Mellon Institute of Industrial Research and School of Specific Industries

Smoke Investigation Bulletin No. 3

Psychological Aspects of the Problem of Atmospheric Smoke Pollution

By
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University of Pittsburgh
Pittsburgh, Pa.
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Introduction

All that can be wisely attempted in an article which aims merely to furnish a preliminary survey of the psychological aspects of the smoke problem, is to outline the scope of the inquiry, to review briefly the direct and indirect data, whether impressionistic, observational, statistical or experimental, which bear on the problem and which are already available in recorded observations or in literary and scientific memoirs, and, finally, to suggest certain problems amenable to statistical or experimental study.

The smoke palls of our industrial centers exert both a direct and indirect influence upon the human organism. The direct influence is due to the immediate contact of the smoke-contaminated and poison-laden air with the skin, mucous membranes and sense organs of the body. The indirect effects are traceable to the various meteorological states which are due to smoke products in the atmosphere, and which in turn directly influence the body. Frequently, possibly always, the smoke conditions and the state of the atmosphere are so inextricably mixed that the biological effects must be ascribed to the joint action of both factors. Only in a controlled experiment would it be possible absolutely to segregate, and thus separately to measure, the effects of the smoke and meteorological factors of weather states. This has not yet been attempted.

The mental effects due to atmospheric smoke and its related weather states are likewise both direct and indirect. The indirect effects are due to the influences exerted by smoke clouds and smoke-produced weather states on the physiological organism—on health, well-being, energy, freshness, potential reserve, sensori-motor efficiency—and to the influences thus directly exerted by the changed bodily states on the mind: on mental tension, balance, inhibition, impulse, inclination, feeling, emotion, thought, and conduct. On the other hand, the direct mental effects are traceable to the immediate influences, whether conscious or unconscious, exerted on the individual's mental action

by his own experiences—by the thoughts, feelings and impulses which have been excited in him by various bodily states, sensations and perceptions produced by cloud and weather conditions—or which have been directly produced by processes of association and habit formation, the latter of which have themselves been initiated by thoughts or responses occasioned, in the first instance, by the physiological effects of external influences. The action of the mind itself does have a determining influence upon its own subsequent attitudes, beliefs, propensities and habits. It is important that these direct effects of the mind's own action upon its subsequent behavior be recognized, for much of the mental gloom and depression occasioned by dismal cosmic influences has merely been initiated by the external stimuli. Their peculiar intensity is largely due to the subject's own introspections, to his own stream of thought. The mental influences are often more pronounced than the bodily influences, whether the mental influences arise from somatic alterations or from introspective changes. Cosmic states are, perhaps, less to be regarded as *causes* of mental action than *factors* which may upset the emotional balance, lessen inhibition and alter the train of thought and conduct.

It is also important to emphasize the fact that no hard and fast line of demarcation can be drawn between the bodily and mental effects of smoke-clouds or smoke-produced weather states. The human organism is a psycho-biological unity, and we cannot, except in a purely artificial and arbitrary fashion, divide the *soma* and the *psyche* into two independent compartments. Bodily states normally influence mental states and mental states, in turn, normally influence bodily processes, particularly the functions of the glandular, circulatory, sexual and neural systems.

I. The Pathology of Smoke

THE DIRECT AND INDIRECT EFFECTS OF SMOKE ON BODILY AND MENTAL WELL-BEING.

A. The direct effects of smoke on health and conduct.

When it is remembered that the average adult consumes about 30 cubic inches of air in each inhalation or possibly 864,000 cubic inches every day, it does not seem an exaggeration to say that more persons are devitalized, disabled and poisoned by the impurities contained in smoke-polluted air, than by the noxious ingredients in food and water. Not only do the solid and vaporous ingredients of smoke-begrimed air—noxious compounds of carbon, sulphur, nitrogen, chlorine, and arsenic—irritate the sensitive membranes of the eyes, nose, throat and lungs, and thus aggravate or cause inflammatory diseases of these organs, or produce collapse of their sensitive tissues, or increase their susceptibility to such specific diseases as bronchitis, pneumonia and subacute forms of phthisis; but the poisonous compounds also enter the gastro-intestinal tract, and this causes nausea, vomiting, diarrhea and systemic poisoning. That the gastro-intestinal tract is affected by inhaled solids has been demonstrated by the experiments of Saito (19)[1] on dogs and rabbits which were compelled to inhale, during periods varying from 1 to 33 hours, air charged with white lead dust. Only from 4 to 24% of the dust was subsequently recovered from the respiratory organs while the remainder was found in the digestive organs. In the case of a man who inhaled the air from 10 to 15 minutes on 20 occasions and who avoided acts of swallowing, 95% of the dust remained in the body, 50% of which was primarily retained in the nares. By processes of exclusion 12% probably found its way to the lungs, for 60 to 80% was recovered from the alimen-

1. Figures placed within parenthesis refer to the corresponding references in the bibliography at the close of the paper.

tary canal. Thus the principal portal of entry of soluable inhaled dust appears to be the alimentary canal.

The deleterious effects on the human system from inhalation of smoke-polluted air, which contains not only acrid and irritating solids, but a certain amount of deadly poisons, should be obvious from a consideration of the comparatively great density of the impurities in the atmosphere of industrial centers. The weight of the solid matter in the soot-laden air at Leeds, England, has been found to be 1.2 mg. per 100 cu. ft. of air, or 200 lbs. per sq. mi. (300 ft. high.) The soot-fall per square mile per year has amounted to 220 tons in Leeds, 820 tons in Glasgow and 259 tons in London. , Moreover, by means of the dust counter the number of dust particles in the air at Leeds has been found to vary from 530,000 to 3,736,000 per cu. inch. In manufacturing cities the number of dust particles often exceeds 300,000 per cu. cm. even in fine weather, as compared with a few hundred in the country (Aitken, 4). A large percentage of these particles consists of the soot from factory, locomotive and domestic fires. Not only are these conditions, bad as they are, aggravated during foggy weather but on moderately foggy days the quantity of solid organic impurities may be increased 700% as compared with fine weather (Russell). During grimy, opaque fogs, the conditions are still worse.

That the constant inhalation of poison-laden air, largely made up of the soot particles which abound in manufacturing cities, diminishes the potential reserve, the productive efficiency and the bodily well-being of our city dwellers by causing specific diseases, has been abundantly shown by various studies. The mortality from acute pulmonary diseases, especially in children and old people, has increased, and the course of pulmonary tuberculosis has been accelerated in Germany as the country has become more industrial. The increase in non-tubercular lung mortality has amounted to 30% in the smoky town of Waldenburg compared with the nearby textile town of Wusterwaltersdorf (Ascher, 16). The death rate per 10,000 for the same diseases is 30.6 in the non-smoky city

of Hamm as compared with 57.4 in the smoky city of Gelserkirchen. In all German towns with a population of over 15,000 the death rate is 24.0, while in the smoky industrial centers of similar size in Rhenish Westphalia it is 34.0, and in the industrial districts in upper Silesia it is 36.0 (Ascher, 4); in rural districts in England it is 17.5 compared with 26.5 in urban industrial districts (4). During the anthracite strike in this country there was reported an increase of suspected tubercular cases. In Rochester there was observed an increase of pulmonary affections with the increase of the smoke nuisance between 1895-1904. In Pittsburgh a recent investigation by Dr. W. C. White shows that pneumonia increases with the density of atmospheric smoke, irrespective of the density of population or of poverty. The increase is as marked in the well-to-do as in the poorer sections with relatively the same smoke density. In late years pneumonia has assumed a very acute and fatal form in Pittsburgh.

