

IS 'BLACK' A SENSATION ?

By JAMES WARD.

The majority of experts answer in the affirmative, but the plain man, when the question is understood, in the negative.

The latter position briefly stated : darkness and blackness distinguished as negative sensation and positive perception.

Examination of the reasons advanced for the former position :—

There is no exact parallel between darkness and stillness ; but only because blackness has become a 'secondary quality' of objects. The 'dark-field' only extended when interpreted as visually empty space. Helmholtz on the whole favours the negative character of black.

Theories to explain black on the assumption of its positive character :—

Hering's theory starts from the facts of 'contrast,' but these not incompatible with the negative character of black ; implies a 'blinding black' ; inconsistencies in his treatment of achromatic and chromatic antagonism ; his medium grey at variance with the facts of visual adaptation ; cannot be identified with the darkness of the adapted eye as his theory requires ; the assimilative process said to underlie black not proven.

Wundt's eclectic expositions : black as the limit of an intensive series ; black as positive and the qualitative opposite of white, first constant in intensity and then variable ; black as an anabolic, inhibitory process which is yet an independent one.

G. E. Müller's theory : an attempt to remedy the defects of Hering's ; accounts for the series of greys by variations in an endogenous 'medium grey' which result from retinal excitations ; this assumption seemingly insufficient to meet the facts ; its physiological improbability ; its 'singularity' not really explained.

Conclusion : desirable to let the facts speak for themselves ; the older and simpler view not yet exploded. Hering has corrected Helmholtz but has not yet established his own theory : its difficulties awaken the suspicion that the assumption of the positive character of black as a sensation is false.

To this question an affirmative answer would be given as a matter of course by everybody unversed in psychological enquiries, and this answer most psychologists and physiologists nowadays seek to confirm by more or less elaborate arguments. Such unanimity seems to constitute a strong presumption of truth. But if any layman were asked whether he has any visual sensation in the dark he would equally without hesitation answer in the negative, and would explain that when he talks of seeing black he means what in psychological language would be described as perceiving a black object. After all then the plain man and the experts take opposite sides; and though the presumption would still be in favour of the latter, if there were no dissentients among them, the position of the minority, backed up as it is by common sense, may fairly claim consideration—the position, namely, that we do not see or sense ‘black’ as something positive in itself, but only perceive black things or forms. The position itself can be stated in a few sentences, but the arguments for the counter position require discussion in detail.

The primitive sensation of sight, it is assumed, consists only of the single quality we call ‘light,’ a quality which ranges in intensity from the zero of complete darkness—as an ideal limit—up to a dazzling brightness that becomes painful and blinding. The first responses to light stimulation seem to be very much on a par with our own to diffused heat or cold: some creatures seek the light and others avoid it; the worm, for example, on a sudden flash of light withdrawing into its hole, and the *Pholas* into its shell. As little as our temperature sense yields us a perception of form does the light sense, at this level, yield any. Only when the stage of visual spatial perception is reached, and some discrimination of form is possible, do black and white attain the meaning they bear for us. In ordinary language—primarily at any rate—we apply these terms only to shapes or ‘things’: to use Helmholtz’s terminology, they are ‘body-colours’¹. A coloured object can only be perceived when its colour differs from that of the surrounding visual field: so far black as a ‘secondary quality’ is on a par with other colours and for *practical* purposes would be equally entitled to the name, even if there were black objects devoid of all lustre and absolutely absorbent of light. But there is still an important difference: in a light-field many colours may be distinguished, but in a dark-field none. Though it is correct to speak of *perceiving* a black object, must we not then maintain that the object, so far as it is really black, yields us directly

¹ *Physiologische Optik*. 2^{te} Ausg. S. 322.

no *sensation*? Its so-called 'black' colour answers only to a portion of the dark field, and with this *causa deficiens* on the sensation level—to adopt an apt comparison of Meinong's—there corresponds a positive percept only because some form or other is demarcated by the rest of the visual field which does yield positive sensations. Similarly the piper is said to 'feel' the holes in his whistle when actually he only touches the solid metal in which they are pierced; or the soldier is said to hear the tattoo though he has no auditory sensation of the silence intervening between successive taps on the drum. An obvious means of differentiating between 'positive' and 'negative' sensations here suggests itself:—The order in which the first occur is immaterial, but the second, that is the absence of certain sensation, can only be experienced when preceded by their presence. We can begin either with, say, rough or smooth, bass or alto, red or blue. We cannot begin by experiencing the impalpable, the inaudible, or the invisible.

Is there then any justification for speaking of visual sensations without luminosity: must we not rather maintain that in darkness, subjectively and objectively absolute, we should not *see* black, since we should not see at all? No doubt we are prone to identify the two concepts, darkness and blackness, for what we may call their sensory content is the same—viz. the absence of visual sensation.

Even Helmholtz seems to do this, regardless of his own distinction between variations of light-intensity and body-colours. "Black is an actual sensation," he says, "*i.e.* perception of a definite state of our organ, even though it is brought about by total absence of light¹." A black state may be brought about in a photographic film by the presence of light; would Helmholtz have said that it is to this state that our organ is brought by the absence of light and that the perception of both is alike? Not only is it obviously inaccurate to speak of blackness as a state of the eye, but even the propriety of calling darkness such a state is very questionable. What it naturally occurs to everyone to ask, however, is why the resting state of the eye is said to be accompanied by a positive sensation when nothing of the kind is asserted of the like state of other sensory organs. By parity of reasoning it would seem we ought to maintain that silence is a positive sensation of sound. But *à priori* considerations, it must be allowed, are not decisive here: it is a question of fact. True, it is replied, and as a matter of fact darkness is not the concomitant of a resting state of the visual apparatus, and

¹ *Physiologische Optik*. 2^{te} Ausg. S. 324.

thus there is no parallel between darkness and stillness. Leaving physiological questions aside for the present, let us see what are the psychological grounds for denying this parallelism.

