A Cognitive Model Of The Effects Of Residential Noise

G. Marie Anderson

Exposure to sound has only recently received wide recognition as an environmental problem. While the effects of sound are perhaps less apparent than problems such as air pollution and population density, sound may be a critical factor influencing the level of well-being of people and should not be ignored due to unnoticed effects. Especially in combination with a variety of the stressors it may be be harmful physically, psychologically and socially.

The purpose of this paper is to review the literature and to examine two alternate models of the effects of residential noise on the occupants. The first model is a biologically based model in which noise is studied as a stress factor, and the second is a model in which noise is viewed as a deficit in a normative framework.

Although a considerable amount of research has been conducted on the effects of high sound levels in a work environment, almost nothing has been done concerning the residential environment. It is possible that the effects of noise may in fact be most detrimental in the home. Numerous researchers have shown that high sound levels provoke direct physiological stress reactions, yet the relationship between sound exposure and stress-related health disorders in the home environment seems uncertain.

Many studies have considered only conditions under which subjects are exposed to extreme and uninterrupted sound levels, which is unusual for the home situation. In order for sounds to be physically damaging, the level of sound would need to be consistently above 90 decibels (Jansen, 1973:435). According to a study by Mize, Futen and Simons (1966), the highest average sound level in a residential setting is between 71.79 and 83.77 dB.

The basic instrument for objective measurement of sound is the sound level meter, which consists of a microphone, an amplifier and a meter indicator. The meter incorporates electrical circuits known as weighting networks. These provide for various sensitivities to sounds of different frequencies. The object of the weightings is to simulate the sensitivity of the human ear at different sound levels for different frequencies. These weightings are generally known as the

Marie Anderson is a lecturer in housing and equipment in the School of Home Economics, North Texas State University, Denton, Texas 76203.

An earlier version of this paper was one of the three winners in the 1976 Tessie Agan Scholarship Competition.

dB(A), dB(B), and dB(C) scales. Each of the scales provides a varying degree of sensitivity. For instance, the A scale provides the least sensitivity at low frequencies and the C scale the most (Burns, 1973:47).

Looking at some representative values of sound levels from various sources may be helpful in understanding measurement of sound intensities. The measurements in Table 1 were made with a sound level meter of the C scale.

TABLE 1
Intensity of Sounds Common in the Home dB(C)

Living Room	
Quiet	50
Vacuum cleaner (nozzle engaged on carpet)	72
Hi-fi (loud but not vibrant)	80
Television (average volume)	68
Kitchen	
Range vent fan	84
Range vent fan and dishwasher	88
Range vent fan, dishwasher and garbage disposer	91
Dishwasher only	69
Garbage disposer empty	72

(adapted from Farr, 1967:100)

Sound As A Stressor

Sound may be considered as a stress factor and may contribute to diseases of adaptation. Typical examples of adaptation diseases include: high blood pressure, diseases of the heart and blood vessels, digestive diseases, diseases of resistance, diseases of the kidney and allergic and hypersensitive reactions.

Selye defines stress as a "state manifested by a specific syndrome which consists of all the nonspecifically induced changes within a biological system. This stress has its own characteristic form but no particular specific cause." (Selye, 1956:54).

The manifestations of stress as they develop over time are termed by Selye as the general adaptation syndrome. The syndrome evolves in three stages: the alarm reaction, the stage of resistance or adaptation and the stage of exhaustion. In the first stage, the body rallies its forces to defend itself. During this period, the effects of stress are most apparent, although the intensity may vary according to the magnitude of the stressor. The alarm reaction causes specific adrenal, thymico-lymphatic and intestinal changes. During the next stage, the body combats the influence of the stressor and the specific physical signs of the alarm reaction disappear. Eventually, after prolonged exposure to a stressor, the capacity for adaptation is lost and exhaustion occurs, the symptoms of which are similar to those of the alarm reaction. While the final stage may involve temporary exhaustion from which recovery is possible, it most often involves death. Particularly important in adaptation theory, is a concept termed "adaptation energy." According to Seyle, every person has a finite amount of adaptation energy which cannot be regenerated by removing the source of the stress. Once this source of energy is depleted, exhaustion occurs.

