

Thither Science may retreat and hump her strong back against the mockeries and phantasms that people the waste of Being around.

Now the essence of the Common-Sense-theory, I take it, is to negate these negations. It obstinately refuses to believe Consciousness irrelevant or unimportant to the rest. It is there for a purpose, it has a meaning. But as all meaning, relevancy and purpose are symbolised to our present intelligence in terms of action and reaction and causal efficacy, Common Sense expresses its belief in the worth of Feeling by refusing to conceive of it out of these relations. When a philosophy comes which, by new facts or conceptions, shall show how particular feelings may be destitute of causal efficacy without the genus Feeling as a whole becoming the sort of *ignis fatuus* and outcast which it seems to be to-day to so many "scientists" (loathly word!), we may hail Professors Huxley and Clifford as true prophets. Until then, I hold that we are incurring the slighter error by still regarding our conscious selves as actively combating each for his interests in the arena and not as impotently paralytic spectators of the game.

WM. JAMES.

II.—ON DISCORD.

MR. GRANT ALLEN, in his recent book on *Physiological Aesthetics*, adopted the words "maximum of stimulation with minimum of fatigue" as the general formula for the conditions of peripheral stimulation most favourable to pleasure in the case of the higher sense-organs. I wish to point out some considerations which seem to detract from the value and generality of this formula. One obvious objection may be seen at once to be the use of the subjective word "fatigue" for the expression of objective phenomena in physiology: and it is ultimately owing, as I believe, to this dangerous and misleading use that the other weak points in the formula, if such indeed they prove to be, easily escape detection.

To illustrate my first objection, we may take a case or two where the sort of ratio expressed in the formula seems familiar to us. We say, for instance, that a skilful violinist extracts from his strings the maximum of transverse with the minimum of longitudinal vibration; or that mountain-air enables us to walk a maximum number of miles with a minimum of fatigue. In either case the two terms of the ratio are clearly distinct things, which may be conceived as increasing together or decreasing together, or one of which may increase as the other decreases.

Now let us look at the word "fatigue" as used in the formula. It relates simply to physiological facts, to the molecular disturbances of stimulated organs in which wear is outrunning repair, and which are thus being brought further and further from the state they were in to start with, without a chance of recurring to that state during the continuance of the stimulation¹; a condition whose relation to the condition of stimulation *without* "fatigue" finds a rough parallel in the difference of behaviour of two bodies respectively moved from a position of unstable and of stable equilibrium. But, holding fast to this objective view of the terms employed, we see of course that the need of repair is simply dependent on the amount of disturbance or wear; that the unfatiguing and the fatiguing stimulation are not two distinct things which can be separately appraised, but are *continuous*, one being an excess of the other beyond the line where perpetual repair is possible. So that our formula seems reduced to "a maximum of getting up to the line with a minimum of going over it".

Cases where the formula is really applicable are those where several sets of nerve-fibres are concerned: for instance, we can speak of a surface covered with strips of the primary colours as inducing the maximum of stimulation with the minimum of fatigue; since here, while the eye ranges about, each colour affords a rest to the nervous elements stimulated by the other two; whereas the same surface covered by one of the colours, and stimulating a single set of elements, would cause a maximum of fatigue. Again, by improving the quality of a musical note, that is, by calling into play more nervous elements in response to the additional harmonic vibrations, we increase the general stimulation without making it anywhere excessive. But the case of single and simple phenomena, or single and simple parts of compound phenomena, is of course an entirely different thing; and here the only way in which we can get any scientific conception including the idea of "maximum of stimulation", seems to be by taking into consideration a new term—the time, namely, during which the stimulation lasts, and by substituting for "minimum of fatigue" the maximum of time during which the sensation is pleasant. Take the case of a fine musical note: if this be of only moderate strength, it can be listened to for a good many seconds with satisfaction: if, on the other hand, it be extremely loud, it may be pleasant for a moment, pleasanter perhaps to many people and in some states of the organism than the gentler note, but rapidly becomes almost unendurable. We

¹ "Stimulation" is used throughout in a physiological sense, to express the movements which constitute the response of the peripheral nervous elements to physical stimuli.

may assume then that for any given state of a particular organ a particular period of stimulation has corresponding to it a maximum intensity of stimulation, which constitutes the condition most favourable to pleasure for that period. But the two factors obviously vary inversely¹; if we increase the loudness of the note we diminish the time during which it is agreeable: and on the subjective side we have very uncertain and limited power of comparing things so heterogeneous as greater intensity and greater prolongation of pleasure; so that, if we ourselves cannot decide in what case pleasure is really most favoured, the physiological conditions most favourable to it become a somewhat indefinite object of search. Our two *maxima*, however, must clearly lie well within the points where, on the one hand, the amount of stimulation would reduce the time of possible pleasurable endurance of it to zero, and where, on the other, the length of time during which it was endurable would imply an almost inappreciable amount of it.

