"NOSE-OPENING" RAYS.

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(With Fig. 1 on Plate VII and Figs. 2–9 in the Text.)

In the case of the ultra-violet rays we know that one group of rays produces vitamin D in the skin, and another group destroys it. Why should not physiological antagonism be found also in the infra-red region? These are new ideas which people have got to get used to, but they are substantiated by experimental observation. Leonard Hill, 1932[1].

ABSTRACT. Leonard Hill's hypothesis that there are "nose-closing" rays and "nose-opening" rays appeared to be of paramount importance in the study of the physical conditions conducive to human comfort. Hill's observations are not confirmed: in well-controlled experiments with eighty-five subjects no evidence whatever is found of "nose-opening" rays.

"Nose-closing" is found to occur not only with a dull fire but also with a bright fire. It can also be produced by heating the subject by convection (heated air) or by conduction (warm fomentation). Even the sun is a potent "nose-closer."

The average person tolerates most heating effects without discomfort and without recourse to mouth breathing: it is only in those who are peculiarly sensitive (*e.g.* by reason of deflected septa) that any difficulty arises.

1. During the past two years a distinguished physiologist, Prof. Sir Leonard Hill, F.R.S., has insistently asserted[2] that there are two, physiologically distinct, types of infra-red radiation; that there are "nose-closing" rays and "nose-opening" rays; that bright incandescent sources of heat, such as lamps, coal-fires and modern gas-fires, are "nose-openers," and that all the dark sources are "nose-shutters."

[1] See footnote 2 (1) below.

[2] See Hill, Sir Leonard: (1) *Electrical Times*, Oct. 20th, 1932, p. 507.—(2) *Ideal Home*, Sept. 1931, p. 231.—(3) *Times*, Nov. 26th, 1931.—(4) *Morning Advertiser*, Dec. 17th, 1931.—(5) Infra-red rays and ventilation, *J. of Physiol.* 1932, **74**, 1 *P.*—(6) Light and air and the health of the citizen, *Medical Officer*, 1932, **47**, 5.—(7) Infra-red rays and ventilation. II. *J. of Physiol.* 1932, **75**, 8 *P.*—(8) Discussion of paper by *C. A. Masterman and T. G. Noble*, Gas Fire Flues and Ventilation, *Gas J.* 1932, **198**, 754.—(9) *Times*, Aug. 13th, 1932.—(10) *Times*, Sept. 30th, 1932.—(11) *Electrical Times*, Nov. 10th, 1932.—(12) Discussion of paper by *H. M. Vernon*, The measurement, in relation to human comfort, of the radiation produced by various heating systems, *Inst. of H. and V. Engineers, Proc.* 1932–33, **31**, 248.—(13) Presidential Address to Sanitary Inspectors' Association, *Sanitarian*, 1932, **1**, 83.—(14) The correct use of heat rays for producing comfort in living rooms, *Plumbing Trade J.* 1933, **12**, 290.—(15) Discussion of paper by *J. S. Owens*, Ventilation and the need for New Standards, *J. Roy. San. Inst.* 1933, **53**, 1623.—(16) Discussion of paper by *H. M. Vernon*, The Estimation of Solar Radiation in relation to its warming effect on the Human Body, *Quart. J. Roy. Met. Soc.* 1933, **59**, 250.—(17) Rôle of Infra-Red Radiation, *Brit. J. Physical Med.* 1932, **7**, 49.

The experiments upon which this hypothesis is based are so simple that they can be repeated by anyone and, as they appeared to be of paramount importance in the study of the physical conditions conducive to human comfort, one of us did repeat them. Following the prescription closely, with the additional precaution of excluding daylight (since sunshine includes "nose-opening" rays), he was unable to detect that the rays from an incandescent lamp counteracted the "nose-closing" rays from a dull electric fire. Twelve colleagues, also, made the test and were unable to confirm Sir Leonard's observation.

Further experiments were clearly required and, as it appeared that suggestion might possibly be a contributory factor, instrumental observations were made and the subject's feelings were ignored.

