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Environment and Health

Casual attention to newspapers and TV news will indicate the breadth of concern over the quality of our physical environment. Air pollution, noise, population density, and urban blight are only a few of the problems that arouse the indignation of the public and the curiosity of the scientist. A principal cause of this concern is the widespread belief that environmental quality is a major determinant of health and well-being. There is, however, little systematic substantiation of this belief. Indeed, it is becoming increasingly clear that psychological factors, such as how the environment is perceived, may have more important effects on health than physical factors have.

This chapter reviews empirical research on two aspects of the environment—density and noise—that illustrate the significance of a psychological approach. It should be noted, however, that a wide range of environmental variables (e.g., water, air pollution, and weather) are believed to influence health and health-related behavior (see Moos, 1976). Population density and environmental noise were selected for discussion here because these areas illustrate the role of psychological factors in mediating the effects of the physical environment on behavior and health. This role is exemplified by Stokols' (1972) emphasis on the importance of social and personal factors in the experience of crowding, and Glass and Singer's (1972) argument that noise affects human behavior according to the cognitive context in which the noise occurs.

Recent laboratory studies abundantly document the importance of psychological variables in determining the impact of noise and density on behavior and health (see reviews by Sundstrom, in press; Glass and Singer, 1972). Most of this research, however, emphasizes acute rather than long-term effects of environmental stimulation, while health impairments typically result from *chronic* exposure to unfavorable environments (cf. Selye, 1956). Thus, we will discuss little laboratory experimentation in this chapter and will concentrate on epidemiologic studies of long-term consequences of density and noise.

Health, as defined by the World Health Organization (WHO), is not only the absence of disease, but also the physical, mental, and social well-being of the individual. Consequently, rather than limiting discussion to studies of the relationship between environment and specific diseases, we will also examine the effects of density and noise on social and mental well-being.

Population Density and Health

Standard epidemiology texts suggest that crowding increases the risk of both infectious and noninfectious disease (Cassel, 1971), and the popular press reports that a broad array of social problems result from crowding.

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One basis for such assertions is research conducted in the 1940s and '50s that indicated higher rates of crime, disease, mental disorder, social disorganization, and mortality for urban than rural areas (see Altman, 1975, for review). However, these early studies typically employed inadequate methodological and statistical techniques, thereby making it very difficult to attribute urban pathologies primarily to rural-urban differences in population density. It is entirely possible, for example, that differences in sanitation, health care, and population composition accounted for the greater urban rates of disease and personal and social disorganization.

Belief in negative effects of density draws sounder support, perhaps, from studies of crowding in animals. The best known of these investigations is Calhoun's (1962) work with Norway rats: crowded animals develop a wide range of pathological behavior, including increased mortality, especially among the young, lowered fertility, neglect of the young by their mothers, overly aggressive and conflict-oriented behavior, withdrawal, hyperactivity, and sexual aberrations. Similar patterns of pathological effects have been reported for mice (e.g., Southwick, 1955; Lloyd and Christian, 1969) and voles (Clarke, 1955).

However, contemporary research on human populations has been less conclusive. Recent reviews of this literature by Freedman (1975), Fischer et al. (1975), and Lawrence (1974) conclude that human population density is not related to physical pathology, mental disorder, or emotional instability. On the other hand, reviews by Zlutnick and Altman (1972), and Moos (1976), while carefully avoiding any definitive conclusions, leave the reader with the strong impression that existing evidence does suggest such relationships. The disagreement is not surprising, since results from different studies are themselves inconsistent, and there is considerable controversy regarding the adequacy of the research methodologies employed. In addition, because different assessments of the empirical literature reflect different conceptions of density, important differences in the psychological impact of different types of high-density environments are often neglected.

A partial corrective to this state of affairs can be found in the distinction between primary and secondary environments. Stokols (1976) suggests that crowding is more stressing in primary environments—those in which persons spend more of their time and in which they relate to others on a personal basis—than in secondary environments—those in which encounters with others are transitory, anonymous, and inconsequential. We have divided the studies discussed below into those dealing with *internal density*—dwelling space per person (e.g., rooms per person or square feet per person), and *external density*—number of persons occupying a residential area (e.g., people per acre, square kilometer, or square mile). Internal density is a measure of density in a primary environment, the home, while external density is a measure of a secondary environment, the neighborhood (cf. Zlutnik and Altman, 1972). These two measures of density may be independent of one another; for example, a luxury high-rise housing project in New York City would have a high external density but a low internal density, while a low-income housing project made up of four-story tenements would have a relatively low external density with a high internal density. Our discussion of both types of density will include only those studies that control for factors that often covary with density (e.g., income, education, sanitation) through the use of partial correlation, multiple regression, or stratification techniques.