To return to our formula. The use of the word "fatigue" seemed to lead to difficulties; but if we relegate it to its rightful place on the subjective side, there are doubtless feelings connected with the higher sense-organs to which it seems quite fairly applicable; and it is incontestable that the physiological counterpart of these feelings is an excess of stimulation in the organs concerned. But my main objection is of a much more serious kind; since, if substantiated, it connects the lax use of the word, not with a weakness or want of clearness in definition, but with a certain amount of failure in the apprehension and discrimination of facts. It will be best to state at once the point which I wish here to discuss. We find the word "fatigue" used to express the objective counterpart not only of what is *felt as fatigue*, e.g., the too prolonged continuance of a loud note, but of what is *felt as discord*, an ultimate and wholly different sensation. The two objective phenomena agree probably in the general character of wear and tear as the two subjective sensations agree in the general character of unpleasantness: but, the natural supposition being that under this most general head the

¹ They probably vary inversely in a very complex way. For the subjective phenomena, and doubtless therefore the objective, are *gradated* as the limiting instant is approached when pleasantness vanishes; and the steps of gradation, and the proportion of the whole time which elapses before the decline sets in, probably differ according to the degree of stimulation; that is to say, with change of stimulation the part of the time during which the sensation is purely pleasant may vary differently from the whole time during which its pleasantness remains above zero. The matter lies quite beyond the reach of experiment, as the subjective facts can never be rendered sufficiently distinct and isolated for accurate examination.

two former differ from each other no less than the two latter, is it not rash to identify them under a common name, when we should never dream of so confusing their psychical counterparts? Discord is not felt the least as fatigue: if then we give the name "fatigue" to the physiological counterpart of discord, are we not likely to overlook the extreme specialty which that particular form of wear and tear (if so it be) must possess, and to rest content with a most imperfect explanation?

It is hardly necessary to remind readers of this journal that the sensation of musical tone is produced by continuous regular nervous stimulation, and that the sensation of discord is due to rapid "beats," that is, to a series of augmentations and diminutions of stimulation interposed in the regular series, and caused physically by the interferences of sound-waves of nearly equal lengths. The separate beats are as little present to consciousness in the pure sensation of discord as the separate vibrations in the pure sensation of tone: the sensation seems quite unique and beyond analysis. The manner of connecting the unpleasantness of the sensation with the theory of stimulation and fatigue is clearly shown in Chapter VIII. of Helmholtz's *Ton-Empfindungen*, which forms a convenient text for the objections I would venture to raise. He points out that a nerve is deadened by strong stimulation, and rendered less sensitive to fresh irritants: a rest, however, enables it to recover its sensibility, and the time of rest necessary in the case of the more delicate sensory organs is extremely short. Now the intermittence which beats cause in the stimulation gives the nerves an opportunity for recovery and repair during each minute period of interruption, and they thus present themselves to each fresh attack of the stimulus in a state of renewed nutrition and irritability. They are therefore subjected to a series of more violent shocks than in cases of unintermittent stimulation, and this violence, as Helmholtz holds, sufficiently explains the unpleasant sensation. He illustrates this position by the case of the eye, pointing out that by looking for even a moment at the sun the sensibility of the retina is so blunted that we see a dark spot when we turn our eyes to the sky; that on coming out of darkness into full daylight we first feel blinded, but the sensibility of our eyes is soon so far blunted that this degree of brightness is found very pleasant; and that so, "by the continuous uniform action of the irritation of light, this irritation itself blunts the sensibility of the nerve, and thus effectually protects this organ against too long and too violent excitement." Intermittent flashes of light, on the other hand, permit fresh renewals of irritability and so act with more intensity, and "everyone

knows how unpleasant and annoying is any flickering light, even if it is relatively very weak".

