Source Zone	Base Case	Alternative 4
98	311	311
105	342	289
84	345	345
C 2	318	294

In the base case, multistate corridor zone 2 (Tupelo, Mississippi) looks attractive relative to other supply zones. Its market cost (HIJK) is close to that of zone 98 (New Orleans), the lowest cost producer, and substantially better than that of zone 105 (Houston). Its potential market would be approximately 14 500 Mg/year (16 000 tons/year).

Under improvement alternative 4, the relative positions of the major suppliers to the Cincinnati market would change. Zone 105 (Houston) is able to take advantage of efficient modal interchange facilities at Memphis to put together an attractive rail-water route. Corridor zone 2 would also benefit from the transportation improvements but to a lesser extent than Houston, which is the new lowest cost supplier. New Orleans (zone 98) would not benefit from the transportation improvement and would fall to third position. The potential market for corridor zone 2 (Tupelo) would increase only slightly as a result of the transportation improvement, which suggests that this improvement program would not enhance economic development opportunities in agricultural chemicals.

FUTURE WORK

A second year's research effort will be directed toward improving the analytical procedure. During the third year, the procedure will be applied to the multistate corridor.

ACKNOWLEDGMENT

This research was supported by the U.S. Department of Transportation.

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Publication of this paper sponsored by Committee on Social, Economic, and Environmental Factors of Transportation.

Regulatory Implications of Individual Reactions to Road Traffic Noise

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A basic problem in setting standards for acceptable levels of road traffic noise is deciding on a criterion of acceptability. The possible criteria reduce to three categories: noise impacts (i.e., activity interference and effects on health), attitudes toward noise, and actions taken to reduce the impact of noise (e.g., complaints). The rational selection of a criterion or criteria needs to be based on careful empirical analysis of two sets of relations: (a) the relations among the plausible criteria and (b) the relations between the criteria and noise measurements. The first set of relations is examined by using questionnaire data collected at 37 sites adjacent to highways in southern Ontario. The results show significant but relatively weak links between impacts and attitudes and between attitudes and actions. The analysis results (a) question the use of activity interference measures, and particularly speech interference, as a criterion for setting standards and (b) confirm the inadequacy of regulating against traffic noise on the basis of complaint action.

Faced with the problem of establishing acceptable levels of environmental noise, the difficulty immediately arises of deciding on a basis for defining acceptability. It seems obvious that the definition should be based on some measure of the adverse effects of noise on an exposed population. But the question remains as to what specific measure should be used. The various plausible measures that have been identified and considered can be reduced to three main categories: noise impacts (specifically, activity interference and effects on health), reported annoyance, and community action (usually complaints).

Drawing almost entirely on the results of studies of human response to aircraft noise, the U.S. Environmental Protection Agency (EPA) isolates speech interference as the primary basis for defining acceptable levels of noise (1). It is reasonable to question whether this is too narrow a view and, perhaps more important, whether it is valid for noise sources other than aircraft, particularly road traffic, which, although not the most intensive, is certainly the most extensive source of environmental noise.

Basic to a rational definition of acceptability is a clear understanding of the relations among the three categories of adverse reaction previously mentioned and in turn between each of these categories and physical noise measurements. The first concern is the focus of this paper; the second is the subject of work in progress. In this paper, the relations among impacts, attitudes, and actions are examined with reference to road traffic noise by using questionnaire data collected in the Toronto-Hamilton area of southern Ontario. The paper proceeds from a discussion of the conceptual framework and the existing literature to a description of the data source. The results of the analysis are then presented, and their implications for the setting of standards for road traffic noise are discussed.

CONCEPTUAL FRAMEWORK AND EXISTING STUDIES

In a relatively early paper, Borsky called for the establishment of "an analytical model of the complex human responses to noise" (2, p. 219). In fact, he suggested a four-stage model that consists of (a) perception of noise, (b) activities affected or interrupted, (c) annoyance that results from interruption, and (d) complaints that result from this annoyance. McKennell has expressed a similar sentiment in asserting that "we require a model for the understanding and prediction of complaint" (3, p. 229).

The conceptual model that forms the basis of this analysis is sequential in nature and builds on Borsky's idea of stages of reaction to noise. However, it has been formulated so that each component is delineated more specifically for the purposes of investigation and analysis (Figure 1).