Nature has fortunately provided us with two nostrils, and it is possible to breathe through the one and at the same time to utilise the other for measuring inspiratory and expiratory pressures. For this purpose it is only necessary to connect the second nostril by means of a rubber tube to a sensitive manometer of the aneroid type recording upon a moving chart.

In a dark room, the subject, carefully blindfolded, sat close to a dull electric fire or a non-luminous electrically heated panel. He closed one nostril with the connection to the manometer and breathed through the other. After about 15 or 20 min. grace, to enable him to settle down, records were taken without his knowledge, outside the room. An electric lamp, screened by glass, was at intervals switched on and off, from outside the room, to illuminate the subject's face. No evidence was obtained that the inspiratory pressure was less when the lamp was on, even in the case of a subject breathing with difficulty through a nostril constricted by a deflected septum.

These experiments were communicated to the Institution of Heating and Ventilating Engineers in November, 1932[1]: the technique has since been criticised by Sir Leonard Hill on the ground that the subjects were blindfold and that this may have inhibited the phenomena[2].

In January, 1933, an account of the experiments was presented to the Inter-departmental Committee of the Medical Research Council and the Department of Scientific and Industrial Research. This committee agreed that Sir Leonard Hill's contentions on nose-closing and nose-opening rays were not borne out and considered that it was desirable to carry out a comprehensive series of experiments to establish the facts; if blind persons were taken as the subjects, the observations would be on a firmer basis.

2. Before describing the further series of experiments which have now been made, it may be well to refer more particularly to some of the assertions which Sir Leonard has made and to emphasise that the effect which he claims to have discovered is not to be regarded as a rarity to which only a few people are sensitive nor yet as a micro-effect requiring exceptionally delicate instru-

[1] Dufton, A. F., Radiant Heat, *Inst. of H. and V. Engineers, Proc.* 1932–33, **31**, 230.

[2] Personal communication to T.B.

ments for its demonstration. Sir Leonard not only finds the effect in more than 50 per cent. of subjects tested by him[1] but reports that a nose-closing effect was produced up to a distance of 40 ft. from a 300-watt gas-filled incandescent lamp with a screen of cellophane interposed[2]. He remarks that the sensitivity of the skin to the rays is very great: the intensity of radiant heat at this distance from the lamp is of course very considerably less than that due to the presence of a clothed man, 10 ft. away, in an ordinary room or to an increase of one-tenth of a degree Fahrenheit in the temperature of the walls of the room. No less remarkable is the statement that a screen of the horny layer of the skin (desquamated) 2 in. square, set in a sheet of cardboard, kept the affected side of the nose shut when held in front of the face up to a distance of 27 ft. away from this lamp. Sir Leonard avers, moreover, that these facts held approximately good for his colleague, who also had a deflected septum. He states also that a source of dark heat at body temperature can exert a nose-opening effect[2].

Sir Leonard finds that a trough of cool water produces an effective screen of vapour but reports that a dense cloud of steam, or a layer of water, does not protect the skin from the "nose-closing" rays[3].

3. Sir Leonard does not rely only upon his own experimental evidence. In the *Electrical Times*[4] and in the *Plumbing Trade Journal*[2] he states that Miss Murray of the Physiological Department of Bedford College has recorded the reflex effect produced by the rays and that about 25 per cent. of those tested proved sensitive to the rays.

We have visited Miss Murray's laboratory and learn from her that these preliminary experiments were quoted rather prematurely, before she had tested different sources of radiant heat, but she is not sure that the effect is due to a specific type of radiation, and suggested that it might be due to a sudden alteration of skin temperature. She finds no evidence of "nose-opening" rays from an incandescent lamp.

4. The present experiments were made in the air-conditioning room at the London School of Hygiene and Tropical Medicine, where it is possible to work under well-defined controlled conditions. The subject was seated in a comfortable cane arm-chair and was screened from draughts and from most of the light of the room, which is not brightly lit, by a shelter made of paper stretched upon a wooden frame, Fig. 1 (Pl. VII). The subject faced, at a distance of 6 ft. 6 in., one of a pair of electric fires. The fires were mounted upon a silently running trolley behind screens of tin and wood contrived so that the subject could be irradiated by each fire in turn. The input to each fire was adjusted so that the intensity of radiation upon the face of the subject was 65 B.TH.U. per sq. ft. per hour and the temperatures of the elements of the fires were measured with an optical pyrometer and found to be 1600 and 1350° F. The one fire was very bright and the other very dull; the elements in the dull fire had a surface two and a half times as great as that of the bright element.

