatomy and physiology, also 59

years old, can also produce only "extremely faint and indistinct memory images", both in form and colour, but the degree of distinctness seems to vary noticeably, without being able to specify the circumstances on which this depends. Before falling asleep, he often has the well-known hallucinations, but with very different clarity, "under certain circumstances so clearly that the phantasy images are hardly inferior to the objective images in clarity of the contour and intensity of the colours"; in dreams, areas and other objects appear to him with colours [3]. On the other hand, he does not easily see after-images and normally has a pure black field of vision (whether completely free of light dust?) when closing his eyes. When trying to hold on to memory images, they periodically disappear, or, as he prefers to express it, "periodically become a mere thought thing". The position of the memory image in the absolute space changes with the position of the eyes, so that he imagines the memory image also above when he raises his eyes [4]. He can only imagine the memory images in front of him. He finds no essential difference in the ease of the production of the memory images with open and closed eye. If the task is to produce memory images with the eye closed, he must concentrate his attention in the memory image to such an extent that "the sensation of the black field of vision loses clarity over it", and he does not succeed in painting a single memory image into the black field of vision in such a way that it seems to be surrounded by it, as is the case with an afterimage. However, "the simultaneous perception of a memory image and an after-image seems possible to him, if the sensations of the after-image and memory image do not alternate so quickly that one considers them to exist simultaneously. But the memory image, which is already extremely indistinct in form and colour, becomes even more indistinct through the simultaneous presence of the after-image, and the reflection on it becomes more strenuous". During the production of memory images, he finds "a certain effort in the head unmistakable, none in the eyes"; in the same way, "memory of what is heard seems to cause an effort in the head, and the local feeling of memories of what is visible and audible seems to him to be approximately the same". The feeling in the head during strained contemplation "resembles an inner pressure."

3) W. Hankel, professor of physics, 46 years old, remembers that as a boy he could produce memory images arbitrarily with sensual vividness, as if he saw them with his eyes, and that he could change these images; but this is no longer the case. However, he can still clearly imagine objects with their colours (e.g. the colour spectrum) and with their form, but no longer with the character of sensual phenomena, no more than if he saw them with his eyes. He cannot speak of a certain place where they appeared to him, or indicate a certain relation of them to the black field of vision with closed eyes, from which he must abstract his attention just as he does from external objects when creating a memory image. Also, he cannot paint memory images into the black visual field in such a way that they appear to be surrounded by it like afterimages. He has no hallucinations before falling asleep, but he has many dreams during sleep. His field of vision when his eyes are closed in the dark is pure black, with only a sparsely interspersed dew of light, which is normal everywhere, but easy to overlook without paying special attention to it. On the whole, he produces memory images more easily with open

than closed eyes. He can hold on to such images without them changing involuntarily, whereby only, as a matter of course, the attention gradually dulls. He can imagine a tower behind him as easily as in front of him, a spectrum of colours more easily in front of him than behind him. Whether the memory images move with the movement of the head and the eyes seemed difficult to him to decide. The production of memory images seems to him to be accompanied by a feeling of intention localized behind the forehead; this feeling, however, lies further back when thinking about melodies than when thinking about visible things. The feeling of effort during contemplation seems to him more expansive than contractive.

4) M. W. Robisch, professor of mathematics and philosophy, a few years younger than me, easily creates coloured memory pictures of coloured objects, but he does not easily succeed in obtaining a firm, definite drawing of them or in holding on to the pictures steadily, since the imagination, so to speak, soon plays them to pieces. In dreams he sometimes sees areas with oriental colourfulness. Afterimages also appear to him very easily, so that when his eyes are closed (the left of which is paralyzed in vision) they tend to fill his visual field for a while, but finally leave it empty. Before falling asleep he often has the well-known facial hallucinations. He could not decide whether he would produce the memory images more easily with open or closed eyes. In order to produce memory images when the eyes are closed, he must turn his attention away from the black field of vision, cannot project the images onto it, nor can he perceive them simultaneously with afterimages. The visual fields of the memory and after-images seem different to him and the black of the eyes disappears from his consciousness while he is occupied with visible objects. But, in order to make a non-familiar memory image clear to himself, however, he feels the effort as if he were using his eyes when looking at familiar memory images, not his head behind them; just as he has a feeling as if he were using his ears when remembering familiar auditory impressions, and as if he were tasting with his tongue when remembering gustatory impressions. However, in order to make an unfamiliar memory picture clear to himself, he feels the effort more like in the head behind the eyes than in the eyes. When he feels a thought, as if he wanted to break his head about something, he does not have a feeling of contraction of the scalp (as I do), but as if the head was to be blown apart from the inside, and the skull resisted the pressure from the inside. It produces memories in areas other than the face just as easily as in the face itself.

Concerning the specific question whether the memory images seem to move with the head and eyes, he explained himself after my request for a more detailed written record thus :

"I cannot actually say so absolutely, unreservedly, that memory images seem to me to move with head and eyes, that I could perceive their movement, rather the matter behaves like this. I stand at the window of my room, see from there the Paulinerthurm according to its position against the church roof, the library building etc. and all this again framed by the window. Of this whole, I am left with a memory image that floats before my eyes inwardly just as it does when I see it in that place. Now I can turn around, go into the next room, etc., so when I remember

that view, the image will always float in front of me in the same position against my body as the objects I saw were in front of me, and this remains the same when I walk up and down, turn around. Just because the image does not change its position in relation to my body or at least the head and the eyes in particular, I cannot say that I observed a movement of the image, but I come to assume such a movement only by reflection, when I become aware that the position of my eyes and my body has become a different one. If I imagine - going downwards from the window - "the church lies behind you, while the Thomas Tower lies in front of you", then I can indeed imagine the "behind me", but not all at once with the "in front of me", but I feel as if I must first look around for this purpose".

5) My own wife, who has been questioned by me many times, Clara Maria, sister of Prof. Volkmann, 51 years old, with very sharp and healthy senses in every respect, and of very vivid memory, can most clearly reproduce colours and shapes of objects in her memory, even in dreams sometimes sees areas in colours and sunlight, antifemale only nightly, as if Gray in Gray, and before falling asleep not infrequently has the well-known hallucinations, whereas she knows nothing of afterimages that occasionally arise and has great difficulty in obtaining such even in deliberate attempts. The field of vision in closed.

The eyes are pure black, with only a sparse dew of light normally interspersed. She can quite well hold on to memory images steadily with her attention, without them disappearing, fluctuating, changing. When she moves her head, memory images do not seem to move with her if she imagines them as fixed, but this is the case if she does not fix them with her imagination. She sees the memory images more vividly with closed eyes than with open ones. She can draw individual memory images, such as that of a rose, into the black of the closed eye, so that they seem to be surrounded by it, but this costs her much more effort than when she tries to produce the memory image independently of it, in which case the inner head seems to be more active to her than the eyes. The images generally seem to float in front of her eyes, but she can also imagine them sideways and with some difficulty backwards, but in doing so it is as if she had to turn around or really directed her eyes there, an expression that she made independently of Robisch and without being guided by it. When she imagines a whole region with closed eyes, she thinks she sees it clearly in front of her in colours with background and foreground, as in reality, whereby the black of the eye disappears completely, but it is still as if she sees it more by means of an activity of the whole inside of the head than of the eyes. The feeling of effort, when she wants to think about something, seems to her to be a feeling of contraction, as it seems, very similar to mine, without my indication having preceded it. She is also able to recall auditory impressions, such as the sound of a familiar person's voice, floral scents, and taste sensations easily and clearly. A violet smell, a carnation smell, for example, comes back to her most clearly.

6) Dr. M. Busch, 39 years old, known as a traveller, author of various travel writings, which are characterized by vivid descriptions, and editor of *Die Grenzboten*, sees easily and vividly memory images with clear outlines and in their full

colours, but knew nothing about afterimages, dreams rarely, but vividly and also sees colours in dreams, never has hallucinations before falling asleep and has a dark, uniform, somewhat bluish visual field when closing his eyes. He can also retain clear memory images with steadiness. On repeated trials he finds that the memory images follow the movements of the eye and head; asked, however, whether this still occurs when he intentionally presents the objects of memory as fixed, he finds that they then also remain fixed. In the case of familiar memory images of visible objects, he directs his attention to the black field of vision with his eyes closed, paints bordered memory images with ease in colour and in fixed contours, so that they seem to be surrounded by them, or places an entire region before his eyes and feels the activity with which he sees it, as if in his eyes, not in his brain.

He is able to reproduce what he has heard no less clearly than what he has seen, as if he had used the ear. However, as with Robisch, this feeling, as if he used the external sense organs for memories, takes place only insofar as he imagines familiar memory images, whereas in the activity of reflection, in order to bring together an unfamiliar memory image, the brain rather than the eyes seems to be active until the image is there in full clarity, where it behaves like the others. The feeling of effort during reflection is a contractive one, as of contraction of the scalp.

From his childhood, from the age of 4, Busch is still able to visualize with the greatest clarity the domestic furnishings and persons of his surroundings; whereas from the school years and university years, no such clear memory images have remained for him. It is strange that a double portion of hashish, which he took on his oriental journey, did not strike, did not awaken any fantasies in him. Just as little succeeded the Etherising despite relatively lung inhalation during a tooth operation. Consciousness and pain remained.

In the last of the cases reported here, the memory images already come very close to sensual phenomena, both in terms of their vividness and other circumstances. But the approximation can go even further; and to complete the climax, I am including some examples of the kind according to other authors*).

Goethe says in s. Contributions to Morphology and Natural Science: "I have the gift, when I close my eyes and, with my head bowed down, think of a flower in the centre of my visual organ, it does not remain for a moment in its first form, but it spreads out and from within it unfolds again new flowers of coloured, even green, leaves; they are not natural flowers, but fantastic, but regular, like the rosettes of the sculptors. It is impossible to fair the sprouting creation, but it lasts as long as I like, does not tire and does not intensify. I can produce the same if I think of the ornament of a colourfully painted disk, which then also changes continuously from the centre to the periphery, completely like the kaleidoscopes".

Cardanus (de variegata rear. lib. VIII. p. 160 sea, de subtilities XVIII. p. 519 seq.) tells of himself that he had been able to imagine luminously what he wanted. - Gruithuisen (Anthropos.