That "much of human life, energy and happiness is wasted by the effects of vapors, noxious because wasted, is now an established certainty" (Gillespie, 8). It has been estimated that London's annual smoke tax amounts to $1,500,000 in death, disease and lowered working capacity alone. Unfortunately up to the present time there has been no scientific attempt made to directly measure the degree in which the producing capacity and the bodily and mental efficiency of city dwellers may be impaired by atmospheric impurities, nor has any effort been made to measure the direct or indirect influences of smoke upon sensory, motor, intellectual, affective and emotional functions, and on the habits and conduct of human beings. A part of the human waste caused by smoke-polluted air is certainly due to the irritation caused by solid smoke particles. The functional efficiency of the visual, naso-pharyngeal, pulmonary, gastro-intestinal and neural mechanisms, may be more or less disabled by constant irritation by solid particles. But it is likewise presumptively probable that irritating, acrid soot particles and poisonous smoke compounds may become factors in causing prema-

ture decay, untimely death, exaggerated fatigue, frequent sickness, instability of attention, malcontent, irritability, lessened self-control and possibly psychic disequilibrium. It is probable that there goes on a gradual process of absorption by the human system of the poisonous products of imperfect smoke combustion. This insensible intake may not give rise to any definitely recognizable acute disorder or specific disabilities. But the process of slow poisoning may insidiously eat away like a mild canker at vital tissues and thus in time deplete our potential reserve, thereby making it impossible for body and brain to function at their points of maximal efficiency. With an impaired brain the mind cannot reach its highest levels of creative insight and constructive achievement. It has often been a matter of comment that people who have lived in relatively smoke-free cities after coming to live in a city like Pittsburgh, have experienced a distinct disinclination to work, or a sort of chronic ennui. A Pittsburgh business man writes that "people coming to Pittsburgh to reside notice a great depression; likewise many residents of Pittsburgh on visits find they feel infinitely better and business men working for periods in cities where there is not the same smoke find they can do twice as much work. These are not isolated cases but the result of very general inquiry which I have made for a number of years.[2] People very frequently remark on the depressed expression not only on the working men of Pittsburgh, but they also observe it in the clubs. It is very frequently referred to humidity, but this is entirely wrong as the humidity in New York ranges much higher than in Pittsburgh. This certainly is a condition that tends to keep people from coming here and makes people desirous of leaving at the first opportunity."

The writer of this essay has now lived in Pittsburgh somewhat over a year and has experienced during this time a marked distaste or disinclination to engage in pro-

2. The writer has confirmed this statement in inquiries made among a number of recent professional arrivals in Pittsburgh, who say they are more fatigued by their work here than in other cities where they have labored.

ductive authorship. Clear, trenchant, reflective thinking seems to have been more difficult; and the attempt to write concisely, incisively and perspicuously has seemed more labored. Is it possible that the low esteem in which Pittsburgh is held in the world of productive scholarship—a matter of occasional remark among medical men and other scientists—is due to the fact that the air which its scientists must breathe is polluted and poisoned by smoke? [There are other contributory factors, as we shall see in the following sections, viz., the various devitalizing weather states induced by smoke, and possibly the common use of convection heat from gas stoves in the living rooms. Convection heat from gas stoves, it is maintained by Scotch investigators, is more injurious than heat by radiation (21).] Is it possible that the highest spiritual creations of the citizens of smoke-begrimed cities are being sacrificed on the altar of commercial greed? Is it possible that, in the interests of a pseudo-economy, we are impairing the very brains of the people by permitting our breathing air to be saturated with the poisons of preventable fumes? Is it possible that the industrial energy for which Pittsburgh has become famous is less due to the surpassing excellence of the brain and brawn of its workers than to the munificent bounty of its mines? We shall probably not be able to offer any satisfactory answer to questions such as these until a series of controlled psychological experiments on efficiency, fatigue, and endurance (in so far as various motor, sensory, and intellectual functions are concerned), have been carried out under varying degrees of density of atmospheric smoke.

B. The indirect influences of smoke on mental and physical well-being; the meteorological aspects of atmospheric smoke contamination.

I shall first discuss the meteorological variations produced by smoke, and then the effects of the smoke-produced weather states upon well-being.

The smoke-clouds of our cities influence a number of weather states which affect human conduct. The meteoro-

logical conditions particularly affected are: sunshine, clouds, humidity, fogs, temperature, electrical potential and luminosity. That the smoke from factory and domestic fires, by filling the atmosphere with opaque clouds of smoke and by inducing mists and fogs, deprives the city dwellers of the luminous, vitalizing, cheering, health giving, germicidal rays of the sun, has been proved by numerous observations and tests. It has been computed that seven-eighths of the sun's power is shut out by the smoke in the manufacturing center of London, and five-eighths in Westminster. The percentage of sunshine in these two places compared with the rural stations of Oxford, Cambridge, Marlborough and Gildiston was found to be as follows (12):

TABLE I.

	Winter	Summer
From 1881-1885:	17%	83%
" 1906-1910:	38%	92%

It is observable that the amount of sunshine suffers an enormous reduction in the winter time but only a very slight diminution in the summer, and that during the last five years the conditions have considerably improved, due, as we are told, to the considerable abatement during the last decade or two of London smoke. During one calendar year the hours of sunshine in the center of Leeds amounted to 1164 while the corresponding figure for Adel, which is only 4 miles distant, was 1402 (4). Thus the loss of sunshine in Leeds due to smoke amounted to 17%. The diminution of sunshine in towns near smoke-producing cities is, again, shown in the following tabulation of the comparative monthly average duration of bright sunshine for a period of 20 years (24):

TABLE II.

Station	Nov.	Dec.	Jan.	Feb.
Runhill Row	22.8%	7.5%	14.1%	30.5%
Westminster	27.7%	13.1%	18.4%	32.8%
Kew	50.8%	38.1%	40.3%	54.6%
Cambridge	61.0%	40.6%	48.9%	72.8%

At Kew, seven miles west of London, the reduction of sunshine due to the London smoke has been placed at 37% for a whole year.

In the United States of America for the decennium, 1901-1910, the aggregate hours of sunshine, percentage of possible sunshine, number of cloudy days, number of partly cloudy days, and number of foggy days have been found by the Pittsburgh smoke investigators, from a study of the records gathered by the United States Weather Bureau in various cities throughout the country, to be as shown in Table III.

TABLE III.

STATISTICS OF SUNSHINE IN 18 CITIES OF THE UNITED STATES

Station.	1. Aggregate hrs. of sunshine.	2. Percentage of possible sunshine.	3. No. of cloudy days.	4. No. of partly cloudy days.	5. No. of foggy days.	6. Total of 3 and 4.
Baltimore	26,466	58.7	1440	1018	142	2458
Boston	25,877	56.8	1398	1003	98	2401
Buffalo	23,200	49.7	1713	1324	157	3037
Chicago	26,442	57.9	1238	1282	116	2520
Cincinnati	26,758	58.6	1356	1202	81	2588
Cleveland	22,394	47.8	1584	1187	67	2771
Denver	29,355	65.9	645	1500	45	2145
Detroit	23,201	50.3	1477	1165	133	2642
Los Angeles	31,521	70.9	743	1404	258	2147
Louisville	25,715	56.8	1284	1094	233	2378
New Orleans	26,091	58.6	1045	1365	162	2410
New York	28,762	57.6	1279	1182	120	2461
Philadelphia	25,249	56.6	1369	1071	127	2440
Pittsburgh	22,573	49.0	1385	1294	185	2679
Portland, Me.	26,914	59.4	1321	1040	303	2361
San Francisco	25,453	56.3	900	1136	241	2036
St. Louis	24,957	58.7	1185	1019	42	2204
Washington D. C.	25,078	55.8	1088	1135	115	2223

It is observable that all the cities which have become notorious in the matter of smoke pollution show a very low percentage of sunshine, the worst conditions obtaining in the two cities having the most unsavory reputation for

smoke, viz., Cleveland and Pittsburgh. These two cities consistently have the worst records for sunshine, for percentage of possible sunshine and for cloudy and partly cloudy days (combined totals). Unfortunately no meteorological data are available from stations situated in non-smoke-producing centers whose geographical conditions are similar to those obtaining in smoke-producing cities like Pittsburgh, Cleveland, Detroit, Cincinnati and St. Louis. The above data only enable us to compare the atmospheric conditions of one smoky city with another smoky city or with cities whose geographical surroundings are so different as to render the data useless for comparative purposes. However, the data recently collected by the Smoke Investigation of the University of Pittsburgh show, in complete accordance with similar English findings, that the lessened amount of sunshine in Pittsburgh is due to the smoke factor. Figures based on the number of tons of coal consumed in Pittsburgh from 1905 to 1911 show a fair degree of parallelism between the quantity of coal consumed and the number of smoky days. During the years in which an increasing amount of coal has been burned (owing to the heightened cost of gas) the hours of sunshine have fallen from about 2800 to 2200. Likewise the days on which the United States Weather Bureau has observed light or dark smoke in Pittsburgh, have increased as follows for the successive years from 1905-1911: 85, 87, 106, 124, 112, 100 and 156 days (O'Connor, 17). With the increase of coal consumption has come an increase of smoky days. Dr. Benner tells me that the per cent. of daylight (as chemically determined) in Pittsburgh was reduced for last November about 32%, for December 23%, January 36% and February 44% as compared with the town of Sewickley which is only about 12 miles distant. There can then be no doubt that smoke lessens the amount of sunshine.