Studies of Internal Density

Public-health officials have long been concerned with the minimum amount of household space required for the maintenance of physical and mental health. Informed opinion on this lower limit varies widely: the Chombart de Lauwes (cited by Hall, 1966:172) report on the French working-class family shows minimal pathologies with 90–140 square feet of interior household space per

person; Madge (1968) indicates expert European consensus at a 170 square-foot minimum; while the American Public Health Association (1950) sets the desirable standard at over twice this figure. It is possible (even likely) that available space alone is not the key determinant of pathological effects of internal density. Freedman (1973) suggests that the critical factor is the sheer number of people living in a restricted space, and Galle, Gove, and McPherson (1972), among others, stress available privacy, as indexed by the number of rooms (or rooms per person) in a dwelling unit.

Several studies have used a variety of these measures and calculated their associations with social and physical pathologies, such as rates of crime, public assistance (e.g., welfare payments), suicides, and mental-hospital admissions. Although not entirely consistent, the evidence suggests that, at least in single-family households, internal density is not an important factor in physical and mental health among the general population. For example, in Schmitt's study (1966) of 29 Honolulu census tracts, after statistical controls for income and education were employed, persons-per-room was moderately related to only one of nine measures of health and adjustment—namely rates of juvenile delinquency. Unrelated measures included rates of deaths, infant deaths, suicides, tuberculosis, venereal disease, mental-hospital admissions, illegitimate births, and imprisonment. Similarly, in a study conducted in the Netherlands, Levy and Herzog (1974) found that number of persons per room had uniformly low and negative associations with nine indicators of mental and physical health. That is, density in the home reduced rather than augmented various pathologies. The authors suggest that the Dutch family may provide a form of protection from external stress, thereby ameliorating the adverse effects of high family density.

Studies in the continental United States and in Canada also reveal dissociation between internal density and pathology. In a Canadian study, Gillis (1974) examined 30 Edmonton census tracts. After controlling for income and ethnic background, he found that the proportion of dwellings with more than one person per room was marginally related to public assistance rates and unrelated to rates of delinquency. Similarly, Freedman, Heshka, and Levy (1975) analyzed data from 338 New York City health districts. After controlling for ethnicity and social class, they found no relationship between persons per room and rates of mental illness, delinquency, infant death, illegitimacy, and venereal disease.

Some evidence suggests minimal effects of internal density on the general population. Consider, for example, a study of 75 Chicago communities by Galle, Gove, and McPherson (1972); after controlling for income and ethnicity, number of persons per room was positively related to mortality rates, public assistance to persons under 18, and fertility rates. (This last finding is the inverse of the density-fertility relationship reported in many animal studies.) In addition, the investigators found that the higher the average number of rooms per housing unit, the fewer the admissions to mental hospitals. Reanalysis of the Galle et al. data by Ward (1975) indicated that density did not account for as much of the variance in each of the dependent measures as was reported in the original study.

While internal density may only minimally affect the general population, certain population groups—the very young, the old, and those under other forms of stress (cf. Levi and Anderson, 1975)—may be more susceptible. A survey conducted by Booth (1975) illustrates this point. Members of 560 Canadian households were interviewed and given physical examinations. It appears that densities "seldom have any consequences and even when they do they are modest" (Booth, 1975:11). Nevertheless, household crowding did adversely affect child health and physical and intellectual development, and had greater negative effects on people under stress caused by low income or other problems. Booth's study is one of the few large-scale investigations of individual rather than aggregate data. Use of the individual instead of demographic-geographic areas provides measures of pathol-

ogy that are (1) less sensitive to fluctuations of covarying demographic factors (e.g., income and education), and (2) less likely to be affected by distortions in measurement in particular population groups (e.g., under-reporting of mental-hospital admissions among the middle class).