§. 449) tells the case of a man, who in his youth could imagine his father luminously, what he later succeeded less well. - J. Müller (phant.p. 484 (§. \M. p.U9) commemorates a painter H., who often succeeded in seeing what he imagined with will in the dark field of vision, shining and coloured. These arbitrary phantasms, however, developed and changed immediately without will determination. Brière de Boismont (Des halluc. p. 39) reports the following case:

"One painter, who had inherited a large part of the clientele of the famous Sir Joshua Reynolds, and believed him to be of superior talent to his own, was so busy that he confessed to me, says Wigan, that he had painted 300 portraits, large and small, in one year. This fact seems physically impossible; but the secret of his speed and astonishing success was this: he needed only one sitting to represent the model. I saw him execute before my eyes in less than eight hours the miniature portrait of a gentleman whom I knew very well; it was done with the greatest care and a perfect likeness.

I asked him to give me some details of his process, and this is what he replied: "When a model came along, I looked at it attentively for half an hour, sketching on the canvas from time to time. I didn't need any longer. I would remove the canvas and move on to another person. When I wanted to continue the first portrait, I took the man in my mind, I put him on the chair, where I saw him as clearly as if he were 616 in the sky; and I can even add with sharper and more vivid shapes and colours. I looked from time to time at the imaginary figure, and I began to paint; I suspended my work to examine the pose, absolutely as if the original had been before me; every time I cast my eyes on the chair, I saw the man."

Gradually, this painter came to confuse his fantasy images with reality, fell into a thirty-year mental illness, from which, however, he was finally recovered, after which his memory and painting talent still showed almost undiminished. However, he died soon after.

Some other examples belonging here are reported by Briere de B. p. 58 f. and 479 of his work.

Especially carefully H. Meyer in s. Physiology of the Nerve Fiber p. 239 ff. the arbitrarily generated sensory phantasms observed by himself, and I share his description here specifically, because it comes from an exact observer and thereby is taken into account the special circumstances of their mode of generation, the better, because it does not seem to have been very well known.

"Through much practice, I have reached the point that it is possible for me to arbitrarily arouse subjective facial sensations. I made all experiments by day or night with closed eyes. At the beginning it was very difficult for me. In the first experiments, which I succeeded in, the whole thing became apparent.

The shadows were given by less strong, somewhat bluish light. In further attempts I saw the objects dark and with bright outlines, or rather only outline drawings of them formed by bright lines on a dark background. I can compare these drawings less to a chalk drawing on a black board than to a phosphor drawing on

a dark wall at night, but discounting the luminous vapours of the phosphor. If I wanted to see a face, for example, without thinking of a specific person, I would see the borderline of a profile shining in the black ground of the darkness; so, too, when I wanted to copy Darwin's attempt (*Zoo Nomia* I. 1. p. 378), only the edges of the cube appeared as luminous lines in the dark ground, but several times I saw the cube really white and its edges black, it was then in a lighter ground; I could even see a white cube with black edges in a lighter field and a black cube with white edges in a darker field at will and can still do this at any moment. After a longer period of practice, the experiments became more complete and better. I can now see almost any object I want as a subjective appearance, in its natural colour and illumination. Thus I have already called objects of the most diverse kind before my eyes. I always see them on a more or less light or dark, mostly dim, background. Even familiar faces I have seen in all vividness with the colour of the cheeks and the hair quite sharp. From the results of these experiments I have to note the following:

- 1) Sometime after the creation, the figures disappear or change into others without my being able to prevent this.
- 2) If the colour does not belong integrally to an object, I do not always have it completely under my control. A face, for example, never appears blue to me, but always in its natural colour, whereas instead of the imaginary red cloth, a blue one can appear at times; in general, the production of a certain colour is more difficult than that of a certain shape, and the first one succeeded in me. 485
I did not succeed in the first attempts, since I had already succeeded in the *lelzle* [5].
- 3) I have succeeded a few times in seeing pure colours without objects; they then filled the entire field of vision.
- 4) Objects that are not familiar to me, i.e., mere fantasy images, I often do not see, and instead of them, familiar objects of the same kind appear to me; for example, I once wanted to see a brass sword handle with a brass basket, but instead I saw the more familiar image of a rapping basket.
- 5) Most of these subjective appearances, especially if they were bright, leave afterimages if the eyes are opened quickly during the dwelling of the appearance; for example, I thought of a silver stirrup, and after looking at it for a while, I opened my eyes and saw the dark afterimage of it for a long time.

It is best to do the experiments with my back in a quiet position and with my eyes closed; there must be no noise around me, because this would prevent the perception from increasing to the necessary intensity. The experiments are so easy for me now that I am surprised that I did not succeed right at the beginning and that I think everyone should be able to do it as well. The main thing is to let the perception become intense enough by directing the attention exclusively to it and removing all disturbance.

What has been mentioned so far concerned facial perceptions. Meyer also made attempts to produce auditory, olfactory, gustatory sensations by the power of attention, which would be equal to the sensual ones in strength and character. He did not succeed here, but with sensations on the skin, about which he reports the following:

"On the skin, I easily succeed in producing subjective sensations wherever I want. However, because a longer period of visualization is necessary for this, I can only evoke sensations that last for a longer period of time, such as warmth, coolness, pressure; on the other hand, I cannot evoke sensations that pass quickly, such as from a sting, cut, blow, etc., because I am not able to evoke the corresponding sensations so ex abrupt with the appropriate intensity. The first-mentioned sensations, however, I can excite quite well at any skin places, and they can become so vivid that I, I may want or not, have to stroke with the hand over the skin place, as one is used to do in cases of local skin sensations".

That, by the way, under favourable circumstances, even violent pain can be produced by a very vivid imagination, is shown by the following case, also reported by Meyer:

"An educated man of the merchant class once told me (Meyer) that one day when he came home he had been frightened by one of his small children by the fact that the latter had squeezed a finger between the door just as he entered; at the moment of the fright he had felt a violent pain in the corresponding place of the same finger of his own body and this pain had not left him for three days".

Hereafter I turn to some general remarks.

Lutze calls the colour perceptions produced by memory absolutely colourless, and to myself, as well as to Weise and Volkmann, they appear to be pretty much like that; but not only the other persons, whose data I have given above, but by far the greatest majority of the many persons, whom I have occasionally asked about this special circumstance, assured with the greatest certainty that they were able to reproduce the colours of the objects clearly also in memory. Some described the vividness of the colours of their memory pictures, e.g. of the rainbow, the flowers, a sunlit region, even with vivid colours and did not want to believe that one would not be able to reproduce such in memory. Indeed, I have repeatedly been lively regretted that with the colour stimulus of the world of memory I am deprived of a main stimulus that it provides [6].

It is very likely that the greater or lesser ability to produce clear memory images is related on one side to the habituation, brought about by disposition, profession, living conditions, to direct one's attention more to the outside world or to abstract from it, and at least this applies very conspicuously to Lutze, Weise and myself. I must confess that I usually have to stimulate myself or be stimulated to see and hear what is going on around me, and after walks I have sometimes not known for sure which of two quite different branch paths I have taken. Hankel, on the other hand, who so much vividly [7].

Busch, who has more memory images than I do, is accustomed to keep a sharp eye on external things, and even when he is completely occupied with his subject during his lectures, nothing in his circle of listeners escapes him. Busch, whose memory images reveal the strongest approach to sensual phenomena among the persons I interviewed, says himself that the tendency to perceive objects faithfully and clearly for reproduction during

his travels may have refreshed his memory for external objects, which, as it seems, was already vivid in his youth, but had become outdated during his studies. It is also true that women, whose attention is on the whole much more turned to the outside world than that of men, as many as I have asked them, can easily produce clear and colourful memory images. But Volkmann writes to me, which seems to me not without interest, that with his wife the intentionally produced memory images are very indistinct and pale, while they sometimes come before the soul with an almost frightening vividness, such as the image of a distant daughter during the performance of female work in the highest clarity of form and colour.

In the meantime, the tendency to reflect on external things can possibly also be inversely caused by the ease of reproducing them inwardly; and indisputably not everything can depend on habituation, but there must also be innate differences of productivity in this field. The weakness of Volkmann's memory images, which almost corresponds to mine, is not connected with a correspondingly one-sided abstraction from the outside world, even though I believe that the turn inward also predominates in his case; and Robisch's profession, which is similar to mine, would not lead us to expect so much more vivid memory images, even though he indisputably abstracts less from the outside world than is the case with me.

The example of Hankel and Busch, as well as the examples, which J. Müller (plant. G. p. 45. 82) cites from himself and, according to Gruithuisen, from another, invite us to examine whether in children, who, like women, are preferably turned towards the outside world, the memory and memory images are not more abstract from the outside world than in me.

It is not clear whether the children's phantasy images are on the average more vivid than those of adults, but it will be difficult to make reliable comparisons of their own memories and to obtain reliable data from children.

The difference whether memory images are more easily obtained with open or closed eyes may also depend essentially on the different ability to abstract the attention from the outside world. Where this is difficult, the external things will always have a disturbing effect; where it is easy - and this could be different even in the same individual according to circumstances - the general stimulation by the light or perhaps also the habit that we see things only with open eyes, may have a favourable rather than a disadvantageous effect. In general, women seem to produce memory images more easily with closed than open eyes; at least three others, whom I asked about this besides my wife, admittedly only after very casual observation, explained themselves in the same sense. Prof. Ed. Weber, on the other hand, like Hankel and myself, found it easier to produce memory images with open than closed eyes.

The different behaviour of different persons in this respect reminds us that also with some persons hallucinations occur more easily with open than closed eyes, while with others it is the other way round (see below).

To the greater or lesser ease of the production of afterimages the ease of the production of memory images seems to be quite related. Robisch and I, for example, both see afterimages very easily, but while with him the memory images are vivid, with me they are quite weak. By the way, as is well known, in the case of afterimages one has to distinguish the first positive phase, which is mainly dependent on the duration of the afterimage, and the second negative phase, which is mainly dependent on the dulling of the afterimage; and it would require further investigation whether different individuals might differ in the relation of both phases, after which the relation of the memory images to the afterimages would also have to be investigated in relation to both phases [8].

The question, how memory images behave during movements of the head and the eyes, seems to be answered only with regard to answer the special circumstances of their generation and observation. If one imagines them fixed during the movement, then they also seem to be fixed according to Busch's and my wife's statements, and as it seems to me myself; on the other hand, if one does not intentionally imagine them fixed, then they seem to change their position in space with the position of the head and the eyes, but not to us, because one is naturally inclined to think them in front of oneself, as this emerges most definitely from Robisch's statements.