[1] See footnote 2, p. 476, (3).
[2] See footnote 2, p. 476, (14).
[3] See footnote 2, p. 476, (8), (13).
[4] See footnote 2, p. 476, (11).

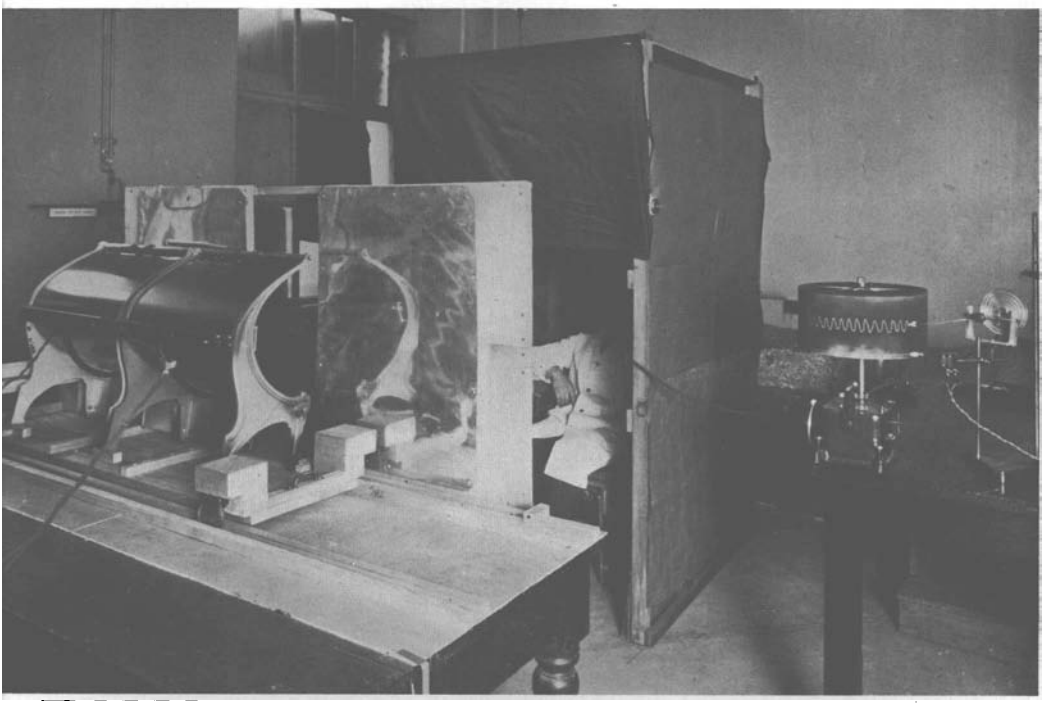

Fig. 1.

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The temperature in the room was maintained at 55° F. and the relative humidity at 60 per cent. Owing to the heat from the fires the shelter was warmer than the room, the air temperature being 63° F. at the level of the subject's face and the equivalent temperature 75° F. The air movement was determined by means of a silvered kata-thermometer and found to be 30 ft. per minute in proximity to the subject's face and 45 ft. per minute at the subject's feet.