Smoke likewise is directly related to the production of moisture, mist, clouds, rain or fogs, because it supplies some of the solid particles which may serve to aid in the formation of suspended drops of water. Rain drops are

often formed around a solid nucleus. Without solid particles of dust in the atmosphere there would probably be much less mist, rain and dew (4). We would, therefore, infer on merely *a priori* grounds that smoke contributes to the production of fogs. That this is so seems to be shown by actual investigation. An investigation conducted by the Meteorological Council in 1901-1903 indicated that 20% of the fogs in London were smoke-induced, (4, 21)—artificially induced and therefore preventable fogs. Most suggestive, as showing that smoke is partly responsible for the existence of fogs, are the fog and smoke statistics gathered in London during the last 30 years, as shown in Table IV (applicable to the winter months only). The number of days of fog have been reduced nearly 300% and the hours of bright sunshine have increased nearly 100% during this 30-year period (10).

TABLE IV.

Date	Days of Fog	Hours of bright sunshine
1883-1892	29.9%	55.6%
1892-1901	20.7%	70.1%
1901-1910	10.6%	93.5%

Likewise in Westminster the number of days of fog averaged 27 per year for the lustrum 1902-1906, and 17 per year for the period 1907-1911. The improvement shown above is due, in large part, to the increased use of gas and electricity and to better stoking (Kershaw, Russell). On the other hand, if we turn to Pittsburgh where the amount of smoke has been on the increase in recent years, we find that the number of days of fog increased from an average of 22.6 per year for the first five year period to 50.2 for the second five year period, 1907-1911.

Not only is smoke related to the frequency of fogs, but it also increases both the duration and the density of fogs. The water globules become coated with a film of black, sticky, tarry soot which retards evaporation. These soot fogs, or "pea-soup" fogs as they have often been called because of their grimy opacity, may at times be-

come practically impervious to the luminous rays of the sun. Even in one of the lighter varieties of fogs the soot products may increase seven fold. Many average soot-fogs reduce the amount of light one-half. On an exceptionally dark day in Berlin the light was only 1/500 of what it was on an ordinary overcast day and only 1/3000 to 1/4000 of what is was on an entirely clear day (H. H. Kimball). The smoke in the center of Leeds on an ordinary day absorbs as much as 25% of the total daylight as compared with the suburban sections of Leeds, or 40% as compared with the suburb of Garforth, which is 7 miles distant (4).

That smoke must materially decrease the limits of visibility is patent from what has been said. The limits of visibility vary with the number of dust particles in the air: 1,000 particles per cu. cm. render large objects like mountains invisible at a distance of 100 miles; 100,000 particles render them invisible 1 mile away, and 1,000,000 particles 1/10 of a mile distant (Aitken). Smoke not only fills the atmosphere with countless numbers, but with extremely opaque particles. These particles may unite with globules of water and this makes the atmosphere still more opaque. As was stated above, in large cities even in fine weather there may be over 300,000 particles per cu. cm., as against a few hundred in the country. Accordingly, we find in London that the limit of visibility in the winter time, even during the clear part of the day, does not exceed one-half mile.

The temperature readings are somewhat unsatisfactory because they usually include only the maximum and minimum records for each day. Minimum temperatures are found to be perceptibly higher in the cities than in the country, partly because of city heat, but chiefly because the smoke blankets prevent the escape of the heat at night. In Pittsburgh the minimum temperature averages about 4° higher than the temperature in the adjacent stations (Kimball). In the day time the upper surface of the smoke clouds absorbs portions of the sun's heat, and this inevitably lessens the heat on the ground surface. The

solar energy has been reduced 40% by smoke clouds (12), and it is possible that very little heat penetrates to the earth's surface during a very dense smoke cloud. In London the surface temperature during a given reading was 44° F., while 59 ft. directly above it was 51.5°, a difference of 7.5°. Between 9 A. M. and 3 P. M. the surface temperature rose 7.5°, while the roof reading rose 16.5°, or more than twice as much. Although thoroughly satisfactory data are not available it is undoubted that smoke (which is most abundant in the atmosphere in the winter time, owing to lessened convection) lowers very perceptibly the diurnal winter temperature in smoke-producing cities.

Finally, smoke indirectly affects the electrical potential of the atmosphere. I know of no direct study of this question, but it is possible that smoke causes a decrease in the potential because it tends to increase humidity. An increase of humidity decreases the potential (save possibly during fogs, as noted later, 14). We are also told that the potential increases with the turbidity (Trubung) of the atmosphere, and consequently with high barometric pressure. Since smoke tends to decrease the diurnal temperature, particularly in the winter time, it apparently tends to increase the diurnal potential, as the potential decreases with increasing temperature (14).

Having thus discussed the atmospheric changes caused by smoke we now turn to the second question. How do the various smoke-induced weather states affect the mental and bodily health and happiness of human beings? It is evident that the problem can be formulated largely in terms of sunshine dynamics. On the one hand, we have the psychic and physiological influences of positive states of sunshine: brightness, luminosity, warmth, dryness, the presence of the infra-red, spectral and ultra-violet rays, and high electrical potential (because of dryness). On the other hand, we have the effects of the negative states: gloom, darkness, cloudiness, fogginess, rain, moisture, cold and low electrical potential. It is utterly impossible to

separate all of these components, and it will, therefore, be no easy task to measure the influences of each component.

Literature, both poetry and prose, contains frequent allusions to the alleged effects of sunshine or the absence of sunshine on the feelings of man. Charles Lamb "felt himself immortal" and "a great deal taller" on bright days. Moore took delight in sitting in the sunshine:

"Blessed power of sunshine! genial day,
What balm, what life are in thy way!
To feel thee is such real bliss,
That, had the world no joy but this,
To sit in sunshine calm and sweet,
It were a world too exquisite
For man to leave it for the gloom,
The deep cold shadow of the tomb."

Byron felt "more religious on a sunshiny day," Pope refers to "the soul's calm sunshine," Rousseau sat with bared head in the sun; Shelley so coveted the most intense sunlight that he did his writing from the roof, while it is a common observation that people generally, and particularly the aged, instinctively seek the sunshine. Mrs. Hemans wrote a rapturous apostrophe to the sunbeam:

"The sunbeam of summer
O! what is like thee;
Hope of the wilderness,
Joy of the sea."

Many writers cannot do satisfactory work unless the weather fits the mood, motive or scene; unfavorable weather states cause a disagreement in the thought processes (27).

Southey refers to the depressing influence made upon him by the "vile, dark, rainy clouds" of Great Britain, when he returned from a sojourn of 15 months in sunny Italy, where his brain was in a state of high illumination. An Italian proverb runs thus: "Where comes no sun the doctor comes." Similarly a German saw: "The funeral coach turns twice as often on the shady side of the street

as on the sunny side." J. Ashby-Sterry has dwelt upon the demoralizing effect of the London fog:

"A London fog when it arises
All London soon demoralizes."

"It chokes our lungs,
Our heads feel queer,
We cannot see, we cannot hear!
So when this murky pall drops down,
Though dearly loving London town,
We feel we cannot quite revere
A London fog."

Likewise Walter C. Smith:

"A grey fog in the early prime,
A blue fog by the breakfast hour,
A saffron fog at luncheon time,
At dinner a persistent shower
Of smut, and then a dismal power
Of choking darkness and despair,
Thickening and saddening all the air."

A special questionnaire investigation on nephelopsychosis made some years ago by G. Stanley Hall and the writer (9) indicated that heavy black clouds and fogs may often strike fear or terror into children, or may make them feel depressed and gloomy or restless. Some children experience "terrible fear" at times and others feel that "something dreadful will happen when the horrible black ones appear." There are cases on record of actual motor paralysis caused by terrifying clouds. There is here an interesting parallelism between the emotional responses called out by clouds in the children of to-day and the responses called out in primitive races. In his mythopoetic tendency primitive man read fear and danger in dark clouds, particularly the black thunder clouds. The smoke clouds of our city probably depress children just as any dark clouds do, and when particularly black may also arouse nephelophobias.