With respect to stimulation so violent as that caused by looking at the sun, the statement that the blunting of the nerve-sensibility acts as a natural preventive of "too violent excitement" is surely too general. For, though the power of producing the subjective impression of *light* is at once considerably blunted, it would be rash to assume that the peripheral nerve-elements concerned in that impression play no part in the sensation of increasing *discomfort*, which would result if a person's eyes were forcibly kept open and exposed for a few seconds to the direct action of the sun. But anyhow here the stage of possible comfort is instantly passed: that stage in the eye's power of adaptation lies within a certain limit of stimulation. Thus, when the retina encounters ordinary daylight after total darkness, nervous wear outruns repair (that is, on the subjective side, discomfort is felt), until the stored-up superfluity of irritability has run down, so to speak, after which wear and repair go on equally. The stages of the shifting ratio between wear and repair might be roughly illustrated by a steel spring, which will yield and then remain steady under certain weights, but which, if the pressure be excessive, will rapidly pass all the positions of steadiness and snap; the limits of normal and reparable wear, the counterpart of agreeable sensation, corresponding to the steady positions of the spring. Under direct exposure to the sun, the snapping comes, that is, the molecular disturbance far outruns all chance of recovery in an almost inappreciable time. But this would happen whether the sensibility of the retina had been previously blunted or not: let us then neglect such violent cases, which tend to confuse the subject, and confine ourselves to the limits within which regular stimulation is the counterpart of endurable and agreeable sensation, as only here can the problem of intermittence and its effects be introduced.

Now, in trying to connect the unpleasant sensation corresponding to intermittence with *intensity* of stimulation, understood in the ordinary and natural sense, we at once come across a difficulty which is not removed by the undoubted fact that the intermittence enables the nerves in some measure to renew their irritability, and which may be illustrated by the following case:—Suppose that a person with good eyesight reads a book for half an hour by a strong and agreeable light, or looks for the same time at a bright landscape, or merely sits talking in a sunshiny room. The sensibility of his eyes is not to his knowledge affected by the process; for aught he is aware of, the page or the landscape or the room looks as bright at the end of the time

as at the beginning, and the blunting of irritability must at any rate have been very small. Now suppose him to read a book or sit in a room illuminated by a much lower but still sufficient light, and let the light flicker. The discomfort will be very decided: but it seems impossible to make out that the normal kind of stimulation of the end-organs connected with sight is more *intense* here than in the former case. The stimulation has no doubt been more intense than if the light, instead of flickering, had remained steady at its highest strength: but the light in the first case we considered was very much stronger than this; and in order to make out the intensity of stimulation or molecular disturbance in that first case to be *less* than in the second, we should have to suppose a self-protection amounting to a great and continuous blunting of the power of response to stimulus; and, as this would be represented in consciousness by the reduction of the page or room to darkness long before the expiration of the half-hour, the supposition is contradicted by facts. The subjective feeling of brightness was far greater at every instant of time in the first case than in the instants of greatest brightness, when the nerve-irritability was most thoroughly renewed, in the second: and the subjective feeling of brightness is the concomitant of a high amount of stimulation. It seems illogical then to imagine greater *violence* of stimulation in the second case. The question as regards the eye is complicated by the fact, to which Helmholtz does not call attention, that much of the discomfort caused by flickering is due to the perpetual *muscular* readjustments necessitated by the variations in the strength of the light. But if we agree to neglect this element, the proposed explanation could only pass muster in a case where the light, supposing it to be steady, was as strong as the eye could comfortably stand, in which case making it flicker and so permitting renewals of nervous irritability would send the sensation over the line of discomfort: if we look at a less extreme case, we seem driven to connect the unpleasantness not with *excessive* response of the nerves to stimulus, but with a special feature of *discontinuous* response, whether referable to perpetual stoppings or perpetual startings or both. We need phrases like "violence of stimulation" or "excessive response" (which are both better than "fatigue") to express the excessive molecular disturbances which would be caused by increasing the steady light on the page or in the room till it was disagreeably dazzling: we want another expression for the exceptional order of disturbance introduced by the repeated intermitteces. It is not of course meant that the latter may not be in some way included under the general rule of wear and repair: but it is in itself a quite different species of wear from that

involved in excess of the regular and normal stimulation. A man's frame will need repair after rolling a truck along rails for three hours, and also after setting it going, letting it stop and setting it going again, and continuing this jerky labour for an equal time: but the movements in space and the work done will be very different in the two cases.

