THE EFFECTS OF TENURE AND TYPE OF DWELLING ON SUBJECTIVE RESPONSE TO TRAFFIC NOISE

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ABSTRACT

Previous research has suggested that the type of residential dwelling and the tenure status of an individual affects response to noise. However, the effects of these variables has been assumed but not empirically demonstrated. Using questionnaire data collected at selected residential sites, in the Toronto region, this analysis tests the separate and joint effects of dwelling type and tenure, on response to road traffic noise. The results show that tenure status had no effect on a resident's response to traffic noise. There was only a weak dwelling type effect, with detached unit residents being slightly more disturbed than multi-unit residents by the equivalent noise level. The findings do not support a policy of varying noise standards for different types of residential area.

ACKNOWLEDGEMENTS

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CHAPTER ONE

INTRODUCTION

The problem of noise pollution is receiving increased attention from both scientific researchers and the public at large. This growing awareness of the problem is due to two factors. First, there is the actual increase in ambient noise levels due to increased traffic levels, greater population density and increased ownership of noise generating machinery, such as air conditioners and lawn-mowers. Estimates of noise levels in the average American city indicate that there has been an increase of 30 decibels over the past 30 years. This means that the urban ambient noise level of today is approximately eight times as loud as it was 30 years ago.

A second factor is the awareness of the serious effects which continued exposure to loud noise may have on man. There have been numerous studies which have documented these effects, and although there is not a complete consensus, it is generally agreed that noise can cause (i) annoyance, (ii) sleep disturbance, (iii) interference with task performance, (iv) interference with perception of auditory signals such as speech communications, (v) temporary hearing loss or (vi) permanent hearing loss (Glass and Singer, 1972; the Central Institute for the Deaf, 1971; Kryter, 1970). In light of this, it is not surprising that noise has, of late, received a great deal of attention.

Much of the research has been directed towards predicting people's disturbance due to exposure to a variety of noise sources. Initially, the problem was largely an engineering concern - the attempt to find an appropriate index which would relate the level of noise to an individual's reported disturbance (Bolt, Beranek and Newman, 1971a; U.S. Environmental Protection Agency, 1974).

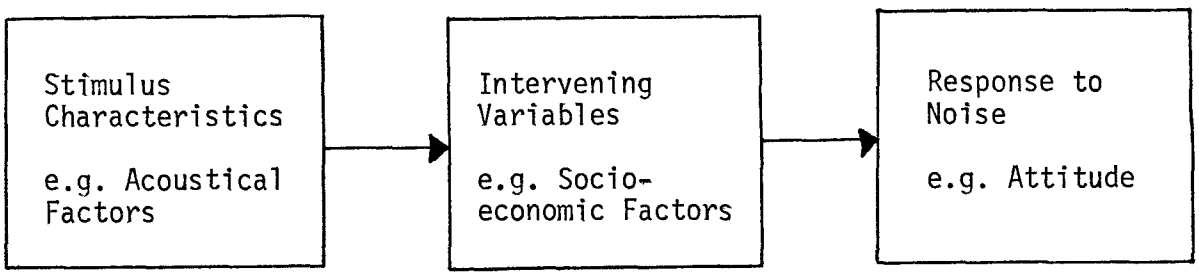
However, it was soon found that annoyance due to traffic noise was not solely a function of the level of the sound stimulus. An individual's attitude towards noise is actually a very complex concept, influenced not only by acoustical variables such as loudness and duration, but also by what have been termed 'conditioning' and 'intervening' variables (Bolt, Beranek and Newman Inc., 1971b). These intervening variables can be various personal or situation factors such as the presence of visual barriers, the activity a person is engaged in, the individual's demographic characteristics or his beliefs about the noise source (figure 1).

The examination of the effects of two such intervening variables is the purpose of this paper. The aim is to study the effects of an individual's dwelling type (single vs. multi-unit) and tenure (own vs. rent) on response to road traffic noise, which is generally recognized as the most widespread source of noise annoyance (Noise Advisory Council, 1974).

The effect of these two variables on attitudes towards traffic noise has not been the focus of detailed empirical study. However, some planning agencies appear to assume that such variables are important for they have suggested acceptable noise levels which vary for different types of dwellings. For example, Rackl et al. (1975) suggested that the upper criterion noise level during the day should be 74 dBA for single, detached homes, but can be as high as 79 dBA for multi-unit homes. Yet, to date,

Figure 1

The Role of Intervening Variables



there has been little systematic research to support these assumptions.