Although the stress syndrome is extremely important, its significance is related primarily to stress severe enough to initiate a general adaptation syndrome.

> The state of stress must be quite severe before any drastic changes in body chemistry of function take place, and such intense stress is not normally a part of daily life. Stress is only harmful if it is excessive or if the stress mechanism iteself does not operate properly. (Gross, 1958:101)

Such stress related to sound levels, therefore, is probably not present in most home environments, unless, of course, the intensity, duration and frequency of the sound is excessive.

While it is possible that the sound environment in the home could be so intense as to cause "adverse" stress, this apparently is somewhat rare.

The conclusion of many researchers on the question of the effects of sound exposure has been that ill effects are not related directly to the sound but to the perception of the sound as "noise" and its consequent annoyance. Intense sound is thus not necessarily a requisite component (Farr, 1976:100). Noise, then would be defined as unwanted sound by an individual in a specific context. The implication is that the general adaptation syndrome may be both direct and indirect.

Obviously, the level of sound varies from setting to setting. In a home near an airport, for instance, sound may reach critical levels, compounding the effects of sound from the internal and external sources. Sound may also adversely affect health when other conditions, such as atherosclerosis or coronary heart disease are present. Rosen concludes that even sound levels below 90 dB and non-continuous sound may be hazardous under these conditions (Rosen, 1970).

A 1967 survey in the Soviet Union found a positive correlation between aircraft noise and morbidity rates as determined from more than 145,000 diagnostic charts. In comparison with the control population living 40km from the airports, the morbidity of persons over 15 years of age living within 1-5 km of the airports was two to four times greater depending on the system examined; i.e. cardiovascular, neurological or gastrointenstinal (Informatics, year 1971: 126). In another report, a medical survey in Osaka, Japan, indicated that populations living near the airport gave evidence of increased insomnia, headaches, hysteria, decreased appetite and increased blood pressue in comparison with the general population (Informatics, 1971: 127). A well-documented study of aircraft noise in the community (Rohrmann, 1973) provided similar conclusions. Both exposed and control respondents were interviewed using standardized questionnaires and subjected to frequent psychological and physiological examinations at test stations. Cameron (1972), concluded that the results of his study suggest an association between sound exposure and increased prevalence of acute and chronic disease, although the actual data do not appear to support that conclusion.

In a study of the effects of airplane noise on health, the results indicate only a very small correlation between the level of exposure to aircraft noise and health problems (Graeven, 1974). A study of traffic noise in Sweden found the same low level of correlation (NSIBR, 1968: 60).

Other inquiries, while not directly related to the home environment, are meaningful in terms of sound exposure as a general environmental stressor. In an investigation of the Maabans of southeast Africa, this isolated tribe was found to live in virtual silence on a basically vegetarian diet. Elevated blood pressure as in coronary heart disease was found to be unknown. However, when Maabans moved to Khartoum under conditions of noise, diet changes and other stressors, they developed hypertension and coronary heart disease (Rosen, 1970: 58). To assess the effect of the one factor, noise, among many environmental stressors in an uncontrolled natural experiment is difficult. The conclusions of that study do, however, agree with research with laboratory animals. Rats in a laboratory situation were exposed to a combination of environmental stressors, audiogenic, visual, and motion. The experimental group became irritable, exhibited excessive salivation, urination, defecation and, like the Maabans, became hypertensive. One finding which sound be of particular interest to contemporary society is the fact that the researchers discovered that daily doses of tranquilizers did not prevent the development of hypertension and, in fact, the lethal effects of the environmental stressors were increased by the drugs (Buckley and Smookler, 1970). The implications of these latter results are especially frightening in a nation where "pill-popping" to relieve stress has become so predominant.

