The influence of light on the skin / by Robert L. Bowles.

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Reprinted from the British Journal of Dermatology, *No. 105, Vol. 9.*]

THE INFLUENCE OF LIGHT ON THE SKIN.*

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At the request of our President, I appear before you to open a discussion on the "Influence of Light on the Skin." It was his wish that we should take up new ground, and he intimated that he himself would help on similar lines. In order usefully to carry out his wishes, it becomes necessary that I should lay clearly before you the bases on which the discussion might rest, and that I should roughly indicate the lines on which it can best be conducted to a practical and satisfactory issue. First, then, we have to deal with the skin itself, secondly, with its environments.

At a meeting of Dermatologists it is easy to deal with the first part of my subject, as I have merely to remind you, that the skin has its anatomy, its physiology, its pathology, its different nature in different races, and its remarkable idiosyncrasies in individual men, women, and children, and that it varies in thickness, colour, quality and sensibility. It has its epithelium, with its singular developments the hair and nails, it has its blood-vessels, its lymphatics, its nerves of various kinds, and its cells and cellular tissue.

Physiologically, it protects, secretes, and excretes, and controls and modifies the temperature of the body generally. It is, moreover, always in an active state, its integumentary character exposing it to the influences among many others, of friction, motion, heat, cold, and, lastly, the subject of our discussion—"Light."

* A paper read to open a Discussion at the May meeting of the Dermatological Society of Great Britain and Ireland.

Pathologically, also from its exposed position, it is liable to all kinds of changes, primarily from the excessive action of physiological influences, from physical and chemical injury, from the attacks of malign animals, and from the invasion of horrid parasites and microbes of every description.

The second part of my subject, the part that Physics play in the disturbances and derangements of the skin, I approach with the profoundest diffidence.

I will not pretend to expound to you the laws of Physics: as a physician is constantly compelled to apply some of the forces of Nature in his daily work, it is to be expected that he is at least informed of its elementary principles, and that he can, on occasion, become better instructed in those principles. I will, therefore, only venture to try and make clear to you some of the views connected with *Light*, and to elucidate as much as possible some of its actions on the skin which I wish to submit for your discussion.

Heat, Light, Electricity, Chemical Action, Gravitation, Cohesion, Motion, and so forth, tools of the physician equally with the physicist and the engineer, are all transformable into one another, and interchangeable backwards and forwards in every possible way; in form and number these changes are endless, in time eternal. And yet, according to many of our highest authorities they may all be expressed in a single word—"Motion"—and the changes spoken of, as the transformation of energy.

The radiant energy of light is believed to make itself evident by a wave-like action, transverse to the line of propagation like the waves of a shaken rope, a vibration of an ether supposed to permeate space. A beam of light is, as you know, by a prism, readily divisible into the primary colours of the Solar Spectrum; and each respective colour, red, yellow, or blue, has special attributes or properties; primarily heat, luminosity, chemical action. Each of these colours shade into other colours and may be sub-divided, and each sub-division has been shown to have its peculiar selective action on chemicals, on the retina, on the living blood, and on the skin and tissues generally. These selective actions, when progressing in an orderly manner, are physiological and beneficent to the organism, in excess or deficiency, pathological and eminently malign.

There are portions of the Solar Spectrum, however, which are

invisible in the ordinary way; for instance, vibrations of the infra-red rays have been shown by photography to extend fourteen times the length of the visible spectrum, and the ultra-violet rays nine times its length; how much further who can tell?

In like manner electrical radiations, Roentgen rays, and other forms of energy, are also invisible, but yet we know their power.

On the skin the various actions of light begin by irritation; implying disturbance, change; a transformation of energy; physiological or pathological according to the nature and intensity of the irritant: corrosive, vesicant, or rubefacient only.

In medicine, irritants may be inorganic and chemical in their action; as for example the hot iron, strong acids, caustic alkalies; or organic, as in acrid vegetable and animal substances, mustard, cayenne, turpentine, cantharides; but organic or inorganic, they only can act through those forms of energy formerly known as the "Imponderable forces of Nature."

Without these forces can no change take place.