Like Booth, several other investigators report that children and members of the lower class are particularly affected by internal density. Winsborough (1965) reports that increased number of persons per room is related to increases in infant death rates. Mitchell (1971) found that among low- but not high-income Hong Kong families, square feet per person was related to superficial signs of psychological stress (i.e., self-reports of "worry" and "unhappiness"). Density, however, was not associated with other indices of stress such as self-reports of psychosomatic symptoms and withdrawal from family and work roles.

To sum up, while weak to moderate relationships between household density and various pathologies are sometimes reported, internal density in family residences is not an important factor in physical and mental health. Even rates of infectious diseases, presumed to be prevalent under high residential density, are consistently unrelated or negatively related to density. The findings do suggest, however, that household density may aggravate existing stress conditions (e.g., in low-income populations), and may be a moderate stressor for the very young. For certain susceptible populations, and when combined with other stressors, internal density may have deleterious effects on mental and physical health. Caution is needed, however, since all of the studies reported here are correlational and hence do not allow easy causal inference.

Studies of internal density in institutions. Internal density may not be a major contributor to ill health in households, but several recent studies in prisons, naval ships, and college dormitories suggest an opposite conclusion. For example, D'Atri (1975) reports that prisoners housed in dormitories have higher systolic and diastolic blood pressure than those housed in single-occupancy cells. Similarly, three females living in college dormitory rooms designed for two report more health problems than those living with only one roommate (Aiello, Epstein, and Karlin, 1975). There was no effect of "tripling" on the health of male students. A study by Baron, Mandel, Adams, and Griffin (1975) also reports no increase in number of visits to the health center for males tripled in double rooms. Increased visits to the dispensary are, however, reported for males crowded aboard naval ships (Dean, Pugh and Gunderson, 1975).

Other dormitory research indicates that density can result in interpersonal problems, for example, a desire to withdraw and avoid others (Baum et al., 1974; Valins and Baum, 1973), and a dissatisfaction with roommates (Baron et al., 1975). Thus, residential crowding with strangers may be experienced differently from crowding within a family household, indicating that the nature of the social relationships between residents may be important in determining the impact of internal density (Cohen, 1978).

Studies of External Density

A rather different approach to the study of population density focuses on the number of persons living on a specified amount of residential land (the neighborhood). Unlike internal density (which is measured in primary environments), external density provides information about the amount of contact one is likely to have with others in a secondary environment, where encounters with others are transitory, anonymous, and inconsequential. The available evidence on the effects of external density is inconsistent. Several studies report clear detrimental effects on health, while others report no such associations. While some discrepancies may be due to differences in the pathologies being measured and how they are defined, nevertheless studies using similar measures have also led to conflicting conclusions.

Reports of significant density effects include Schmitt's (1966) analysis of data from a

large sample of Honolulu census tracts. Positive correlations were obtained between number of persons per acre and seven of nine indices of health and well-being. Directly related to external density were rates of death, venereal disease, tuberculosis, mental-hospital admissions, illegitimate births, delinquency, and imprisonment. (Unrelated were rates of infant death and suicides.) Similar effects are reported in a recent study of 125 Dutch geographic regions (Levi and Herzog, 1974). After controlling for various social-class factors (e.g., income), increases in persons per kilometer were associated with increases in rates of death, male (but not female) heart disease, admissions to general and mental hospitals, delinquency, illegitimate births, and divorces.

In the only study directly relating school achievement to density, Michelson (1970:158) administered a battery of standardized ability tests to 710 elementary-school children. When social-class factors generally thought to explain student achievement were controlled for, number of families on the block was found to be related to several achievement measures. The relationship was not linear, however: student scores declined appreciably only when the number of families on the block exceeded 100.

Four other investigations suggest no relationship between external density and various pathologies: Galle et al. (1972) found no relation with mortality, fertility, public assistance, juvenile delinquency, and admissions to mental hospitals; Gillis (1974) found no relation with rates of public assistance and juvenile delinquency; Freedman et al. (1975) found no relation with rates of mental illness, infant death, venereal disease, and illegitimacy (however, a weak relation was found with juvenile delinquency). Booth's (1975) study of Canadian families also found minimal evidence that dense neighborhoods affect mental or physical health or family relations. The few weak associations he does report suggest beneficial (e.g., density stimulates neighborhood political activity) rather than detrimental effects.