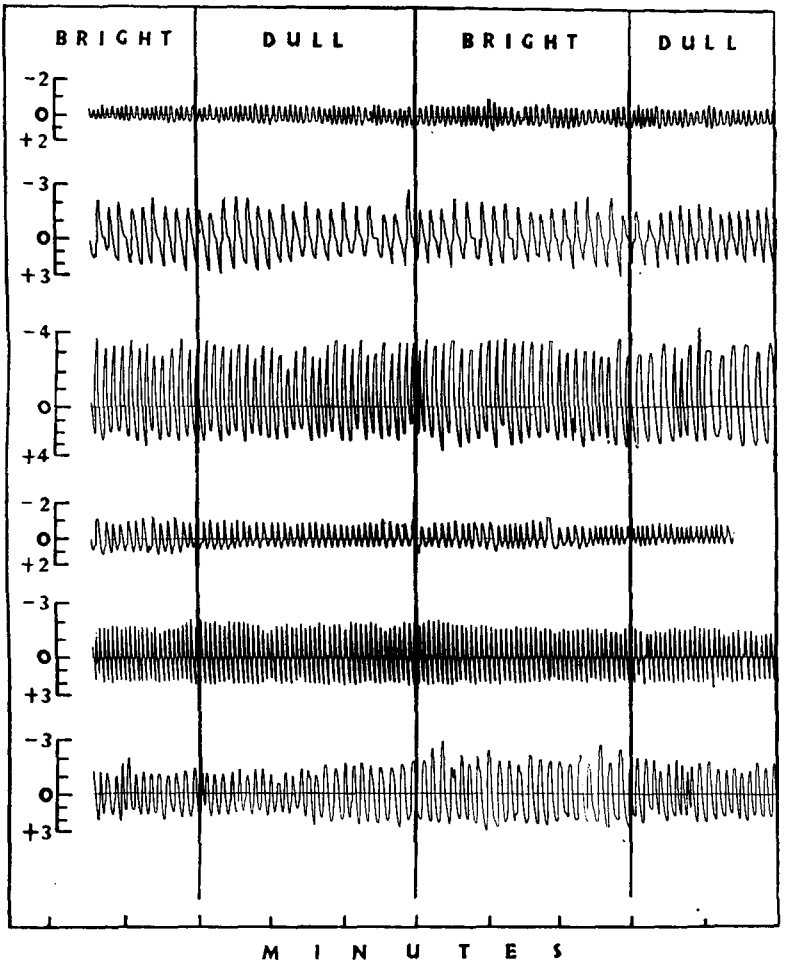


Fig. 2.

Thirty blind men, from St Dunstan's, were tested in this manner. They were exposed to the bright fire for 8 or 9 min., then to the dull fire for 3 min.; to the bright fire for another 3 min. and then to the dull fire for 3 min. The inspiratory and expiratory pressures were recorded in the manner described and Fig. 2 shows portions of the records for six of these subjects. The time marks are at minute intervals, and the pressure is scaled in centimetres of

water. No evidence of any difference in the inspiratory pressure due to change of the quality of radiation is apparent in these six or in any of the thirty records.

Fifty-six additional records were obtained from forty-five sighted subjects (twenty-seven males and eighteen females), who were prevented from seeing the fires by means of opaque goggles. The records were precisely analogous to those from the blind subjects and gave no evidence of any antagonism between "nose-closing" and "nose-opening" rays.

The records have been subjected to more than a cursory examination, and it has been thought well to determine for each experiment the ratio of the mean

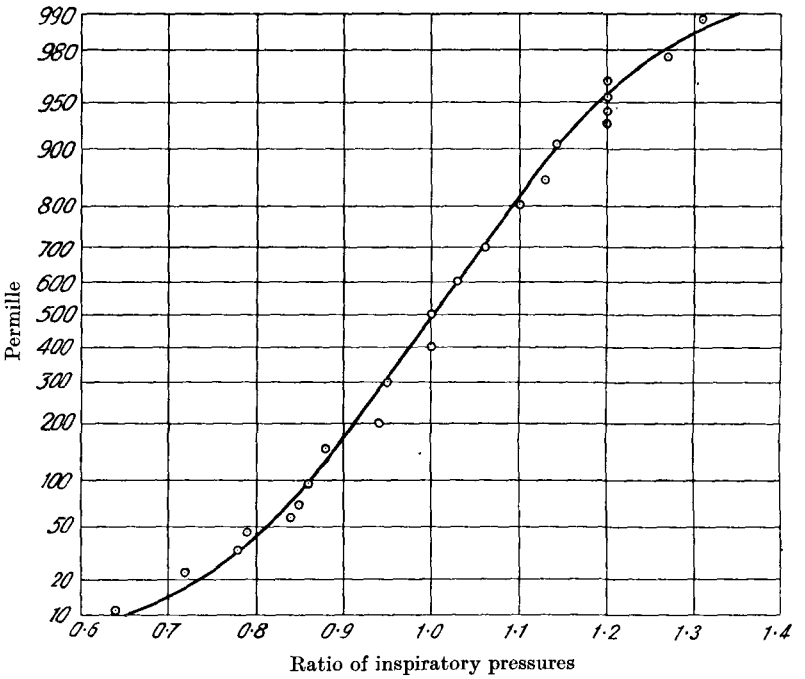


Fig. 3.