In yet another study of the Maabans, Jansen (1964) compared the vasoconstriction of Maabans to Germans when exposed to 90 dB pure tones and 90 dB white noise. Vaso constriction appeared and disappeared much more quickly in the Maabans, indicating greater elasticity of blood vessels. With regard to vasoconstriction, results of laboratory tests have shown that this reaction begins to disappear after approximately five minutes of high sound levels. In other words, autonomic adaptation occurs. Research cited by Rosen (1970),however, indicates that "while the constriction of the blood vessels begins to disappear, the reaction may persist for as much as 25 minutes before disappearing completely." (p. 57). Furthermore, the constriction was found to occur to the same degree in those accustomed to the noise as to those unaccustomed, indicating, perhaps, an absence of long term physical adaptation to high sound levels. Another dramatic effect of intense sound was cited by Rosen (1970) in which rabbits exposed to intense sound levels for 10 weeks showed a much higher level of blood cholesterol than control animals with identical diets. The experimental rabbits also developed greater aortic atherosclerosis with higher cholesterol content than did the control animals. Along with the major diseases of adaptation which have been evidenced in the results of much research, Selye has described the occurrence of decreased resistance to infection. This manifestation has been demonstrated in a controlled study of mice where after several weeks of daily stress exposure (high sound levels included), the mice were much more susceptible to certain viral infections (Jenson and Rasmussen, 1970).

In general, there appears to be evidence of a relationship between exposure to extreme sound levels and stress-related health problems. Research not considered here seems rather conclusive that such a direct, causal relation does exist. However, this is only under special circumstances, such as a factory environment. A more probable explanation under home-like conditions involves variables such as an individual's present health, the combination of environmental stressors and the effect of annoyance and other conditional variables on health.

Perceived Noise and Annoyance

Annoyance may be regarded as a psychological consequence of noise deficit. Numerous methods have been employed to measure annoyance. There are no highly valid and reliable methods of measuring something as subjective as annoyance, although it is possible to obtain some indication of the annoyance caused by sound by asking a sufficient number of individuals about their reactions. In most of the studies considered here, a series of questions pertaining to annoyance were asked and each question was treated as an annoyance variable. Leonard (1973) developed one scale for measuring annoyance which yielded a high level of internal consistency (.91 and .93 for two time periods). Examples of items used in the compilation included: 1) interference with listening to radio or T.V., 2) disturbs family's sleep, 3) interferes with conversation, and 4) noise makes you keep windows shut during the day or night. These and seven other items were rated and summed. Another annoyance scale was based on reported occurrences of subjective annoyance caused by traffic noise in Sweden and the intensity and frequency of such annoyance (NSIBR:33). The scale is as follows:

Index	**Range of Different Annoyance Classes**
0	Do not notice the noise
2	Notice the noise/am not bothered
6	Not very bothered/once or twice per month Rather bothered/once or twice per year
8	Not very bothered/once or twice per day Very bothered/once or twice per month
10	Rather bothered/once or twice per week
11	Very or rather bothered/once or twice per week or more frequently

(NSIBR: 33)

This scale was tested by relating it to other expressions of annoyance. A strong correlation was reported.

Most studies cited in the literature are subject to bias due to problems of measurement. Results indicate, for example, that specific structural questions which are used in most studies result in higher annoyance ratings than open-ended questions.

The results of much research indicates that cognitive factors leading to annoyance may have a more significant effect on people than the stressor itself. According to Kryter (1970) the annoyance value of sound is characterized by five qualities: 1) unexpectedness, 2) interference, 3) inappropriateness, 4) intermittency, and 5) reverberation. Farr (1967) adds one more — the origin of the sound. Other qualities which may influence annoyance are intensity, duration and frequency (Borsky, 1969:189).