When we pass to the ear the problem becomes much simpler and more distinct, for several reasons. First, we get rid of the irrelevant element of *muscular* fatigue, caused by adjustments of the pupil to varying degrees of light. Secondly, the visual intermittences are felt *as such*, and the confused feeling of discomfort may seem fairly describable by the word "fatigue"—especially under cover of the associated muscular feelings, whereby the difference from the normal fatigue caused by excess of light is necessarily much disguised; whereas in discord the intermittences are not perceived as such, but give rise to a new sensation to which no one would dream of applying the name "fatigue". Again, confusion is avoided in the case of the ear by the organ's very limited power of self-adaptation. For the ear seems little liable to anything analogous to being first dazzled (like the eye in emerging into daylight from the dark) and then getting its sensibility blunted to the comfortable pitch which represents equilibrium between wear and repair. Deafness of course ensues from prolonged exposure to excessive sound, but this is owing to real structural injury: and in the case of musical tone,¹ at any rate, I do not think it is ever the experience of a healthy ear to find a single sound intolerably loud for a few seconds, and then to get reconciled to it; whenever it is disagreeably loud to begin with, it gets worse.

Let us now take two means of stimulation for the ear analogous to our former two cases of the strong steady light and the weaker flickering light: they will evidently be a loud single tone or concord, and a soft discord, say a very loud octave and a very soft discord of a semitone, played on a finely-toned organ. The former is of course felt as pleasant, the latter as unpleasant: and in consistency it is sought to connect the former sensation with a lesser and moderate amount, the latter with a greater and violent amount of stimulation. But the actual physical stimulus is obviously very far greater in the case of the loud concord than of the soft discord: the whole burden of the explanation must therefore be

¹ With respect to extremes of non-musical sound, opinions may vary. The getting accustomed to such an extreme, in the sense of gradually becoming able to distract attention from it, hardly implies that the acoustic sensibility has been deadened. Here again it is almost impossible to isolate the phenomena sufficiently for experiment.

thrown on the other factor of stimulation, namely the degree of irritability or molecular instability in the organs concerned. First, then, with respect to the loud concord, in order to make out the stimulation in the case of this, the *greater*, stimulus to be *less* than that caused by the soft discord, we should have to suppose the sensibility or power of response to be very greatly and rapidly deadened: but we have sufficient proof that the nerve-elements are performing their functions in a highly vivacious and persistent way in the fact of our continuing to hear and appreciate the sound for many seconds just as perfectly as we did at first. Secondly, with respect to the discord, we can take this as soft as we please; so that the relation of the perpetually repaired organs to the intermittent stimuli is not analogous to that of an eye brought from darkness into daylight, but brought from darkness into obscure twilight; and in such a case "intensity of stimulation" ought not in reason to outrun the conditions of agreeable sensation. For, looking at our two factors of stimulation, we see that it is only the amount of stimulus which can be indefinitely varied, and there is an obvious limit to the extent to which we can draw on the other factor, that of irritability dependent on nutrition. The perfection of nutrition and repair cannot be more than perfect; it cannot be carried, cannot therefore carry irritability, beyond a certain natural point; so that, however unstable be the condition of maximum irritability, we ought by diminishing the strength of the physical stimulus to be able to avoid causing wear to outrun repair. While, granting of course that the greater the irritability the less the stimulus which will suffice to cause the amount of stimulation corresponding to *unpleasantness*, we still know that the amount of stimulation which normally corresponds to *pleasantness* is a very considerable one: and we cannot postulate the perpetual renewal of such a miraculous amount of irritability as would be required to bring stimulation up to and far beyond this point even under the action of a very weak stimulus. The intermittent stimulus produces, according to Helmholtz, "a much more intense and unpleasant excitement of the organs than would be occasioned by a continuous uniform tone". More unpleasant certainly: but the assumption is that it is more unpleasant simply *by dint of* being more intense, however soft the sound, in face of the fact that more intense excitement still, caused by a much greater stimulus acting regularly on organs which are proved by the concomitant sensation to remain perfectly responsive and undeadened, is felt as pleasant. And over and above all this, if it *were* more intense in the manner imagined, it ought to be felt as *loudness*: "loudness," as Mr. Grant Allen himself remarks in one place,

"is the subjective concomitant of intensity in stimulation". And the sensation of loudness has absolutely no relation to that of discord, which retains its unique character even when barely audible.