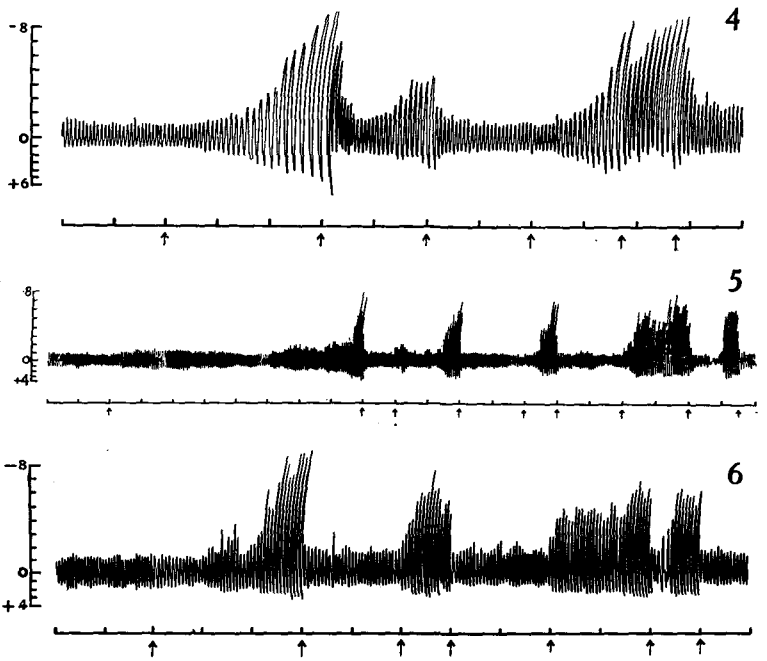
inspiratory pressure with the dull fire to that with the bright fire. According to Sir Leonard's theory the ratio should be greater than unity. The values actually varied from 0·6 to 1·3, and the frequency distribution is shown on permille paper[1] in Fig. 3. The median value is 1·00 and the semi-interquartile range 0·06. It is clear that the distribution is substantially normal: the variations are random and not to be ascribed to any change in the quality of radiation.

5. Sufficient evidence has been adduced to refute the suggestion that a bright incandescent source of heat is potent as a "nose-opener" and therefore to be preferred to a dark source. It remains for us to state that we have found

[1] Dufton, A. F., Graphic Statistics: Permille Paper, *Phil. Mag.* 1930, **10**, 566.

nose-closing to occur not only with a dull electric fire but also with a bright electric fire and, *mirabile dictu*, with the clinical gas lamp, which is especially commended by Sir Leonard Hill[1].

In the course of our experiments we found that the nose-closing caused by heating the face was immediately relieved by sponging the hand, although Sir Leonard states that to neutralise the effect of an electric fire a cooling agent must act on the same part of the skin as that irradiated[2]. We found, moreover, that with the clinical gas lamp the nose-closing occurred even when a wide trough of water at 110 or at 65° F. was placed in front of the fire.



Figs. 4–6.

In all these experiments the conditions remained the same as before. The first 2 min. of the record in Fig. 4 shows the breathing pressure of a subject before he was exposed to either electric fire. He was then exposed to the bright fire for 5 min. At the end of 3 min. exposure breathing became difficult and the forehead was sponged with water. This gave temporary relief. At the end of the 5 min. a screen was interposed in front of the fire and this also gave instant relief. At the end of 2 min. the screen was removed and the subject was exposed to the dull electric fire. The nostril was again constricted and after $1\frac{3}{4}$ min. a 100-watt lamp was switched on. Breathing remained difficult and after 1 min. the lamp was switched off and the fire screened. This screening gave relief.

[1] See footnote 2, p. 476, (14).

[2] See footnote 2, p. 476, (5).

