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R. Joseph Lucero

John P. Brantner

Byron W. Brown

Gordon W. Olson

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R. JOSEPH LUCERO[3], JOHN P. BRANTNER,
BYRON W. BROWN, GORDON W. OLSON

ABSTRACT — A simple count of disturbed incidents in the mentally ill and total radio transmissions of the Minneapolis Police Department were collected daily over a six-month period. These were correlated with calendar time, temperature, humidity, and barometric pressure for the same period. Separate comparisons were made of all these measures for December 1959 with those of other Decembers.

All the weather variables correlated linearly and significantly with the behavior variables; temperature and humidity, positively; barometric pressure negatively. Calendar time for the half year correlated linearly and negatively. December 1959 had a higher crime and mental disturbance rate than other Decembers; this was accompanied by higher temperature and humidity.

Popular belief has always held that weather influences behavior. Respectable and competent scientists have tried, in the past, to find a basis for the belief but have usually failed, generally for good reasons. Such an investigation necessitates polymaths or large teams of cooperating scientists from such disciplines as mathematics, medicine, physics, chemistry, psychology, anthropology, history, and meteorology. Past investigators have tended to overlook alternative explanations outside their fields of competence, to employ assailable statistics, and even, at times, to become involved in their results at the expense of objectivity.

Interest in this whole general area has recently increased. This interest ranges from a recent and only mildly frivolous article by Tobias Wagner (1964) entitled "Meteoropsychiatry?" to the Annual Report of the Committee on Institutional Cooperation (1963), directors of a mutual program of graduate studies at 11 Mid-Western Universities, in which is described a "new inter-institutional approach in the graduate training of specialists concerned with the effects of weather on man, animals, and plants," a program of graduate training in biometeorology that "could not have been achieved within a single university because no one institution can afford to construct and maintain the necessary wide variety of specialized environmental laboratories and field facilities."

Although Irving Langmuir's work on climate modification was rejected in the early 1950's as "utterly fantastic," E. J. Workman (1962), a decade later, urged repetition of Langmuir's work, re-examination of his results, and consolidation of them with recent advances in the area of study. "We should, I believe, find out what went wrong; we should write down what has been learned" (Workman, 1962). A renewal of interest in the work of Ellsworth Huntington and a reappraisal, in the context of a half-century's increase in knowledge, of some of his hypotheses and suggestions for further research, may be long overdue.

Considerable interest in the effects of seasonal variations has been displayed recently (Bradley and Lucero, 1958; Lucero, Brown and Davis, 1963; Bradley and Lucero, 1959). Such variations include many measurable and, in some cases, manipulable factors: temperature, storms, winds, precipitation, relative and absolute humidity, absolute barometric pressure, degree of change in barometric pressure per unit of time, daily ratio of daylight to darkness, relative hours of day and night, social expectations of appropriate behavior (e.g., marriage in June), cultural associations (e.g., the Christian seasons of Advent and Lent, the secular December merchandising season, school vacations) agricultural and, hence, dietary factors, the reversed seasonal factors above and below the equator, geographical modifications of the range and severity of seasonal climates, and many others. Perhaps the reason for the equivocal but generally positive and always suggestive results of past studies in seasonal variations was rooted in the treatment of the complex of more or less independent factors as a single variable.

The opposite side of the equation has, in all the studies of seasonal variations involving humans, been no less complex. Adolescent crime, eminence, suicide, homicide, admission to mental hospitals, and other gross, relatively rare or usual pathological behaviors have been used as

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[3] R. Joseph Lucero: A.B., 1948, University of Wisconsin in Psychology and M.A., University of Minnesota in Clinical Psychology; Sigma XI. Presently, Mental Health Research Consultant, State of Minnesota.

John P. Brantner: A.B. (Magna), 1948, University of Minnesota, in Psychology, Ph.D., 1958, University of Minnesota in Clinical Psychology; Phi Beta Kappa. Currently, Assistant Professor, Division of Clinical Psychology, College of Medical Sciences, University of Minnesota.