Sir Archibald Geikie has ascribed the subdued, grim character of the Scot to the gloom of his valleys and the canopy of cloud "which for a large part of the year cuts off the light and heat of the sun." The French formerly regarded the Englishmen as "rude, unlettered . . . surly, ill-conditioned men, having lived in an unhappy climate where perpetual fog, only varied by rain, prevented the sun from ever being seen, suffering from so deep and inveterate a melancholy that physicians had called it the English spleen, and under the influence of this cruel malady constantly committing suicide, particularly in November, when we were well known to hang and shoot ourselves by the thousands" (2).

On the other hand, there are those who believe that the monotonous gloom of England has inoculated the Britain against moods of depression and hypochondria, and made for the evenness of temperament which is said to characterize him (18). Gloomy weather would thus serve as a catharsis against the very depressions which it is said to induce. I must confess that this reasoning seems to me to be quite specious. The effects of meteorological monotony, particularly of depressing states, probably do not differ from the general effects of physiological or psychic monotony: narcosis, hypnosis, fatigue, overstrain, distaste, or aversion. However that may be, there can be no doubt that many persons experience an exhilarating, tonic effect on a bright, sunshiny day and a depressing influence on gloomy days—assertions that have, indeed, been ridiculed by Dr. Johnson. Fortunately these impressionistic views on the buoyancy of sunshine and on the depression of gloom (particularly cold or hot, damp, dark days) find a certain degree of support in scientific studies.

Deprived of sunshine the human skin assumes a pale greenish hue, like the skin of the people in the polar regions. This is probably due to the absence of the blue and ultraviolet rays of the sun which dilate the blood vessels and bring the blood to the surface, and to the absence of the infra-red rays which are associated with heat. Sunshine

promotes transpiration and perspiration, and thus favors the elimination of toxic products through the skin. Bright, sunny days lessen the strain on the kidneys.

The amount of blood and the per cent. of hemoglobin are increased by sunlight and decreased by darkness. Oerum, in an experiment on animals, found that light increased the quantity of blood 25% in 4 hours. Likewise Grawitz and Graffenberger have observed a diminution in the quantity of blood in animals kept in the dark, while Marti found under similar conditions that the number of red blood corpuscles was lessened (13). There is thus a loss of red coloring matter in the blood of animals kept in the dark. The well-known baker's anemia points to the same impoverished state of the blood in night workers (Gardenghi, 13). Not only so: in an examination of 29 persons Finsen (7) found less hemoglobin in the winter than in the summer, presumably because of the diminished sunshine in the winter time. Diesing suggests that the lack of sunlight in northern countries is an essential factor in the causation of rachitis. The rays of the sun—specifically the blue and ultra-violet rays—thus exercise a tonic or stimulating action on the organs of circulation, transpiration and elimination, and very probably also directly stimulate the nervous system. Finsen has shown that benumbed or apparently dead insects have been revitalized by the application of ultra-violet rays. It is doubtful whether this stimulating effect is due to increased electrical potential, as argued by Dexter (5), because the more intense the sunshine and the higher the temperature the lower is the potential (14). The stimulating effect is probably due to the chemical action of the short rays of light. These rays probably penetrate the deeper tissues of the body just like the X-rays. It is well known that persons suffering from chronic joint disease, particularly from joints affected with tubercular sinuses, can be greatly benefited or entirely cured by constantly exposing the affected limbs to the direct rays of the sun. Guggenbuhl, it will be recalled, attained some success in the treatment

of cretinism simply by removing the cretins from the dark Alpine valley to the sunlit summit of the Abendberg.

Because of the stimulating effect of sunshine, may not an excess of sunshine be just as detrimental as a deficiency? It has, indeed, been assumed that the climatic dangers of the tropics are largely due to the injurious tropical sunlight, particularly to the abundance of the ultra-violet rays. Woodruff holds that the failure of the white race to colonize in the tropics is due to the excessive light, and not to the heat and humidity. The light, he contends, tends to produce ennui, neurasthenia and ultimate collapse in blond persons (26). This conclusion is not sustained by recent investigations. Experiments have shown that monkeys do not succumb from insolation in the tropical sun if care is taken not to allow the bodily temperature to rise, by conducting away by brisk air currents the excessive heat (Aron, 23). The injurious quality of the solar light is thus due to the infra-red and not the ultra-violet rays. The white man can secure adequate protection in the shade from the heat rays, and by wearing white clothing he can be adequately protected from the ultra-violet rays.

Whether the retinal excitation by the sun's rays exerts any stimulating influence is not known. It is known, however, that red colors are stimulating. They excite some animals (for example, cattle, frogs and turkeys) and increase muscular strength. Thus Fere obtained the following strength records: with ordinary light, 23 units; with blue, 24; with green, 28; with yellow, 30; and with red, 42 (29). Colors, as is well known, possess marked affective qualities, due not merely to the affective tone of the sensation and the sense feeling, but to the affective elements of consciousness, namely associations, emotions and sentiments (29). That sunlight does exert psychic influences apart from any specific retinal influence is a matter of common experience. Nevertheless, the most important visual influence of sunshine is perhaps not the emotional satisfaction, cheer or exuberance which it engenders, but the optical value of good daylight. Daylight

is relatively colorless because it contains both chromatic and achromatic light. A bright colorless illumination is best from the standpoint of visual efficiency, health and affective quality. It is less fatiguing than a colored light or than intense or dull artificial light. Electric lights are often too intense because of the proximity of the light or because the rays are thrown directly into the eyes or directly upon the object under observation. They thus overstimulate the sensitive layers of the retina, and this may cause degenerative changes. Mercury vapor lamps and old Welsbach burners emit a greenish flame whose affective quality is very disagreeable to many persons. Many of the gas jets in common use, unless equipped with incandescent burners, not only give a weak flickering, dirty yellowish light, which is extremely fatiguing and irritating to the eyes, but they also vitiate the air of the living rooms, particularly in the homes of the poor in the winter time. Add to these difficulties the further fact that by habit and association we have learned to base our visual estimation and discrimination of things on their appearance in broad daylight, and we begin to appreciate the baneful optical effects of the frequent obscuration of the sun by smoke clouds, by smoke-produced water clouds and fogs, and by the filling of the atmosphere with opaque particles. As stated before, particles in the air and fogs may reduce the limit of visibility from one mile to less than one city block. During the dark days which are common in manufacturing cities the lights must be kept burning in the homes, schools, shops and factories—anywhere, in fact, where close eye work must be done—all day. Almost always the lights must be turned on very early in the evenings. Very frequently the intensity of artificial illumination does not meet the requirements of visual health. Aside from this, artificial illumination entails a considerable economic loss. Worse still is the condition of those who, through financial limitations, must work in the dark gloom of smoky days without the aid of artificial light. The writer has shown in a special experiment on the visual estimation of distances that bright objects are judged to

be nearer the observer than similar black objects when placed at the same distance (25). This being the case, it is evident, as indeed common observation indicates, that anything on which the eyes must be fixated in darkened illumination will be imperfectly envisaged. To overcome this optical handicap, there is a strong tendency to move the object too near the eyes. If done repeatedly this entails a severe strain on the muscles of accommodation, causing increased muscular fatigue, which may result in muscular paralysis, inbalance or dioptric distortions. On the other hand, by illuminating an object with good daylight it will be made to appear nearer to the eye. The result is that objects will actually be held at a further distance and distant objects will be seen without eyestrain. If an investigation could be carried out on a large scale with sufficient accuracy, it is possible that a greater prevalence of myopia, myopic astigmatism and other eye disorders would be found in densely smoky cities than in smoke-free cities, so that a positive correlation would be found to exist between eyestrain or certain eye disorders and atmospheric smoke.