Thus, a noise may have a negative effect if it is perceived by the individual to be an annoyance. A scale devised by Kryter and widely used in research is referred to as the "perceived noise level" (PNdB). It differs from other scales in that it is weighted according to the frequency of noise instead of the loudness or intensity. The scale does not consider the emotional content associated with the sound and is estimated independently of the source of the sound.

In accordance with cognitive theory, the literature does not show a direct relationship between sound intensity and annoyance. Farr (1970) contends that age may be a factor which results in noise becoming more annoying. A Soviet survey suggests that 1) annoyance increased with age, and 2) that persons living in the vicinity of airports for a long time expressed less annoyance than those living there a short time (Informatics, 1971). Although Graeven (1974) obtained a weak positive correlation between awareness/annoyance and level of exposure to aircraft noise, he found no relation between demographic variables and annoyance. Leonard and Borsky (1973) found that sound exposure has only a small direct impact on annoyance due to aircraft noise. Certain conditional variables (i.e. fear of aircraft operation and attitude of noise on health) appeared to have a greater independent effect on annoyance than did exposure to aircraft noise itself. Variables only minimally related to annoyance were age, education, ownership of dwelling, income, and length of residence in the area.

Galloway and Jones (1973) simply assume that annoyance is conditioned by cognitive factors. When analyzing the correlation of annoyance with sound intensity, they concluded that the largest component of variance was the intensity of sound, accounting for about one-third of the variance. Annoyance was discovered to occur most frequently when people are sleeping, listening to radio or T.V., driving, conversing, resting and engaging in mental activity. Two-thirds of the annoying situations could, furthermore, be characterized by the time of day in which they occurred. Twice as many took place at night. Individual attributes which appeared to influence annoyance include age, educational background and income. For example, the age group 20-29 was 1.8 times as likely to be annoyed as the average and those over 60 only 0.6 times as likely. A survey in the Netherlands concurs with Galloway's results of the influence of individual characteristics on annoyance with the exception of the age group. The 31-60 age group expressed the most annoyance (Informatics, 1971). Apparently origin of the sound does influence the annoyance value of noise. Apartment dwellers are more likely to be annoyed by noise arising from the activities of neighbors than are single family home dwellers. Presumably, the results were not simply a consequence of less audibility between houses since a distinction was made between noticing a neighbor's noise and being troubled by it. In general, there appears to be a slight tendency to object to one's neighbors' noise more than ones' own.

Data indicated that of those who notice the sound of delivery trucks in their homes, only 10 percent are troubled or annoyed by the noise. But of those who hear noises made by neighbors' pets, nearly 40 percent are annoyed (Broadbent, 1957: 10-7). In another study, neighbors' noises (internal noises) were found to be more disturbing than noise from one's own home, though less disturbing than sounds originating externally. Noise from road traffic was found to be the greatest source of disturbance (Burns, 1973). In a final report undertaken in Sweden, the connection between individual characteristics and attitudes and annoyance were examined. Sex, age, and marital status did not appear to vary along with the tendency to be annoyed by traffic noise. One attribute, in particular, that differed from other research was education. In this study, individuals with less education appeared to express more annoyance than those with more education. The article, furthermore, exhibited a connection between the attitude to traffic noise and the degree of annoyance experienced (NSIBR, 1968).

The results of a comprehensive survey in the vicinity of London Heathrow Airport indicated that annoyance as measured on a numerical scale varied directly with the average peak noise level of the aircraft together with the number of aircraft heard (Burns, 1973).

In general, the findings of most of the studies demonstrate that sound exposure, per se, is not strongly related to an annoyance reaction. The perceived noise is modified by cognitive processes and individual characteristics which then results in annoyance. However, a few investigators have claimed a direct relationship between sound intensity and annoyance. In a study cited by Broadbent (1957), degree of annoyance increased as the aircraft noise level increased.

Two Models of the Effects of Sound

Model 1

The model presented in Figure 1 presents sound as a stressor which results in physiological consequences.