Byron W. Brown: A.B. (Magna), 1952, in Mathematics, M.A., 1955, in Statistics, and Ph.D., 1959, in Bio-Statistics, from the University of Minnesota; Phi Beta Kappa and Sigma Xi. Presently, Associate Professor, School of Public Health, University of Minnesota.

Gordon W. Olson: A.B., 1949, in Psychology, and M.A., 1953, in Clinical Psychology, from the University of Minnesota, Ph.D., 1957, in Clinical Psychology from the State University of Iowa; Sigma Xi. Presently, Chief Clinical Psychologist, Anoka (Minnesota) State Hospital.

variables. They have the advantage of generally being accessible in public records. No one, of course, has held that they are influenced solely by meteorological factors.

To increase the complexity, there is recent evidence that very close temporal controls in such studies are also necessary. Webb and Ades (1964) recently studied the relations between barometric pressure and EEG signs of onset of sleep in naval aviation cadets. They used *hourly* barometric pressure readings in their examination and obtained significant results that were very different from those reported by Raboutet, Lesévre and Remond (1959), who used single barometric pressure readings at noon of the day of the EEG examination.

Two factors in the area of study have changed in recent years. Both are difficult for the general scientist to assess. The first consists of the fact that much of the basic research is not generally available. The second is the manipulation of weather. In the past, man had to accept weather and climate within relatively narrow limits of variation but this condition has changed. Hospitals are experimenting with house-sized pressure and climate chambers large enough for surgical operations and even for daily living experiments over protracted periods, in which artificial weathers can be maintained. The Committee on National Resources, National Academy of Sciences is concerned about the effects of man's manipulation of his environment (1964). "Man, after tens of thousands of years of very slow, very gradual change in the environment, has in the past few hundred years made radical and abrupt changes to which he has to adjust more rapidly than ever before. Evidence indicates significant physiological and psychological reactions to such changes, but neither the causes nor the short- or long-range results are clear." It is also significant that man is able now for the first time in history really to leave the biosphere and be subjected potentially to undreamed of meteorological factors. It was excusable to be ignorant of the effects of climatic variation when atmospheric pressure ranged at the most from 29 to 31 inches of mercury, or when temperature ranged from −40° to 110°F, but it is not excusable to be ignorant of climatic effects when man can manipulate weather or when he may be exposed to hitherto unexperienced extremes of it.

Method

Several problems arose concerning the best procedures to follow in the investigation. The investigators did not have access to classified materials nor to sufficiently large sums of money with which to build control machinery, such as pressure chambers; there was no possibility of the manipulating of important variables. Forced to depend upon available resources, the investigators had finally to use accidental meteorological factors and, as criterion variables, behaviors that were matters of public record.

Through the enthusiastic cooperation of the Minneapolis Police Department, a criterion measure of crime was obtained. A measure of the disturbed behavior of the mentally ill was also obtained from the records of the Anoka State Hospital (Anoka, Minnesota). The United States Weather Bureau in the Minneapolis-St. Paul area supplied records from which various meteorological factors could be extracted.

The following variables were obtained for each day of the one-half year period from July 1, 1962, to December 31, 1962: highest temperature recorded each day, average daily barometric pressure, and relative humidity. The total number of radio transmissions of the Minneapolis Police Department for each day of the period was used as the criterion measure of criminal activity. From the Anoka State Hospital, the daily reports were collected of the behavior of patients in the hospital; this simple count of disturbed incidents for each day, was made the criterion measure of disturbance in the mentally ill.