Briefly, exposure to noise is seen to affect the individual's life-style in some way. This impact can then be broadly divided into the activities that are interfered with and the effects on health that are perceived to be suffered as a result of noise. The model assumes a sequential reaction to noise whereby the direct impacts experienced by individuals are instrumental in shaping their attitude toward noise. This is not to say, however, that attitudes are a simple and direct reflection of these impacts. It is widely recognized by Borsky (2) and others such as Langdon (4) that a number of psychological factors, such as the degree to which other environmental amenities are seen as being present, intervene to complicate this link.

The model further assumes that attitudes once formed affect the subsequent actions of the individual in response to the noise, whether in the form of a complaint or some form of immediate or long-term adjustment. As McKennell (3) points out, this link too is complicated by the intervention of various factors, particularly socioeconomic variables.

Although it has been almost a decade since this conceptual framework was proposed, there has been little empirical analysis of the assumed links between the components. In general, for road traffic noise, the few empirical results reported indicate relatively weak links among the three components of the chain on which this paper focuses—namely, impacts, attitudes, and actions (4, 5, 6, 7).

In terms of the relation between impacts and attitudes, existing results fail to provide clear evidence of the relative contribution to annoyance of different forms of activity interference. In addition, no attention has apparently been paid to the link between human attitudes and reported effects of traffic noise on health. Effects on health are an equally valid and probably more significant adverse impact of noise, and it is important that they be examined. This analysis is directed toward both these ends: It examines in more detail than previously the individual and combined effects of activity interference on attitudes and examines the relation between reported effects of road traffic noise on health and attitudes.

Regarding the link between attitudes and actions, most attention has focused on the relation between annoyance and complaints (8, 9). The results consistently show that only a small percentage of those annoyed actually complain, which confirms McKennell's assertion that "the passage from annoyance to complaint is by no means straightforward nor inevitable" (3, p. 230). There is also evidence that socioeconomic variables are important intervening factors in the relation between annoyance and complaint (10).

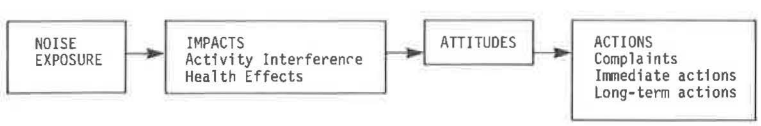
Complaining is, however, only one of many possible actions—some immediate, others more long-term—that residents can take in an effort to reduce the adverse effects of road traffic noise. In this analysis, these other types of actions are examined as well in an effort to extend and clarify the link between attitudes and actions in response to traffic noise.

DATA SOURCE

The data used in this analysis were collected in the summer of 1976 by means of a questionnaire survey of residents at selected sites adjacent to major highways in the Toronto-Hamilton area of southern Ontario. Sites were selected to cover different types of housing (i.e., single-family houses, townhouses, and apartments) and occupancy (i.e., renters and owners). A total of 949 interviews were completed at 37 separate sites. The noise measurements at each site showed the quietest site to have a daytime L_{eq} of 57 dB(A) and the noisiest a daytime L_{eq} of 80 dB(A) with a fairly even range of intervening levels.

The questions asked of respondents covered the normal range of general and specific questions included in most community noise surveys. The questionnaire,

Figure 1. Conceptual model of reaction to noise.



however, had the distinctive feature of requesting a detailed set of disturbance ratings for each noise source mentioned as disturbing. These ratings provided a measure of the degree of disturbance experienced inside and outside the home as well as the overall measure that has been obtained in previous surveys.

ANALYSIS AND RESULTS

The analysis divides into two sections. The first examines the relations between the reported impact of traffic noise (i.e., activity interference and effects on health) and attitudes. The second deals with the relations between attitudes and actions taken, both immediate and long-term. In both sections, the analysis is based on the subset of the total sample who reported being disturbed by traffic noise from a main road. This group comprised 449 of the 949 respondents.