As I have for many years been engaged, whenever opportunity offered, in investigating the effects of sunlight on the human body, and especially the penetrating effects of reflected rays from snow and other surfaces, I was naturally led to inquire whether there could be any relation between what I had observed and the observations of Professor Roentgen. He finds that certain rays generated or excited by electrical action penetrate most of the human tissues and other substances, and are stopped by substances of a different nature. I have, on the other hand, demonstrated that reflected luminous or photo-chemical rays also penetrate the human skin into the deeper tissues beneath, and produce within them great and important changes.* It will, I think, be interesting to compare a summary of facts and conclusions of various phenomena observed by me from time to time with those published in our Medical Journals on the *x* rays of Roentgen.

1. That heat *qua* heat is not the cause of sunburn.
2. That there is strong evidence for believing that sunburn is caused by the

* "Sunburn on the Alps," *Alpine Journal*, November, 1888; "Sunburn on the Alps," Edward Stanford, Cockspur Street, S.W., 1890; "On the Influence of Solar Rays on the Skin," *British Journal of Dermatology*, No. 58, vol. v; *see* also *British Medical Journal*, September 29th, 1894, p. 694.

violet rays or ultra-violet rays of light reflected from snow, and that it is not necessarily of the same quality as that which is incident.

3. Captain Abney finds that the violet or ultra-violet rays are very strong at high altitudes, and believes that altitude has much to do with sunburn.

4. That altitude alone does not explain sunburn, for one may be unburnt on rocks, say at 10,000 feet, and yet become immediately affected on descending to a glacier 3,000 or 4,000 feet lower down.

5. That sunburn and snow-blindness arise from similar causes, and that sunstroke and sun fever may be associated with the effects of penetrating light rays.

6. That rays from the electric light produce much the same results as sun rays reflected from snow.

7. That the bronzing of the skin and the browning of the wooden châlets are probably produced by rays reflected from snow.

8. That various pigments, but chiefly those containing red and yellow, stop or alter reflected rays and prevent the physiological and pathological changes usually due to them.

9. That freckles, which are but the milder effects of luminous or chemical rays, stop the penetration of those rays through the skin.

10. That the sometimes very serious inflammatory changes in sunburn and in what Mr. Hutchinson designates "summer eruptions" are due to the penetration of reflected luminous or photo-chemical rays through the skin to the deeper tissues beneath.

11. Photography often demonstrates the existence of freckles and, report says, various eruptions deep in the skin which are perfectly invisible to the naked eye, showing that the luminous or photo-chemical rays are by them stopped or altered, and not reflected back, as no change is produced on the negative—an effect which suggests that these photogenic rays have penetrating powers as yet unknown.

12. That the wood of Swiss châlets is burnt perfectly black (carbonized) on its surface by rays reflected from snow, which rays in time penetrate deeply into the substance of the wood and change it to a dark brown colour.

13. That the first effect of snow rays on a new châlet is shown by its action on the resin of the wood, which "sweats out" and leads more easily to the charring of the woody fibre itself and the subsequent changes iu the deeper parts.*

14. Captain Maude, R.E., has shown from his own personal experiences and from experiments on many friends, that solar rays in India produced sun fever of a very serious kind, which was entirely prevented by the wearing of an orange lining to all his clothes and inside his hat. These experiments demonstrate the penetrating power of light rays through clothes unprotected by colour, and their important influence on health. In relation to this, I have shown that a lady wearing a linen blouse with red and white stripes was strongly marked with red and white stripes on her shoulders, but the red line on her skin corresponded with the white lines of the linen, that is, the red stripes had completely stopped all rays from affecting the skin beneath them.

15. I have often shown that rays reflected from certain surfaces such as water, gold and silver lace, white walls, white veils, certain clouds and mists act physio-

* Professor Thompson shows now that resin is transparent to Roentgen rays (*British Medical Journal*, February 8th, 1896).

logically in a peculiar manner and quite differently to direct light, and that some physical change hitherto unexplained must take place in light during or after reflection.

16. In relation with the foregoing are those marvellous changes in the vegetable kingdom connected with the formation of chlorophyl and the deposition of starch.

From these and many other observations I cannot help feeling that Roentgen's x rays may be modifications only of ordinary light, and that their further elucidation must go hand in hand with a further inquiry into the profound changes caused by reflection to which I have above referred. It need not necessarily be assumed that what we call darkness implies an absence of all the forms of light.