Here is to be reminded of the behaviour of the involuntary hallucinations. J. Müller says of the involuntary hallucinations occurring before falling asleep and otherwise when the eyes are closed, which will be described in more detail below: "Also, with closed eyes, I have never been able to cause them to move with the eyes like the blinding images." He emphasizes (p. 38) their difference in this respect from the dazzling images (i.e., afterimages after an intense impression of light) still explicitly by saying: "The dazzling images change with the movement of the eyes their relative place relation to our own corporeality; the fantastic images maintain with all movement of the closed eyes a constant place in relation to our own spatiality, if they do not move for inner reasons of their spatiality [9,10]."

As a rule, the faculty of memory, where it is weak or strong in the field of the sense of sight, seems to behave in the same way in the other fields of sense; at least I have not yet found any exception in this respect; but there will probably be such; and especially artists in the various subjects and in general those who occupy themselves with a certain one-sidedness with objects whose perception belongs to a special field of sense, will have to be questioned; for which I have so far missed the opportunity. In general, I have considered other sensory areas only in passing and at the top; and it would, for example, in relation to auditory perceptions, first have to be especially investigated whether a good memory, e.g. for the sound of voices and instruments, always coincides with a good memory for pitch and melody.

The feeling of tension of the attention during the use of the different sense organs seems to me only a muscular feeling.

We can ask then, which muscles should be connected to the contraction of which muscles when we use our senses, and which

muscles should be connected to the contraction of which muscles when we use our senses. One can then ask, to the contraction of which muscles the feeling of tension of the attention is supposed to be connected during strained contemplation? My feeling gives me very definite information about this; it seems to me quite decidedly not like the feeling of a tension inside the skull, but like that of a tension of the scalp with a contraction of the same and a pressure on the whole skull going from the outside to the inside, indisputably produced by a contraction of the muscles of the scalp, which harmonizes quite well with the expression, to break one's head, to pull one's head together. In an earlier pathological state, when I could not tolerate the slightest sustained thought and no theory could yet determine me, the muscle sensations clearly felt in the scalp, especially in the back of the head, took on a pathological character with every attempt at thought.

Like me, Busch, my wife, Rute and some others whom I have questioned, also found the feeling of reflection to be contractile; Robisch and Hankel, on the other hand, found it to be expansive. This difference is remarkable and should be examined in more detail.

I will go into some more general considerations in section e), and now turn to various phenomena that, to a certain extent, represent transitional elements between afterimages and memory images, in that they approach one or the other more from a certain side or according to circumstances.

b). Memory Afterimages

In the representation of memory phenomena, I have so far diligently abstracted from a mode of their production, according to which they are represented with relatively clear forms and colours even to those who, like Volkmann and myself, are otherwise able to produce them only extremely weakly; a mode of production which simply consists in the fact that one produces the memory image immediately after momentarily looking at an object.

Robitsch as well as my wife declared that they could produce the memory images they were familiar with of objects not seen briefly before at least as easily and clearly as after fresh, brief observation; on the other hand, in my case as in Volkmann's, the advantage of fresh observation is very conspicuous, and probably just as it is in the case of anyone who only produces clear memory images with difficulty. Hankel also acknowledged the advantage of fresh production, and it seems to me not without interest to give some more details about the partly peculiar relations of these memory images produced in the act, which for the sake of brevity I will call memory after-images. I give them this name because, like afterimages, they are grasped immediately after seeing the objects and approach them clearly, even seeming to coincide with them in the case of some persons (Rute), although they bear all the essential characteristics of memory images as they present themselves to me, Volkmann' and H ankein.

I obtain a memory after-image when I momentarily look sharply at some object, light or dark, coloured or non-coloured, then

immediately close my eyes or turn them away, which latter I find even more advantageous here than the former, and immediately, best of all while still closing my eyes or turning them away, set the memory activity in motion in the otherwise usual way. I then see the picture quite clearly for a moment, with the drawing and even the colour of the object I am looking at, as I am never able to get from objects I have seen for a long time; only its definiteness and colour fade very quickly and give place to the usual indistinctness.

One will undoubtedly be inclined from the outset to see in it nothing but an ordinary after-image dependent on after-duration, and I myself entertained this opinion after the first superficial experiments. But there are four circumstances by which such a memory afterimage differs for me in an equally striking way from ordinary afterimages and from the, only weaker, actual memory images, such as I otherwise receive from previously seen objects.

1) Afterimages arise whether one has directed attention to the object or not (cf. p. 432). In order to obtain a memory afterimage, however, I must have previously directed my attention to the object in question, just as I do to obtain an ordinary memory image. The more sharply I focus my attention on the object while looking at it, the more clearly the memory afterimage can appear to me afterwards; hence I cannot obtain a clear memory afterimage of a whole region at once, but only of limited objects, such as a human being, a flower, whereby I cannot reproduce anything of the surroundings of the object in the memory afterimage if I have not extended my attention to the nearest surroundings while looking; Whereas in the actual after-image the surroundings are involuntarily represented with the object, whether one has looked at them with the same attention or not.

2) If, after momentarily looking at an object in ordinary daylight, I direct my attention with closed eyes to the black field of vision, or with open eyes to the objective ground before me, and wish to take in what I see there merely receptively, which are the conditions under which an after-image is able to appear to me, I see nothing; rather, in order for the memory after-image to appear, I must turn my attention away from the external sense and wish to call forth the image inwardly in an active manner just as I would if I wished to call forth an ordinary memory image. I also see it all the more clearly the more I exert my memory activity in the usual way. I involuntarily tense my scalp, as I am wont to do when I am in a state of intense concentration (cf. p. 49I).

Furthermore, when the memory image has faded or become unclear, which happens remarkably quickly, I can often revive it repeatedly, albeit with diminishing clarity, if I allow the memory activity, which always soon diminishes of its own accord, to make a new effort.

3) While an actual after-image appears to me, up to certain limits, the clearer and more intense the longer and more steadily I have fixed on the object, I find, strangely enough, just the opposite in the case of memory after-images. They appear most clearly to me when I have only cast a quick but most attentive glance at the object in question, since it seems to me as if the stimulus to the

attention, which is necessary for the formation of the memory afterimage, becomes dulled during a longer observation, whereas it has the freshest effect during the shortest.

This may be connected with the fact that when I create a memory image, for example, of a man chopping wood or advancing rapidly, it appears to me in the attitude of a moving man (i.e. as the sculptor would depict the man), but not really moving, since the moment of the sharpest attention seems to determine the appearance of the image. But this experience is not entirely unambiguous, because my gaze on the object in general may only be brief if I am to preserve the memory afterimage clearly, in which short time no great movement can be accomplished, nor does a full clarity of the image take place.

Occasionally it can be remembered that even if the disc of the thaumatrope, on one side of which, for example, a bird is a bird on one side and a cage on the other, is rapidly rotated by its diameter by means of the axe thread twisted between the fingers, the cage and the bird are successively presented to the eye in all possible foreshortenings, but the bird seems to be sitting in the cage, as if only one of the infinite number of appearances (which seems to me to be somewhat foreshortened overall) were to come to the fore. In this case, however, it probably depends on the fact that the appearance changes most slowly when moving due to the position where the facial line is perpendicular to the pane.

4) The after-images that I receive of objects that are not themselves luminous in ordinary daylight, for example, by fixing a coloured object for some time and then turning my gaze to a white ground or pushing it forward, do not present the object to me in its own colour but in the colour complementary to it, since the duration of the primary impression is too short to be noticed, while the memory after-image is too short to be noticed.

The first is that the memory afterimage always reproduces the object in its own colour without complementary resonance.

After the foregoing distinctions, however, I have to consider a point in which the memory afterimage conspicuously joins the actual afterimage. If the memory after-image seen with open eyes has gone out with me, and I always keep the intention to see it in the same direction (which is essential to success), but without strengthening it anew, a momentary blink of the eye is sufficient to revive it momentarily and weakly, as if I had strengthened the intention; an attempt which I can repeat often in succession. That this means of revival also works with after-images, I have explained in Pogg. XLIV. 528; but in the case of memory images of previously seen objects, the addition of the eye is of no use to me in reviving them. Incidentally, it is not the darkening of the field of vision by the blinking of the eyes that brings about the revival of the afterimages of memory; for a sudden widening of the eyes or a forcible sideways turning of the eyes accomplishes the same thing, but indisputably only an inwardly propagating stimulus given by the movement.

Volkman, to whom I have communicated these experiences about the memory afterimages, writes me that he finds them

quite confirmed; only he remarks that, contrary to the statement made under 4) concerning the usual afterimages (obtained by prolonged fixation), these appeared to him at first, before the transition into the complementary colour, also in the primary colour, and indeed this can be different according to the individuality [11].

Under ordinary circumstances, a momentary observation of an object does not grant me any afterimage at all, i.e. an image that can be perceived without a special effort of memory. In the following way, however, I succeed, after a momentary sight of a colour, in catching, so to speak, an after-colour without such exertion, which, however, is not equal to the primary one either, but complementary to it.

I take a tube that is black on the inside in front of one eye and point it at a coloured ground next to which there is a white ground. I first close both eyes for a while, then I open the eye in front of which the tube is placed so that the coloured ground momentarily catches my eye and I immediately turn the tube towards the white ground. With the great sensitivity I have for subjective phenomena, I see, despite the fact that I only momentarily see the objective colour ground, the after-colour of this ground on the white ground; but it is always complementary to it.

In the meantime I cannot help noticing that I perceive very well the appearance of the thaumatrope in the colours of the pictures painted on it, which can only be the case because of the simple persistence of the impression. But the circumstances here are different from those in the creation of the memory afterimage. In the thaumatrope, the two images on the front and reverse sides of the pane are often repeated before the eye in rapid alternation, so that the impressions can add up; whereas the memory afterimage is obtained by means of a single glance.

In all this, I myself believe, with regard to the general discussions to be added under e), that my memory afterimage only comes into being by virtue of a direct continuation of the activity underlying the ordinary afterimage into the field of imaginary images, where it can still be grasped by me through memory activity; after it has already extinguished in the field of vision, while in the experiment with the thaumatrope the image preceding by a moment is still composed with the following one in the field of vision itself.