In this connexion I may quote an illustration given by Helmholtz, which seems to me delusive. He says, "If a tuning-fork is struck and held at such a distance from the ear that its sound cannot be heard, it becomes immediately audible if the handle of the fork be revolved by the fingers. The revolution brings it alternately into positions where it can and cannot transmit sound to the ear, and this alternation of strength is immediately perceptible by the ear. . . . Just as this alternation of strength will serve to strengthen the impression of the very weakest musical tones upon the ear, we must conclude that it must also serve to make the impression of stronger tones much more penetrating and violent than they would be if their loudness were continuous." No doubt a change or movement serves often to direct attention to feelings which when uniform were too slight to be noticed: a change even to a lesser degree of stimulation might have this effect, if the attention had got deadened by the monotony of a prolonged impression. But the change here described by Helmholtz would be consciously perceived as a *change of loudness*. In just the same way, with a very much greater strength of tone, if the alternations were slow enough to be perceived as separate, they would be recognised as alternations of loud and soft sound, the loudness unless very extreme being in no way unpleasant. Now by artificial means we can introduce into a single continuous tone, that is, into a simple series of regular stimulations, an intermittence similar to that produced by natural interference in the compound series, whose counterpart in consciousness is the sensation of two discordant tones. Let us then, by way of getting a new point of view, suppose the alternations to get faster and faster till they merge in consciousness into one continuous sensation. What quality or qualities should we expect this sensation to have? We know that there has been no change in the nature and amount of the respective physical stimuli as they gradually got crowded nearer together: *a priori* therefore we find no reason to suspect much change in the nature and amount of the physiological response to each of these stimuli: and hence we should expect that the psychical representative of this response would continue to be the sensation of loudness up to the end of the process. And such we find by experiment to be the case: the quality of loudness remains when the sensation has become single and unintermittent. But experiment reveals another quality which we could not have predicted: the sensation is not

one of loudness only, but is distinctly unpleasant and jarring. Again, if we made the experiment with a soft sound, the rapid alternations of strength, when merged in one sensation, could only bring its loudness up to the low level of what were its louder parts when it was felt as intermittent; but the same jarring quality would be experienced as in the other case. And just so discords, when soft, give a sensation which is not "penetrating and violent," but disagreeable in a special and unique way. The following consideration may set the difficulty in a still clearer light. A continuous low note, having say 120 vibrations to the second, is pleasant: a higher note of equal apparent strength with several thousand vibrations to the second, having its regular series of vibrations interrupted 120 times every second, is unpleasant; so is a discord of two high notes with the same number of beats and interruptions. But here the periods given to the nerves for renewal of irritability are *equal in number* in the two cases of the unpleasant and the pleasant sensation. What right then have we to account for the contrast by speaking of the stimuli as "wastefully attacking the fibres and end-organs concerned" (to quote Mr. Grant Allen) in the one case, and as blunting and so protecting them in the other?

I will adduce only one more argument. If the same kind of stimulation, when excessive, caused the unpleasant sensations both of over-loudness and of discord, those who are able to experience one ought, under the appropriate conditions, to agree in experiencing the other. But it is very common to find that of two persons who are equally susceptible of annoyance from over-loudness one is keenly sensitive to discord and the other totally unconscious of it.

To sum up. The disputed view, when clearly drawn out, implies variety in *degrees*, but not in *kind*, of the stimulation proper to the several end-organs. This stimulation is felt as pleasant up to the point at which nervous wear begins decidedly to outrun repair; when it is felt as unpleasant this point has been passed. The point itself is supposed to be the resultant of two factors: one is the amount of the physical stimulus, which must be called excessive, in relation to a particular state of the organs, whenever the action cannot last for an appreciable time without seriously disturbing the balance between wear and repair: the other is the degree of nutrition and consequent molecular instability in the organs concerned, which must be called excessive, in relation to a particular amount of stimulus, if discomfort is experienced under the action of an amount of stimulus which at other times may be found quite pleasant. We took cases where one sensation was pleasant and another unpleasant, in spite of much greater violence of stimulus in the