The following extracts from the *Ophthalmic Review* of 1889 of Papers by Terrier of Paris, Malakoff of Moscow, and others, on "The Influence of Light on the Eye and Skin," and especially of the Papers of Widmark of Stockholm, show that the observations which I have made are now conclusively proved by direct experiment.

Ophthalmic Review. 1889.

WIDMARK (Stockholm): "The Influence of Light on the Anterior Parts of the Eye," Transactions of the Biological Society of Stockholm, October, 1888.
"The Influence of Light on the Skin." The same, March, 1889.

The recent observations of Terrier of Paris, Malakoff of Moscow, and others (*see* O. R., May, 1889), concerning the effects produced by the electric light upon the eye and skin gave no absolute proof as to whether these effects are due to the chemical or luminous rays. Widmark has made further experiments and obtained conclusive results.

He found that when the eye of a rabbit is exposed, with widely separated lids, to direct sunlight or to the electric arc light of 1,200 candle-power at a distance of 25 cm., an ophthalmia resembling the so-called snow blindness is produced. The conjunctiva in the exposed area swells and reddens; the pupil contracts; the colour of the iris is slightly altered; the corneal epithelium desquamates, and there is a secretion from the conjunctiva. These changes were formerly attributed to the excessive dazzling of the retina.

Berlin, Terrier, and others have shown, however, that they are produced by the direct influence of light on the affected parts. This is completely confirmed by Widmark. When a screen having a round aperture 2·5 mm. diameter was placed before the eye of a rabbit, so that the light fell only on the pupil and not on the rest of the eye, no irritation beyond a slight corneal haze corresponding with the pupillary area was produced. On the other hand, when the pupil was screened and the rest of the eye exposed the usual effects were produced.

In order to test the action of the different rays, a hollow lens filled with a saturated solution of alum was placed at its own focal distance from the arc light. By this means a parallel pencil, deprived of its ultra violet and ultra red rays, but

of increased luminous intensity, was obtained. This pencil produced no effect upon the front of the eye. The usual results, therefore, cannot depend upon the luminous rays. Further experiments, controlled by the thermometer, proved that the irritation of the eye occurs in the absence of heat rays.

Rock crystal and glass are nearly alike in their power of transmitting light rays and heat rays, while they differ greatly in regard to chemical rays, the crystal permitting them to pass, the glass absorbing them. Utilizing this difference in his experiments, Widmark was able to demonstrate the dependence of the ophthalmia on the chemical rays.

The irritation of the conjunctiva and the cornea is due, therefore, to the direct action of the light, and chiefly of the chemical rays, upon the tissues. The irritation of the iris appears to be caused in the same way, for when this membrane is protected it suffers no change, although the retina be exposed. It is probable, the author thinks, that the parts which underlie the exposed conjunctiva become injected by reason of their contiguity to it. The second paper describes similar experiments relating to the action of light on skin. The animals employed were albino rabbits, a sufficient area of the skin being carefully shaved. Rock crystal and glass were utilized in the same way as before. By means of a lens of crystal, which does not absorb the chemical rays, a parallel pencil of light was made to impinge on the skin, but before reaching the skin it was caused to pass through a disc of glass in the centre of which was a hole filled with a small disc of rock crystal. By this means the outer zone of the pencil was deprived of its chemical rays, while the central area retained them. The redness of the skin was produced only in the central area—a clear proof of its dependence on the chemical rays.

In August, 1896, Mr. Travers, of University College, very kindly assisted me in my efforts to discover the cause of the radiant energy from snow being, as universal experience has demonstrated, so much more irritating to the eyes and skin than direct energy from the sun. With very short notice he arranged some preliminary experiments.

1. To show the relative values of sunlight and snowlight in freeing iodine from its combination with hydrogen.

2. To test the relative effects of sun on xxx Paget's plates, inclosed in cases made of aluminium and cardboard, in producing skiagraphs like those of Roentgen.

These exposures were effected on snow at an elevation of 8,040 feet, near the hut of the Ober Aletch Glacier, on three consecutive days. Mr. Travers remained at the hut whilst I paid daily visits from Bel Alp to watch the progress of the experiments.