If this is the case, it cannot be unexpected if the same phenomenon, which behaves as a memory image in me according to its main moments, behaves as an after-image in someone else. This seems to be the case with Prof. Rute, who very easily receives clear after-images, but also easily produces ordinary clear memory images, and from the information he has given me I gather the following: if he has only momentarily caught sight of an object, the same object also momentarily appears to him most clearly in its original form.

But he needs no voluntary effort of attention for this; but, as he closes his eyes or averts his gaze, the after-image appears to him, he may wish it or not, and, on being extinguished,

passes from the positive into the negative, thus bearing all the characteristics of the ordinary after-images. He finds this just as certain as I, for my part, find it certainly necessary to use the activity of memory especially in the usual way in order to see the after-image of memory. Helmholtz's method of producing vivid positive afterimages by momentarily looking at an object after the eyes have been closed for a long time, about which I have no sufficient experience of my own, also gives the phenomenon according to Helmholtz's account without any special tension of the memory activity [12]. It is precisely through these differences, however, that the memory afterimage seems to me to gain its special interest, since it shows particularly clearly how the same phenomenon can fluctuate between the character of the memory image and the afterimage, depending on individuality and circumstances.

After the above had been completely written down, I first became aware of a passage in Purkinje's *Beitar. zoom subjective Sheen*, p. 166, which proves that he had already observed the afterimages of memory with similar characters to those I had observed earlier, but by contrasting them under the mere name of afterimages with the dazzling images (which I had understood to be afterimages) that depend on the duration of the sensory impression. Since his statements partly confirm and partly complement the above, I will leave them here verbatim:

"I often wondered that the blinking of the eyes did not disturb vision, imagining that during it there must be complete darkness. On closer observation, however, I found that the field of vision of the open eye, with all its lights and images, remained before the sense for a short time after the eyelids had been closed. The more attentively I take in a simple, not too extended image, the longer I am able to hold it before the sense with closed eyes. This after-image can be precisely distinguished from the dazzling image. The after-image is only held for a longer time by free activity, and disappears as soon as the will slackens, but can be evoked again by it; the dazzling image floats involuntarily in the mind.

The image of the eye, the sense of touch, continues to set the after-image outside the organ, just as it did in real sight, even stereo metrically.

"The topical activity of the sense, the sense of touch of the eye, continues to place the after-image outside the organ, just as it did in real seeing; it can also represent stereo metrically delimited images, and even when the whole body is moved and turned, the after-image maintains its original place and position. The dazzling image, on the other hand, only represents surfaces, has its place only in the eye and follows its movements. The vividness of the afterimage varies according to the different moods. It is particularly vivid in the case of heightened mental activity after the consumption of spiritual drinks or narcotic substances, or in the case of special interest in the object; in the case of feverish excitement of the blood, especially in the case of cerebral affections, it is often increased to an indestructible objectivity. The blinding image, on the other hand, tends to last longer in a nervous mood, in an asthenic state, and disappears the faster the more energetically life flows through the organ.

Furthermore, the after-image is the clearer and more objective the nearer it is to the moment of perception of the original image, and at each subsequent moment it becomes more and more difficult to preserve it in the same clarity before the senses. The dazzling image of mildly luminous objects, on the other hand, is confused in the first moments after it is seen, and only gradually forms itself completely before the sense, which is only a passive spectator."

c). Appearances of the Sense-Memory and Reaction-Phenomena After Seeing Movements.

If the after-images of memory in the form in which they present themselves to me represent a transitional element between memory-images and after-images, which rather joins the former as the latter, the phantoms of the so-called sense-memory, on the other hand, represent another transitional element, which conversely joins the after-images rather than the memory-images. For they require the direction of attention to the black field of vision in order to be perceived and are not a matter of arbitrary generation and alteration like the memory and phantasy images; they do not, however, present themselves merely as the reverberations of sensory impressions that have just passed in the immediate wake of them, like the afterimages, but return voluntarily in the dark after the eye has long been occupied with other impressions in the light, and reproduce not only the impression of stationary objects but also of movements.

Naturalists often have the opportunity to make experiences that belong here, although they are not often described [13]. The earliest description of this that I know of comes from Henle [14]. He relates that when he had been working for hours in the morning on a preparation of arteries and nerves, late in the evening, in the darkness and while rubbing the eye or during congestion while coughing, blowing his nose, etc., the luminous image of this preparation suddenly appeared in all its details under circumstances where otherwise a flash of lightning might have quickly illuminated the field of vision. The appearance was momentary and involuntary and could not be intentionally evoked again. Similarly, at another time, when he had been examining the flickering tubes of the *Branchiobdella* for several days, the flickering stripes again appeared to him in the evening, among the tangle of threads that appear to the calm eye, shining, sharply bordered and with the same lively trickling movement as they had shown him under the microscope. (Casper's *Worchester*. 1838. No. XVIII.)

I myself have repeatedly had similar experiences (although modified in some respects), particularly striking at a time when my eyes and my whole nervous system suffered from a pathological pickling, which later developed into light-shyness lasting several years.

I take the following from my notes on this:

When I was still professor of physics in Leipzig, magnetic intensity observations were made in the physics department there with the Gaussian apparatus, whereby one sees a black thread moving in the telescope over a white scale with black graduation marks and degrees and at the same time pays attention to the beat of the second's counter. When I had made

these observations for two hours, I only had to close my eyes or look openly into the darkness, and I saw the black thread together with the white scale with the black graduation marks and numbers appear in the visual field all by themselves, and indeed the thread in the same calmly wandering movement over the scale that it had during the observation. I experienced this many times after all the observation dates that fell in that period. Partial lines and threads were easily distinguishable (even if not nearly as clearly as in reality), the numbers, however, never so clearly as to recognise their value. I have never seen the trains luminous. Even 24 hours after such a series of observations, the phenomenon repeated itself every time I closed my eyes, without my having attracted any attention to it. It was not just momentary, but also not constant, but was alternately swallowed up by the darkness, only to reappear again without me being able to control it in any way.

I experienced a very similar phenomenon in connection with the previous one in my hearing. When I lay in bed in the evening after such a series of observations, and even the next morning when everything was completely quiet, I would hear very clearly (continuously) the beat of the seconds counter with its peculiar beat, as if a pendulum clock were running in the next room, so that I had to convince myself that no such external cause was really present.

At the same time, I often made persistent observations on the multiplier, whereby it was important to follow the needle playing over a circular division with attention; I have also often seen this image with the movement of the needle reproduced under similar circumstances as before.

Even after I recovered from my photophobia, similar phenomena often recurred in me, and even today, although less frequently than before, they occasionally return after prolonged occupations where it is necessary to return often with the eyes to the same objects [15]. The following observation, however, seems to me to be of special interest, inasmuch as it shows that for the sense memory, just as for the ordinary memory, the conditions of quite different images can coexist without essential interference.

On 21 February 1847, after dinner, I spent a long time playing with a number of large so-called "Firle" [16]. For a long time after dinner I watched the game with a number of large so-called Firle (Borle, twirl dances; i.e. discs with a pin through the middle, which are set in rapid rotation on the tip of the pin in the manner of a spinning top), which was being played for the amusement of others, and occasionally took part myself. The greater part of the rest of the afternoon and even in the evening, until after 11 o'clock, I occupied myself with drawing the means from several series of observations expressed in numbers. When I finally went to bed, with both eyes closed and open in the dark room, whole series of numbers, similar in form to those I had been dealing with, immediately appeared in black in the dim base of the field of vision, so that I could read them quite well, even if they never had great sharpness and clarity. The phenomenon was not fixed either, but was always soon swallowed up by the darkness, only to give way to another series of numbers. Here, too, attention had no influence at all; and although the calculations were still running around in my head, the series of numbers that appeared

had no relation to them, had quite the character of something seen, not thought. The strange thing, however, was that sometimes instead of the phantasms of numbers, the phantasm of a spinning Firle would appear, although I, vividly occupied with the calculations, had no longer thought of that indifferent pastime during the afternoon or evening, or was thinking of it now; except when the apparition now involuntarily reminded me of it. Sometimes it was this Firle, sometimes that Firle (they were of different sizes and shapes) that appeared in the field of vision, turned and fell over, as it had been in reality. The apparition was unambiguous, although weaker than the phantasm of numbers. This alternation of phantasms, of which the number phantasms appeared much more often, lasted for over an hour until I fell asleep.

In view of Henle's experiences, I have very often tried, by rapidly shaking my head, or rapidly squeezing my eyelids shut, or otherwise strongly and deliberately shaking my head or body, to bring about these involuntary appearances in my field of vision, which appear and disappear again at times when, after a prolonged period of time, they have not been felt.

I have never succeeded, however, in achieving this by myself. Deliberate, quiet vibrations were just as unsuccessful. Nevertheless, I do not wish to deny the influence of vibration altogether, but without being able to pin it down. It seemed to me, however, that the phenomena in question occurred preferably easily with an occasional slamming of the eyelids, often with a quiet involuntary blinking of the eyelids, without my being able to achieve the same again by deliberate night-time action. One also remembers the experiences mentioned in the memory afterimages on p. 495.

It would be desirable if the phenomena of the sensory memory, especially with regard to the reproduction of movements, were raised from accidental observation to experiment. From what has occasionally been observed, it does not seem improbable that, with a suitable method of experiment, the reproduction of moving objects obtained immediately after observation would be seen to be legally moving; indeed, for a certain form of movement the question has already been decided. Where, of course, the movement occurs so quickly that the duration of the impression makes the path described appear to be continuously filled with the visual impression, as in the case of the electric spark, the rapidly curving glowing coal, the after-image naturally takes on this form; if, on the other hand, the eye follows a slowly moving object with its own movement in such a way that it holds it constantly fixed, as is natural to us, the appearance of the after-image corresponds just as naturally to that of a stationary body. But there is a third case to be investigated, namely that the objective image is allowed to move slowly over the retina. But because each part of the retina then receives only a brief impression, the movement must be repeated often, or carried out with a very strong light impression, or both must be combined. The simplest cases to distinguish are the following two: 1) that the objective movement always goes in the same direction, 2) that it goes back and forth pendulously. For the first case, the following facts teach that the objective movement reproduces itself subjectively in the opposite direction; for the second case the facts of the sense-memory that have been

cited lead us to assume that the pendulum-like movement would be repeated subjectively.