former case: and to account for this according to the theory recourse was inevitably had to the second factor—the irritability of the nerves, supposed to be deadened in the former case, perpetually revived in the latter. We objected to each feature of the explanation: to the *deadening* in the case of the continuous tone or concord as being contradicted by the continued vitality of the subjective feeling; to the *revivification* in the case of the discord (*a*) as needing often to be miraculous in degree in order to account for the facts, (*β*) as bound, so far as it did occur, to produce the normal concomitant of intensity of stimulation—loudness, and not something quite different. Next, we found a case where a pleasant and an unpleasant sensation were produced under conditions which, as regards opportunity for renewal of irritability, were identical. Finally, we showed that, whereas sensations depending on precisely the same physiological facts ought to be equally awakenable under the appropriate stimuli, cases were common where one was so awakenable and the other not. We seem thus driven to assume the existence of some other *kind* of nervous disturbance, connected specially with interruptions supervening on a mode of motion which has been sufficiently established to become, so to speak, familiar. We find an illustration, perhaps even a true analogy, in the effect of interruption of any regular rhythm which is being watched by the eye or ear, or produced by our own voluntary muscular actions. In this comparison whole sense-organs, and actions slow enough to be consciously and completely followed, take the place of the infinitely minute nervous elements and infinitely rapid movements we have been considering. And here we assuredly should never think of accounting for the unpleasant sensation by “intensity of stimulation,” the feeling of being balked and disappointed being totally different from that of over-strain or fatigue; not more different, however, than is the feeling of discord from the oppression of excessive sound. If the new and special phenomenon, in either the illustrating or the illustrated case, is to be brought on the objective side under the general rule of wear and repair, it must probably be by supposing energy to be stored up ready for discharge, which, when the regular and established stimulus does not come, is discharged unnaturally, so to speak, and against resistance: as Mr. Grant Allen well expresses it with regard to rhythm, “if the opportunity for the discharge is wanting, the gathered energy has to dissipate itself by other channels, which involves a certain amount of conflict and waste”. If the suggested analogy be applicable, we may imagine the new phenomenon of discord to appear in consciousness as soon as the frequency of the baulkings, or whatever we are to call them,

has become sufficient to bring this sort of conflict up to a certain pitch of intensity.

I may just remark, in passing, that this case of discord serves well to illustrate in how extremely small a degree considerations of peripheral nerve-stimulation can really penetrate into the secrets of artistic beauty. A discord is always a discord wherever it occurs, and has the same wearing effect on the peripheral organs: but the action of the higher co-ordinating centres so overrides the natural character of the sensation as to convert it into an all-important feature of modern music, the simplest bit of which is often crammed with discord.

A few words may be added on the subject of colour-discord. To put a simple case: why is immediate juxtaposition of orange and vermilion on one surface disagreeable? Mr. Grant Allen tries to bring such facts under his general formula on the ground that the same class of optic fibres is stimulated by each of the two colours, and that over-stimulation therefore ensues. But if the orange part were vermilion, like the other, stimulation of the same class of optic fibres would be carried still further and a still greater degree of over-stimulation would result, whence we should logically expect an intensification of the same subjective feeling. This objection is in fact the one which Mr. Sully made in his review of Mr. Allen's book in this Journal, and his *reductio ad absurdum* was perfectly sound, that "it would follow that the same colour spread over a large surface would produce the pain of chromatic dissonance in its maximum degree". To this Mr. Allen replied that though all dissonance is fatigue, all fatigue is not dissonance. No: but even if we could conceive for the moment that the lesser stimulation, being still excessive, was cognised as a special form of discomfort—*colour-discord*, while the more excessive stimulation was cognised as the normal discomfort known as *fatigue*, what are we to say if we find a case where the feeling of the lesser stimulation answers to the above description, but the feeling of the greater is not fatigue but *pleasure*? If "fatigue" is one in kind (as the old formula and the arguments in support of it throughout imply), how will Mr. Allen explain the fact that we are annoyed by a mixed mass of pink and scarlet geraniums, but are pleased by an equal mass of the flowers when they are all scarlet, seeing that the conditions are more favourable to "fatigue" in the latter case? He adds: "What would Mr. Sully say to a person who argued that on Helmholtz's principles one and the same note continued for a long time would produce in the maximum degree the pain of musical dissonance?" But this remark, proposed as an absurdity, really suggests the very difficulty which I have found in accepting Helmholtz's principles of musical dissonance as