"It seems to overlook a very essential point," says Professor Stumpf. "There remains the great difference, that the ear in the absence of external stimulation at all events approximates to the limit of not hearing, while in the analogous case of the eye, the like by no means happens.... We see *nothing*, *i.e.* no external objects—that is clear, but we are far from admitting that we do *not* see in the sense in which we admit this as regards our back or our feet. We are just as distinctly conscious of a sight sensation as we are when the eyes are open, but of sensations of hearing, when it is still, we are in the first instance not conscious at all. The retinal black cannot be described as an extremely feeble sensation; and there is no need, as in the case of the faintest sounds, for highly strung attention in order to perceive it at all. The deepening of black makes the sensation rather stronger than weaker, whereas in the transition to deeper silence, the intensity of the sensation decreases¹." It is certain that in the dark we should not admit that we cannot see in the sense in which we admit this as regards our hands and feet. The fact that we are directly aware whether our eyes are in the dark or not establishes this difference, but is no proof that darkness is as distinctly as light a positive sensation. *Mutatis mutandis*, the same may be said of hearing. When there is nothing to hear we do not say that we do *not* hear in the sense in which we say this of hands and feet. The difference between privative terms and negatives is surely obvious. Certainly 'retinal black,' *if it is a sensation at all*, cannot be described as a feeble one. The interest and the constancy of visual sensations throughout waking life naturally make their cessation impressive and it must be admitted that the cessation of sounds is not often equally striking². But whether it is true that it is harder to convince oneself that a particular darkness is absolute than that a particular silence is so, is surely an open question, and perhaps not an important one. At any rate when we make the attempt what we are intent upon in the one case is light and in the other sound; and if these are not completely absent both alike become fainter as we approach the limit, while the

¹ *Tonpsychologie*, I. S. 381.

² Yet there are some cases in which it is, and then everybody speaks of the cessation as audible. It is this perception of silence that wakes the miller when his wheel stops and the clerk when the sermon is ended. Cf. McDougall, "Young's Theory of Light- and Colour-Vision," *Mind*, N.S. x. p. 96.

deepening, whether of darkness or silence, *if these are sensations at all*, yields a stronger rather than a weaker sensation. We cannot fairly parallel the diminishing sounds in the one case and the increasing darkness in the other. But it is doubtless true—and this perhaps is the point underlying Professor Stumpf's reasoning—that black has an objective significance to which silence furnishes no analogue: hence we have no special term for objects that emit no sound and indeed no experience of such. It is only too easy to confound this positive significance for perception with positive reality for sensation, as ordinary thought and language invariably do; and it is difficult to avoid the suspicion that even psychologists of Professor Stumpf's eminence¹ have been misled by this confusion into begging the question they mean to prove.

We seem to have only an instance of this confusion in the following further statement of Helmholtz:—"We are very well aware when the eyes are closed that the black field of sight has a boundary; we by no means allow that it extends away behind our back²." But when, as here, we are dealing exclusively with sensations, we have no right to talk either of a 'field' or a boundary. Such terms imply spatial perception. A sensation may have more or less extensity but this finite quantity is not the same as bounded space. The extensity of a sensation, like its intensity, is intrinsically limited, not extrinsically, that is to say it is not bounded: a mere sensation of a certain extensity does not 'march' with another of like or different modality. What we are immediately aware of, when we close the eyes on a pitch-dark night is not absolute black, since the internal retinal light is still present; and so long as we attend to this and its continual changes so long we are aware of positive sensations and a certain extensity. But to disregard this, as we commonly do in speaking of such a state as 'total darkness,' and yet to ask where this darkness is localised and what it includes or excludes, seems unmeaning. Still at least it must have some extensity,

¹ An equally eminent physiologist—Professor v. Kries, *so far as he shares the common opinion*—seems to lay himself open to a like suspicion. "Unbiased introspection will never allow black to count as a lower degree of intensity of the sensation of white," he says in one place; but in another, "The unbiased will always be inclined here also [when the eyes are closed] to speak of a cessation of seeing, as absence of sensation (*Nicht-empfinden*)."² Both statements are true: to the unbiased mind, black is positive, *i.e.* for perception, and darkness negative, *i.e.* for sensation; but the unbiased mind would prefer to say not that black is a lower degree of the sensation of white, but that dark is a lower degree of the sensation of light. Cf. Nagel's *Handbuch der Physiologie*, III. pp. 136, 273.