Figure 1. Stress and the General Adaptation Syndrome (G.A.S.)

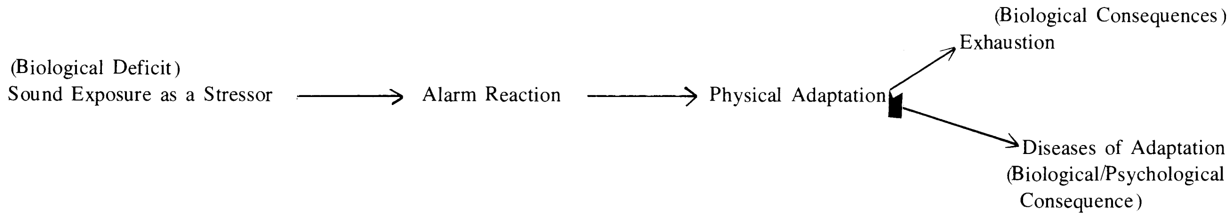
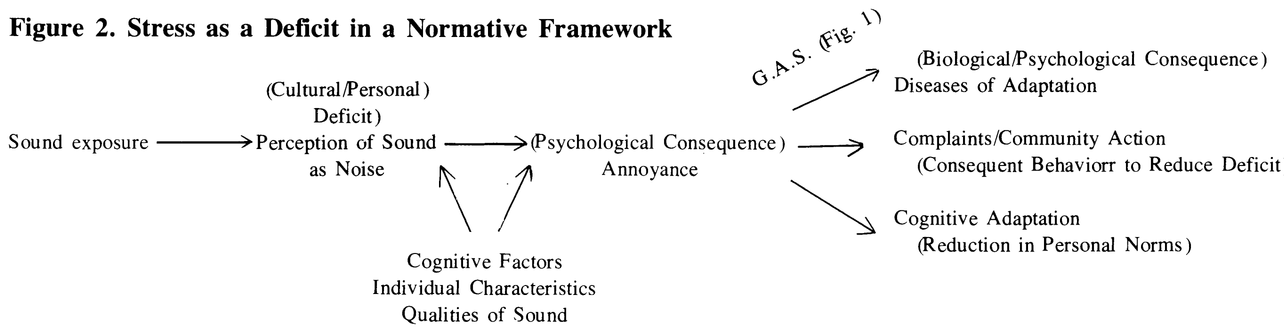


Figure 2. Stress as a Deficit in a Normative Framework



The model is based on Selye's theory of stress and the general adaptation syndrome.

As a dependent variable, diseases of adaptation are considered as a biological/psychological consequence of sound. For health problems to result, the annoyance from the noise must be severe enough to cause an alarm reaction and the remainder of the general adaptation syndrome. Annoyance, therefore, could be considered in Selye's terms as an "emotional stressor." Because of the complexity of the pattern from emotional stress to diseases of adaptation, however, the diagram for Model 2 has indicated only a direct relationship. This relationship also concurs with much of the literature reviewed, since much of the research does not consider the general adaptation syndrome. This model does not allow for the different reactions that have been observed and other factors which seem to influence whether a physical reaction takes place or not.

While there is evidence that intense sound levels result in stress-related disease, literature to support a relationship between annoyance and diseases of adaptation is rather limited. If, however, annoyance is an emotional stressor, then the research pertaining to non-specific stressors and disease is relevant, and evidence to support a relationship between noise annoyance and health problems is moderately strong.

Model 2

The model presented in Figure 2 is adapted from the framework of normative deficits and their consequences, developed by Morris, Winter and Beutler (1975). In this model, sound exposure does not become a deficit until the auditor perceives it as noise.

In this model, sound is regarded as either a personal or cultural deficit, depending on its ultimate effect. If the effect of noise, for instance, is to take community action in order to reduce the deficit, the deficit may be considered cultural. In general, however, cultural norms for "noise" are few, and whether or not a sound is noise more likely involves personal norms or standards.