Finally, Winsborough's (1965) study of 75 Chicago communities provides mixed results. After controlling for socioeconomic factors, he found increased external density was related to increases in infant death rate and decreases in tuberculosis, public assistance to adults, and age-adjusted death rate; and was unrelated to public assistance to persons under 18.

The inconsistency of findings on the relation of external density to health may be due to differences in measurement or accuracy of data, random error, or culturally mediated responses or adaptations to high density. One likely explanation is that reported effects are due not to external density *per se*, but rather to other environmental factors that are often associated with large populations existing in restricted spaces. Thus, future research might focus on such factors as the number of housing units per structure, number of structures per acre, types of structures, and availability of stores, services, and indoor and outdoor common spaces for recreation.

Noise and Health

While noise can impair hearing and interfere with communication (see Kryter, 1970; Miller, 1974, for reviews), the evidence relating noise to serious nonauditory health problems is more equivocal. In sampling the noise literature, we will attempt to clarify the conditions under which noise, especially community noise, results in annoyance, and detrimental effects on nonauditory physical health. Attention will also be given to the effects of noise on subjective states, mental health, and related behaviors.

Subjective Annoyance

Contrary to common belief, sound level *per se* is only a minor factor in response to community noise. While social surveys often report a positive relationship between noise intensity and the average level of felt annoyance, intensity alone seldom explains more than one quarter of the variance in individual annoy-

ance reactions (cf. McKennel, 1973). The major determinants of annoyance (often explaining over half the variance) are psychological factors—the respondents' attitudes and beliefs about the noise and the noise source.

A recent review of the relevant research (Borsky, 1969) suggests that annoyance is heightened when: (1) the noise is perceived as unnecessary; (2) those responsible for the noise are perceived as unconcerned about the exposed population's welfare; (3) the respondent dislikes other aspects of the environment; (4) the respondent believes that noise is harmful to health; (5) the noise is associated with fear. This list is abstracted from several social surveys (e.g., McKennel, 1963; McKennel and Hunt, 1966), and the operative factors affecting annoyance reactions vary from study to study. Nevertheless, psychological factors are consistently more important determinants of individual annoyance than the noise itself.

Noise, Sleep Disturbance, and Health

Is noise-induced sleep disturbance detrimental to health? It seems likely that those deprived of sleep would be more irritable and annoyed than others. There is, however, no quantitative evidence that sleep loss causes mental or physical disability (see Kryter, 1970). While there is laboratory evidence that the so-called vegetative system responds to noise during sleep, Kryter (1970) argues that this system requires rest less than the higher nervous systems and skeletal muscles. "Unless behavioral awakening occurs, or even if it does, within limits, it may be unreasonable to surmise that the beneficial effects of sleep are not realized (Kryter, 1970:524)." Moreover, normal persons who lose sleep compensate by spending more time in deep sleep, by becoming less responsive to external stimuli, and by napping (cf. Miller, 1974). In short, it may be difficult to deprive a normal person of enough sleep to produce serious health effects.

On the other hand, people who are deprived of sleep do complain of the loss and feel that it affects their well-being. Possibly those for whom sleep is more vital may be more sensitive to sleep-loss effects. For example, sleep disturbances might impede the recovery and aggravate the disability of those who are already ill. Thus, noise-induced sleep loss may have its greatest impact on population groups susceptible to environmentally produced disease. Also, continuous sleep disturbance by noise might be likely to reduce feelings of well-being and hence be potentially hazardous to health.

Noise and Mental Health

If noise causes annoyance and loss of sleep, it seems reasonable that prolonged exposure may cause or at least aggravate mental illness. Existing evidence suggests that noise may indeed have some responsibility for the personal disorganization of those living or working in noisy environments. Industrial surveys, for example, report that noise exposure results in increased anxiety and stress responses. Workers habitually exposed to high-intensity noise show increased incidence of nervous complaints, nausea, headaches, instability, argumentativeness, sexual impotency, changes in general mood, and anxiety (e.g., Cohen, 1969; Strakhov, 1966; Miller, 1974). Jansen (1961) reports that workers in the noisiest parts of a steel factory have a greater frequency of social conflicts both at home and in the plant. These results are difficult to interpret, however, since the same workers are often subject to other work stresses (including fear) that may precipitate the reported symptoms.