² *Op. cit.* S. 324.

it may be said. Certainly, provided it have some quality and intensity, but this is the first question. But in truth extension and not mere extensity was what Helmholtz meant; the word he uses is 'sensation of black,' the fact he describes is the perception of a black 'field.' And everyone must allow that when we have advanced to this perceptual level we can discriminate the form of a black object on a white ground as well as that of a white object on a black one; and if, when the white object fills the whole field, this is still regarded as extended, why, it may be urged, should not the same hold of the dark field? But even so, if no positive sensation pertains to a black object, why should any be assigned to the black-field? What more have we than a percept of visually empty space? It seems useless then to attempt to find an answer to our question by appealing to perception¹. A reference to the definition of field of sight which Helmholtz gives in the section devoted to perception (pp. 673 ff.) is conclusive evidence of its perceptual character. In this section too there is a later passage, which, if it stood alone, would be entirely satisfactory:—"The sensation of darkness is the sensation of the resting state,—or if it be preferred—is the absence of sensation in parts of our nervous apparatus for vision, which would be excited if a stimulus were applied to them. To it there corresponds in perception the idea (*Vorstellung*) of parts of space in front of us, that send out no light to our eye; which therefore implies a definite, though also negative, predication concerning the objective state of this portion of space," p. 717. Equally explicit is the following passage—*à propos* of Hering—added to the second edition:—"This perception that a sensation [of light] that might be present, at the moment is not, involves after all a predication concerning the existing state of the organ...and *in this sense* we designate that state too a sensation, viz. one of darkness," p. 379. On the whole Helmholtz may fairly be counted on the side of the minority.

Professor Hering is the chief champion of black as a positive sensation, and he at least is clear of the confusions just referred to between sensation and perception. For him the body-colour black

¹ Moreover, the parallel supposed is by no means exact. The dark-field is presumably coextensive physiologically with the retina—is bounded, that is to say, by the *ora serrata*—whereas the light-field falls within this. To this physiological difference there is an answering psychological difference. What we may call the spatially developed portion of the light-field, to which alone the term 'field' is appropriate—more particularly that portion the projection of which is ascertained by means of the perimeter—has a positive, though not sharply defined, boundary in the sensational fringe into which it rapidly merges. This boundary is lacking to the dark-field as such.

is a positive sensation because in his opinion the facts of light-induction and contrast compel us to regard darkness as one. The so-called sensation of the deepest black he has shown to be possible only under the influence of light. White and black are then, he argues, on a par: in so far as the retina must be partially illuminated if the deepest black is to be seen (*empfunden*). The only difference is that in the case of black the influence of the light is indirect—a most important difference surely. In the dark, that is to say in the absence of all external stimulation, there is always present more or less internal stimulation—the so-called intrinsic light of the retina (*Eigenlicht*). Let us suppose we succeed in finding a dark grey to match this: a strip of such grey on a white ground yields a sensation that is darker still. In place of the psychological effect of contrast to which Helmholtz alone appealed in explanation of this fact, Hering lays stress on the ‘negative induction’ of the white ground as a purely physiological effect: the strip does not merely seem darker by contrast but the sensation actually is ‘darker’ in itself. But Hering does not expressly deny the presence of psychological contrast as one factor in the result: at any rate this is unquestionable. The simplest statement we can make of the psychological effect of the ‘negative’ and seemingly inhibitory neural process, and the statement most in accord with the facts of sensation generally, is to say that this effect too is negative: the sensation is reduced still further towards the zero of absolute darkness and the contrast so much the more enhanced. The fact that part of this total effect is due to the indirect physiological influence of the light stimulus simultaneously present is, so far as psychological description is concerned, wholly irrelevant. Leaving physiological differences aside, we can at least clearly imagine a parallel in the case of sound, which would hold good psychologically at all events. Suppose we hear a loud sound of constant intensity and quality and simultaneously a much fainter one of different quality. Let the intensity of the latter steadily diminish and the contrast in intensity between the two sounds will steadily increase; and there is *à priori* no reason why we should not attribute this growing contrast to the increasing stillness of the waning sound. That there are empirical reasons why we do not is undeniable; but these reasons are more physical than psychological. Muteness or ‘insonance’—to coin a word—is not a secondary quality of objects as blackness is, nor do auditory sensations develop spatial perception as visual sensations do. But it is not difficult to imagine modifications in the two senses—and perhaps in the environment—which would bring about an exchange of rôle, and

then it would be natural to regard blackness as negative and muteness as positive. Whereas seeing is preeminently the space sense, so hearing is above all the time sense, and here accordingly silence does assume a rôle analogous to that of darkness in the case of space. So we find Preyer saying: "Just as black is a sensation indispensable to painting so are pauses indispensable sensations for music¹"; and Mach, followed by v. Ehrenfels, paralleling time-shapes with space-shapes².

But Hering, who starts by considering not the simple fact of darkness itself but the more complex fact of its contrast with white, is led to regard it not as a decrease in, or the zero of, luminosity, but as a positive intensity increasing towards the maximum which he calls pure black, and as thus completely on a par in respect of reality with its contrary, pure white. Even if this were true, it is very questionable whether the fact of psychological contrast would be any proof of it—and of contrasts other than psychological we have no right to speak. In physiology and physics the appropriate term, and also the usual one, is not contrast, but opposition or antagonism: both of which, of course, imply two real processes. But contrast is possible when only one member of the relation is positive and answers to an existing stimulus, the other being its zero and answering to none. The change in consciousness is equally impressive and positive—as a change—whichever way it occurs. A blind man is unaffected by the sudden alternation of light and darkness: to experience darkness we must experience light too. But how does this prove that darkness is a sensation of equal intensity but opposite quality to light³? Yet this is Hering's view. The difficulties it entails are many and great.

In the first place, as Fechner and Fick have urged, if black and white, darkness and light, are alike positively intense, why are they not equally exciting and exhausting? A patient with sensitive eyes, to whom a faint light is painful, might only make bad worse—momentarily at any rate—by shutting out the light altogether. Light admits of indefinite increase, but who will maintain the like of darkness: who ever heard of a blinding black⁴?

¹ *Ueber die Grenzen der Tonwahrnehmung*, 1876, S. 67.