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The first 2 min. of the next record, Fig. 5, show the breathing of another subject before he was exposed to either fire. He was then exposed to the bright fire for 8 min. During the first 5 min. the breathing was not affected. Breathing then became gradually more difficult and the nostril was considerably constricted at the end of the 8 min. A screen was then interposed in front of the fire and this gave instant relief. At the end of 1 min. the screen was removed. Breathing again became gradually more difficult and in 2 min. the nostril was again constricted. Screening the fire again gave immediate relief. At the end of 2 min. the screen was again removed. Breathing once more became difficult and this time the nostril became constricted in 1 min. After 2 min. screening to afford relief, the dull fire was substituted for the bright fire. This constricted the nostril in a precisely similar manner. After 2 min. the subject's face and hands were sponged and this gave instant relief which lasted for 1 min., when the nostril again became constricted. The screen was then interposed in front of the fire and this gave relief at once.

A clinical gas lamp, comprising a conical *Beam* radiant set on a stand with a reflector behind, was then substituted for the electric fires. The intensity of radiation upon the face of the subject was 65 B.TH.U. per sq. ft. per hour, identical with that from either electric fire. The first 2 min. of the next record, Fig. 6, shows the breathing of a subject before he was exposed to this fire. He was then irradiated for 3 min. and his nostril became considerably constricted. A screen interposed in front of the fire gave instant relief. A wide trough of water at 110° F. was placed immediately in front of the fire and at the end of 2 min. the screen was removed. The nostril again became constricted and the screen was replaced at the end of 1 min. After 2 min. the screen was removed and the nostril again became constricted. After 2 min. the subject's hands were sponged with water and this gave instant relief which lasted for ½ min., when the nostril again became constricted. The screen was then interposed in front of the fire and this gave immediate relief.

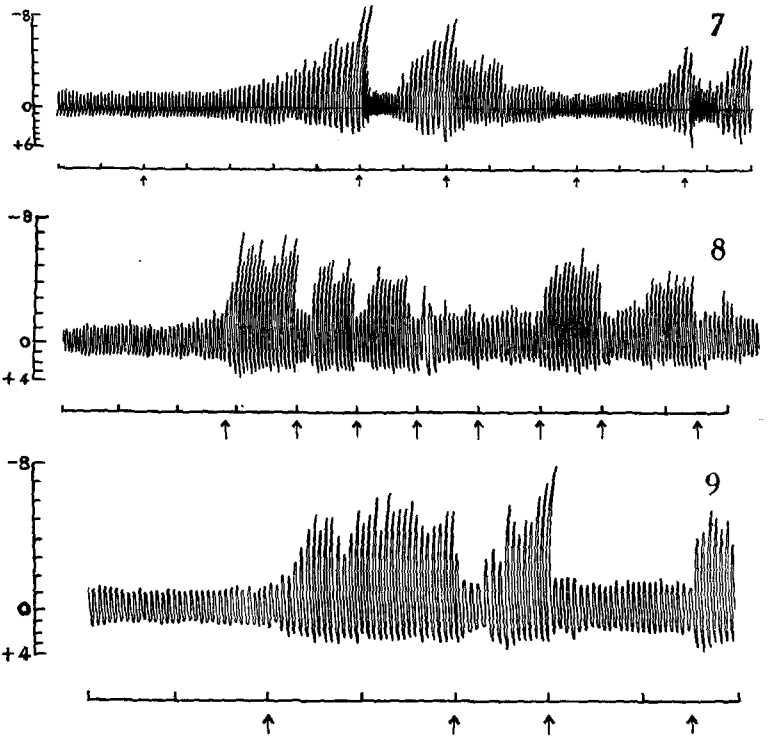
6. It is of interest to recall that the observations of Mudd, Goldman and Grant[1] show a close correspondence between the vasomotor reactions of the skin and of the mucous membranes to sudden chilling and subsequent warming of the body surface. In their experiments the depth and rate of breathing were controlled and the temperature of the air breathed was constant. The mucosae of the nasal cavity and naso-pharynx were particularly sensitive; exposure of the skin to cool air, which scarcely affected the skin temperature, caused a marked depression in the temperature of these mucous membranes, with its accompanying vaso-constriction. In our experiments, when the nose was partly obstructed through exposure to the fires, screening from the fire, or sponging a small area of the skin with cold water gave immediate relief, accompanied by a fall in the inspiratory pressure.