Work on community response to aircraft noise also indicates a detrimental effect on mental health. Two studies relating sound level and mental-hospital admissions were conducted in the surrounds of London's Heathrow Airport. Abbey-Wickrama et al. (1969) compared psychiatric-hospital admission rates of those residing in a noisy and less-noisy part of the same borough. Admission rates were higher for the noisy area; persons most at risk were older single, widowed, or

separated women suffering from neurotic or organic mental illness. These results have been challenged by Chowns (1970), who suggests that the noise and control populations were not demographically comparable and the noise index used by the authors was inappropriate. A later attempt to replicate the study (Herridge, 1974; Herridge and Low-Beer, 1973), using a different technique of indexing noise, reports similar if somewhat less-dramatic results. Even with a small sample, first admissions to hospitals and female first admissions were marginally greater for the high-noise area. A recent comparison of noise and control populations around Los Angeles International Airport (Meecham and Smith, 1977) reports a similar marginal increase in mental-hospital admissions among those living in the maximum-noise area.

Noise and Physical Health

Does noise hurt the human body? Aside from temporary and permanent effects on hearing (see Kryter, 1970; Miller, 1974), there is only indirect evidence for noise-induced physical disease. However, noise *can* alter physiological processes such as functioning of the cardiovascular system (e.g., Jansen, 1973). Since such changes, if extreme, are often considered potentially hazardous to health, many feel that pathogenic effects of prolonged noise exposure are likely. Physiological changes produced by noise consist of nonspecific responses typically associated with stress reactions (Selye, 1956; Glorig, 1971). These include increases in electrodermal activity, catecholamine secretions, vasoconstriction of the peripheral blood vessels, and diastolic and systolic blood pressure. Most of these reactions have been documented in laboratory studies involving short-term exposure to relatively high sound levels.

Do such physiological effects constitute evidence that noise is detrimental to health? The question is, at best, difficult to answer. On the one hand, habituation of physiological responses often occurs after only short exposure to noise (e.g., Glass and Singer, 1972); thus, prolonged noise exposure might not necessarily produce continuous elevation of physiological processes inimical to normal bodily functioning. On the other hand, several physiological reactions to short-term noise exposure are consistently found in individuals considered susceptible to disease. For example, patients with cardiovascular disorders and those whose behavior patterns place them at risk of heart disease often show elevated catecholamine concentrations in blood and urine (e.g., Friedman and Rosenman, 1974). Similarly, vasoconstriction responses to environmental stressors have been associated with cardiovascular dysfunction and risk of coronary disease (e.g., Williams, 1975). While many argue that these and similar findings reported in animal studies indicate pathogenic effects of noise exposure (cf. Welch and Welch, 1970), the evidence nevertheless remains essentially circumstantial. Controlled studies are clearly needed to establish the nature of the linkage between disease and continuously noisy environments.

Several epidemiological studies report suggestive evidence that extended noise stimulation results in impaired health. In a survey of Los Angeles and Detroit residents (Cameron et al., 1972), respondents reporting frequent exposure to noise had a greater prevalence of chronic and acute illness than those reporting no exposure. Similarly, Grandjean et al. (1973) found that respondents experiencing high levels of aircraft noise consume sleeping pills and need to consult a doctor more often than those exposed to lower noise levels. Interpretation of both studies is at best tenuous, since there were no controls for other noise-related factors such as income, education, and housing quality. The first study also lacks independent measures of sound level and thus may indicate that those who complain about noise, irrespective of the actual sound level, also complain about their health.

Several studies have investigated the impact of long-term noise exposure in industrial settings. Jansen (1961) found a higher incidence of vascular disorder and cardiac arrhythmia among steelworkers experiencing high com-

pared to low sound levels over a three-year period. A similar study of workers in a boiler factory (Cohen, 1973) indicates that individuals situated in noisy plant areas for a five-year period had more work-related accidents, more health disturbances, and higher absence rates than a comparison group situated in quieter work places. Health problems occurring more often for those exposed to intense noise levels included respiratory problems, such as sore throat, and allergenic, musculoskeletal, cardiovascular, and digestive disorders. An analysis of a second plant, which produced electronic missile and weapon parts, had similar but weaker results (Cohen, 1973). Additional data suggest that in both plants younger, less-experienced workers in high-noise areas experienced the most adverse health effects.