² Mach, *Die Analyse der Empfindungen*, 1^{te} Aus. 1886, S. 104; v. Ehrenfels, "Ueber Gestaltqualitäten," *Vierteljahrschr. f. wissenschaft. Phil.* 1890, S. 263.

³ It does not follow, as Professor G. E. Müller seems to argue (*Zeitschr. f. Psych. u. s. w.* xiv. S. 25 f.), that because in the case of colour-contrast diverse qualities are involved, therefore they must enter also into brightness-contrasts, and mere difference will not suffice.

⁴ It is true that Hering substitutes *Deutlichkeit* for *Intensität*, but this—as Fechner

Secondly, if black and white are in all respects antagonistic, then they ought entirely to neutralise each other when combined in a certain proportion—as is the case with complementary, or rather, antagonistic colours, as Hering prefers to call them. In place of this, however—though there are no red-greens or yellow-blues—there is a continuous scale of black-whites, and therefore a neutral or medium black-white (or grey), in which the two colours concur to an equal extent. This difference Hering attempts to explain by the hypothesis that red and yellow light act anabolically, green and blue katabolically, in producing the corresponding sensations; whereas all light is katabolic as regards white. If this were not the case, if mixed sunlight acted anabolically—producing black, as green light produces green—and if this anabolic action were as intense as the katabolic which yields white, “then,” says Hering, “we should not see such sunlight at all¹.” But at all events, however produced, this assimilative process yielding black, according to his theory, actually exists, and in the medium grey it *is* present to the same extent as the dissimilative process which yields white. Why, then, is there any sensation in that case, when in the parallel case of two antagonistic colours there is none at all²? This serious inconsistency, which every critic of Hering’s theory has emphasized, would be wholly removed by the recognition of the merely negative character of black. But there is another difference between the supposed antagonism of black and white on the one hand, and that of antagonistic colours on the other. Blue and yellow, though antagonistic, are otherwise so far independent that the intensity or the saturation of the one may diminish without that of the other increasing, or *vice versâ*. Whereas more white involves *ipso facto* less black, and *vice versâ*; and of saturation in connexion with them we have no occasion to speak at all. This seems to show not only that both belong to one and the same process, but to suggest the purely negative character of one of the two; if so, there can hardly be much question that black is the one.

Thirdly, since there are not two intensities of the same grey, Hering

notes—is only an abuse of terms. If anyone chooses to say that the twilight glimmer differs from the noonday glare merely in being less *distinctly* light, we can only protest. The graphical and numerical exposition of his position which Hering gives (*Zur Lehre vom Lichtsinne*, § 22) shows clearly that he is dealing with what everybody else calls intensity.

¹ *Zur Lehre vom Lichtsinne*, S. 122.

² The subsidiary hypothesis of ‘specific luminosities’ which Hering afterwards advanced, even if verified, would not obviate the difficulty in question.

assumes that what we call its intensity is determined entirely by the relative, not by the absolute, amounts of its black and white constituents¹. Such thoroughgoing relativity, without a parallel elsewhere, leads to extraordinary consequences when we come to consider the facts of visual adaptation, as Professor G. E. Müller has already pointed out². The pitch-blackness we experience on first entering a cave disappears at length as the eyes accommodate themselves; we then perceive 'the intrinsic light of the retina,' which is only a deep grey; on returning to the daylight in like manner the dazzling glare is after a time exchanged for distinct vision as the eyes re-adapt themselves to the increased stimulation. In both cases, then, a stationary state is eventually reached, in which, to use Hering's language, "a complete balance between assimilation and dissimulation is attained"; in both cases, that is to say, the ratio of black and white is the same; and therefore the sensations ought to be identical. The wide difference that in fact obtains between them, though a refutation of Hering's 'psycho-physical principle,' shows indeed that there are not two intensities of a given grey, regarded as a combination of black and white, as there may be two intensities of a given clang. But it also shows that the assimilative process, which has the same ratio to the dissimilative in both cases, cannot be the 'cause' of a positive sensation of black; for, if it were, there would be *two* intensities of the same grey.

Fourthly, the meaning which Hering assigns to 'medium grey' is very different from the ordinary one. The plain man would tell us that he knows nothing of a fixed medium grey at all, since he knows nothing of a fixed, absolute black or white. But, given a certain illumination, he would probably understand 'medium grey' to mean the body-colour that appeared equidistant between the two taken as the respective standards of black and white. For Hering, on the contrary, medium grey is not a body-colour at all, but what we see "on awaking during the night in a pitch-dark room." The 'intrinsic light of the retina' that then obtains "must, according to my theory," he tells us, "be the medium grey, for the assimilative and dissimilative processes being then approximately equal, the sensation must be about equally distant from those of absolute black and white³." That facts *seem* to contradict his theory he candidly allows. But why is the contradiction only apparent? Not because it is not really the fact that the darkness

¹ *Op. cit.* S. 55 f.

² *Zeitschr. f. Psych. u. s. w.* XIV. S. 65.

³ *Op. cit.* S. 88 f.

of the adapted eye is nearer to the intensest black we can experience than it is to sunlight, but solely because *if* there were actually light rays working assimilatively on the retina with the same intensity as that of the rays which work dissimilatively "we should necessarily have a sensation of black, which in depth or intensity would exceed quite extraordinarily the deepest velvet black actually experienced and be altogether blinding." Yes, *if*; but, as Hering naïvely adds, "there are no such rays...and according to my theory there cannot be¹." The 'intrinsic light of the retina' is then a medium grey only in the sense of lying midway between absolute white and a "merely conceivable" absolute black, of which we neither have, nor can have any experience.