Examples of the first case, which easily present themselves in ordinary life, are that the objects on the road, which seem to move beside the carriage while it is moving, seem to assume an opposite motion at the moment of stopping, and that, when one turns one's gaze from a rapid under observation to the sand and pebbles on the road, they seem to move in the opposite sense to the motion of the water. More specific observations on this phenomenon have been made by Plateau on the one hand, and by Opel on the other, and the strange fact that the direction of the movement in the subjective after-image is opposite to the objectively observed one has been compared with the emergence of complementary after-images [17,18]. Opel, who has investigated the phenomenon particularly carefully and has himself provided an apparatus for its safe production, points out the following 6 conditions as indispensable for the safe success of the experiment.

- 1) The movement under consideration must continue uniformly and in the same direction.
- 2) It must be quite rapid on the whole, but not so rapid that it makes it impossible for the eye to distinguish between the individual moving points; - which, of course, does not depend on the absolute, but only on the angular velocity in relation to the position of the eye, thus also in particular on the distance of the latter from the moving object.
- 3) It must be observed for a good while, i.e. on average for about a minute, generally until the eye is almost tired (which duration will, of course, be quite different for different eyes).
- 4) The eye must thereby, as in the subsequent fixation of a still image, itself be in (relative) repose, and the eye must be at rest. In particular, it must not be irregularly shaken by random movements of the body or head.
- 5) The still object to be fixed must present a surface that is not modified in any way by the alternation of colours or the shading of its parts.
- 6) Both when observing the moving and the still image, the eye must fixate on a certain point without going crazy, and must therefore not be tempted to follow the movement to a greater or lesser extent in the former case, or to wander back and forth along the contours of the moving image. "

With regard to the second case, which is to be considered according to p. 502, there is still a complete lack of experiments. Quite casually, I repeatedly moved a patch of white paper on a black background back and forth in front of the fixed eye; but although I very easily have afterimages and appearances of the sensory memory, I still received no result; nothing appeared. Nor was I able to obtain a result by means of stroboscopic discs. The condition of my eyes, however, forbids me to carry out the experiments for a longer period of time with strong pendulous light impressions and with necessary changes, where a result could probably be obtained, since these experiments cannot be otherwise than very strenuous.

d). Involuntary Hallucinations and Illusions [19]. Hallucinations are Generally Understood to be Delusions.

The latter are the mental impressions which, for the deceived

person, take on the character of sensory perceptions aroused from outside, without there being anything in the external reality to stimulate them. It will not be possible to draw a sharp distinction between them and the memory and phantasy images on the one hand, which have been heightened to the highest vividness, and the phenomena of the sense memory on the other; but many hallucinations are not a matter of arbitrary production like the phantasy images and arbitrarily recalled memory images, and many do not slavishly reproduce previously experienced sensory phenomena, like the phenomena of the sense memory. These forms, which have not yet been dealt with, will therefore preferably be discussed in the following. Illusions are understood by some to be deceptions of every kind, while others, as may be done here, distinguish between illusions and hallucinations in so far as they understand illusions to be deceptions, for which, however, causal objects exist, but which are misperceived, while in the case of hallucinations there is a lack of external causal objects of the appearance at all. Thus it is an example of an illusion when one sees an object that is really there with a false colour or distorted features, while it is an example of a hallucination when one sees an object that is not there at all.

Simple cases of hallucinations are sparks before the eyes, sounds in the ears, as they so often occur in congestive states according to the sense organs concerned; but also shaped phenomena, such as human figures, speeches, can appear through hallucinations. These include the fantasies of many fever patients and insane persons, the phenomena of nightmares, hallucinations following the consumption of narcotics, and the hallucinations following the consumption of alcohol.

The literature on hallucinations and illusions is very large and cannot be exhausted here. I shall content myself with listing the new writings that have come to my knowledge, which preferably refer to this subject, of which, however, I only know the titles of I, 6 and 7. Incidentally, not only do all works on mental illness deal with hallucinations, but also countless treatises and reports on individual cases [20].

It would be desirable to be able to distinguish by significant names between the phantasms produced voluntarily, which, apart from their mode of origin, are so much alike, and which were spoken of in section a) p. 484 ff. in connection with the memory pictures, and the phantasms produced involuntarily, which will be spoken of hereafter, but I have not been able to think of any quite suitable ones.

But even in mentally healthy persons, when fully awake, with open eyes, very developed hallucinations may occur under certain circumstances, indeed the number of strange cases of this kind which have been reported is very large. Among the most credible, interesting, instructive and extensively described cases of this kind, with whose physiognomy the very many other cases correspond, is the case of the formerly famous bookseller and writer Nicolai, described by himself in the Berlin Monostich. of May 1799 and in the first volume of his Philos. Axhandle. p. 58 ff, also reproduced in Hibbert's writing, the specific reproduction of which, however, would exceed the limits to be set here.

It also seems to me that for the connection with the phenomena

described under a), before such conspicuous forms of hallucination as are presented in Nicolai's case, and which are indisputably always connected with bodily states of illness, the hallucinations before falling asleep, which are observed by so many in a good state of health*) deserve preferential attention, in regard to which I believe I can do nothing better than the description, so beautifully founded on introspection, by J. Müller's description of facial phantasms, based on self-observation.

§34. "It is seldom that I do not, before falling asleep with my eyes closed, see in the darkness of the field of vision manifold luminous images. I remember these phenomena from my early youth; I always knew how to distinguish them from the actual dream images, for I could often reflect on them for a long time before falling asleep. Frequent introspection has also put me in a position to capture their appearance, to hold on to them When I want to observe these luminous images, I look into the darkness of the field of vision with my eyes closed and completely at rest; with a feeling of relaxation and the greatest rest in the muscles of my eyes, I sink into the darkness of the field of vision.

I am completely immersed in the sensual calm of the eye or in the darkness of the field of vision. I reject all thoughts, all judgements; in the case of a perfect rest of the eye as well as of the whole organism, I only want to observe in regard to external impressions what will appear in the darkness of the eye as a reflex of inner organic states in other parts.

§35: "If in the beginning the dark field of vision is still rich in individual spots of light, mists, changing and shifting colours, then instead of these, images of various objects soon appear, at first in a dull shimmer, soon more clearly. There is no doubt that they are really luminous and sometimes colourful. They move, transform, sometimes emerge entirely to the sides of the field of vision with a vividness and distinctness of image that we otherwise never see anything so clearly to the side of the field of vision. With the slightest movement of the eyes, they usually disappear, even the reflection scares them away on the spot. They are rarely familiar figures, usually strange figures, people, animals I have never seen, illuminated rooms I have never been in. There is not the slightest connection between these apparitions and what I experience during the day. I often follow these apparitions for half an hour until they finally pass over into the dream images of sleep.

§36: Not only at night, but at any time of the day I am capable of these apparitions. Many an hour of rest, far removed from sleep, I have spent with closed eyes observing them. I often only have to sit down, close my eyes, abstract myself from everything, and these images, which I have been accustomed to since my early youth, appear involuntarily. If only the place is quite dark, if only I am mentally quite calm, without a passionate mood, if only I have not eaten or taken a spiritual drink, then I may be sure of the apparition, even if sleep is not to be thought of.

§37: "Often the light image appears in the dark field of vision; often, too, before the appearance of the individual images, the darkness of the field of vision gradually lightens to a kind of

inner dull twilight. Immediately afterwards the images appear.

§39: "I can distinguish in the most definite way at which moment the phantasm becomes luminous. I sit there for a long time with my eyes closed; all that I want to imagine is mere imagination, imagined delimitation in the dark field of vision, it does not shine, it does not move organically in the field of vision; all at once the moment of sympathy between the phantasm and the light-nerve occurs, suddenly figures stand there shining, without any stimulation by the imagination. The appearance is sudden, it is never first imagined, imagined and then luminous. I do not see what I want to see; I can only allow myself to see what I must see luminously without all stimulation.

§.40: ... "I can imagine and imagine for hours if the disposition to the luminous appearance is not there, but this will never be the case.

The imagined receives the appearance of liveliness. And suddenly a light, not first imagined, appears against my will, without any recognisable association.

§ 41: These phenomena occur most easily when I am quite well, when there is no particular mental or physical excitement in any part of the organism, and especially when I have fasted. Through fasting I can bring these phenomena to a wonderful vitality. I have never noticed them when I had drunk wine before .

§. 66. "Never have I been able, with eyes closed, to cause the fantastic images to move with the eyes like the dazzlers.

§147: "As easily as the phantasy images occur involuntarily in me, I have almost never been able to produce a certain phantasm of a certain illumination and colouring by my own will, even with the greatest effort. I have spent half days in this exercise of the will in the dark. The phantasy images were always a phantasy that defied the will, which I was unable to evoke or hold on to. As easily as I see subjective colours, I have never been able to will a red, a blue into the field of vision and fix it" .

§. 157: "Dream images are nothing other than the luminous phantasms that appear in the visual substance when the eyes are closed. As a rule they exist with recognition of their objectivity, often also with the consciousness that only dream-images are seen. In the latter case, the dream images are not at all different from the fantasy images before falling asleep. In my self-observations before falling asleep, I have often been surprised at the beginning of the real dream. The real dream, with the putting to sleep of reflection and the recognition of the objectivity of the phantasy images, occurs most easily and immediately when the darkness is gradually replaced by the inner subjective illumination of the field of vision". (There follows a more detailed description of this in the original).

As far as hallucinations are concerned, which are connected with states of illness, these generally have the character of excitements of the nervous and vascular systems, and perhaps they are always based on congestive states in the brain. This is expressed partly in their causative moments, partly in accompanying symptoms, partly in remedies. Apart from Nicolai's case, which provides

proof of this both in terms of the causal origin and cure, I would remind you of their habitual occurrence in fevers, in some cases of madness, such as the drunken madness (in which the brain is often found to be overfilled with venous blood after death), after the consumption of narcotics, after the death of a patient, after the death of a patient, after the death of a patient. after the consumption of narcotics, by which the pulse is extraordinarily increased, and so on. Fleuret and Meti vie found, after numerous observations in the Salpeter, that among all the insane persons there, those afflicted with hallucinations had, on the average, the most frequent pulse; it was itself more frequent than in those afflicted with mania [21]. But I also find a case reported where the hallucinations continued after the greatest loss of blood [22].