Although the framework allows for physiological consequences of sound, as in Model 1, the effects of sound exposure in the residential environment are not confined to biological deficits and consequences. How an individual deals with this source of stress (dependent on individual characteristics) influences the effects of the sound. While sound levels in the home may not result in "disease and infirmity", the perceived noise may cause psychological stress which is induced, for example, by a feeling of insecurity or lack of privacy.

Depending on the influence of the intervening variables, Model 2 allows for three possible reactions to noise exposure: biological consequences (as discussed in Model 1), complaints/community action to reduce the deficit, and cognitive adaptation by reducing personal norms.

Given the inconsistent outcome of the effects of noise reported in the research, adaptation of one's attitudes toward noise is a possible consequence of annoyance. While this seems a plausible result, no research has been undertaken to validate it.

Another possible dependent variable in Model 2 involves definite efforts to reduce the noise deficit without adapting one's personal norms or standards; that is, to make a complaint and/or be willing to become engaged in community action. This is not to imply that community action is the most desirable behavior, although it may be the most effective. What is important is that the individual may act to reduce the noise deficit, be it simply a complaint (e.g. to the police) or involvement in a cooperative effort. As an example of effective action, residents near a power plant complained vigorously about a large fan and the result was a reduction in the noise (Rosenblith, 1955: 69). These individuals were not willing to adapt their norms.

Of several research articles that collected data on complaints, two concluded that a positive correlation exists between annoyance and complaint activity (McKennell, 1973; NSIBR, 1968). In another paper, Rohrmann (1973) correlated sound exposure directly to noise-reducing activity r=.23. Although these results seem somewhat encouraging, they may not be quite what they appear. In the Swedish reports, only 62 persons out of 664 respondents declared any form of noise-reducing activity. Out of 664 persons, more than 400 were in an annoyance class and of 95 persons in the highest annoyance class, only 30 percent had engaged in any sort of action. It is true, however, that the noise-reducing activities were concentrated in this group (NSIBR, 1968: 58). The same was true in McKennell's (1973) study, in which, as a group, those who registered complaints constituted only a fraction of both the exposed population and of the annoyed in the population who did not complain. Again, however, 63 percent of the complaintants were those who were highly annoyed. Moreover, McKennell found several individual characteristics that appear to influence complaint action. These included: occupational class, educational level, value of one's house, membership in organizations, and political activity.

That annoyance is a prerequisite of complaint action, seems logical and is substantiated in these two studies. But more important is the fact that only under certain conditions does complaint action appear to be a result of noise-induced annoyance. The circumstances seem to be due primarily to individual characteristics, although Borsky (1969) adds to personal variables and intensity of annoyance the following: 1) pressure of other local problems, 2) belief in the usefulness and possible success of complaints, and 3) availability of local leadership and organizations (p. 192). In general, however, it appears that few annoyed persons ever complain in order to overcome the noise deficit.

What, then, about the many individuals who are annoyed by noise but do not attempt to reduce the deficit by complaint action? A reasonable explanation would seem to be that these persons in some way cognitively adapt by reducing or changing personal norms. While this component of the proposed model is not confirmed by the literature — indeed, no research has apparently been conducted — there is at least one suggestion of such a relationship. In a Russian study (Informatics, 1971), it was reported that as length of residence near airports increased, annoyance with airplane noise decreased. Perhaps, these individuals had cognitively adapted to the noise.

Discussion

In light of the literature reviewed, one finds that certain elements of the proposed model (Figure 2) are supported more than others. First, that sound exposure in a home environment is a *direct* determinant of stress-related disease is generally inconclusive. While the validity of the biological model in Figure 1 cannot be denied, particularly since it is well-supported, it appears to be pertinent primarily for conditions outside of the residential environment. The home is not normally a source of sounds intense enought to result in biological adaptation or impairment. What may be critical in the home environment is an individual's perception of sound as noise (Figure 2). While the sound level may be one factor which influences perceived noise, there is evidence based on the literature, that cognitive factors, personal characteristics, and other qualities of sound play significant roles. Indeed, intensity of sounds has been demonstrated by several researchers to have little bearing on an individual's perception of noise.