complete: and indeed the remark has its exact parallel and converse in the argument which forms the gist of the present paper. I have argued that, on the theory that stimulation is one in kind and only varied in degree and is completely expressible in terms of intensity, it is impossible to explain how it happens that its subjective concomitant in certain cases is an impression not of loudness but of discord: conversely, had I taken discord as the chief and central phenomenon, the fact with which I should have confronted the theory would have been that the feeling of the stimulation due to a loud continuous note is unaccountably not discord but loudness. The above remark proposed by Mr. Allen may in fact be used as a *reductio ad absurdum* of the view he adopts on musical discord exactly parallel to Mr Sully's *reductio ad absurdum* of his view on colour-discord. Mr. Sully, after his criticism on this point, adds: "We do not say that these disagreeable combinations may not be brought under such a principle of painful stimulation as that laid down by Mr. Allen, but if so, it must be effected in quite another way." This appears to me to be a suggestion parallel in kind to that advanced above as to the supervention, in cases of intermittent nervous stimulation, of some special kind of dissipation and disturbance: but if such facts really exist in the case of discordant colours, they are probably of a much more obscure kind, since they can hardly depend on anything so simple as interruptions of an established rhythm.

Two further considerations may be mentioned which tend to discredit the view that "fatigue" or excess of normal stimulation is a sufficient explanation of colour-discord. First, to return to our example of vermilion and orange, the special unpleasantness ceases when the one is made to shade off into the other: and yet here again the same optic fibres are used to a greater extent, as the eye passes and repasses along the surface, than when it was more restrictedly occupied with the dividing line where the two colours lay side by side without gradation. Secondly, the briefest time will suffice for the unpleasant sensation to be felt. This is an objection which we are precluded from urging in the case of note-discord, because there the "fatigue" was connected with intermittences of which a large number occur in a second: but colours, however discordant, cause no such intermittences, and the "fatigue," if such it be, ought in reason to grow by gradual and sensible degrees, just as it would in the case of a single bright colour when looked at continuously. All things considered, one is led to guess that the extent to which explanations resting on peripheral nervous conditions apply to sensations of colour-discord and concord must be very limited. They may cover, for instance, such broad effects as the obviously

resting action of complementary colours, which affect different fibres: but one seems more and more driven to refer the more delicate shades of feeling to associational and intellectual elements. This must be the case even with single colours which are not bright, stimulating or fatiguing, and can be looked at for a long time without serious discomfort, but which are simply ugly. Again, it is impossible to abstract the colour from the object; and even beautiful colours displease us in inappropriate and unusual positions. Such associations, however, as we can consciously discover will often be found provokingly insufficient if pressed as explanations. For instance, the pleasantness of the gradation from bright red to orange, as compared with their immediate juxtaposition, might perhaps suggest a connexion with the frequency of such gradation in nature, as for example in sunsets. But then we also continually find in nature a total absence of gradation in nearly related tints whose juxtaposition is nevertheless felt to be delightful; as in looking at a light blue sky through blue-green leaves. And indeed a slightness of divergence in colours often seems the essential feature of their *harmony*; whence a new difficulty in accepting as final and complete the view that "those combinations produce discord which successively stimulate the same class of structures". And these experiences of colour-effects often occur in isolated acts of observation without any relation to surrounding conditions; so that they cannot possibly be explained on the same grounds as the presence in music of sound-discords, which are enjoyed as parts of a complex and *organic* whole. Such considerations are almost enough to make one despair of anything like an exact and complete *rationale* of colour-discords and affinities: it would at any rate lie far beyond the scope of any conceivable formula.

EDMUND GURNEY.

III.—THE DIFFICULTIES OF MATERIAL LOGIC.

IN a notice of Mr. C. Read's *Essay on Logic*, published in MIND XII., some remarks were made upon the possibility of a purely objective treatment of the science. There was not then space for an adequate discussion of the subject, but it seems sufficiently interesting and important to deserve fuller examination.

That neither Logic nor any other science can possibly be regarded as being out of relation to the human faculties, we are presumably all agreed. Its necessary relativity, in this sense, is universally admitted. Things are what they are to our facul-