Finally, it may be doubted whether it is even physiologically conceivable that an anabolic or constructive process should ever attain the intensity possible to a katabolic or destructive one. Moreover, not only is it *à priori* very questionable on biological grounds² whether anabolical processes ever entail *specific* sensations at all; but, further, there is no clear evidence that in fact they do³. *If* black or darkness is a positive sensation there must be a corresponding neural process, that is certain; but Hering's assumption that this is to be found in the assimilative process that makes the sensation of light possible seems to be an assumption merely, and an assumption too which the negative character of darkness would render altogether needless. It is also certain that the dissimilative process must be accompanied or followed by an assimilative one; but again it is an assumption pure and simple that there must be an answering sensation, viz. black.

Since the appearance of Hering's classical contributions Wundt too has been a prominent champion of black as a positive sensation. But if anything were calculated to make an unbiassed reader sceptical, it would be the examination of Wundt's various expositions. In the earlier editions of his *Physiological Psychology* he represented the whole series—white, grey, black—as simply an intensive series, in which white passes through grey into black, "its lowest degree." In the later editions, after proceeding as before, he suddenly turns round,

¹ Cf. above the passage quoted on p. 415.

² Cf. Fick, *Sitz. Ber. d. Physik. Med. Ges. zu Würzburg*, 1900, S. 9–15; G. E. Müller, *Zeitschr. f. Psych. u. s. w.* xiv. S. 74.

³ In his theory of the temperature-sense Hering in like manner assumed two antagonistic processes: had this assumption been confirmed by recent experiments, it would have afforded some support to the corresponding theory of the light-sense, for cold is unquestionably a positive sensation.

saying: "Nevertheless, it is unquestionable that at the same time we subjectively experience (*empfinden*) black and white as qualitative opposites¹...." Their relation to bright and dark *objects* may have helped to fix the distinction, but is insufficient to account for its origin, since we also ascribe black to the dark field of sight, from which all objects are excluded². It is true that Fechner has used the term *Augenschwarz* for what, since Helmholtz, is generally called *Eigenlicht*. But the term in this sense Wundt stigmatizes as "wholly unwarranted": the black that he intends is neither "white nor coloured³," in short, it is the absolute black that, according to Hering, we never actually experience at all. But now it is surely notoriously not true that we ascribe such a black to the 'dark field,' and still less true that we do this before we come to distinguish objects as black or white. Wundt wholly ignores the important difference on which Helmholtz, and even Hering have insisted, between mere light or shade as grades of 'luminosity' and black or white as body-colours or secondary qualities of objects. It is just because of this difference that we can ascribe black to a 'bright object' and white to a 'dark' one, when—recognizing the objects—we take account of their different illumination. That Wundt is unwittingly talking the language not of sensation, but of perception, is manifest from his phrase, "*ascribe* black to the dark-field." Turning, however, to his description of this sensation in detail, we come upon fresh difficulties.

First, we have an intensive series, ranging between 'absolute black' and 'absolute white,' though, since black is always present, there is really no absolute white. The intensity here diminishes with the intensity of the light-stimulus till we reach a threshold which is called "the darkest white" (*das dunkelste Weiss*)⁴, while the final limit of the series is called "the darkest black" (*das dunkelste Schwarz*)⁵. What we wonder is the relation between these two, and which of them corresponds to "the lowest intensity of white"? If there are *sensible* degrees of black, wherein can their difference lie? If it be in the amount of white

¹ Yet he had himself seriously questioned, and even rejected this view in an earlier work. Cf. "Die Empfindung des Lichts und der Farben," *Phil. Stud.* iv. S. 360 f.

² *Grundzüge der physiologischen Psychologie*, 4th Ausg. i. S. 504; 5th Ausg. ii. S. 162, slightly altered.

³ And yet it is always present when a white or coloured impression is sufficiently diminished, is, in fact, the "lowest intensity-grade of white," *loc. cit.*

⁴ *Op. cit.* 4th Ausg. i. S. 503. This term is omitted in the last edition, though the thing is still implied.

⁵ *Op. cit.* 4th Ausg. i. S. 558; 5th Ausg. ii. S. 245.

present, and this on the whole we must suppose so long as the light-stimulus can be further diminished, then the threshold reached was not the darkest—why not say the blackest?—white. In that case the blackest white must itself be black, the zero limit of the series, as Wundt himself has said; and then it only escapes becoming a contradiction by being the nonentity which zero implies. But the series is also a qualitative series, Wundt now maintains, and so regarded, black—in spite of its being the lowest (or zero) degree of white—is a positive sensation, in quality the opposite of white. To say nothing further of the anomaly of a sensation that has a positive quality, but no intensity, it is enough to observe that from the mere fact, if fact it be, that the series is a qualitative one it does not follow that both extremes are positive. We can imagine a series of tones, for example, rising (or falling) continuously in pitch and diminishing continuously in intensity; the limit of such a series would be silence, and this, it is allowed, is not a positive sensation. But black is equally the limit of innumerable qualitative series, beginning with red, yellow, green, etc. It can hardly be at once a positive quality and the precise opposite of them all; and if it is really the precise opposite of white, this difference would only tend to show that the white-black series is a purely intensive one, and black its limit or ‘lowest grade.’