Dark days repress the infra-red rays and thus diminish solar energy. In fact, on excessively smoky days only a small amount of solar heat penetrates to the earth's surface. This circumstance may be rather welcome to man during the excessive heat of the summer (although objectionable to plant life), but during the winter time it may cause much misery, particularly among the poor, because of the excessive diurnal cold during this season (smoke clouds elevate the nocturnal temperature). It is also possible that the reduction of the heat profoundly affects the habits of the community. Thus Dexter (5) has shown that low temperatures (10°) produce an excess of drunkenness amounting to 38%, while high temperatures (85°) decrease drunkenness to the extent of 40%. High winds, which lower the bodily temperature, also increase dissipation. The increased tendency to dissipate probably results from an attempt to seek forgetfulness from misery

in alcoholic narcosis, or from an attempt to artificially elevate the body temperature by indulgence in drink.

Dark days exert a particularly sinister influence upon working people. One factory head has ventured the opinion that a disagreeable day yields about 10% less in labor returns than an agreeable day. During human labor the chemical products of activity are greatly augmented. The amount of carbon dioxide given off during a day of work is nearly twice as much as during a day of rest. Observations on the embryos of frogs also indicate that more carbonic acid is given off when it is light than when it is dark (Moleschott). Therefore, merely reasoning from these premises, it would appear that the bodily waste products from muscular activity, and probably also to a lesser extent from mental activity, are more injurious on dark than on bright days. Not only so: dark, sunless days are likely to be moist, rainy or foggy. During foggy days particularly the poisonous gases are unable to rise because of the atmospheric stagnation that obtains during fogs. On these days the amount of carbon dioxide may sometimes be increased from 200 to 300% as compared with clear days. Dexter (5) attributes the devitalizing, depleting effects of fogs to lowered electrical potential. He regards atmospheric states of high electrical potential as stimulating and vitalizing to animal life. But it has not been conclusively shown that the electrical potential is decreased during fogs. On the contrary, it is maintained that fogs, especially thick, winter fogs, usually raise the potential (14), while the low ground fogs in late summer and fall have been found to lower the potential. But then, again, Chauvenau found that thick, city fogs exercised no influence on the electrical potential. It has, therefore, not been proved that lowered electrical potential has anything to do with the depleting effects of fogs; but I am of opinion that the suppression of the tonic chemical rays of the sunshine is an important factor.

Again, moisture in the atmosphere may become very injurious because it absorbs the poisonous exhalations of living organisms. Hence the air which must be breathed

on moist, dark days is liable to be surcharged with toxic waste products which poison the individual.

The effects of moisture *per se* vary with the temperature. During warm, moist atmospheric conditions there is diminished evaporation from the lungs, fewer red corpuscles (because there is less oxygen in the air), increased tendency towards intestinal troubles, lowered resistance, and greater mental and bodily fatigue and prostration; while during cool moist weather catarrhal, respiratory and rheumatic affections are aggravated (3, 26).

It has been observed that changes in the density of moisture affect the sensitivity for odors, tastes and touch. Tea-tasters do their best work on fair days (11).

That the electrical potential decreases with increase of humidity has, apparently, been established, except under conditions of fog. It we grant that a state of high electrical potential stimulates and energizes the organism, then a part of the devitalizing effect of humid days must be ascribed to a lessened potential.

Not the least detrimental effect of the dark smoke strata of our cities is the fact that they intercept the bactericidal rays of the sun, namely, the blue and ultra-violet rays. These rays either check the growth of, or completely exterminate, various kinds of pathogenic bacteria (1, 6). Their deadly effect on the tubercle bacilli is universally recognized. Indeed, as Sternberg points out, sunlight is one of the most potent and one of the cheapest agents for the destruction of pathogenic bacteria. Less diseases are found during sunshiny than foggy or cloudy weather, while the death rate increases considerably during fogs. Thus during a November fog in Glasgow the death rate rose to 13.9 while in other Scotch towns free from fog it was only 3.3. But the increase in the mortality is not merely due to the fact that the sunless, foggy states lower the temperature and favor the growth of micro-organisms, but the water globules absorb particles of dust and acrid smoke and the toxic products of respiratory waste. (In factories dust particles become vehicles for the products of human fatigue.) The inhalation of these products irri-

tates and poisons the mucuous membrane. Moisture is particularly injurious in cases of pathological nasal obstruction. We should not forget, then, that fog and particularly dense smoke fog may entirely extinguish those rays of the sun which exert not only a germicidal action, but which also possess a tonic, vitalizing quality, viz., the short wave lengths.

Now, since smoke diminishes the sunlight, reduces or suppresses the heat giving infra-red and the tonic ultra-violet rays, and diminishes the electrical potential (at least during certain states of the atmosphere); since smoke increases humidity, both during cold and warm weather, but particularly during cold states; and since it also increases fogs, and since fogs and humidity tend to increase the poisonous, bactericidal and solid contents of the air and to decrease the electrical potential and the heat light rays; it is evident that smoke must exert an important influence on human health, happiness and efficiency, and that the smoke nuisance must be regarded as a problem of very vital concern to any community that would conserve the vital efficiency of its citizenship.

The assumption that smoke is an immediate, indirect conditioning factor in human behavior, because of its sinister influence on weather states (aside from its intrinsically pernicious qualities), is at least suggested by the only comprehensive study extant of the relation of weather to abnormal behavior: viz., Dexter's investigation of the influences of various weather states on the conduct of a large number of child and adult offenders in Denver and New York City (5). The data which he studied included records of misdemeanors in schools, penitentiaries, and hospitals for the insane, arrests for assault and battery, for suicide and murder, records of deaths and bank errors, and strength tests. From this study Dexter arrives at the conclusion that days with high temperature and high humidity are unfavorable to metabolism. More specifically: anabolism is favored by high temperatures (though high temperatures deplete the vital reserve), high winds (because of better ventilation), and fair days with

low humidity; while katabolism is increased by low temperatures, high humidities, high barometric pressures, rainy and cloudy days, and calms. (During fogs there is usually a condition of calm and a fall of temperature.) The katabolic weather states tend to deplete vitality, lower the vital reserve and augment the death rate, while the anabolic states tend to stimulate, invigorate, irritate and increase the nervous tension. Conformably with this classification of weather states Dexter finds statistically that anabolic conditions increase all the data which are of the nature of offenses.

Thus—to limit the discussion to the weather states which are influenced by smoke—school misdemeanors were increased on fair and dry days, on days with high winds (an increase of 200% in Denver), and days with low humidities (increase of 200% in Denver between 10° and 30°; and 33% in New York City between 50° and 55°). Assaults were likewise increased on clear days. The records of suicide and attempted suicide during a period of 5 years in New York City indicated that suicides were 31% more frequent on dry than on wet days; 21% more frequent on clear than cloudy days (another investigation gave an increase of 1700% on clear and dry days, while an article in the Popular Science Monthly states that the excesses were on days of high humidity), and less frequent on rainy days. The traditional view is that most suicides occur on cloudy and not on clear days. Villemair claimed that nine-tenths of all suicides took place on rainy and cloudy days, while Dickens, Lytton and Pope stage their tragic climaxes on cloudy days. Statistical evidence does not support these popular notions.

Likewise clear, and particularly excessively dry days, increased the number of arrests for inebriety, although in the article in the International Journal of Ethics it is said that humidity increases drunkenness.

On the other hand, school misdemeanors were reduced on humid, rainy, snowy and possibly on cloudy days and days with high temperature; while adult assaults, murders and disciplinary cases in penitentiaries and institutions

for the insane were also reduced on excessively humid days. On foggy days more bank errors were made in New York City, a finding in harmony with the practice adopted by the Bank of England of requiring clerks to work at less intricate and less important problems on foggy and depressing days.

Waiving certain discrepancies which appear in a comparative examination of Dexter's various articles it appears that school misdemeanors, assaults, suicides and drunkenness are increased on clear and dry days. The increase in the assaults and drunkenness may be due to the fact that people go out more on clear than on wet days, hence have more opportunities for getting into brawls—though one might argue that on dark, foggy days they would be driven into the saloons, thereby increasing the offenses. On dry days perspiration is increased and therefore there is more demand for liquid refreshment. But, what is more important, there is also very probably some stimulating or irritating quality in clear, dry, sunshiny weather. Dexter assumes this, though he does not ascribe the stimulating quality to the dryness but to the increased electrical potential of dry air. Pupils are stimulated on clear, dry, sunny days, hence they are more active, aggressive and enterprising, but likewise more restless, high strung, emotionally unstable and therefore also more mischievous. A superabundance of energy and not a state of enervation predisposes to childish pranks and nervous explosions. An increase of vitality and nervous tension upsets the unstable equilibrium of the predisposed offender, gives him a false sense of strength, and an exaggerated idea of self-importance (often paranoia-like in its intensity), and hence he becomes more aggressively criminalistic. Moreover, the exhilarating qualities of tonic days give the potential suicide just the courage he needs to take his own life, the courage which he may be unable to muster during states of depleted vitality. Devitalized states of the body breed fear, diffidence and cowardice.