Impacts and Attitudes

Each respondent who indicated being disturbed by main-road traffic noise was asked which if any activities were interfered with and what if any perceived effects on health any members of the household had experienced as a result of the noise. In the table below, the frequency with which activities and effects on health were mentioned shows the prominence of sleep-related impacts:

Impact	Number of Times Mentioned	Percentage of Total Sample	Percentage Disturbed
Activity interference			
Sleeping	156	16.4	34.7
Relaxing indoors	53	5.6	11.8
Relaxing outdoors	76	8.0	16.9
Conversing indoors	27	2.8	6.0
Conversing outdoors	40	4.2	8.9
Working indoors	16	1.7	3.6
Working outdoors	8	0.8	1.8
Watching television	63	6.6	14.0
Speaking on telephone	15	1.6	3.3
Eating	18	1.9	4.0
Effect on health			
Nervousness	30	3.2	6.7
Hearing loss	6	0.6	1.3
Irritability	84	8.9	18.7
Headaches	35	3.7	7.8
Sleep interrupted	228	24.0	50.8
Kept awake	110	11.6	24.5

For both activity interference and effects on health, the impact on sleep was mentioned far more frequently than any other impact. Speech interference, whether in general or in telephone conversations, was mentioned relatively infrequently; this contrasts with the results from studies of aircraft noise and suggests once more that reactions to noise cannot be dealt with independently of the noise source.

It needs to be stressed that the effects on health are those that are perceived to have occurred. Clearly, the perception may in some cases underrepresent and in other cases overrepresent the actual effects. However, given that no medical records were consulted, the degree of correspondence between perception and reality remains unknown for these data.

Four measures of attitude were used in the analysis. Each was based on a self-rating of disturbance from main-road traffic noise on a 10-point scale ranging from 0 (not at all disturbed) to 10 (unbearably disturbed). Intermediate scale points were unlabeled, and respondents could give noninteger ratings (e.g., 2.5) if they wished. This scale is assumed so that the analysis has interval properties. The four measures of attitude based on this scale correspond to the overall rating of disturbance, the rating inside the home, and ratings outside on the exposed side of the building and on the shielded side of the building. In certain residential developments, particularly apartments, the respondent's dwelling unit did not have a shielded side, in which case the shielded rating was not obtained.

The analysis of relations between noise impacts and attitudes used analysis of variance and multiple classification analysis. The impact measures form the categorical independent variables, and the attitude scores form the interval-scaled dependent variable. The effects of the different impacts are considered both individually and in selected combinations.

The relations between individual impacts and attitudes were examined by using a one-way analysis of variance (Table 1). The resulting F-ratio and associated probability indicate whether a statistically significant difference exists in the mean attitude scores between those who do and do not report experiencing each impact. The eta coefficient is a measure of the association between the reported impact and attitude. It is the appropriate measure of association where the independent variable is nominal and the dependent variable at least interval as in this case (11).

For the activity interference variables, the results show that 23 of the 40 relations examined are significant beyond the 5 percent level. When one considers the relations with overall attitude toward traffic noise, conversation, watching television, and sleep interference are the strongest predictors although the eta coefficients are not impressive. Given that eta^2 can be interpreted as the proportion of the variance in the dependent variable explained by the independent variable, interference with outdoor conversation and television watching—the strongest predictors—both account for only 2 percent of the variation in overall attitude.

The relations with the other attitude scales form a logical pattern in that indoor activities are more strongly related to indoor ratings of disturbance and outdoor activities are more strongly related to outdoor ratings. Outdoor activity interference is more strongly linked to the ratings for the exposed side of the building than to those for the shielded side.

In relation to effects on health, the relations are generally stronger; all but 2 of the 24 relations examined are significant beyond the 5 percent level. The strongest relations are with the indoor rating, which is reasonable since the effects on health considered are generally more likely to occur as a result of exposure to noise inside the home. Although the relations are stronger, the eta coefficients are still quite small. The largest eta is only 0.27 for the relation between irritability and indoor rating, which means that only 7 percent of the variation in attitude is explained.

The variables that emerged as the best predictors of attitude in the one-way analysis were included in a multivariate analysis to determine whether the impacts provided better predictions when combined than when treated individually. The results of the multiple classification analysis performed as part of the multivariate analysis of variance summarize the effectiveness of the combined predictors (Table 2). Multiple classification analysis describes the pattern of the relation between a set of nominal independent variables and an interval-scaled dependent variable (12). The relation between each independent variable and the dependent variable is examined by controlling for the effects of the other independent variables. In addition, the overall relation between the independent variables and the dependent

Table 1. Relations between individual noise impacts and attitudes.