We are of opinion that "nose-closing" is probably caused by any rapid

[1] Mudd, S., Goldman, A. and Grant, S. B., Reaction of the Nasal Cavity and Post Nasal Space to Chilling of the Body Surface. I. Vasomotor Reactions, *J. Exp. Med.* 1921, **34**, 11.

warming of the skin and that it is not dependent upon any particular quality of radiation.

We are confirmed in this opinion by experiments upon subjects stripped to the waist and exposed to a rapid increase in *air* temperature. Fig. 7 shows the record of the breathing during one such experiment. The room was initially at 64° F. and after 2 min. the air was rapidly warmed, the temperature rising to 90° F. in 5 min. This heating caused the nostril to constrict and breathing became difficult. Sponging gave temporary relief. At the end of another minute the temperature was 94° F. and the heating was stopped. The nose



Figs. 7–9.

again became constricted and at the end of another minute a window was opened. The temperature fell rapidly and the breathing was easier. After 3 min., when the temperature had fallen to 80° F., the window was shut and the heating resumed. The nostril constricted again and after $2\frac{1}{2}$ min., when the temperature had reached 91° F., the subject was sponged. This again gave relief.

Although the subjects were heated directly by the air, it was not possible to prevent the walls of the room from being heated to some extent and to eliminate entirely the effects of radiation.

Ampler confirmation is afforded by experiments in which a small area of the skin was rapidly warmed by fomentation, that is by pure conduction. Fig. 8

shows the record obtained in such an experiment. Just before the third minute of the record a fomentation was applied to one forearm of the subject. This heating caused the nose to constrict. Sponging a bared leg at the fourth and at the fifth minute caused temporary relief. The fomentation was removed at the sixth minute and this gave immediate relief. At the seventh minute the forearm was sponged with cold water and at the eighth minute a second, somewhat cooler, fomentation was applied. This caused the nostril to constrict again and the fomentation was removed after 1 min. The nose opened again but the relief was not complete and the nostril gradually closed again. After $1\frac{1}{2}$ min. sponging gave further relief.

7. People have been getting so used to the new idea that bright incandescent sources of heat are "nose-openers" that it may come as a surprise to learn that the sun is a potent "nose-closer."[1] The record in Fig. 9 illustrates this. After 2 min., the subject, stripped to the waist in a room at 75° F., was exposed to direct sunlight. The nostril constricted almost at once and after 2 min. exposure temporary relief was obtained by sponging the back (which was not irradiated). The nose soon closed again and, after 1 min., the subject was screened from the sun and this gave immediate relief. After a further $1\frac{1}{2}$ min. the screen was removed and the nose closed again.

8. It may be well to mention that, while each of the three modes of heating, conduction, convection and radiation, has been shown to be capable of causing nose-closing, it does not by any means follow that discomfort must necessarily ensue. In our experiments one nostril was always closed and the heating was sudden. When the heating is gradual one would expect less vasomotor reaction and less congestion of the nose. Furthermore, under ordinary conditions both nostrils are in use. The average person tolerates most heating effects without discomfort and without recourse to mouth-breathing: it is only in those who are peculiarly sensitive, by reason of deflected septa, for example, that any difficulty arises.

ACKNOWLEDGMENTS.

In conclusion we wish to express our appreciation of the assistance rendered by the blind subjects and to return our thanks for the willing help afforded by St Dunstan's.

Our best thanks are also due to our many colleagues and to those others who have kindly and with good humour lent us their noses. We are indebted to the Davis Gas Stove Company for the loan of the clinical gas lamp and to the British Electrical and Allied Industries Research Association for lending us the electric fires.

Finally we wish to thank the authorities of the London School of Hygiene and Tropical Medicine for the facilities placed at our disposal and to record our indebtedness to Mr C. G. Warner for help during the experiments.

[1] Sir Leonard Hill states that bright sunlight does not produce any nasal congestion. (See footnote 2, p. 476, (17).)

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