On the other hand, the humid and hot days are devitalizing (because of low electrical potential, according to Dexter) and therefore lead to inaction. Depleted vitality and nervous exhaustion are inhibitory of action, hence during devitalizing weather states misdemeanors decrease in number.

There is no doubt that opposed weather states exercise stimulating and irritating influences, on the one hand, and enervating and inhibitory influences, on the other hand; but it is not clear that this is due to a difference of electrical potential. It remains to be shown that heightened electrical potential acts as a nervous tonic and irritant. The theory assumes that heightened winds and sunshine increase the potential; but meteorologists tell us that the potential is independent of both the direction and the velocity of wind; and that the more intense the sunshine the higher the temperature, and the purer the air, the lower is the potential (14). It is apparent that these conclusions go counter to the theory demanded by Dexter's empirical findings (except in the case of humidity uncomplicated by fogginess), and that a more satisfactory basis of explanation is to be sought in the bio-dynamic properties of the sun's rays, especially of the blue and ultraviolet rays. These rays dilate the blood vessels, increase the hemoglobin, increase anabolism, transpiration, irritate the skin, stimulate and vitalize nervous, muscular and mental action, and augment the potential reserve, working force and functional efficiency of the individual. If this is true it is clear that bright, sunny states while they increase misdemeanors and crimes in unstable individuals, also—and this is more important—energize the human organism.

On this theory the damp, dark, smoky, foggy days are depleting and depressing just because (at least so far forth) they are lacking in the tonic, health-giving rays of the sun. The investigations cited above indicate that these weather conditions actually are in the main devitalizing, depressing and inhibitive of action, and that they, therefore, decrease breaches against law and order. These

conclusions do indeed seem to be justified by the rather incomplete statistics of violence which are available from the various cities of the country. Thus, Table V, statistics of homicide, show that there is no increase in the frequency of murders in the cities whose atmosphere is supposed to be surcharged with smoke and where, accordingly, depleting weather conditions obtain.

TABLE V.

HOMICIDE STATISTICS FOR 31 AMERICAN CITIES.

	1901-1910.		1911.	
	No.	Rate per 100,000	No.	Rate per 100,000
Memphis, Tenn.	556	47.1	85	63.4
Charleston, N. C.	159	27.7	25	42.3
Savannah, Ga.	154	25.6	25	37.8
New Orleans, La.	702	22.2	83	24.1
Atlanta, Ga.	215	17.1	48	29.8
Louisville, Ky.	356	16.5	36	15.9
Nashville, Tenn.	132	13.6	40	35.3
St. Louis, Mo.	804	12.6	108	15.5
San Francisco, Cal.	343	11.42	44	10.4
Cincinnati, Ohio	328	9.4		
Chicago, Ill.	1659	8.4	203	9.1
Spokane, Wash.	55	8.0	3	2.7
Seattle, Wash.	119	7.6	20	7.9
Washington, D. C.	210	6.8	31	9.2
Manhattan and The Bronx, N. Y.	1249	5.1	197	6.9
Cleveland, Ohio	234	4.9	50	8.6
Pittsburgh, Pa.	243	4.9	50	5.3
Providence, R. I.	97	4.8		
Boston, Mass.	283	4.6	33	4.8
Dayton, Ohio	44	4.3	8	6.7
Brooklyn, N. Y.	583	4.2	61	3.6
Baltimore, Md.	215	4.0	27	4.8
Reading, Pa.	32	4.0	7	7.2
Philadelphia, Pa.	529	3.7	66	4.2

Hartford, Conn.	24	3.3	4	4.0
Buffalo, N. Y.	109	2.8	25	5.8
Minneapolis, Minn.	71	2.7	11	3.6
Newark, N. J.	68	2.3	6	1.7
Rochester, N. Y.	43	2.3	14	6.2
Milwaukee, Wis.	56	1.7	11	2.8

As a matter of fact, Shipley has argued that the ratio of murders in various cities of the United States is directly related to the prevalence of various alien races, the Mexicans being the chief homicidal offenders (121 murders per 100,000 of the population), followed by the Chinese (65) and the Italians (50.2) (20).

The statistics for suicide in Table VI are mostly for cities with low smoke density. It is observable, however, that the suicide rates are low in the two worst smoke-effending cities tabulated, viz., St. Louis and Pueblo.

TABLE VI.

SUICIDE RATES PER 100,000 IN AMERICAN CITIES FROM 1900-1909.

(L. L. Hoffman.)

San Francisco	52.0
San Diego	38.5
Hoboken	35.4
Sacramento	35.3
Los Angeles	30.2
Oakland, Cal.	29.7
St. Louis	29.7
Seattle	27.8
Springfield, Ill.	27.8
Pueblo	27.7

These statistics are in complete agreement with European suicide statistics. The traditional view had it there was an abnormally large percentage of suicides in England and that this was largely due to a cosmic factor—the murky, smoky gloom of Great Britain. Investigation

shows, however, that the percentage of suicide in England is less than in any other European country. (See 15, and references in 2.)

For assault and battery, and drunkenness I have been unable to obtain statistics. I believe, however, that we are justified in concluding, from the rather meager facts in our possession, that the devitalizing weather conditions produced by manufacturing cities do not increase misdemeanors and crime. On the contrary, they seem to inhibit rather than incite offenses against the law. From the standpoint of the police courts depleting days seem to be a desirable asset, while bright, tonic, irritating days are an undesirable asset. Granting the truth of this contention, let us not forget the complementary and more important facts presented in the preceding pages; namely, that gloomy, humid, foggy days (such days as are produced by smoke-begrimed skies) lessen vital potential, reduce or retard activity and impair efficiency, while bright, dry, sunshiny days increase the potential reserve, liberate energy, augment working capacity and stimulate ambition. To be sure, an unbroken series of smoky days might prove too stimulating, or at least too monotonous, but the elimination of city smoke will at the most only eliminate the frequent and oppressive smoke-induced weather clouds. Nature will still furnish an ample supply of misty, cloudy and rainy days.

NOTE ON THE INFLUENCE OF CLOUDY AND CLEAR DAYS ON THE INSANE.

Books on psychiatry and several psychopathologists whom I have consulted have very little scientifically established information to offer on the reactions of the insane to divers weather states. The following reply from Dr. Max E. Witte who, as Superintendent of large hospitals, has been in intimate contact with the insane for over a third of a century, is suggestive: "I regret that I am unable to give you anything definitely set down in black

and white, and in figures, but there is no question whatsoever, and it is a matter of remark, even to the least observant of our nurses, that the insane are very sensitive to weather conditions, and are particularly disturbed and influenced in an unfavorable way by clouded, overcast weather. Those who are of an excitable, maniacal tendency are more noisy, boisterous, and restless; those who are depressed are more gloomy, and inclined to forebodings, and generally more miserable in feeling than they are during dry and clear weather.

A period of several consecutive days of clouded, overcast weather is promptly followed by reports of restlessness, greater depression, and a general disposition to be disorderly, and even violent, on the part of those who are disposed that way.

On the other hand, dry, sunshiny weather coming on after such a period, is soon followed by quieter, gentler and generally more comfortable moods.

The insane, unless materially demented, react more fully to outside influences, due in part, in some forms, to greater emotional mobility, and more particularly to a lack of restraint by the will; and also, in part, to the fact that they have their attention less occupied with the matters and affairs of every day life, than do the sane. Still, I take it, that the sane, judging by myself, are subconsciously influenced by weather conditions. I notice in myself, on observation and analysis, that the shades that haunt me during gloomy weather, fade with the coming of the sun.

I have no doubt that the climatic conditions that permanently manifest themselves, the clearness or cloudiness of the sky, have impressed the peoples, say for instance of Europe, in the course of ages, with certain national racial characteristics; and I have no doubt that the murky, smoky atmosphere of your city exerts an influence to a greater or lesser degree upon the morals and disposition of the young people who dwell habitually in your climate.