Once a sound is perceived as noise, the likelihood that annoyance will occur increases. This relationship has been examined rather thoroughly, and the literature seems to substantiate this element of the proposed model. Research further indicates that mere exposure to sound has less effect on annoyance than do those factors related to perceived noise.

If annoyance occurs, the model (Figure 2) suggests that an individual may reduce this deficit by complaint action or by adapting personal norms with regard to the noise. While complaint action as a consequence of noise-induced annoyance is rather infrequent, the limited amount of research does suggest a cogent relationship. In order for this relationship in Figure 2 to be more meaningful, one should consider the literature and allow for modification of the model by other variables such as personal traits and support by others for the complaint action.

If an individual is not inclined to take part in complaint activity to reduce the noise deficit, it seems logical that he might adapt his original attitudes toward the noise. Although such a relationship has not been tested, this should be an important element of future research, for without adjustment, annoyance may become an emotional stressor strong enough to result in disease. Admittedly, testing the validity may be problematic since it will be necessary to determine if an individual has indeed cognitively adapted (as in Figure 2) or if the noise has become a source of stress capable of inducing the general adaptation syndrome and possible biological or psychological consequences. As previously pointed out, no *specific* research has apparently been conducted relative to noise-induced annoyance as an emotional stressor. If, however, such annoyance can be equated to an emotional stressor as described by Selye, this association is supported to a larger degree.

In general, the research on environmental home noise appears to be in exploratory stage. Little in-depth analysis has been attempted, due possibly to a lack of interest in the problem and lack of available data. This situation, however, is changing as awareness of the detrimental effects of noise, particularly in combination with other environmental stressors, rises. Recognition is emerging in the form of noise abatement controls as recently enacted in New York City. Although controls may partially alleviate the noise pollution, they cannot be the entire answer since "noise" is such a personal, subjective matter.

> With the exception of the most intense noises, no single noise is likely to evoke exactly similar responses from all the individuals in a population exposed to it (Burns, 1973, p. 115).

Individuals who are bothered by noise can, however, do much to improve their sound environment without benefit of controls and without adapting personal standards. For instance, one can avoid living in especially noisy areas, purchase low noise-rated equipment, choose a dwelling that is shielded from roadways, or choose a dwelling in which the noise-producing areas are separated from those requiring quiet. There are various ways an individual can help himself once he recognizes the existence or potential existence of a problem.

Besides controls and individual initiative, the problem of unwanted noise could be reduced with improved housing design. This could involve many factors of which a few might be: siting a building in relation to roads, parking, industry, and other housing; better sound insulation, more effective zoning of activities within houses, fewer and more thoughtfully-designed openings, and the incorporation of welldesigned, sound-insulated equipment. Not only can the building and equipment industries contribute to improvement of the residential environment, but so can city planners when determining locations of roads, airports, and industry in relation to residential areas. The noise environment of existing housing might, furthermore, be improved by the addition of shielding devices such as landscaping and architectural sound barriers. It is evident that much can be done to alter the noise environment and positively influence the future of housing. In order to ensure positive results, however, further research should be undertaken to discover more precisely the nature of noise-induced annoyance.

References

Borksy, Paul, 1969. Community aspects of aircraft noise. *Proceedings*. Congress on noise as a public health hazard.

Broadbent, Donald E., 1957. Effects of noise on behavior. In Cyrie M. Harris, *Handbook of Noise Control*. New York: McGraw-Hill Book Company, Inc.