Impact	Attitude: Overall Significance (F)	Overall eta Coefficient	Indoors Significance (F)	Indoors eta Coefficient	Outdoors, Exposed Side Significance (F)	Exposed Side eta Coefficient	Outdoors, Shielded Side Significance (F)	Shielded Side eta Coefficient
Activity interference								
Sleeping	0.01	0.14	0.001	0.21	NS	0.08	NS	0.09
Relaxing indoors	NS	0.06	0.001	0.19	NS	0.07	NS	0.03
Relaxing outdoors	NS	0.08	NS	0.04	0.001	0.17	NS	0.01
Conversing indoors	0.01	0.13	0.001	0.18	0.05	0.11	NS	0.08
Conversing outdoors	0.01	0.15	0.05	0.10	0.001	0.17		0.12
Working indoors	NS	0.08	NS	0.01	0.05	0.09	NS	0.01
Working outdoors	NS	0.04	NS	0.02	NS	0.04	NS	0.10
Watching television	0.01	0.15	0.001	0.23	0.05	0.11	NS	0.10
Speaking on telephone	NS	0.08	0.01	0.16	0.01	0.13	NS	0.10
Eating	NS	0.09	NS	0.07	NS	0.05	NS	0.01
Effect on health								
Nervousness	0.001	0.16	0.001	0.19	0.01	0.15	0.05	0.15
Hearing loss	0.01	0.15	0.001	0.17	NS	0.05	0.01	0.17
Irritability	0.001	0.22	0.001	0.27	0.001	0.16	0.05	0.15
Headaches	NS	0.09	0.001	0.16	NS	0.07	0.001	0.22
Sleep interrupted	0.001	0.21	0.001	0.25	0.001	0.21	0.05	0.15
Kept awake	0.001	0.20	0.001	0.25	0.01	0.13	0.01	0.17

Note: NS = not significant.

Table 2. Relations between combined noise impacts and attitudes.

Impact	Attitude: Overall Significance (F)	Overall R/R^2	Indoors Significance (F)	Indoors R/R^2	Outdoors, Exposed Side Significance (F)	Outdoors, Exposed Side R/R^2
Activity interference						
Sleeping	0.01		0.001			
Relaxing indoors			0.05			
Relaxing outdoors					0.05	0.211
Conversing indoors	NS	0.251	NS	0.364		
Conversing outdoors	0.05	0.063			0.05	0.045
Watching television	0.05		0.001	0.133		
Speaking on telephone			NS			
Effect on health						
Nervousness	NS		NS		0.05	
Irritability	0.001	0.331	0.001		0.05	0.289
Headaches			NS	0.412		
Sleep interrupted	0.001	0.110	0.001	0.170	0.001	0.084
Kept awake	0.05	0.001			NS	
Combined						
Conversing outdoors	0.01					
Watching television	0.05	0.332				
Irritability	0.001	0.110				
Sleep interrupted	0.001					

Note: NS = not significant.

variable is calculated. The results are valid only if the interaction effects among the independent variables are not significant. This basic condition was met for the analysis reported here.

The figures given in Table 2 indicate the significance of the effect of each impact adjusted for the effects of the other variables in the same combination and also the proportion of the variation in attitudes accounted for by the combined impacts (R^2). As expected, the adjusted effects were less significant than the unadjusted effects in all cases, which indicates that the impacts are correlated to varying degrees. A consistent finding, however, was that the difference between the unadjusted and adjusted effects was least for sleep-related impacts; this confirms the finding of previous studies (4, 5) that sleep interference is relatively independent of other traffic noise impacts.

When compared with the eta coefficients reported from the one-way analysis of variance (Table 1), the R^2 values show that the explained variation in attitudes has been increased by using a combined set of predictors, but the gain is very modest. The best prediction (R^2 = 0.17) is for the indoor rating of traffic noise based on the combined set of health impacts although only three of these—irritability, interruption of sleep, and being kept awake—have significant adjusted effects.