The weather was bad and uncertain but there was *some* sunlight, and some interesting and definite results were obtained.

Bottles containing equivalent proportions of a sulphuric acid solution and potassium iodide were fixed in cases and exposed

simultaneously to the sun and snow; some bottles were coated with pigments, others with cloth of various colours, but each case contained also some of the solution in an uncovered bottle as a control experiment.

The results were expressed in iodine equivalents, and they appear, as Mr. Travers expresses it, "to indicate that the actinic value of the reflected light from snow is somewhere about 0·7–0·8 of the value of the direct rays of the sun."

So far, then, we see that it is not simply the *amount* of *actinic* energy contained in reflected sunlight which produces such marked effects and we must await further knowledge.

The X-Ray plate exposed to the sun displayed skiagraphs of a piece of tin, as you will see in this photograph, whereas on the plate exposed to the snow no change could be detected, but as there are reasons for the possibility of this plate having been spoiled, this experiment was not conclusive. Mr. Travers, in his remarks on the experiments, says:—

"In dealing with the published accounts of the cases of sunburn and dermatitis produced by the so-called X-rays, it is not at all certain that the injury done to the hands and arms of the operators was due to the rays which are capable of penetrating aluminium sheets, &c. We know that the radiations from a Crooke's tube include rays which come within the *visible portion* of the spectrum, and it is *to these rays* that we may attribute the power of producing sunburn.

"Further, while it takes a very long time to produce sunburn in the neighbourhood of a tube which will fog a photographic plate, contained in a dark slide, in a few seconds, light reflected from the snow will sunburn in a very short time but will not fog a plate in a dark slide.*

"In a paper which appeared either in the *Lancet* or *British Medical Journal* a few weeks ago, it was shown that the effect produced by certain kinds of light—*e.g.*, light from incandescent gas or arc lamps —produced injurious effects. 'The injury could not be attributed to the presence of a greater intensity of ultra-violet or violet light than was present in sunlight, but was due to the absence of 'red' radiation.

* This plate may have been spoiled.

"For a healthy condition of the retina and epidermis it is necessary that the ratio between the intensities of the radiations in different parts of the spectrum shall remain nearly constant.

"Neglecting the effects produced by the phenomena of fluorescence and calorescence we are justified in making the following assumption. In the reflected light from snow the heat rays are nearly entirely absent, the violet (chemical) rays would be present with almost the same intensity as in the direct sunlight. It must be remembered that we are not here dealing with reflection from a plane surface. In snow the surface is so rough that an incident beam of light is completely dispersed at its surface, and the illumination of a point above the snow will not vary, within limits, with the angle of the incident beam.

"Considering the lack of evidence in favour of the X-rays pure and simple, being a cause of dermatitis similar to sunburn, it is worth while reviewing the facts in support of the theory that the true cause is to be found in the violet, or chemical rays, or in the increase of intensity of the violet rays with regard to the intensity of the red rays.

"I think that the facts cited in your paper (*British Medical Journal*, March 7th, 1896), particularly in sections 5, 6, 8, 11, 14, &c., furnish sufficient support."

Here you see, from an entirely physical point of view, Mr. Travers, like Widmark and others, arrives at conclusions similar to my own—namely, that the vital changes on the skin are due to the chemical rays, and apparently to the chemical rays alone, and that the rays issuing from a Crooke's tube are not an entirely new form of energy distinct and separate from light, but contain a proportion of luminous and chemical rays, and that light, as such, as well as the divisions into which it can be split up, may penetrate wood, clothing, and the human tissues. Immediately on the publication of Professor Roentgen's discovery, I claimed for the X Rays, as then produced, an affiliation to those of light, and predicted (*Lancet* and *British Medical Journal*, March, 1896) that they would be found to affect the tissues in a way similar to the violet rays of light. It was not long before this was shown to be the case, and various and intense forms of dermatitis ending even in necrosis have now become, unfortunately, a common experience. Whether

these rays are simply a form of light does not concern me, we *know* them to be a *form of energy*, a form, indeed, that has to be reckoned with by all who dabble in it, and I cannot help feeling that rays which will produce such serious pathological results on the skin and and are known to traverse heart and lungs and brain, may have a therapeutic or toxic effect, according to the manner in which it is employed and according to its dosage.