Because of the presence of marked weekly cycles in crime and hospital behavior (e.g., more crime on Friday and less on Monday) it was decided to analyze the data separately for each day of the week. For each day's data, the criteria for crime and disturbed incidents were related simultaneously to temperature, humidity, and barometric pressure. Because of the trend expected over the whole half year as a result of general decrease in temperature, calendar time was used as a fourth variable so that it could be partialled out in looking at the other correlations. Results for the several days of the week were in agreement and the averages of the seven results were computed. The average multiple correlations, simple correlations, and partial correlations (for calendar time fixed) are given in Table 1.

TABLE 1. Relations between Various Behaviors and Weather Factors

Independent Variables	CRIME (# Radio Transmissions) simple correlation	CRIME (# Radio Transmissions) partial correlation	Incidents in Mental Hospital simple correlation	Incidents in Mental Hospital partial correlation
Factors.				
Calendar Day	−.53		−.35	
Daily High Temperature	.61	.38	.34	.10
Relative Humidity ...	.22	.06	.25	.16
Barometric Pressure ..	−.23	−.14	−.20	−.12
Multiple Correlation ..	.73		.47	

A Pearson-product-moment-correlation coefficient was also computed between the criterion measure for crime and that for mental disturbance for the 183 days of the study.

It was noted by experienced observers in the Police Department that the December of 1959 had a much higher crime rate than the Decembers of the years 1958, 1960, 1961, and 1962. Means and standard deviations were calculated for these months for the highest temperature of the day, the average barometric pressure, and the average relative humidity.

Disturbed incidents were also calculated for the Decembers of the years 1959, 1960 and 1961. Disturbed incidents per patient were then calculated for the same years.

Results

The simple correlations in Table 1 indicate that the several factors are correlated with both crime and dis-

turbed behavior in the mental hospital in roughly the same way. Both indices decrease from July to December. This is also indicated by the positive correlation between temperature and each index. Relative humidity, also higher in the summer than the winter, shows a positive correlation with the two indices. Barometric pressure is negatively correlated with each index, again expected from the generally lower pressure in the summer and the higher pressures in the winter months. Note that the multiple correlations for the two indices are .73 and .47 respectively.

It was anticipated that most of the correlation between the criteria and the several meteorological factors would be because of the overall change in the weather pattern from July to December. However, when this trend in calendar time was partialled out, similar but diminished correlations between the criteria and temperature, humidity, barometric pressure were obtained in all cases. The remarkable similarity in pattern for the two criteria remained (see Table 1).

December 1959 had an unusually high rate of crime for the city of Minneapolis. If our hypothesis is correct, the weather measures should also be extreme for that month. Table 2 shows that temperature and relative humidity were much higher for the month of December 1959 than for Decembers of the other four years covered.

Significantly deviant weather factors in that December should also be reflected in an extreme number of disturbed incidents among psychiatric patients in that particular December. Table 3 shows that in December 1959 there were more of these incidents reported than in the other two Decembers studied.

TABLE 3. Disturbed Psychiatric Incidents in December

	Hospital Population Size	Actual frequency of disturbed incidents	Incidents per person
59-60	1055	774	.73
60-61	978	693	.71
61-62	1008	596	.59
Total	3041	2063	

Discussion

Calendar day effects (or seasonal variations) were the most pronounced. This is, of course, a composite of many factors and, in point of fact, includes broad variations in at least two of the other measures, temperature and humidity. The effect of atmospheric pressure in this study is small and subtle. The work of Webb and Ade suggests that hourly barometric readings would yield more interesting results. The influence of atmospheric pressure on behavior may well be very great, but of a transitory nature, changing from hour to hour.

The reliability and validity of the criterion measures need comment. These are both accessible, recorded measures. The recording of disturbed psychiatric incidents was done by human nurses, themselves subject to the influences under study. These measures are valid, but not greatly reliable. On the other hand, the automatic count of the daily number of radio transmissions made by the Minneapolis Police Department is a highly reliable measure. Its total validity as a measure of crime might be questioned. These fairly gross measures yielded significant results; better measures might lead to even more impressive findings.