In summary, these results confirm previous findings in two respects. First, they show that attitudes toward traffic noise are significantly related to the adverse impacts of the noise that an individual has experienced, and to this extent the link between impacts and attitudes in the conceptual model is supported. Second, however, the results show that this link is by no means a simple cause-and-effect relation. The proportion of the variation unaccounted for by the impacts indicates that intervening factors play an important role in shaping attitudes. These results go beyond those previously reported in showing that reported impacts on health are more strongly related to attitude than are the activity-interference variables. Furthermore, they indicate that sleep-related impacts are generally the ones most significantly related to reported disturbance from road traffic noise.

Attitudes and Actions

Information was obtained from each respondent disturbed by main-road traffic noise to determine what actions, if any, had been taken to reduce the impact of noise. Besides information on complaint action, respondents indicated what other immediate or longer term actions they had taken. In the table below, the number of times the actions included in the analysis were mentioned shows how few people have complained:

Action	Number of Times Mentioned	Percentage of Total Sample	Percentage Disturbed
Complaint	24	2.5	5.4
Immediate			
Close windows	244	25.7	54.3
Stay inside	61	6.4	13.6
Turn television on or up	112	11.8	24.9
Any of above	284	29.9	63.3
Long-term			
Erect barrier	36	3.8	8.0
Consider moving	261	27.5	58.1

This again underlines how unrepresentative complaint action is as an index of disturbance or annoyance. This is perhaps more the case with traffic noise from a main road than with noise from other sources because it is rarely possible to isolate the cause of disturbance other than in the most general terms and this provides little basis for formal complaint.

Immediate, short-term actions designed to reduce the impact of noise are much more common and, of these, closing windows was the most frequently reported. Longer term actions were again generally less frequent. The erection of barriers (fences, walls, or trees) is singled out here for inclusion in the analysis. Information on other actions was obtained in the questionnaire, but they were not mentioned frequently enough to warrant analysis. Respondents were also asked whether they had ever considered moving to avoid unwanted noise. Over 58 percent of those disturbed by main-road traffic noise said yes. Clearly, many who mention having considered moving may have little or no intention of doing so. Nonetheless, the responses are included in the analysis to determine to what extent they are a function of attitudes.

Stepwise discriminant analysis was used to analyze the relations between attitudes and actions. The purpose of this technique is to define the linear combination or combinations of independent variables that maximally discriminate between the groups defined by the categories of the dependent variable (13). In this analysis, the independent variables were the four attitude scales previously described, and the groups comprised those who had and had not taken each of the seven actions given in the preceding table. Seven separate analyses were therefore performed to examine the relations between attitudes and each of the actions.

From the results given in Table 3, it is obvious that each of the seven actions is dominated by a single attitude variable. In five cases, only the first variable entered into the equation makes a significant contribution to the action that reflects the degree of correlation among the scales. In three instances, the dominant variable is the overall rating; in two others, it is the outdoor exposed rating; and in the remaining two, it is the outdoor shielded rating. The indoor rating makes no significant contribution to any of the actions. It must be borne in mind that the significance referred to here is based on the combined attitude variables. When the attitude variables were considered individually, each of the four was found to be significantly related to each of the action variables.

The canonical correlation for each function provides a "measure of association between the discriminant function and the set of (g - 1) dummy variables which define the g group memberships" (14, p. 442). Based on these coefficients, the relation between attitudes and actions is strongest for "consider moving" followed by "any of above" and "turn television on or up". Although each of the functions significantly discriminates between the groups defined in the action variables, the relation between attitudes and actions reflected in the canonical correlations is at best moderate and in most cases weak.

Further evidence of this weak relation is seen in the percentage of cases correctly classified into the two groups on each action variable by using the discriminant scores for each case. The stronger the relation is between the predictors and the group variables, the greater the discriminating power of the function and the more accurate the classification of group membership are. With two groups and equal prior probabilities of membership in each, 50 percent accuracy in classification could be expected in the long run on the basis of chance alone. The results show that knowledge of respondents' attitudes toward road traffic noise provides better predictions of action than could be expected by chance, but nevertheless an accuracy that ranges from

Table 3. Results of discriminant analysis: attitudes and actions.