If there is a demonstrable difference between people's response to noise as a function of their dwelling type or tenure status, this will have a number of important planning implications. The first concerns the increasing pressure in urban areas to develop vacant land next to highways for residential uses. Are there dwelling types which will be generally associated with fewer traffic noise disturbance problems? A second implication concerns the current trend of constructing high rise apartments next to highways, even though there has been little rigorous evaluation of the supposed advantages of building this type of housing in comparison to other dwelling types. Thirdly, an increasing number of apartments are condominiums. In order to predict the response to noise that will characterize the condominium dweller, it is important to separate and isolate the effects of type of dwelling and type of tenure. Finally, as townhouses become more common, it is important to know how the level of noise disturbance reported by their residents, both owners and renters, compares with residents in apartments and detached homes.

The aim of the research presented here is to answer some of these questions. The major feature of the paper is that the effects of tenure and dwelling type are isolated in order that their influence on response to noise can be evaluated separately. To accomplish this, the data base utilized represents five of the six possible combinations of the two variables, tenure and dwelling type. It was not possible to collect a sample of single, detached unit renters.

A survey of the existing literature which relates to this problem

is presented in the following chapter. A series of research hypotheses arise out of the survey and are discussed in chapter three. The research design of the study is discussed in chapter four followed by the results of the analysis. The final chapter summarizes the general conclusions and implications of the research.

CHAPTER TWO

REVIEW OF THE LITERATURE

As discussed in the introduction, an individual's attitude towards traffic noise is very complex and is not solely the result of the stimulus itself. It may be influenced by other attitudes or other environmental variables.

Attitude toward traffic noise has been described as a "complex concept in which annoyance is not only stimulated by certain sounds emitted by motor vehicles, but in which annoyance is substantially conditioned by the meaning the noise may have for people" (Bolt, Beranek and Newman Inc., 1971b, p.1). A number of researchers have studied these antecedents to annoyance with traffic noise. Some of the intervening factors which have been considered are the activities engaged in, the presence of barriers, attitude towards the noise source (Bolt, Beranek and Newman Inc., 1971b), adaptability to noise (Finke et al., 1975) and the socio-economic and life style characteristics of the individual (Taylor and Hall, 1977a).

However, noticeably absent from this list are considerations of dwelling type and tenure. This is a serious shortcoming of the existing literature, given the importance for residential planning of knowing the nature of these effects.

Bolt, Beranek and Newman Inc. (1975b) discussed in great detail the role of antecedent variables. In their work, they defined two sets -

situational variables, such as noise source, time of day and activity engaged in, and conditioning variables, such as age, sex, occupation and income. They did not, however, include tenure or house type. This is especially surprising as a great deal of care was taken in the selection of the sample sites and sample homes for their study.

Finke et al. (1975) also recognized that noise stimulus variables alone do not sufficiently predict reaction to noise. However, the variables which he selected as moderator variables were adaptability to noise, sensitivity to noise and knowledge about the noise source. Again, no mention was made of dwelling type or tenure.

This does not mean that house type and tenure have been ignored completely. Often, however, any references to their influence on attitudes towards noise are simply passing statements, with little evidence to support them. A NCHRP report simply stated that in general "property owners are more conscious of the deleterious effects of noise on property values, than are apartment dwellers"(Gordon, 1971, p.21). A classic example of giving only passing attention to the issue is provided in Lamure's 1975 paper in which he simply states that "owner occupiers of houses are more likely to complain, at similar noise levels, than tenants of public authority housing" (Lamure, 1975, p.383). Neither study presents any empirical evidence in support of their comments.

Such sweeping statements clearly demand rigorous testing. To accomplish this, it is necessary to separate the effects of tenure and dwelling type. To date, only their combined effect has been considered, and even then not in a systematic fashion. One such study was the parent study of this work, conducted in the summer of 1975. Taylor and Hall

(1976) found that respondents living in owned, single-family homes were considerably more disturbed by freeway noise, than were respondents in rented multi-family units. However, it was impossible to determine whether the difference in reported disturbance was due to the own/rent distinction or the single/multi-unit distinction or some combination of both.

Some insight into these questions is provided by research which considers only one of the two factors. Several studies simply consider the own/rent variable. For example, a 1971 NASA study concluded that within the five miles of the flight sectors of airports "residential usuage should be confined to dwellings and facilities specially adapted to the noise environment, preferably of the *rental* type" (TRACOR, 1971, p.85). Unfortunately, no empirical support is provided for this statement.

A Japanese study, examining response to train noise, also considered the own/rent factor (Toshio et al., 1973). They conducted 424 interviews, and on the basis of the responses, concluded that there was no relationship between disturbance due to train noise and whether people owned or rented their homes. The question remains as to whether the same holds for responses to highway noise. Also, it is not clear if the Japanese researchers made any attempt to control for noise levels between the two groups - owners and renters.