I confess I should not be disposed, until we know more, to risk the effects of a radiant energy of such power on the delicate cells of my own brain.

Like the short wave length radiations from a luminous source, this particular form of energy causes certain salts to fluoresce, and only the characteristics of wave motion (diffraction and interference phenomena) are wanting to prove its intimate relation with the energy of light. This knowledge seems to be already attained, if the experiments of MM. Calmette and Huillier, reported in a Paper to the French Academy, should turn out to be correct (*Comptes Rendus*, and translated in the *Electrical Engineer*, New York, for July 22, 1896).

Besides this, you will remember, that in our experiments of last year Mr. Travers showed that sunlight produced skiagraphs of a bit of tin in a way similar to those produced by what are usually accepted as X Rays.

Luminous rays have long been known to pass through the human tissues, and here you see displayed by means of this electric lamp the bones and joints of my hand quite as clearly as by Roentgen rays, and this piece of wood from an old châlet in the Alps is affected (browned) for some inches into its substance. Mr. Hurry Fenwick tells me that he has used, since 1888, the electro cystoscope in a dark room to illuminate the suprapubic region, and that there is a dull red glare when the light is in the bladder, and that the same would probably be seen in the sigmoid flexure if filled with water. Certainly the entire face can be illuminated in a dark room by a small electric lamp in the mouth.

The literature of the subject is, as far as I know, scanty. Dr. Unna, of Hamburg, as far back as 1885 dealt (*Monatshefte für Praktische Dermatologie*) very fully with the subject of pigmentary changes in the cutis, and suggested that they depended on the effects

of the chemical rays, and that curcuma and colours acting on the light rays would prevent change taking place. In 1893 ("Selected Monographs on Dermatology," New Sydenham Society, p. 118), he summed up the views of Arty, Riehl, Erhman and others, saying that all agreed that pigment does not originate in the epidermis, but is transported thither from the cutis, and at the same time he dealt with other points of interest connected with light on the skin.

In the *British Medical Journal* of December 7, 1895, is a Paper by Dr. Finsen, of Copenhagen, on "The Red Light Treatment of Small-Pox," touching upon the history of this and allied subjects, and giving recent information and references of a very instructive kind.

And there is an excellent paper by a Dr. Hammer, of Stuttgart, "The Influence of Light on the Skin," published in 1891, which a friend was kind enough to translate for me. Dr. Hammer deals with the subject first biologically; for example, the action of light on worms and other sightless creatures influenced by light through the skin—a side of the subject which time will not to-day allow me to enter upon. On the physical side he quotes the experiments of Terrier, Malakoff and Widmark, which I have just read to you as extracted from the *Ophthalmic Review*, and on which he places absolute confidence.

About ten years ago I sat up late into the night at a mountain inn in the Alps with *a* "Dr. Hammer," and discussed with him freely all I had observed and what I contemplated doing: he helped me with suggestions on the physical aspect of the question and told me he would work and observe for himself. As, in his paper, the Dr. Hammer of Stuttgart experimented exactly on the same lines that I had done, and uses my words and quotations, I assume it must be my "Dr. Hammer" of Bel Alp.

He was much impressed at the time with the belief that fluorescent substances would be found effective in the prevention of sunburn, and he experimented by covering the exposed skin with certain substances, such as glycerine, vaseline, watery solution of quinine, Unguentum glycerini, with sulphate of quinine, cold water, and so forth, and compared the results with the uncovered skin. As in my own experiences, no transparent substances except quinine, which is strongly fluorescent and therefore absorbent of the ultra violet rays, gave satisfactory results.

From beginning to end I found Dr. Hammer's work entirely corroborative of my own, but he is by no means as impressed as I am with the important fact that *reflected light* burns much more rapidly than direct.

The exact causes of this have not yet been demonstrated, but some *are* known ; for instance, snow and water filter off from sunlight the red rays and their accompanying heat, and leave the luminous and ultra violet rays free,—Prismatic analysis.

On plant life, a cold night in spring opens the door to the devouring parasite, always at hand to prey on the injured; a sultry day in summer to the blasting blight.