According to Bail larger and Moreau, a horizontal position favours hallucinations, indisputably because the blood flows more towards the head; and Panel also reports of a melancholy female where the hallucinations of the auditory system ceased immediately when she sat down.

The images which appear in the hallucination in the delusional and ecstatic states are, according to their nature, mostly clearly dependent on earlier external living conditions and occupations, but also on the earlier imaginary life of the person, which naturally both are themselves so connected that a pure separation in the assessment of the causal moments of the hallucinations is not well possible. (For evidence see, among others, Hagen, p. 16 ff.).

From another point of view, the hallucinations, as already remarked above, often consist in light phenomena without form; and the formed phenomena also often begin with them or are accompanied by them, a proof that, apart from all influence of the faculty of imagination, a disposition to them must exist in the sphere of the senses. (Cf. Hagen p. 252.)

The hallucinations of several senses frequently combine and then not infrequently in such a way as corresponds to laws of association.

“Observation seems to have established that hallucinations are rarely confined to a single sense; while recognising the truth of this fact, on which M. Fonville insists a great deal, it can be stated that, in general, hallucinations of this or that sense dominate over those of the other senses. It is especially in acute illnesses that several hallucinations are observed at the same time. When there are hallucinations of several senses, these hallucinations are usually closely related. Thus it has been remarked in the observation of the hallucinist who leched the walls, because they appeared to him to be covered with delicious oranges (see page 139), that he smelt at the same time the odour and the flavour of these fruits. Mr. Bail larger has reported the observation of a woman who received a flower-pot on the head and immediately heard the noise made by the pot as it shattered on the pavement. Later, she felt the same blow twenty times a day and heard the same noise". (Brière de Boismont p. 557.)

Often, too, the hallucinations lack all rational coherence, and Nicolai says, e.g.: "Although my nervous system was so very tense, so very weak, in short so out of tune, that such figures

could appear, yet with me these dazzling works followed no known law of reason, of imagination, and of the otherwise usual association of ideas. "

The deception by hallucinations, as if external objects of perception were present, may be more or less complete according to circumstances, and is in any case perfect in many cases. In fact, all possible degrees seem to take place here. Some hallucinators are perfectly conscious of their condition and of the deception; they really recognise the phantasms as phantasms, whether they do not in some respect have the full character of reality, or whether they are found incompatible with the coherence of real relations, which asserts itself from another side, as soon as full consciousness is otherwise present.

"Nicolai assures us that I was able to distinguish between phantasms and phenomena at all times, just as I was in the greatest calm and prudence, and that I never once made a mistake. I knew exactly when it merely appeared to me that the door was opening and when the door was really opening and someone was really coming to me. "He also saw the colours somewhat paler than in reality. Similar in a case reported by Bonnet [23].

In other cases, however, it is different. "I see," said a cured sick man of this kind to Esquire, "I hear as exactly as I see and hear you." - "If my perceptions are erroneous," said a sensual priest to Fonville, so I must also doubt everything you tell me, I must doubt that I see you, that I hear you."

A patient said to Fleuret: "You say that I am mistaken, because you do not understand how these voices that I hear reach me, but I do not understand how this is done any more than you do; what I do know is that they arrive, since I hear them: they are as distinct for me as your voice, and if you want me to admit the reality of your words, let me also admit the reality of the words, which come to me, I know not where, for the reality of the one and the other is equally sensible for me [24]. "

One also very often sees madmen and feverish persons performing actions which prove that they certainly confuse the illusions of the senses with reality.

In some persons it is stated that their visions disappeared when they closed their eyes, while in others it was sufficient to lower the eyelids to cause hallucinations to occur. In still others it made no difference whether they opened or closed their eyes. Nicolai says: "Incidentally, the figures appeared to me at all times and under the most varied circumstances equally clearly and definitely; when I was alone and in company, by day and in the dark of night, in my house and in other people's houses. When I closed my eyes, the figures were sometimes gone, sometimes they were there even with my eyes closed. But if they then remained away, after opening the eyes, approximately the foreseen figures would reappear. Rd. Crichton has remarked : "that patient, when they first begin to fantasise in fevers, only do so when the room is darkened, or when they close their eyes; but when they open them, or when the room is sufficiently lighted, the fantasising ceases, and they often say themselves, when they remember the things they saw, that they are convinced they were fantasising [25]. "Various cases in which

the hallucinations disappeared by closing the eyes are described in Rute's *Ophthalmic*. I. p. 193 u. Grief - singer's writing p. 72.

In conflict with external sensory perceptions, hallucinations behave in such a way that, depending on the circumstances, they can be displaced by them or, conversely, displace them or be able to combine with them.

According to Bail larger, some hallucinators can interrupt their hallucinations if they turn their attention to external impressions, while others are unable to do so. This is why hallucinators often lose their hallucinations during the presence of the doctor, which return as soon as the doctor is removed [26].

It is often found that when phantasms cover an indifferent background, they disappear when an object which attracts attention is placed in their apparent position, or when an obstacle to vision interposes itself between the visions and the apparent position of the vision.

J. Müller (plant. G. p. 35) remarks in general: "Those who have seen fantastic images with open eyes while awake, testify that one cannot avert one's eyes from them, i.e., that when they are approximately in the centre of the field of vision, they coincide with all objects which fall into the visual axis when the eyes are averted. Greathouse (Beitar. z. Physiognomies p. 238. 259) has collected observations of this kind from his own experience and that of others."

In a case reported by Scott in *s. Demonology*, a man who, by the way, was quite sensible, had, after many other preceding hallucinations, the apparition of a skeleton, which he was quite unable to banish, in spite of the fact that he kept repeating to himself that it was only a shadow. Is this skeleton," the doctor asked, "always before your eyes? The patient answered in the affirmative, "So it is now too?" Indeed, replied the patient. "And where do you see it?" Immediately at the foot of my bed, and if the curtains are left open a little, the skeleton, as it seems to me, fills this empty space.... The doctor stood between the two half-opened curtains at the foot of the bed, which were indicated to him as the place the apparition occupied. He now asked if the ghost was still visible? Not quite, replied the patient, because your person stands between him and me; but I see the skull of the ghost over your shoulder."

In one case reported by Rd. Brach, a 12-year-old girl, frightened by a strangely dressed man with a red cap who was gnawing on a bone, had contracted a spasmodic malady and a frequently recurring vision in which that man appeared to her as a phantasm. When she first approached the phantom or tried to reach for him, he took a few steps away from her. Rd. Brach made the following experiments about four days after the first attack: He had the patient walk a few times towards the apparition until she was up against a wall and then asked her if she could still see the person through the wall. This was not the case; for if she was allowed to step within a step of the wall, the apparition disappeared. If, on the other hand, it was made to stand close to a window, the apparition would flee out of the window and look at it through the window. If one let her look into a mirror, she would not see the apparition but her own image. If someone came between

her and the place where, according to her, the man was, she would see him partially, insofar as he was not covered by the intervening person. If someone stood straight on the spot where the simulacrum was, the simulacrum disappeared completely on one occasion, but on another occasion it also stood sideways. With the application of suitable nerve drops, the spasmodic coincidences gradually diminished and the phantom began to pale and give way. At first the red cap became yellow and paler altogether, then the outlines of the whole figure became more indistinct, then the man disappeared and only the face, cap and hand in which he held the bone remained, then the face and hand also remained gone and the patient could only see the bone and the cap over it, which also became continually whiter and paler. After 5 weeks, however, the illusion and St. Vitus' dance had disappeared. (Med. Zeit. v. Versine f. Helik. in Pr. 1837. No. 5.)

It is undoubtedly to be regarded as a conflict with objective perceptions when phantasms appear several times transparent or translucent, where they then seem to behave in a similar way as when one produces a double image, e.g. of a leaf, on a sheet with print or writing, which then shines through the double image. I find several such indications.

To Cardanos the various figures seemed to consist of small rings like the links of armoured shirts. "Everything was transparent, though not as if it seemed to be nothing at all". (Hagen p. 47.) One who saw the corpse of a secret before him would see a copper engraving through the figure of the same. (London med. gaz. March 1843.) Other remarks that the more the soul was in an inactive or suffering state, the more vivid were his hallucinations, so that real objects were not seen in the room. "But if the attention was disturbed when the phantasms were awakened and set in motion by some kind of effort, they began to become, as it were, transparent, and the objects of sensation appeared as if they were seen behind the phantasms. It was not in the least difficult to make one or the other object visible at will, for the phantasms almost disappeared as long as the attention was firmly fixed on real objects". (Hibbert p. 286.)

Illusions, understood in the sense given on p. 505, may be regarded as a kind of combination of hallucinations with external sensory impressions, of which innumerable examples may be cited, though this would be partly superfluous and partly too far-reaching.

Notwithstanding that the images produced by hallucinations generally bear all the colours of the real world, the circumstance, already apparent in Meyer's *Experiences* (p. 485), that the inner production of colours is more difficult than that of forms can also be seen in some experiences concerning hallucinations [27]. Nicolai, when his phantasms began to disappear, would first see the colour of them fade and the figures become completely white when their outlines were still very definite, and also in the case of the girl (p. 513), who repeatedly saw the strangely dressed man as a phantasm, the red cap would first become yellow and then gradually paler when she gradually recovered.

As a test to distinguish a phantasm from a real object, Brewster stated that one should press one eyeball to see whether a double image would arise, which could only arise under the condition

of a real object. However, Paterson reports of a case where a definite phantasm is said to have doubled when the eyeball is moved with the finger. This would not be impossible insofar as the idea of doubling itself indisputably gives a double image in the imagination, which can be formed as such in a person inclined to hallucination; in this case, however, the whole sample appears unreliable [28].

It is important to note that not a few cases are known in which vivid hallucinations took place while the patients suffered from black stare, and in which the optic nerves were both completely atrophic in the section. A description of such cases is given by J. Muller, *Über plant. Gees.* p. 31 ff. and *Ft ate in s. Ophthalmic.* I. P. 194.

e). General Considerations

From the totality of the facts which have been given concerning the relation of memory-images and after-images, and the transitional elements which interpose themselves between the two, one receives the impression that the processes which underlie the memory-images and after-images are not in themselves essentially different, that it is rather the same psychophysical process which, depending on whether it is stimulated directly from within or from without, gives a memory-image or an after-image, the former as a later echo, the latter as an immediate echo of an objective image. With this different mode of production, the difference in strength, the contrast in the feeling of spontaneity and receptivity, and the different local feeling for the two phenomena can be related as follows.