I do not recall ever having seen any study, or more extensive investigation of this interesting topic."

II. The Aesthetic Aspects of Smoke Pollution

"The smoke nuisance is the greatest hindrance to the highest development of civic beauty and refinement" (Holdsworth, 33). Historically the first anti-smoke propagandas were waged against the nuisance on aesthetic grounds. In London the use of "Sea cole" was legally prohibited during a portion of the middle ages because the smoke palls marred the beauty of buildings, which were at that time painted in whitewash, with colored decorations in front (34). Violations of the smoke statute were considered so serious that a citizen of London was executed in 1306 for burning "Sea cole" (22). With the lapse of the anti-smoke ordinance in the middle of the sixteenth century the use of lime white and colored effects on the exterior of buildings was abandoned, and in their place appeared an unsightly, discolored, mottled, greasy coat of tarry soot on the outside of buildings.

A smoke-contaminated atmosphere imposes very severe restrictions on the efforts of the architect, sculptor, painter, decorator and landscape gardener to beautify our cities. This limitation applies to the character of the paints and colors, the nature of the materials, the style of architecture, interior decoration, and the possibilities of artistic horticultural effects.

Exterior painting in the form of mosaic or polychromic ornamentation cannot be successfully employed to any extent in smoky cities (32). Colored effects on stones, metals, ordinary or glazed bricks or faience will not for long retain their purity in a murky atmosphere. A grimy, blotchy, streaky, inartistic, abject appearance of the exterior chromatic decoration of buildings in smoky cities is a matter of common observation. Even glazed white bricks when used inside the building may become dirty and discolored. Observation shows that placards in red lead become gradually decolored in cities, even when protected against the sun and rain, but not in the country

air (35). The pernicious influence of the smoke on color effects is probably due to the fact that the colors become mechanically covered over by a coat of tarry soot and dirt. This tarry mass may effectually obliterate all color effects. It tends to adhere so firmly that it can only be removed, if at all, with great difficulty and with the aid of special solvents, and in the process of removal the colored paints often tend to scale off with the dirt. The defiling effect of the actual dirt is the most objectionable influence of smoke on stained glass. But smoke may also cause the disintegration of paint films, owing to the corrosive agents which smoke often contains. It is thus evident that smoke largely restricts exterior coloration to a play of light and shade. In fact, it tends to restrict paint effects to the darker shades.

Smoke also causes decay of interior paintings and tends to restrict the furniture and furnishings to the more somber hues. In smoky atmospheres the interiors of buildings are usually more or less dark, hence special efforts must be made to keep the paintings free from dust and soot films. But constant mechanical or chemical cleaning or washing lessen the brilliancy of the color effects. A smooth, varnish-like or glazed coating on mural decorations is favorable for purposes of cleaning, but inimical to the best artistic effects. The matt enables the colored designs to show off to the best advantage, but matt is absorbent and attracts smoke and dirt products and resists successful cleaning. In the case of paint on plaster the corrosive products in smoke (particularly sulphuric acid) penetrate through the paint so that it tends to scale off; while in the case of fresco the porous surface of the carbonate of lime provides opportunity for the tenacious lodgment of dirt and for the destructive action of the acids. The carbonate is transformed into gypsum. It is so expanded that it loses its binding power, while the painting-ground is also often destroyed (30). It should be remarked incidentally that housewives in smoky cities are much inclined to keep doors and windows shut in order to exclude soot and dirt. While this may be

aesthetically commendable, it is none the less hygienically objectionable. Moreover, the great amount of extra labor required to keep houses clean in smoky cities consumes the vital reserve of many women and robs them of the leisure moments which are theirs by right and which are essential for bodily rest and mental recreation and improvement.

Not only is smoke inimical to the highest aesthetic utilization of artificial coloration—particularly exterior coloration—but it obliterates the most richly colored panorama of nature, namely, the iridescent clouds of the sky. The situation in cities is bad enough without the smoke, for in large cities the tall buildings prevent many people from ever getting a glimpse of the beautiful cloud-scapes of the sunset or the splendor of the sunrise. But when you add the smoke palls to the buildings you often effectually close all visual approach to the richly illumined and picturesquely silhouetted clouds of the day and the resplendent stars of the night. That this frequent obscuration of the sky limits the aesthetic resources of any community has been shown by the writer in the article to which reference has already been made (9).

Clouds are capable of calling out the strongest emotions of the soul—fear, depression, gloom, awe, reverence, joy, cheer and hope. Children take great delight in watching cloudscapes and in discovering objects in the constantly changing forms. Over one hundred different kinds of objects were recorded in the replies which were tabulated in this investigation. Richly illumined, iridescent and constantly changing cloudscapes afford a most fertile field for the exercise of imaginative creativeness. The masters who have charmed the race by their imaginative descriptions often have derived their most exquisite conceptions from the flying cloudscapes rather than from beautiful flowers, mountains, parks or buildings. No work of art can elevate the feelings to such lofty adoration of the marvels of nature as the colored glories of the sunset and sunrise (Biglow). The scenes of the Scandinavian gods and godesses were staged in cloudland. The clouds

have impressed themselves upon the cosmogony, mythology, religion, morals, beliefs and superstitions of primitive races as well as of modern children. The modern child's emotional reactions are vestiges of ancestral attitudes towards clouds, while the modern painter and poet still find inspiration in cloudland. City smoke not only cheats us of our birthright, by depriving us of an important means for developing the powers of observation and imagination as well as of a source of aesthetic culture (because it covers the heavens with an opaque blanket); but it also displaces the cathedrals of nature with an uninteresting, nasty, black, opaque pall of soot which stimulates tendencies toward discontent and frequently arouses morbid emotions. Mankind has always taken a delight in color. Under primitive conditions man bedecks his body with colored habiliments for purely decorative rather than protective purposes. Deprived of the enjoyment of the natural terrestial color effects by high buildings, man resorts to the artificial coloration of his buildings. But the smoke palls tend to subvert his every effort to satisfy the demands of his color sense. The abatement of smoke will do much to restore hue and chroma to their rightful places in the aesthetic development of manufacturing cities.

Smoke defaces, disfigures or destroys buildings and restricts the styles of architecture. The sulphuric acid particularly corrodes or disintegrates practically all kinds of building materials (slate and granite possibly excepted). Marble tends first to turn green and then black; limestone deteriorates very rapidly, turning to gypsum owing to its great affinity for sulphur. The absorption of sulphur causes the stone to expand, thus rendering it soluble and powdery so that particles are constantly washed or blown away. The very best stone obtainable was used in the new additions to the House of Parliament in London, and every care suggested by modern science was taken to preserve the materials, yet the buildings were much eroded after a few years. One of the worst aspects of the smoke nuisance is the insidiously destructive in-

fluence of smoke on ancient buildings, relics or monuments.

Smoke thus not only shortens the life of building materials, but it destroys the force of expression of the architecture so that buildings are reduced to a shabby mass of begrimed masonry. The sharp outstanding moldings, designs, friezes, cornices, ornaments and carvings—the essentially artistic in architectural construction—are not only rapidly eroded but they are obliterated by the dense deposit of tarry soot, or rendered invisible because of the diminished illumination caused by the murky palls of smoke that hang over our cities. In the city of London 650 tons of soot have been deposited per square mile of ground surface, and soot deposits ¾ inch thick have been scraped from cornice projections. The beauty of the architectural views consists in the distinctness of the outlines. Soot deposits conceal the artistic effects not only on stone and brick but also on wood. The difficulty cannot be entirely overcome by cleaning, because cleaning tends to remove the sharp edges and outlines. Moreover, preservatives for water proofing often leave an unpleasant color and frequently are not effective unless 18 or 20 coats are applied (for example of baryta-water).

The ornamentation of city buildings is thus seriously restricted, while the preservation of historical landmarks is jeopardized by smoke pollution. Smoke and architectural embellishment are irreconcilable enemies.