Nevertheless, it is, Wundt maintains, an “indubitable fact” that the series is also one of qualitative differences. Let us turn, then, to his account of this second aspect of the series and see how it squares with the first. In place of beginning with white as a positive quality, diminishing in intensity as the light diminishes till black is reached when all light is gone, he now begins with black as a positive quality, with which, as such, the presence or absence of light has nothing at all to do. Its physiological counterpart is taken to be “a permanent internal excitation (*innere Dauererregung*) of the retina, which accompanies and outlasts all other excitations”: hence all our sensations of light and colour are mixed with absolute black. At first Wundt regarded the intensity of this black as constant, attributing all the variations of intensity in the black-white “mixture-system,” (*Misch-system*) as he calls it, to varying external light-stimulations: there were “no independent degrees of intensity in black.” On this hypothesis the intensive and the qualitative aspects would become identical—in other words, the qualitative aspect would become an intensive aspect simply—*provided the constancy of absolute black were the constancy of zero*. And a very little reflexion will lead most people to

suspect that an excitation of the retina that is always present, always constant, and "involves no exhaustion" is an *Unding* that can only be equated to zero¹. At any rate, Wundt himself seems to have come at length to this conclusion, for he now—*more suo*—silently drops his first hypothesis, without considering it necessary to refute the arguments he had previously advanced in its favour². But according to his latest view the intensity of the black complement in his *Mischsystem* varies as well as that of the white³. But now he ought no longer to refer the gradations of the system exclusively to variations in the intensity of the external excitations caused by light, as he none the less continues to do. In fact, there is no longer any warrant for speaking of the series as a continuously graduated intensive series at all. For aught that appears to the contrary, the intensity of the 'system' may now be uniform, the intensity of one component increasing as that of the other diminishes, as Hering indeed assumes. One cannot run with the hare and keep with the hounds: Wundt, having at length parted from Helmholtz and sided with Hering, must perforce accept the consequences. For example, there cannot be two intensities of the same grey, Wundt says—as we all say—and this is obvious so long as the intensity of a given grey is regarded as determined exclusively by the intensity of the external excitation. But if we elect to regard the black due to internal excitation as also a factor and an independent one, then we can only maintain that there cannot be two intensities of the same grey, if, as Hering does, we are consistent enough to maintain also that the character of the grey depends only on the ratio, not on the absolute amount, of the two factors. Is Wundt prepared for this?

Matters are not mended when we find that Wundt, like Hering, attributes the internal excitation on which black depends to an anabolic process, and regards this as inhibitory in its action⁴. But, so far as it is inhibitory, the process cannot be a permanent and independent one, as Wundt assumes: it must presuppose the external excitation, on which the sensation of white depends. And it must neutralise this more or less completely⁵; in a word, its action must be negative, and equally

¹ The sensation corresponding to absolute black will then be "the null-point" of the whole series, and as such Wundt in the very same context actually describes it.

² Cf. *Phil. Studien*, iv. S. 365–367.

³ *Psychologie*, 5^{te} Ausg. II. S. 163.

⁴ *Op. cit.* 5^{te} Ausg. II. S. 242, 248.

⁵ As already said, Wundt in his article (*Phil. Studien*, iv. S. 360 ff.) controverts Hering's view concerning the primitive antagonism of black and white as sensations;

so the sensation it is supposed to induce. But why a fundamental, vital process should yield specific sensations, to say nothing of doing this only in the case of a single sense, Wundt, as little as Hering, attempts to explain.

In his remarkable articles *Zur Psychophysik der Gesichtsempfindungen*¹ Professor G. E. Müller exposes and endeavours to remedy the defects of the Hering theory. But he is so completely in accord with Hering on the question now before us that he never for a moment pauses to substantiate the claim of black to the character of a positive sensation. The "altogether peculiar phenomenon," as Wundt allows it to be, that black and white form not merely an intensive but also a qualitative series is for him too 'an indubitable fact'; so much so that in spite of its peculiarity and its difficulties, it is one he finds it needless scrupulously to verify. And yet he escapes these difficulties as little as his predecessors, although his main concern is "to modify the theory of antagonistic colours so as to explain the quantitative singularity of the black-white sensations without the help of Hering's unwarrantable [psychophysical] principle²"—to explain that is to say the existence of a graduated series of black-whites (greys), though there is no corresponding series of red-greens or yellow-blues, without the assumption that one and the same grey may result from different intensities of black and white, provided their ratio is the same.

For Hering's antagonism of anabolic and katabolic processes Professor Müller substitutes the more rigorous antagonism of reversible chemical or molecular actions; and whereas Hering leaves it doubtful how far his antagonistic processes are peripheral or central, Müller distinctly assumes that his own reversible actions take place both in the retina and in the central 'visual substance.' But he distinguishes carefully between the processes occurring in the retina proper and in his subcortical or cortical retina—as we may fairly call it—on the one hand and the nervous processes by which they are connected on the other. Further he supposes that during the resting or neutral state all three antagonistic processes (white-black, red-green, yellow-blue) presumably occur, alike in the retina and in the central visual substance, as a consequence of the molecular 'collisions' due to incessant thermal disturbances; the several antagonistic pairs being very approximately

and to the last charges him with inconsistency in maintaining this antagonism of black and white, while yet regarding grey as a compound of the two. But now we have Wundt himself asserting both!

¹ *Zeitschr. f. Psych. u. s. w.* 1896-7, Bde. x. and xiv.