Through whatever inner mediations the counter-sounds of externally produced images in memories come about, about which we know next to nothing, it nevertheless appears quite natural that they, in so far as they are only late after-effects of these images, it seems more difficult to explain why, in cases that always remain exceptional, they can come so close to this upper limit, and even seem to reach it, that they remain so far behind it, as is the rule. If, however, in some ecstatic states they even seem to surpass the outer images in vividness, this is only the case in so far as the excited state in which the organism finds itself during inner reproduction is incomparable with that in which it finds itself during reception.

The fact that we have the activity of producing the memory images, and the receptivity with which we conceive of the after-images, can easily give rise to those who are inclined to divide the phenomena of the soul into those that are essentially connected with physical processes and those that are not essentially connected with them, to place at least the act of producing the memory images, if not them themselves, on the first side, and the objective images and their after-sounds on the second side. But it seems to me unclear, and for this reason alone untenable, to separate the activity of producing or perceiving the images from the images themselves in such a way that the latter can proceed abstractly in the soul, while the latter cannot proceed abstractly in it. Without wishing to return at all to the dispute with views that contradict a system based on the view of the extended seat of the soul, we have to remember, for our part, that the memory-image, like the after-image and objective image, float

neither psychically nor physically in the void, but are special determinations of general consciousness on the one hand, and of the general psychophysical process underlying it on the other. In the sense of the scheme and with regard to what has already been said, I present it thus: we have the feeling of spontaneity in the memory images, because in the generation from within the total wave is raised more strongly by the elevation of the sub-wave as a harmonic; in the generation from without the reverse is true; but the formation of the harmonic is the same in both cases. In the meantime, there is in principle nothing to exclude cases where the total wave also rises more strongly from within by raising the harmonic than the subharmonic; then we have the involuntary hallucinations, which are to be regarded only as an exception; and in general many transitions are possible here, as we have considered them in the memory afterimages, phenomena of the sense memory, and so on.

As regards the local relations in question between memory-images and after-images, it is generally evident from the observations reported that when unfamiliar memory-images are awakened the attention must be turned away from the outside world with the eyes open, and from the black field of vision with the eyes closed, and must be withdrawn behind it in the sense of feeling, and that where the memory-images are not familiar the attention must be withdrawn from the outside world and from the black field of vision with the eyes closed, and where the memory-images are not familiar the attention must be withdrawn from the outside world and from the black field of vision with the eyes closed.

Where the memory images remain weak, they can also only be perceived and retained in such abstraction from the external sense, in a similar way as one must also abstract from one sense area in order to be able to become aware of the perceptions in another. This speaks for the fact that the field of memory images in state nascent and as long as they remain weak, and the field of afterimages, which coincides with the black field of vision, are localised differently in the brain in a similar sense as the different sensory areas themselves.

On the other hand, if one observes an after-image in the closed eye or the black field of vision itself attentively, one finds the tension of attention turned towards the outside world in the same way as when one observes external objects with open eyes. This speaks for the fact that the field of after-images and external perceptions must be regarded as coinciding.

Furthermore, it is found that in order to reflect on something audible or olfactory, the memory of which is not familiar to us, one must turn one's attention back from the external sense in quite the same way as in order to reflect on something visible, without the feeling of a different localisation being manifested according to the difference of the sensation on which one is reflecting. According to this, it is to be assumed that the entire images of the imagination occupy in their origin a common field that is different from that of the sense images, so that the attention can change between these two fields just as it can change between different sense fields themselves.

This consideration is not invalidated by the fact that the feeling of tension of attention on which we are basing this is probably a reflective muscular feeling (cf. p. 190 f.); for a diversity of motor fibres excited by reflex points back to a diversity of primarily excited sensitive fibres.

The spatial difference between the area of memory images and after-images, however, is not to be regarded as a divorced Ness; rather, both areas are naturally organically connected, are common to the general nexus of the two brain processes, including the brain itself, transfer their effects into one another and associate activities with one another.

The external stimulus of light calls forth powerful activities in the field of external perceptions; the effects of these extend into the field of imaginative images, and leave behind in them the conditions unknown to us, to which the possibility of the arbitrary and associative excitation of the weaker memory and phantasy images is bound. Conversely, according to the phenomena that the memory and fantasy images present with greater vividness, we must believe that the evocation of imaginary images in one field extends effects into the other field, that of sensory images, in such a way that real sensory images can step over the threshold in it, provided such attain the essential characters of the objective impressions and afterimages and require the same direction of attention.

The difference that memory images, being more vivid, can also be painted more easily into the black of the eye, which has presented itself as a kind of opposite between me and Busch like Meyer, is perhaps only due to the fact that they all the more easily outweigh the impression of the black of the eye, which is itself still equivalent to an impression of light. At least I myself find the difficulty or impossibility of painting memory images into the black of the eye in very natural connection with the fact that the black of the eye makes a much more intensive impression on me than the memory images produced in the withdrawal of attention from the black of the eye. If I try to enter them in the black, their pale lineaments are completely extinguished, but appear in their peculiar weakness when, withdrawing attention from the black of the eye, I enter them, as it were, in the void. Where, as with Busch, the memory images are naturally very vivid, or, as with Meyer, increased to great vividness through practice, this obstacle naturally falls away, and it may become quite natural to record them preferably in the field where the objective images and after-images are recorded.

The apparent contradiction, too, that I and many others, when looking at the memory pictures, rather see the part of the apparent contradiction, too, that I and some others, when looking at memory images, think rather to use that part of the head which the brain occupies, while to others it seems more as if they needed eyes and ears for this purpose, is indisputably connected with the different strength of the memory images. I myself can never make the memory-images so strong that, from their original mushroom, they noticeably influence the sensory region; but have difficulty in retaining them in their first formation; as I slacken the activity of reflection, they extinguish, and I therefore also always have the feeling of tension of attention, which is

connected with reflection. Where, on the other hand, the images of memory gain strength and duration, where they reach into the area of the senses, the corresponding feeling of tension of attention associates itself.

It is not improbable that the activity which is first stimulated by the external light in the optic nerve and only then propagates to the brain, in the case of the afterimages also continues in the optic nerve itself and in the case of the imaginative phenomena, if they flourish to sensual vividness, extends backwards to that point, whereas this is not the case with weaker imaginative images. But it is not possible to decide on the validity of this special version of the localisation view.

f). Some Remarks on Dreams.

There is a great deal of scattered empirical material available on dreams, the various turns and forms they can take, their causal moments, their transitions into somnambulism states, and so on [29]. However, due to the extent of the subject matter, I must refrain from more detailed communication, and this will be all the more permissible as I have refrained from the outset from completeness in this whole field and had to do so. Here, I will only comment on what I have said on p. 462 about dreams.

I would like to add a few supplementary remarks to what I have already said about dreams.

According to the facts communicated in section a) of this chapter and the discussions made under e), we have reason to consider the arena of psychophysical activity, which is subject to the formation of imaginative images and to these images themselves, as long as they remain weak, not as a separate one, but as a different one from the field of activity that is subject to sensual images, in such a way, however, that activities in both fields can associate with one another and effects can overgrow into one another. I assume that the scene of dreams is also different from that of the waking life of the imagination, but that in very vivid dreams corresponding reflexes occur in the sphere of sensory and motor activity, as is the case with vivid ideas in waking life.

In itself it is not improbable that the temporal oscillation of the psychophysical activity of our organism is causally connected with a spatial oscillation or circulatory movement in a similar way as we are accustomed to find in periodic phenomena in external nature; that therefore the peak of the main wave of our psychophysical activity, which is pressed down below the threshold, normally occupies a different place in sleep than the peak above it in waking, and that coincident with this the scope of the harmonics exceeding their threshold, to which the dream ideas are attached, is different from that in waking.

If it were not so, the incoherence in which the dream-life appears from the waking imaginative life and the essentially different character of the two would seem to me inexplicable. If the scene of psycho-physical activity during sleep and waking were the same, then the dream could, in my opinion, be merely a continuation of the waking life of imagination on a lower level of intensity, and would have to share its substance and form. But it is quite different: "The life of the day, with its efforts and pleasures, its joys and pains,

is never repeated (in the dream); rather, the dream aims to free us from it.

Even when our whole soul has been filled with an object, when deep pain has torn our innermost being, or a task has taken up all our mental strength, the dream either gives us something quite foreign, or it takes only individual elements from reality for its combinations, or it only enters into the key of our mood and symbolises reality. Thus the slumber images are almost never familiar figures, but figures such as we have almost never seen, strange formations and shapes, the like of which are not easily found in the outside world. (Burbach's *Physiol.* III. p. 474.)

"Memory is not easy in dreams: everything is as if it were happening now. And never does anything present itself in dreams that we once really encountered; only dreamed things are perhaps repeated. Imaginary images of regions are seen, familiar regions rarely at all, and then not without change. In the same way, no familiar melodies come to us in dreams, but new ones do, whether we remember them as dreamed melodies after waking, or whether the melody that becomes conscious to us at the moment of waking and in a half-awake state can be recognised as one that comes from sleep. The very fact that these melodies cannot be held fast after awakening indicates that they belong to the night life. They are like dreams, and again like thinking while asleep, which we cannot do exactly at all. What the dream takes from reality, it tends to falsify. Often the persons appear in their former, not in their present circumstances. Different points in time are mixed together. One misses the connection between before and after. (Uber den Geist und sein Viralness Zur Nature, by an unnamed author. Berlin 1852. p. 209.)

The experiences which we can make in waking life itself of the success of turning our attention away from any region prove that the mere lowering of our attention below the main threshold in the sense of our scheme only changes the degree, not the nature and order, of conscious life. The innumerable actions which we perform in unconsciousness while awake, such as washing, dressing, handling ourselves, while thinking of quite other things, are quite in the same sense and spirit, equally sensible, as those which we perform with full consciousness and in full connection with it. Not so with what we do and imagine in dreams. Nor can this be explained by the fact that, owing to the closure of the external senses, we can no longer orient ourselves to the external world and therefore also begin to err inwardly; otherwise the stillness of the night and the closure of the eyes would have to produce the same result; but through this the spirit, while awake, is no longer able to perceive the world.