	Attitude									
					Outdoors					
	Overall		Indoors		Exposed Side		Shielded Side			
Action	Coefficient	Significance	Coefficient	Significance	Coefficient	Significance	Coefficient	Significance	Canonical Correlation	Group Members Correctly Classified (%)
Complaint	0.23	NS	-0.41	NS	0.58	NS	0.64	0.001	0.24	63
Short-term										
Close windows	-0.56	0.001	-[a]	-[a]	-0.35	NS	-0.25	NS	0.22	60
Stay inside	-[a]	-[a]	-0.15	NS	-0.57	0.001	-0.47	NS	0.24	61
Turn television on or up	-0.37	0.05	-0.06	NS	-0.18	NS	-0.60	0.001	0.32	67
Any of above	-0.49	0.001	-0.04	NS	-0.42	NS	-0.25	NS	0.32	65
Long-term										
Erect barrier	-0.75	NS	0.41	NS	-0.55	0.01	-0.12	NS	0.22	63
Consider moving	-0.62	0.001	-0.22	NS	-0.37	0.05	-[a]	-[a]	0.41	67

Notes: Coefficients are standardized discriminant function coefficients. Significance of the contribution of each variable to the function is based on change in Rao's V.
NS = not significant.

[a] The variable failed to meet the entry criterion based on partial F-ratio.

a low of 60 percent to a high of 67 percent is not impressive.

Considering the following complete classification table for the complaint variable leads to a better understanding of the implications of this relatively poor level of prediction:

	Predicted Group				
	No Complaint		Complaint		
Actual Group	Number	Percent	Number	Percent	Total
No complaint	139	62.6	83	37.4	222
Complaint	7	30.4	16	69.6	23
Total	146		99		245

The figures show that 83 (37.4 percent) of those who had not complained were indistinguishable in terms of their attitudes from those who had complained. Further, 7 (30.4 percent) of the complainants were indistinguishable from the noncomplainants. This overlap confirms the unreliability of complaint action as an index of annoyance. A substantial percentage of those who have not complained are clearly as much disturbed by road traffic noise as the complainants. In light of this finding, the adequacy of regulating against traffic noise in response to complaints must be seriously questioned.

In summary, the relations between attitudes and actions taken to reduce noise impacts are similar to those previously examined between impacts and attitudes in that they are significant but not strong. Here, again, a simple cause-and-effect relation is confounded by the effects of various intervening variables. The question that now has to be addressed is that of the implications of the relation that have been described in this section, specifically in terms of their importance for setting noise standards.

CONCLUSIONS AND IMPLICATIONS

This paper began by asserting the need to examine the interrelations among noise impacts, attitudes, and actions to provide a better basis for setting standards on acceptable levels of road traffic noise. The immediate problem was seen to be that of deciding on a criterion of acceptability. In this section, the implications of the results previously described are discussed with reference to this problem.

Considering first the relations between the reported impacts of noise (i.e., activity interference and effects on health) and human attitudes, it is clear that there is far from a one-to-one correspondence between the two. This is evident from the fact that many more people reported being disturbed by traffic noise than indicated having experienced specific activity interference or effects on health and also from the weak correlation between the impacts—both individually and in combination—and attitudes. This clearly implies that setting some standards with the aim of eliminating specific noise impacts will not totally eliminate annoyance. This has been recognized in previous studies (1) where the conclusion has been that there appears to be no practical way of setting standards so as to ensure the elimination of annoyance. Although the results of this analysis would in some ways seem to lead to the same conclusion, a word of caution is necessary. The extent of the disparity between the reported impacts of road traffic noise and reported disturbance that is evident in these data makes questionable the adequacy of setting standards on the basis of impacts alone. To do so may well leave an unacceptably large percentage of the population annoyed. The strategy adopted by EPA (1) of recommending a standard 5 dB(A) below that required to eliminate impact (in that case, speech interference) as a margin of safety may not be sufficient. It seems necessary to go beyond this kind of ad hoc approach to the problem and carefully compare the relations between noise levels and annoyance with those betwen noise levels and reported impacts. This is the approach that we have adopted in our own analysis in progress.

The results of this analysis also provide a basis for assessing the appropriateness of using speech interference as the criterion for defining acceptable levels of road traffic noise. The choice by EPA of speech interference as the critical factor was defended on the grounds that it "has been identified as the primary interference of noise with human activities, and as one of the primary reasons for adverse community reactions to noise and long-term annoyance" (1, p. D-34). However, the empirical findings to substantiate this statement are almost exclusively confined to aircraft noise, and the question arises as to whether the results of studies of road traffic noise are equally supportive.