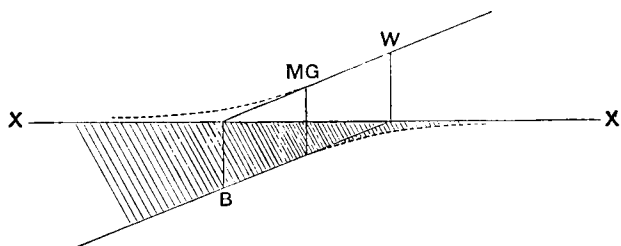
² *Op. cit.* xiv. S. 62.

in equilibrium and of constant intensity, since the temperature is practically uniform. When the balance between two reversible or antagonistic reactions in the retina is disturbed, only the intenser of the two produces a nervous excitation; when both are equal therefore the retinal process does not affect the corresponding central process at all¹. In the case of black and white then, when a nervous excitation occurs it is one which would of itself give rise either to a sensation of white or to a sensation of black, but not to a mixed sensation of grey. Thus, if these centripetal excitations were all, we should experience pure black and pure white varying in intensity, as hot and cold, for example, do; but we should know nothing of a graduated series of greys. But on Müller's theory, as we have just seen, they are not all; in the central visual substance during its resting phase the black and white reactions still occur, though they balance each other. Here, however, these reactions are not merely physical processes as in the case of the retina, but psychophysical; in other words, the reactions are *ipso facto* excitations, 'endogenous excitations,' as Müller calls them. Hence the so-called, and in fact if the theory be sound the mis-called, 'self-light' of the retina or *Augengrau*. So Müller works his way to what, like Hering, he regards as the medium-grey; but it is a centrally, not a peripherally, excited sensation. And now, when say the retinal W (white)-process predominates the excitation consequent upon it, on reaching the central visual substance, increases the W-process and excitation and diminishes the B (black)-process and excitation that are there taking place: so, *mutatis mutandis*, when the retinal B-process predominates. Thus the existence of a graduated series of black-whites (or greys) is supposed to be explained.

But not only are the assumptions underlying this explanation questionable; there is also at any rate one difficulty inherent in the explanation itself. The series of greys obtained we may represent by means of the following figure, in which perpendiculars above *XX'* stand for white intensities and perpendiculars below for black, *MG* being the medium grey of the visual centre when free from peripheral excitations. So long as the components of this grey last, a series of continuously increasing white excitations will yield a corresponding series of light greys and a similar series of black excitations a series of dark greys, the limit of the one series being pure white, that of the other pure black. But it is reasonable to assume that the intensities of both

¹ *Op. cit.* xiv. S. 21, 25.

components of MG are small—and Müller himself speaks of them as “possessing a minimal value ($W_0 + B_0$)¹,” and so it is highly probable that excitations from the retina may arrive which will practically more than exhaust one or other of them—in fact if photometric estimates of the intensity of the ‘subjective grey’ are any evidence, this would certainly happen. In that case we should have beyond the series of



greys an indefinite series of pure whites of varying intensity on the one side and a corresponding series of pure blacks on the other, as indicated in the figure. But this would conflict with the other position, viz. that the black-white series is wholly a qualitative series or ‘*Mischsystem*,’ which Müller in common with Hering and Wundt strenuously maintains. Indeed he calls the series in distinction from the series of tones “essentially limited (*prinzipiell begrenzt*), because we cannot conceive the change consisting in the sensation becoming blacker or whiter prolonged beyond pure black and pure white²,” i.e. beyond the lines B and W , where the white and black components respectively vanish. Not only are these limits for Müller essentially impassable, but like the rest of us, he seems inclined to question whether they are ever even attained, whether, that is, we ever experience pure white or black at all³. For those who regard the white series as purely intensive there is no difficulty in this: it simply means that we have no experience of either the zero or the maximum of the series. But for Müller the difficulty is serious, assuming, as he does, that excitations having a considerable range of intensity but answering only to pure white reactions or pure black reactions are sent up from the retina and, on arriving at the visual centre, are only prevented from becoming sensations of pure white or black by admixture with the endogenous black or white—described as ‘minimal’ to start with—which diminishes steadily in intensity as their intensity increases. To represent this

¹ *Op. cit.* xiv. S. 35.

² *Op. cit.* x. S. 34.

³ *Op. cit.* x. S. 34, xiv. S. 35 n.

diminution as asymptotic (shown by dotted lines in the figure) will not practically mend matters; for when in the fraction $\frac{w}{w+s}$ s is very small compared with w , the value of the fraction is indistinguishable from 1. In short it would seem that Müller's theory only avoids the difficulties familiar in Hering's by failing to account for the series of greys as we know them.

But there is another difficulty, and perhaps a more fundamental one. Granting that 'endogenous' W- and B-reactions and -excitations take place, why should they—nay, how can they, blend to form grey? A 'mixed sensation' is either psychologically meaningless or it answers to what is really a sensation-complex, such as a clang for example; and the sole evidence for its complexity is the possibility of 'psychical analysis.' But grey is not in this sense a mixed sensation, it is not psychically analysable into black and white. All this Professor Müller admits¹. All the mixture there is then is a mixture of excitations and it is solely in this psychophysical sense that Müller uses the term 'mixed sensation.' But how can equal antagonistic excitations combine to produce a positive result instead of neutralising each other? If they cannot coexist in the same nerve fibre, why should they in the same neuron? Müller himself—*à propos* of binocular colour-mixture—seems to admit this difficulty. "The occurrence of a yellow-blue sensation," he says, "is entirely excluded; for that would presuppose that excitations due to antagonistic forces... could be transmitted together into one and the same beat (*Bezirk*) of the nervous system²." But if they cannot be transmitted there how can they originate there? The reactions are reversible chemical or physical processes taking place to an equal extent in consequence of irregular heat-encounters throughout a substance free from external disturbance: that is to say we have a case of dynamic equilibrium, and no external work is done. If we imagine a Maxwellian demon ubiquitous throughout the substance, to him the reactions might still furnish excitations, but each excitation would be a distinct event: there would be no reason for two antagonistic ones to blend. And apparently it is something of this sort that Müller does imagine, for—after describing the neutral state of the visual substance as one in which there is no change of energy—he adds, "but in which from the molecular mechanical standpoint many things happen that for psychophysics are by no

¹ *Op. cit.* x. S. 14.