On man, chill may pave the way for the bacillus of pneumonia, of influenza, or other catarrhal conditions, so may physical injury from light or other form of energy prepare the soil for microbes which affect the skin, and destruction and local death may follow in their track.

The rapid destruction of tissue in certain individuals, in Mr. Hutchinson's " Summer eruptions " affords strong evidence of such possibilities.

Tradition, writers of romance, and poets, seers of their time, all direct attention to the singular effects of different forms of light on the *nerve centres*. Lunatics, moonstruck lovers, prowlers of the night, afford illustrations, and who can deny the alluring influence of the brilliance of the gin palace on the poor wretches that crowd its portals —the moths and the candles.

As practitioners of medicine we know and value the therapeutic influence of light properly applied.

How soothing to the ruffled mind are gentle wanderings in woods and green pastures ; how comfortable a suitably shaded room, and how uncomfortable the glaring gas. The lower organisms all feel such conditions in their respective ways, and it will not be long, I think, before experimental evidence will reduce to certainty what is now a vague but strong belief.

Time, and the vastness of the subject, will not permit me to deal more in detail with the application of these principles to diseases of the skin ; you, better than I, will know how to do this : I will only in conclusion raise a protest against the too exclusive supremacy of the ubiquitous microbe, in the causation of disease, at present dominating

the "mens medica," and claim from you increased and more earnest attention to those mighty terrestrial and cosmic forms of energy, without which no organic thing, not even a microbe, "can live or move or have its being."

In the course of the discussion which followed the reading of the paper

Dr. Bowles, in reply, said he thought the general tenour of the discussion had been in the direction of accepting the fact that the chemical rays were the irritating ones, and that probably chemical rays mixed with Roentgen rays produced the dermatitis which Roentgen rays are said to give rise to.

Dr. Crocker had raised an objection, in one sense, as to light producing pigmentary deposits, because they might depend, at certain times, on certain neurotic conditions. No doubt they did. He (Dr. Bowles) only claimed the chemical action of light rays as one form of irritant; there were many irritants which would produce changes, changes both in the activity of the skin and in the deposit of pigment, because the deposit of pigment came from the blood, in consequence of vaso-motor irritation and subsequent chemical change. Those deposits, which were due to neurotic conditions, must also arise ultimately from chemical action, because pigment was known to be a chemical compound. It was of importance to remember what Dr. Crocker and the President had said with reference to the influence of the electric light on the eyes and the wearing of suitable spectacles. He thought they should take that hint and think the matter over.

Mr. Spencer Watson had referred to fluorescence. That was a very important matter, and one which had not yet been sufficiently investigated. They intended to have made experiments on the subject in the Alps last year, but the weather was unfavourable. He would ask Mr. Spencer Watson to remember what was said in the paper about quinine, glycerine, and various mineral oils, which were said to be fluorescent in their nature, namely, that they did not prevent sunburn in the Alps when applied to the skin.

As to the influence of light upon small-pox, he would like to make one remark. He wanted to claim an influence for green light. He made a curious observation last year at Berne. He was walking

along the white road on a dark night, looking at the beautiful definition of the leaves of the trees caused by the powerful arc electric lamp above, when he noticed that the shadows were perfectly green. He stood away from the shadow of the leaves, and noticed that the shadows cast by his stick and by his body were also green-fringed. Afterwards he had opportunities of testing with the light between him and the green trees. Here again the shadows were green. It is clear, therefore, that when they looked at a green tree the green radiance must exist in the intervening space, although invisible when viewed transversely. That might account for something he had hinted at—the soothing effect on the nervous system of green light. They all knew and acknowledged the fact that green light was a pleasant one to the senses. He had visited the National Gallery to see if the great painters showed knowledge of the existence of green shadows, such as he had observed. He found that Turner, Constable, and especially Rosa Bonheur (who painted shadows from white horses in the neighbourhood of trees perfectly green) had some knowledge of the subject. He could not help thinking that they would have to take that matter, as well as another, the absorption of the red of the spectrum setting the other radiations free, into consideration in studying the subject. Common experience certainly showed that reflected light from snow did more harm than direct light from the sun.