Other surveys of workers in noisy industries have noted an increased incidence of circulatory, allergenic, and neurological problems of assorted descriptions that have been attributed to excessive noise exposure (e.g., Shatalov et al., 1962; Anticaglia and Cohen, 1974). However, all of the industrial noise studies are subject to serious criticism because of their failure to control for other adverse workplace or job factors, e.g., task demands and risks, that may covary with the noisiness of the job (cf. Cohen, 1973; Miller, 1974; Kryter, 1970).

It is also important to note that several industrial surveys failed to find a relationship between noise and ill health. For example, Finkle et al. (1948) report that men working in turbojet noise of 120 dB showed complete adaptation to noise. Results for renal function tests, electroencephalography, and hematological examinations were all negative. Glorig (1971) also reports "no increase in cardiovascular problems, and/or ulcers and no increase in fatigue or irritability or tendencies to nervousness" for those working under noise in industrial settings.

In general, then, the evidence for noise as a pathogenic agent in disease is weak. It is more likely that noise affects health and related physiological functions in susceptible individuals, and/or when it is combined with other stressors such as pressures on the job.

Adverse Behavioral Effects of Community Noise

Since our definition of health includes physical, social, and mental well-being, it seems appropriate to examine recent studies on how community noise affects learning and development in children. There is increasing evidence that unacceptable noise levels in and around schools seriously interfere with the educational process. Bronzaft and McCarthy (1975) report that students in elementary-school classrooms facing elevated trains were poorer readers than those in quieter rooms on the other side of the building. The authors suggest that reading deficits were probably caused by noise interference in teacher-child communication (11 percent of classroom teaching time was lost daily because of passing trains). Further evidence for noise-induced interference in the classroom is provided by a study in which traffic noise was broadcast over loudspeakers outside a large classroom building (Ward and Suedfeld, 1973). Less student participation and attention were observed under induced sound compared to a no-noise control group.

Another study suggests that noise may, in fact, interfere with normal child development. Wachs et al. (1971) administered a psychological test based on Piaget's model of intellectual development to 102 infants between 7 and 22 months of age. There was a negative relationship between scores on the development test and mothers' reports of home noise levels. Moreover, infants who were unable "to escape" from noise performed more poorly on the developmental test than those who had opportunities to remain in quieter areas in their home environment.

Evidence also suggests that prolonged exposure to noise interferes with the development of a child's verbal skills (Cohen, Glass, and Singer, 1973). The investigators hypothesized that to cope with continuous noise, a child reared in a noisy environment would

become inattentive to sound. While this mechanism might be successful in tuning out noise, it is also maladaptive if it eliminates relevant as well as irrelevant sounds. Inattention to relevant sound, such as subtle speech cues, could result in impaired auditory discrimination and, in turn, explain subsequent difficulties in learning to read. This hypothesis was supported by a study of children living in apartment buildings built on bridges spanning a busy expressway. The results indicated an inverse relationship between verbal skills and the noisiness of the children's apartments. Children living in noisier apartments showed greater impairment of auditory discrimination and reading ability than those living in quieter apartments. The length of residence increased the magnitude of the correlation between noise and auditory discrimination. Additional analyses ruled out social-class variables and physiological damage.

Taken together, the foregoing studies suggest that community noise may indeed have detrimental effects on learning and developmental processes. Further research is clearly needed to document these associations, and to answer questions about the impact of noise on other aspects of personal and social well-being.

Psychological Factors in the Human-Environment Interface

Residential density and environmental noise both appear to affect physical and mental health. While direct physiological response to these environmental stressors may be the reason, there is increasing evidence (primarily from the laboratory) that many adverse effects are mediated by psychological factors. We alluded to this evidence in the first section of this chapter. More specifically, it appears that beliefs about the controllability of a stressful environment (i.e., the degree to which subjects believe they can escape from a stressor) are more important determinants of stress response than the magnitude of the stressful stimulus itself (e.g., Glass and Singer, 1972; Sherrod, 1974). These studies report that noise and density have minimal impact on behavior during exposure; adverse effects are observed after stressful stimulation is terminated. More importantly, the magnitude of the negative aftereffects varies as a function of the uncontrollability of the stressor.