² *Op. cit.* xiv. S. 40.

means without significance: on the contrary they form the basis of the sensation of subjective grey (*Augengrau*).¹

But the qualitative 'singularity' of the black-white series is more fundamental than its quantitative and involves hardly less difficulty. Why are there not also central blends of blue and yellow, red and green? "Of course," Professor Müller remarks, "what has been said [of the grey series] is by no means meant to exclude the supposition that the endogenous excitations of the visual substance in principle [*im Grunde*] consist not only of black and white but also of four chromatic excitations as well²." But he insists that in point of fact there is, normally at all events, no evidence of the existence of these last. For the moment, however, we are not concerned with facts but with Müller's theory. The existence of the black and white endogenous excitations is hardly yet to be enrolled as a fact, and meanwhile the theory that suggests it must be consistent. Müller assumes that the 'strong preponderance' of the endogenous grey is such as to deprive the chromatic blends of any appreciable effect. Some preponderance there is good ground for assuming in view of the preponderance of white in our visual experience generally; but that experience hardly suggests a preponderance that amounts to total suppression. In fact we seem forced to choose one of two evils: either the endogenous grey holds the field by reason of its great absolute intensity or it is so near the threshold that the red-greens and the blue-yellows are below it. In the first case the saturation of our colour-sensations would be affected, and in the second, as already urged, a complete series of greys would hardly be possible. If endogenous excitations occur, as they very well may, there is no reason to suppose that they differ essentially from the internal excitations to which in their absence the retina would give rise. Nor is there at present any sure means of separating the two. After long sojourn in the dark what we are aware of is best described as a fine and faint galaxy twinkling in many colours. Müller seems to regard his endogenous excitation as a uniform background of medium grey for all this 'light-dust' or 'light-chaos,' as it is sometimes called. Wundt's contention that this background is not grey but black seems nearer the truth, for when, as occasionally happens, one discerns starless patches in this 'dark-field' they seem comparable to the blackness produced by 'contrast' in Hering's experiments. The simplest explanation of both, it may be urged, is the temporary

¹ *Op. cit.* xiv. S. 64, *init.*

² *Op. cit.* x. S. 344, *fin.*

cessation or inhibition of the intrinsic light¹: all which makes against Müller's endogenous grey, and supports the more common-sense view of the purely negative character of black².

Surely the simplest way is to let the facts speak for themselves. Blue and yellow are complementary or antagonistic, because they do not yield a graduated series by mixture as blue and green do: black and white are not complementary or antagonistic because they do yield such a series. The series intermediate between blue and green is a qualitative series because it depends on variations in two distinct stimuli and cannot be produced by varying one alone: the series between black and white is not a qualitative series, because it can only be produced by variations of the one positive stimulus, internal or external, yielding white. Blue and green are both positive sensations, because both have assignable stimuli and can occur in any order and independently: black is not a positive sensation, because it has no assignable positive stimulus and depends solely on the cessation of light, internal and external. On the whole then we may conclude that the older and simpler view that "darkness or black is nothing but the result of the state of rest of the whole or part of the retina"—as Johannes Müller puts it³—is not yet exploded, and that, for the present at any rate, it is therefore premature to claim for the opposite view now in vogue the dignity of 'indubitable fact.' Hering's many admirable experiments show indeed the insufficiency of Helmholtz's explanations of so-called simultaneous and successive 'contrast'; but the physiological processes of induction which they reveal cannot be said to shut us up to the acceptance of the positive character of black till his theory is cleared of the grave difficulties that at present beset it. It by no means follows that because Hering has refuted the Young-Helmholtz theory he has, *ipso facto*, established his own. If black is verily a positive sensation nothing should be easier than to show this beyond cavil psychologically and physiologically. But this has never been done. To retort that "to define it as the

¹ Cf. McDougall, "Young's Theory of Light and Colour-Vision," *Mind*, N. S. x. pp. 58, 96.

² *A propos* of an experiment which he has described (xiv. S. 35) Professor Müller maintains that it is "altogether inconceivable" (S. 36 n.) how this experiment is to be explained without assuming the positive character of black. Yet Professor McDougall (*op. cit.* p. 94) seems to have done this satisfactorily, and even to have turned the tables by experiments of his own which give results incompatible with theories of a special black-process.

³ *Physiologie*, 1846, Bd. II. S. 296.

absence of all light-sensation is as useless as to define green as the absence of all red or the sphere as the absence of every other figure¹," is a palpable begging of the question, evidence not of a strong case but of a weak one. Nobody would object to defining silence as the absence of all sound till he had shown beyond question that it was something more. Nothing is commoner than to find that an intractable problem involves a false assumption—like the famous poser submitted by Charles II to the Royal Society, 'Why does a kettle of fish weigh more when the fish are dead?' disposed of by the discovery that they don't. Similarly the problem of black as a positive sensation may yet be as simply disposed of by the discovery that it isn't.

¹ *Op. cit.* S. 63.