Buckley, Joseph and Harold H. Smookler, 1970. Cardiovascular and biochemical effects of chronic intermittent neurogenic stimulation. In Bruce L. Welch and Annemarie S. Welch (eds.) *Physiological Effects of Noise*. New York-London: Plenum Press.

Burns, William. *Noise and Man*, 1973. London: William Clowes and Sons.

Cameron, Paul and Donald Robertson, 1972. Sound pollution, noise pollution and health: Community parameters. *Journal of Applied Psychology*, February.

Cannon, Walter B. *The Wisdom of the Body*. 1932. New York: W. W. Norton and Company, Inc.

Farr, Lee E. 1967. Medical consequences of environmental home noises. *Journal of the American Medical Association*, October 16.

Galloway, William and Glenn Jones, 1973. Motor vehicle noise: Identification and analysis of situations contributing to annoyance. *Proceedings*. International congress on noise as a public health problem.

Glass, David C. and Jerome E. Singer, 1972. *Urban Stress*. New York-London: Academic Press.

Graeven, David B., 1974. The effects of airplane noise on health: An examination of three hypotheses. *Journal of Health and Social Behavior*, December.

Gross, Nancy E., 1958. *Living with Stress*. New York: McGraw-Hill Book Company, Inc.

Informatics, Inc., 1971. Medical and physiological studies of air traffic noise. *An Assessment of Noise Concern in Other Nations*. United State Environmental Protection Agency, December 31.

Jansen, G., S. Rosen, J. Schulze, D. Plester and A. El-Mofty, 1964. Vegetative reactions to auditory stimuli: Comparative studies of subjects in Dortmund, Germany, and the Maaban Tribe in the Sudan. *Transactions of the American Academy of Opthomology and Otolaryngology*.

Jansen, Gerd, 1973. Non-auditory effects of noise, physiological and psychological reactions in man. *Proceedings*. International congress on noise as a public health problem.

Jenson, Marcus M. and A. F. Rasmussen, 1970. Audiogenic stress and susceptibility to infection. In Bruce L. Welch and Annemarie S. Welch (eds.) *Physiological Effects of Noise*. New York-London: Plenum Press.

Jonsson, Erland, 1973. Methodological aspect of studies of community response to noise. *Proceedings*. International congress on noise as a public health problem.

Kryter, K. D., 1970. *The Effects of Noise on Man*. New York: Academic Press.

Leonard, Skipton and Paul Borsky, 1973. A causal model for relating noise exposure, psychosocial variables and aircraft noise annoyance. *Proceedings*. International congress on noise as a public health problem.

McKennell, Aubrey, 1973. Psychosocial factors in aircraft noise annoyance. *Proceedings*. International congress on noise as a public health problem.

Mize, Jessie J., Fern Tuten, and Joseph W. Simons, 1966. A study of sound levels in houses. *Journal of Home Economics*, January.

Morris, Earl W., Mary Winter and Ivan F. Beutler. A normative deficit model of consumer behavior. In

B. B. Anderson (ed.) *Proceedings of Association for Consumer Research 6th Annual Conference, Advances in Consumer Research* (Vol. III)

National Swedish Institute for Building Research and the National Swedish Institute for Public Health (abbr. in paper NSIBR). 1968 *Traffic Noise in Residential Areas*. Stockholm: AB Svensk Byggtjanst.

Rohrmann, B., 1973. An interdisciplinary study on the effects of aircraft noise on man. *Proceedings*. International congress on noise as a public health problem.

Rosen, Samuel, 1970. Noise, hearing and cardivascular function. In Bruce L. Welch and Annemarie S. Welch (eds.) *Physiological Effects of Noise*. New York-London: Plenum Press.

Rosenblith, W. A., K. N. Stevens, and R. H. Bolt, 1955. A community's reaction to noise: Can it be forecast? *Noise Control*, January.

Selye, Hans, 1956. *The Stress of Life*. New York: McGraw-Hill Book Company, Inc.