Also relevant to this discussion is the work of Seligman (1975), which suggests that a psychological state of helplessness results when we continually encounter aversive events about which we can do nothing, that is, events that involve a noncontingency between instrumental responses and outcomes. A range of motivational, cognitive, and emotional disturbances results when individuals perceive this noncontingency, which is tantamount to believing that they are incapable of exerting control over their environment (e.g., Hiroto, 1974; Glass, 1977). The more extreme documented effects of helplessness include mental and physical disease, and even death (Seligman, 1975; Schulz, 1976; Langer and Rodin, 1976).

Noise, Helplessness, and Health

Several findings in the epidemiological literature on noise and health are amenable to the interpretation that a sense of helplessness affects response. Consider, for example, data cited earlier indicating that those living in "noise slums" were more likely to be admitted to a mental hospital than those living in less-noisy areas. Herridge (1974) suggests that the mental distress of those exposed to prolonged noise was due more to feelings of helplessness than to the noise *per se*. This assertion is supported by data indicating that residents of noisy areas are less likely to complain about aircraft noise than residents of control areas (Herridge, 1974). In other words, although apparently disturbed, they appear to exert minimal effort to modify or escape the noise. It should be recognized that helplessness may be aggravated by existing stresses associated with the social class and living conditions of the noise slums; people living in such areas often lack the organization and power necessary to affect any aspect of their environment. The

addition of uncontrollable noise to the stressors typical of a low income and the general quality of many of these neighborhoods can only reinforce feelings of powerlessness.

The developmental study by Wachs et al. (1971) also suggests the importance of control in producing noise effects. Recall that noise had a particularly adverse impact on development when the child was unable to leave the noisy environment. While consistent with the psychological view being proposed here, interpretation of these data in terms of control is somewhat risky. The report failed to specify the nature of "escapability," which may have also implied less total noise exposure for children who could escape.

Data on annoyance responses to noise less equivocally suggest the importance of perceived lack of control and helplessness. Thus, noise is less annoying when the individual feels that those at the source of the noise are attempting to minimize its effects (Borsky, 1969). This result is similar to Glass and Singer's (1972) finding that those with access to a person with control are as unaffected by noise as those subjects who had control themselves. Annoyance is also minimized when there is less reason to be concerned about control. That is, annoyance is low when respondents perceive the noise is important or feel it is unlikely to harm their health (Borsky, 1969). Additional evidence of the influence of helplessness on annoyance comes from a study by Graeven (1975); residents reporting an inability to control noise in their environment were more annoyed than those reporting control.

In contrast to the work reviewed above, research on the impact of environmental noise on *physical health* has ignored psychological factors. The direct effects of variations of noise parameters (e.g., intensity) on health and related behaviors have been emphasized. Future research emphasizing the role of an individual's feelings about and perceptions of the environment may allow us to establish a more precise link between one's relationship to a high-noise environment and the body's long-term responses to that environment.

Few empirical studies have examined the role of helplessness in mediating reactions to high density. However, Sherrod and Cohen (in press) point out that laboratory experiments reporting density effects characteristically deprive subjects of control over their level of social interaction and/or their ability to escape the crowded situation. The negative consequences of density may therefore be in part due to the subject's feelings of helplessness. Rodin (1976), for example, argues that household (internal) density limits control and leads to decreased expectancies of a contingency between responses and outcomes. Subjects from high-density homes should, therefore, show less initiative and independence compared to subjects from lower-density environments. Some support for this notion comes from studies showing that after controlling for race and parent education, children living in crowded conditions were less likely to exercise their own choices when given such an opportunity (Rodin, 1976). Children from high-(internal) density apartments were also more susceptible than their lower-density counterparts to experimental inductions of helplessness used in Rodin's research.

These findings recall earlier-cited studies showing that internal density specifically affects the behavior and health of children. Youngsters are typically unable to control their outcomes, for their lives are determined largely by parents and other adults. The additional lack of control that results from living in crowded conditions may reinforce self-perceptions of helplessness and lead to impaired cognitive and emotional functioning.

We suggest, then, that the degree to which individuals are generally capable of controlling their outcomes may be a major determinant of their susceptibility to the negative impact of stressful events. This notion receives still further support from studies of institutional density. Unlike most families, institutions often deprive adults of control over both their social and physical environments by dictating where and with whom they interact.