The influence of smoke on metal work is equally pernicious. The sulphuretted hydrogen in smoke blackens, disfigures or tarnishes nearly all metals. Copper and bronze rapidly darken, iron rapidly corrodes, aluminum is affected by vapors and acids, many metals become pitted from electro-chemical action, and even gold or gilded articles become dull. Gilt titles on books will fade in the city while retaining their luster in the country. Bright and uneven metallic surfaces may also become coated with a mottled, sooty smear. To keep sign plates on any metal work bright and shiny requires constant work in smoky cities. The protective coatings used are

not entirely satisfactory because they tend to crack or to peel off, or to leave pin holes. Constant cleaning entails large expense both because of the labor required and because of the wear on the metal. Rather than assume this added burden of expense merchants in smoky cities tend to minimize the use of brilliant metallic ornaments. In consequence such cities often lack that polished metallic splendor which is one of the charms of the tourist cities of the earth.

Outdoor statuary in metal or stone in smoky cities suffers from all the disadvantages affecting buildings and metal work. The bituminous deposits cannot be removed by washing, and statues can only be protected by layers of water proofing. But even then ugly layers of grime will cover the exterior and render unsightly some of our best treasures of municipal art.

The possibilities of landscape or decorative gardening are also artificially restricted in a smoky atmosphere. Cloudiness as such is one of the most important items in agricultural climatology. But in addition to this there are many shrubs and trees which do not thrive in smoke—rhododendrons, conifers, evergreens—while the beauty of all trees, shrubs and flowers is marred by deposits of smoky opacity.

In consequence of the above artistic limitations, the artistic education available not only for the masses but particularly for students of art in smoky cities, is necessarily restricted. Their first, and sometimes only, artistic impressions are derived from an artistically limited and ultra-utilitarian environment, and from besmirched and sordid surroundings instead of from a clear, clean atmosphere of artistic excellence.

Not only do grimy, physical surroundings debase the aesthetic ideals of the dweller in smoke, but they also probably tend to foster personal habits of carelessness. The children playing in the streets in grimy cities become so accustomed to soot and smut that they learn to revel in grime and to glory in grease. To say that we have become a "well washed" race (as say Sir Thomas Oliver

and Dr. Woods Hutchinson) because we are being constantly defiled by atmospheric smut is tantamount to saying that we have become moral, healthy and vigorous because of contamination by the social plague or infection by virulent bacteria. It is not so. Even if we do resort to more frequent external cleansing this does not render us any cleaner, because we may forthwith become begrimed by the omnipresent smut of the air. Moreover, our lungs and alimentary canal can not so readily be "washed out," so that smoke at least keeps us interiorally begrimed. So far as the young child is concerned, the labor of cleaning is usually thrown upon the mother. Mothers evidently grow weary of washing the faces and hands and changing the clothes of their youthful progeny several times a day. Hence the child is left to wallow in dirt. Adults may tend to continue the habits which they formed as children. They, too, at any rate, grow weary of constant ablutions and changes of garments, and will tend to adopt the more somber shades of apparel which are less readily soiled by soot. The lighter raiment which often is more pleasing to the eye, and in the summer time is more conducive to comfort, must often be tabooed in smoky cities. The wearing apparel in such cities in consequence will offer less variety than in cities of low-smoke content. Women in white fabrics must not venture to sit down on an unprotected park seat in smoky cities less they carry away a conspicuous ribbon of grime across their backs.

It is possible that habits of carelessness, indifference, or ready satisfaction which the dwellers in smoky cities may tend to acquire, in respect to personal cleanliness and dress and in respect to the artistic and cleanly appearance of the external city surroundings, may transfer to other aspects of their psychic existence, because, while the doctrine of formal discipline has been exploded in its crass form, psychological experiments show that habits which have been acquired in one phase of mental action will transfer more or less to other phases of mental action which have similar or identical elements (36).

Finally it should be emphasized that cities befouled with murky smoke are at a decided disadvantage as tourist or residential places. Wealthy tourists and globe trotters go to the brilliant, resplendent, ornate, clean cities—the show places—and not to the nasty, pungent smoke producers. Even if the tourist perchance does come to a dirty town he will rarely tarry there for any length of time. Few towns which tolerate the smoke nuisance can hope to compete for tourist trade. The loss in tourist trade caused by preventable smoke in manufacturing cities represents an enormous economic loss to the trades and professions of those cities. Not only so, people looking for a city residence will not seek centers reeking with smoke. Retired people of wealth will prefer the smoke-free cities of culture and art where they can inhale the uncontaminated, invigorating ozone of sun-kissed skies.

Summary of Conclusions

I. The injurious organic effects exerted by smoke on human beings are both direct and indirect. The direct effects are due to the injury caused by the smoke contents themselves, while the indirect effects arise from meteorological changes produced by atmospheric smoke.

II. The mental effects of smoke and smoke-produced weather states are likewise both direct and indirect. The indirect effects issue from bodily changes produced by smoke or smoke-produced weather states, while the direct effects are due to the influences of the mind's own states upon its subsequent thoughts, disposition and conduct.

III. Smoke fills the atmosphere with acrid, poisonous compounds and soot particles which may serve as carriers of the obnoxious products of human fatigue, which irritate the sensitive membranes of the eyes, nose, throat, lungs and gastro-intestinal tract, increase the susceptibility of gastro-intestinal, pulmonary and naso-pharyngeal disorders, diminish the potential reserve, working capacity and well being of the individual, increase fatigue, irritability and malcontent, and may tend to hasten premature decay.

IV. Smoke lessens the duration and intensity of sunshine, reduces the intensity of daylight, the limit of visibility and the diurnal winter temperature; increases humidity, mists, the frequency and duration of fogs and possibly alters the electrical potential.

V. Sunshine is an important bio-dynamic agent. It promotes anabolism, transpiration and perspiration, and increases the percentage of hemoglobin. The blue and ultra-violet rays of sunshine exert a bactericidal effect on pathogenic bacteria, and a tonic, vitalizing influence upon the human organism. Sunshine exerts an exuberant influence on the feelings. Moreover, colorless daylight is superior for visual efficiency, optical health and affective quality.

VI. Dark clouds have a depressing, devitalizing effect. They may cause fear in children, reduce working efficiency, and labor returns; give rise to eye strain and dioptric disorders; give rise to disquietude, restlessness and forebodings in the insane; and may increase drunkenness because of the reduction of the diurnal temperature in the winter time.

VII. Humidity increases the solid, poisonous, bactericidal contents of the air, aggravates various pathological conditions of the body, reduces the sensitivity of some sense organs and depletes the vital potential. Fogs, in addition, increase the inaccuracy of mental work (bank errors), increase the prevalence of diseases, and augment the death rate.

VIII. Clear, dry days are anabolic in character and thus produce a superabundance of energy. While this may lead, as statistics seem to show, to an increase of school misdemeanors, assaults, suicides and arrests for drunkenness in emotionally and nervously unstable individuals, it also tends to energize the human organism, augment its functional efficiency and enhance its achievement capacity. Negatively the data seem to indicate that smoky weather states (just because they deplete energy and thereby inhibit action) lessen rather than increase crimes of violence.

IX. Smoke clouds are inimical to the highest aesthetic development of urban communities. They seriously limit not only the possibilities of municipal art, in respect to architecture, statuary, painting, and ornamental gardening, but also limit the possibilities of art education in the community in question. They begrime, deface, decolor, destroy and corrode interior and exterior artistic effects in color, brick, stone, marble or metal. They befoul the persons as well as the dress of the inhabitants, limit the range of wearing apparel, and may foster habits of indifference. They obliterate the natural terrestial panorama of art, the iridescent clouds of the sky. Because of the murky, abject inartistic appearance of these cities, they are avoided by the wealthy tourist and the retired

person of wealth who is in search of a desirable place for residence.

X. Our knowledge of the mental influences of atmospheric smoke pollution should be rendered more complete by systematic psychological research. Two methods are available for this investigation, namely, the questionnaire method and the experimental method. By means of the questionnaire a mass of interesting and valuable experiential, observational and impressionistic data can be collected from children and adults bearing on smoke psychology. By the experimental method it is possible to measure in quantitative terms under controlled conditions of smoke density, the influence of smoke upon the functional efficiency of various sensory, motor and intellectual processes. To prosecute such a research one requires controlled subjects, controlled apparatus and controlled smoke rooms.

My thanks for courtesies extended to me in connection with this research are due to Dr. R. C. Benner, Mr. J. J. O'Connor, Jr., Dr. W. W. Strong and Mr. E. H. McClelland.

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