Neither the simple lowering of the conscious life of the soul below the main threshold nor the withdrawal from the influences of the outside world is sufficient to explain the peculiarity of the sleeping life in comparison with the waking life. Instead of a mere reduction of psycho-physical activity under the occlusion of the external senses, it is rather as if psycho-physical activity were transferred from the brain of a rational man to that of a fool; but because both brains, or rather parts of the brain, are directly connected, and the movement itself is a coherent and successive one, the general psychic connection between them also continues to exist.

It is indisputable that the order of psychophysical activity and of the life of the imagination attached to it depends not only on the disposition but also on the development that its organ has undergone under its own influence, hence the way in which the ideas, the feelings of an adult, an educated man, associate and follow from one another, even with the same original disposition, is ordered quite differently from that of a child, an uneducated man; But the nature of the individual ideas that we now have is connected with the nature of the reverberations that our earlier life and thinking have left behind. Now the seat which the psycho-physical activity of imagination occupies in waking has worked itself out accordingly under the full and effective influence of a coherent rational life with man and world, inasmuch as the psycho-physical activity itself has been under this influence and has organised its seat accordingly. Not so with the seat of psycho-physical activity in sleep, into which only the after-sounds of this life pass under the threshold. Instead of comparing it with the brain of a fool, we shall therefore compare it even more cogently with the brain of a child or a savage, only with the consideration that it stands in such connection with that of an adult, of an educated man, that on the transition from waking to sleep and the corresponding displacement of the crest of the wave of psycho-physical activity, the after-sounds of the latter's life of sensation and imagination are drawn over as dream-waves into the new seat. Since here they are not subject to any organisation worked out by education, they begin to err; just as a child or savage does not understand what an adult or educated person tells him, draws undriven conclusions from it, and weaves unregulated phantasy pictures from it. Or again, it is like stepping out of a city with fixed streets, houses with house numbers, etc., etc., into a natural wilderness without paths; there the gait becomes indeterminate; soon a deer appears here, soon there, but the orderly gait ceases. If one merely closes one's eyes while awake, this is different; the psycho-physical activity, previously occupied more in the outward direction, gathers, concentrates in the seat of the sensible inner life, into which the paths of the senses lead directly, but does not move into another.

Incidentally, although the dream life is relatively less coherent and not as rationally ordered as the waking life, it nevertheless has its own coherence. Thus, when we fall asleep again after an intervening awakening, the dream of the first sleep continues in the second, without the intervening ideas of waking interfering, which also speaks for the fact that waking and dream life have a different setting. This is especially common among night-walkers, so that, as with every awakening to daily business, with every sleep they return to the accustomed kind of dream-life. (Burbach III. p. 474.) Thus one can easily lead a quite different way of life in the city and in the country, and in the course of an iceberg, from one place of abode to another, always return to the same coherent way of life. But it would be impossible to change one's way of life at the same place of residence. What applies here to the resettling human being applies to the resettling psychophysical activity in the human being.

However, the circumstance that the course of the imagination in dreams is not bound to such fixed paths, i.e. that it is freer and that the lack of order is not to be understood absolutely but only relatively, can under certain circumstances make greater

achievements possible in dreams than in waking, and the imagination can sometimes produce something, especially in dreams, that it would not have been able to do in waking. (For examples, see Burbach's *Physiol.* III. p. 469.) The deduction from the exterior contributes to this.

The dreamer is a poet who lets his imagination run wild and is completely absorbed and lost in an inner world, so that the apparition becomes truth to him.

Let us take one last step in our consideration. As the summit of psycho-physical activity, lowering itself more and more, at the same time turns more and more towards a part less accessible to sense stimuli, it will nevertheless bring about an elevation of the interior, to which it turns, towards the time of waking, so that the main psycho-physical wave will indeed have sunk on the whole and remain below the threshold; but nevertheless at one place in the interior it will have risen towards the time of waking, and this place will have moved nearer to awakening. And so it is also possible that in abnormal and extreme cases this goes as far as real awakening, and with it a new awakening takes place, separated by sleep from ordinary waking and passing over into it again through sleep, which then, however, is necessarily related to an all the deeper falling asleep of the ordinary seat of waking life. This could be the awakening to somnambulism.

If somnambulist waking seems more sensible than dreaming, this could be due to the fact that the inner world, which is after all alien and often populated with visions, becomes more clearly comprehensible in the brighter consciousness of the new waking.

However, I consider it questionable to extend the attempt to represent the phenomena of sleep psychophysically even further to the particular phenomena of somnambulism. It is not that we cannot hope that psychophysics will also shed light on this aspect, which has not yet been seen; it is not that general thoughts on the subject cannot already be developed. But in order to lead to something certain, many things must first be established in this field on the part of the facts as well as the psychophysical laws, which are not yet certain.

The fact that dream-imaginings can lead into the sphere of external muscular activity and external sensations is evident, on the one hand, from the fact that sleepers not infrequently move as a result of dreams, and, on the other hand, from the fact that vivid dream images can persist even after awakening as after-images, after-perceptions. Greathouse reports several of his own and other people's experiences of the senses of sight, hearing and taste in his *Beit rage z. Physiognomies. Contributions to Physiognomy and Autonomy.* 1812. p. 237 ff. and 256, which Burbach reports in s. *Physiologies* III. p. 465 and J. Müller in s. *Shrift Uber plant. Gees.* p. 36 have partly reproduced. The following examples of personal experience are given by II. Meyer in s. *Physiologies der Nirvanas* p. 309.

"I was walking in a dream in a dark, narrow valley beside a canal in which the water flowed turbidly and blackly; suddenly a small pale yellow pug came and barked at me fiercely, always threatening to bite me; I warded it off by turning to its side as it

jumped about; then I awoke, it was already quite light dawn, and I saw the clear black after-image of the pug hovering before my eyes for a long time.

Another time I dreamt of a party; the bustle was colourful and the waiters were running to and for with the ; I caught sight of one of them who was going out of the door with great agility, then I woke up, it was already dusk, and for a long time I would still see the dark image of the waiter holding the the ebrette in a somewhat bent-over position before my eyes.

I had a similar apparition of a Capuchin holding a pistol in his hand.

These afterimages all appeared to me as dark shadows with somewhat blurred edges."

According to Ilienach, the essential difference between the involuntary hallucinations before falling asleep, which easily pass over into dreams, and the voluntarily produced sensory phantasms of section a), may only be due to the fact that those from the seat which the summit of the main psychophysical wave occupies under the threshold during sleep, and those from the seat of the summit above the visual wave during waking, are into the sphere of the senses, of which the former can already take place on approaching sleep. This explains why the latter involuntarily play into waking life with fantastic dream-like images, even if they are not yet dreams, while these are determined by volition and association according to the laws of waking.

References

1. (Translator) Fechner did not discuss eidetic imagery that later emerged as a construct in German psychology in the 1920s and 30s.
2. For example, when I think of cut eggs on spinach, where the white, yellow and green stand out very sharply against each other.
3. The following remark: "In my dreams, I believe that the auditory perceptions are more vivid than the colors. I cannot remember having olfactory dreams. I certainly never have dreams of taste. I eat in dreams not at all rarely, but always without taste sensation."
4. I neglected to ask whether this is still the case when he intentionally imagines the object of memory as fixed during the movements of the eyes or the head.
5. (Transl.) the meaning of this term 'lelzle' is uncertain. It may be a typographical error.
6. In his article *Seele in Wagner's Wörter!* p. 469.
7. According to the short information in s. *Article Seele in Wagner's Wort.*
8. (Transl.) Here, Fechner is anticipating research by Erich Jaensch in the 1920s.
9. *On Fantastic Ges.* E. p. 35.
10. (Transl.) *Hypnagogic imagery* named by M Alfred Maury in 1848.
11. With the exception of what I added earlier, after later observations, about the success of the eye-blink.
12. *Amtl. Bericht über die 34. Versamml. der deutschen Naturforscher in Karlsruhe.* S. 225.
13. Rute tells me, for example, that the phantoms of the sensory

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- memory, after previous observations, often occurred to him to the point of becoming annoying, especially in the evening in bed.
14. Casper's Wochen
 15. For more examples in this respect, see my *Centralbl. f. Naturwiss. Naturwiss.* 1853. S. 777. 780.
 16. (Transl.) A spinning disc used for amusement.
 17. *Pogg.* LXXX. 287.
 18. *Pogg.* XCIX. 540.
 19. Hibbert, *Andeutungen zur Theorie der Geistererscheinungen*, a.d. Engl. Weimar 1825. 2) J. Müller, on the fantastic apparitions of the face. Coblenz 1826. - 3) Hagen, on sensory illusions. 1837. - 4) Griesinger, the pathology and therapy of mental diseases. Stuttg. 1845. - 5) Moreau, *du Hachisch et de l'aliénation mentale*. Paris 1845. - 6) Michéa, *du delire des sensations*. Paris 1846. - 7) Szafkowsky, *Recherches sur les Hallucinations*. Montpellier 1849. 8) Briere de Boismont, *des Hallucinations*. Paris 1852. - 9) Leubuscher, *über die Entstehung der Sinnestäuschungen*. Berlin 1852.
 20. They are described in more detail by Nasse in *s. Zeitschr. f. Anthropol.* 1825. 3, p. 166 ff., and essentially in agreement with it by J. Müller in his paper "Ueber die phantastischen Gesichtsercheinungen" 1826, p. 20 ff.; as far as I remember also in some treatises by Maury and by Baillarger in the *Ann. möd. psychol.* the place of which I can no longer give, and undoubtedly several other times.
 21. *Fror. Not.* XXXVII. 137.
 22. Briere de Boismont p. 61 3.
 23. Bonnet, *essay analytique sur Tarne*. Chap. 23. p. 426; Hagen's *Sinnestäusch.* S. 47.
 24. Leuret, *fragments de la folie*. p. 203.
 25. Hibbert S. 2 85 51; 2
 26. Schmidt's *Jahrb.* 1849. S. 77.
 27. The statement by Robitsch p. 480 is not entirely correct, but concerns less decisive phenomena.
 28. *London med. gaz.* 4 843 March.
 29. Among the richer compilations is that of Burdach in *s. Physiology*, III. p. 460 ff.; and probably there is also much to be found on this subject in the following detailed work, which, however, I do not know from my own view: Lemoine, *du sommeil au point de vue physiologique et psychologique*. 1855. bailliere. 410 pag.

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