Individuals crowded in these nonfamily settings are constrained not only by the absence of space and privacy, but also by the feeling that they cannot control what happens to them. The adverse effects of institutional density might, therefore, be due as much to feelings of helplessness as to the direct impact of crowded living conditions.

Conclusions

This chapter has emphasized that human responses to environmental stressors such as noise and density might be mediated by psychological factors—specifically, by the beliefs concerning environmental controllability. Such beliefs are important both in determining individual response to stressors, as exemplified by the role of perceived control in annoyance reactions to noise, and in specifying population groups most likely to show health-related reactions to stressful events.

Environmental stressors are most likely to affect subpopulations unable to control their outcomes. Thus, those in institutions, those with low incomes and low levels of education, and the young are especially likely to show adverse reactions to a particular stressor. The addition of uncontrollable noise or density operates to reinforce their feelings of powerlessness.

Research cited earlier indicates that helplessness often leads to mental and physical distress independent of the direct impact of an environmental stressor (Seligman, 1975; Schulz, 1976; Langer and Rodin, 1976). Thus, the influence of stress on human health and well-being may be determined more by the individual's beliefs about his/her relationship with the environment than by the environment itself. An important implication of this analysis is that the health of those living in high density or with excessive noise can be improved not only by changing their environment, but also by changing their attitudes toward their environment. Providing people with opportunities to terminate, periodically escape, or at least modify unwanted stimulation may greatly ameliorate the negative consequences of physical stressors. Indeed, increased control over other areas of their lives might result in less-pronounced responses to stressors such as noise. Thus, community organization, if it improved important facets of the neighborhood, might reduce the aversive impact of environmental stress, including a variety of health-related effects.

Research Needs

There is need for further research on how psychological factors mediate the physical environment's effects on health. Unlike the atheoretical approach used in the past, future epidemiologic studies must be designed to test systematically formulated propositions—for example, studies focusing on beliefs about the environment (e.g., its controllability) and their relationship to specific health-related behaviors.

A psychological approach also requires collection of data for individual subjects rather than aggregate data. Individual assessment can include interviews and/or questionnaires concerning attitudes and beliefs about the environment, as well as objective and/or subjective measures of health and health-related behaviors. Individual data also allow closer control of factors that often covary with exposure to environmental stress (e.g., social class), and more sensitive measures of the criterion behaviors.

Longitudinal studies of people routinely living or working under environmental stress are also essential. We are presently unable to say with any certainty what happens when individuals are exposed to a given situation for different periods of time. Do we adapt to stressors with prolonged exposure? What is the pattern of adjustment? Do we pay a cost for adaptation (cf. Selye, 1956)? These and related questions can be answered by comparing measures of health and well-being of the same person before exposure, immediately after exposure begins, and at intervals for one to several years. It would also be useful to do

longitudinal studies in situations in which the environmental stressor will be removed or attenuated. By assessing health during the exposure period and at various intervals after the stressor is removed or attenuated, it would be possible to determine whether or not the effects of prolonged stress are permanent.

We have suggested a commonality among environmental stressors. Thus we have argued that the effects of noise and population density are mediated by similar psychological factors —beliefs about one's relationship to his/her environment—and that these factors are more important than the physical parameters of the stressor. This type of analysis suggests that psychological variables may be central in predicting human response to a wide range of environments. Future research on reactivity to weather, air pollution, and other natural and human-built environments may also profit by employing measures of the individual's relationship to the physical environment.

A final word must be said about how control over other aspects of the environment can ameliorate the effects of environmental stress. Recent clinical work indicates that people's perceptions of control over contingencies in their everyday activities profoundly affect their mental health (e.g., Lewinsohn, 1975). Thus, manipulation of beliefs about the ability to control outcomes could have a drastic effect on response to the environment. Intervention research on both individuals (i.e., people apparently affected by environmental stress in their community or workplace who are treated individually) and aggregates (where community interventions—formation of neighborhood committees, etc.—provide people with the perception that they can control their lives), could help clarify the role of perceived control in ameliorating the effects of stressful life events.

Admittedly, the suggestions noted above involve research efforts that are unusually time-consuming, costly, and, in some cases, formidable because of a scarcity of situations that would be amenable to controlled study. However, the theoretical and practical implications make such research essential.

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