The relation between calendar day and criminal behavior might seem obvious—more people are outside in the warm months than in the cold, and hence more opportunity exists for crime. However, the relation between calendar day and disturbed psychiatric incidents is fairly independent of the opportunity afforded by pleasant weather. All the incidents took place under roofs inside the wards of a state hospital.

The analysis of the December data provides a sort of check on the rest of the study. A deviation in one criterion measure (the abnormally high crime rate noted by the police for December, 1959) was partially accounted for by deviant meteorological factors found in that particular December. These factors must be operating in subtle ways—the difference between a December with a mean temperature of 24°F and one with a mean of 36°F does not that obviously change people's habits. That this deviant December produced a rise in the ostensibly independent disturbed incidents in a psychiatric hospital suggests that this subtle change in weather has wide-ranging effects on human behavior.

Conclusions

1. All the weather variables were found to correlate linearly and significantly with the behavior variables: temperature and humidity, positively, and barometric pressure negatively.
2. Calendar time correlated linearly and negatively with the measures of crime and metal disturbance. Conversely, had the study been done from January through June, it seems clear that the generally rising temperature through these months would have resulted in a positive correlation between calendar time and the criteria.
3. December of 1959 had a higher crime and mental disturbance rate than other Decembers and it was found that temperature and humidity were also significantly higher in December of 1959.
4. In general it may be stated that there exists a significant relation between certain meteorological events and the frequency of occurrence of two types of path-

TABLE 2. Crime Rate and Weather in December.

	Daily High Temperature					Average Barometric Pressure					Average Relative Humidity				
	58	59	60	61	62	58	59	60	61	62	58	59	60	61	62
M	24.2	36.8	26.0	24.8	27.6	29.24	29.15	29.24	29.08	29.19	70.4	80.4	70.2	75.5	67.3
σ	13.82	6.71	12.71	11.69	15.10	.0249	.0215	.0246	.0285	.0223	6.95	4.12	8.30	11.15	10.75

ological human behavior, crime and disturbance in the institutionalized mentally ill.

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Learned Societies Around the World

Norway

Norwegian Academy of Sciences and Philosophy (Det Norske Videnskaps-Akademi) in Oslo. Founded 1857. Two divisions: (1) natural sciences and mathematics with 154 members; (2) historical-philosophical division with 128 members. Many publications report the activities of the Academy.

Royal Norwegian Society of Arts and Sciences (Det kgl. norske Videnskabers Selskab) at Trondheim. Founded 1760.

Society for the Promotion of Sciences (Skelskapet til Vitenskapenes Fremme) at Bergen. Founded 1927.

Norwegian Academy of Technical Sciences (Norges tekniske vitenskapsakademi) at Trondheim. Founded 1955.

In addition, there are 26 other scientific societies in nearly every field and numerous publications such as the *Acta* which are of importance throughout Scandinavia.

Swiss Confederation

The number of Federal, regional, cantonal, and local scientific societies is considerable, perhaps higher than in any other country. The cantonal or local societies often enjoy international reputations. Among the most importat learned societies are the following:

Swiss Society of Arts and Humanities (Schweizerische Geisteswissenschaftliche Gesellschaft).

Swiss Society of Natural Scientists (Schweizerische Naturforschende Gesellschaft).

Swiss Academy of Medical Sciences (Schweizerische Akademie der Medizinischen Wissenschaften).

Swiss Society of Jurists (Schweizerischer Juristenverein).

Swiss Society of Statistics and Economics (Schweizerische Gesellschaft fur Statistik und Volkswirtschaft).

Swiss Society of Sociology (Schweizerische Gesellscraft fur Soziologie).

Swiss Association of Engineers and Architects (Schweizerischer Ingenieur- und Architektenverein).

Most associations and societies publish technical periodicals of high, and in many cases, international reputation. According to the 1952 edition of the "Schweizerischer Zeitschriften-katalog," Olten, there are approximately 400 such technical publications.