The results of this study strongly suggest that they are not. Speech interference was far from being the primary type of activity interference reported. Nearly four times as many people mentioned sleep interference as mentioned interference with outdoor conversation. Interference with conversation was also exceeded by reports of interference with relaxation. The strength of the relation between speech interference and attitudes implied by the EPA statement is not strongly supported either. Of the activity interference measures, those that involved speech interference were the most strongly related to the attitude scales (Table 1), but the correlations were relatively weak. Furthermore, several of the effects on health emerged as better predictors of attitude than did speech interference.

The general conclusion seems to be that the universal adoption of speech interference as the criterion for setting acceptable levels of noise is dubious. There are good practical reasons for using speech interference (specifically, the ability to accurately gauge the degree of interference caused by different noise levels), but these alone are insufficient to defend the adoption of speech interference as the critical criterion for standards on road traffic noise if the empirical justification is lacking.

The fact that reported effects on health generally emerged as better predictors of attitude than did the variables of activity interference suggests that the impacts of noise on health deserve more consideration in the setting of noise standards than they appear to have received. Admittedly, there are practical problems involved in this since it would be necessary to go beyond the reported effects on health used in this analysis and consult medical records to assess the effect of noise on health with any degree of reliability. Even if records were accessible, there would still be problems in isolating the effect of noise among the many potential variables that affect health. Nevertheless, the effects of noise on health still warrant consideration as possible criteria for setting standards.

The basic implication of the relations between attitudes and actions is to confirm the need for specific standards for road traffic noise. Given the ambiguous wording of many existing environmental regulations, the status quo approach to regulating noise levels has been to respond to complaints. The results of this analysis confirm those of previous studies: Regulating on the basis of complaints is totally inadequate. This is evident from the fact that only a very small percentage of those disturbed had ever complained and also from the weak relation between attitudes and complaints shown by the discriminant analysis. The unreliability of complaints as an index of disturbance is further underlined by comparing the small number of complainants with the much larger number of people who had taken immediate actions to reduce intrusion from noise or who had considered moving to a quieter neighborhood.

This analysis in itself is clearly not a sufficient basis for drawing final conclusions on criteria for setting standards on road traffic noise. Nonetheless, this examination of the relations among impacts, attitudes, and actions provides important empirical findings that can serve as a partial basis for regulatory decisions.

The results of this analysis must be considered in relation to those derived from an analysis of the relations between the various impact and response measures considered here and measurements of noise level. That type of analysis is the focus of work in progress. Taken together, the results of the two analyses will significantly strengthen the existing empirical basis for decisions on standards for road traffic noise.

ACKNOWLEDGMENT

The support of the Ontario Ministry of the Environment and the Canada Council is gratefully acknowledged.

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Publication of this paper sponsored by Committee on Transportation-Related Noise.

Effectiveness of Shielding in Reducing Adverse Impacts of Highway Traffic Noise

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Construction of noise barriers or other forms of shielding between residential areas and noisy roadways is one of several approaches to reducing community noise levels. Some studies have suggested that the psychological effect of such shielding is greater than its acoustical effect. This suggestion was tested by using home interview data from five pairs of residential sites. The two sites that made up each pair experienced the same noise level at dwellings but had different types of shielding or barriers. It appears that there is no psychological effect for road traffic noise specifically but that there is an effect for attitudes toward overall community noise. This psychological effect appears to be negative for solid noise barriers, low for single rows of trees, and highest for a row or rows of intervening housing.

Many jurisdictions are in the process of implementing a variety of procedures for reducing the level of traffic noise that reaches residential areas. For example, in the United States, the Federal Highway Administration will provide funding for traffic management procedures to reduce noise, for the construction of noise barriers, or for the purchase of land for such construction or to serve as a buffer zone (1). In Ontario, the Ministry of Transportation and Communications has earmarked funds for construction of noise barriers along major highways through residential areas. In Britain, the government has undertaken to insulate houses for purposes of sound reduction wherever the existing sound level exceeds cer-