A 1971 study of aircraft noise also concluded that tenure had no significant effect on annoyance due to aircraft noise (TRACOR, 1971). Again, it is not clear whether the noise levels between the two tenure groups were controlled for. There may also be a difference in responses to aircraft noise compared to highway noise. However, the findings of these two studies do appear to suggest that observed differences in disturbance between the

owned, detached unit and rented, multi-unit respondents may be due more to the influence of dwelling type than tenure.

There was no readily available research which directly considered the influence of the type of dwelling on people's response to noise. Many researchers seem to implicitly recognize that there may be a 'dwelling type effect' and control for it by interviewing within only one housing-type category.

However, a few researchers have considered the role of background noises, which is indirectly related to the dwelling type distinction, as multi-unit dwellings are generally believed to have higher background or interior noise levels. A summary report prepared by the Central Institute of the Deaf (1971) concluded that when background noise is great, the annoyance attributed to a particular intrusive noise is less than when the same noise intrudes in an area with less background noise. This supports a generally held belief that an intruding noise can be masked by loud background noise. This could perhaps, provide an explanation for the lesser disturbance due to traffic noise reported in multi-unit dwellings.

However, Shultz (1974) reported a finding which at first appears to contradict the previous study. He suggested that people who live in homes with high background noises are more sensitive to railway noise than people with a quieter background. Shultz implied that in conditions of continual noise, people were even more sensitive to the occasional extra noise of the train. However, this does not necessarily contradict the previous study. The nature of the noise source may influence these results as train noise is of sudden and short duration while noise from a major highway is relatively continuous. Johnson and Carothers (1974) studied the effects of noise

variation on response to noise. They tentatively concluded that an occasional, very loud noise is less annoying than a quieter noise which fluctuates more frequently. In other words, for a noise such as trains, the residents respond to each occasional noise fluctuation individually and are less annoyed in comparison to the road traffic noise which rises and falls in loudness continually.

Finally, as previously mentioned, most studies control for house type, choosing their sample from within either single, detached units entirely or from within multi-unit buildings. Although this means that dwelling type is implicitly assumed to have some effect, it clearly does not allow for comparisons between responses from varying types of dwellings. For example, Hitchcock and Waterhouse (1974) studied apartment tenants' responses to expressway traffic noise. They examined attitudes toward the convenience of the highway, the type of exposure to highway noise and demographic factors. However, as the study was conducted using only apartment tenants, it is not possible to compare with the responses of single, detached unit residents exposed to the same noise source.

However, these studies, which use only apartment tenants as respondents, have helped to suggest some reasons for the discrepency between their levels of annoyance as compared to single, detached unit dwellers. Towne (1966) conducted a survey in thirty-eight apartment buildings in Portland, Oregon, within one mile of a freeway. He found that although the noise was disturbing to the residents, there was no consistent correlation between noise levels and the apartment rents people were willing to pay. Towne accounts for this in terms of the greater mobility of apartment dwellers in comparison to residents in other dwelling types. It was conjectured that

since the apartment tenants view their stay as temporary, they are less concerned about the quality of the neighbourhood and therefore have a greater tolerance of noise.

One of the common assumptions is that higher *internal* noise levels in apartments account for the tolerance of external transportation noise among the residents. A number of apartment surveys have indicated that internal noise is an important factor. The results of a survey by the United States Environmental Protection Agency, conducted among apartment dwellers, indicates that noises generated from within the apartment building are indeed a common source of annoyance (table 1).

Table 1

Percentage of Respondents Who Mentioned Source

Noise Source	From Adjacent Apt.	From Own Apt.
Plumbing	71.0%	13.0%
Garbage Disposal	73.1%	32.0%
Dishwasher	42.3%	68.0%
Doors Slamming	86.5%	
Walking	50.0%	
T.V./Radio	7.0%	
Telephone	1.0%	
Noises From Bedroom	10.0%	
Talking in Halls	17.0%	

Source: United States Environmental Protection Agency (1971), p.49.

A series of British studies found that approximately one-quarter of the occupants of apartments were disturbed by internal noise (Northwood, 1976). The noises found to be most disturbing were voice (live or T.V./ Radio), music, impact of doors and feet, and plumbing.

Unfortunately, neither of these studies consider what effect these

internal noises have on any disturbance due to external noises. However, a study, conducted in The Hague, Netherlands, found that among apartment dwellers surveyed, more respondents (26%) were annoyed by traffic noise than noise from any other source (Bitter and Horch, 1958). The next most dominant source was 'children playing' (12%). However, it is interesting to note that for those respondents annoyed, the latter source 'troubled people more intensely'.

As previously mentioned, some planning agencies have developed land use guidelines based on acceptable noise levels. If the land use regulations for property next to airports or highways discriminate between dwelling types or tenure status, they could provide useful information as to why such distinctions should be drawn.

A number of planning guidelines do draw distinctions between dwelling types. Wyle Laboratories (1975) proposed a set of indoor and outdoor criterion levels for community noise (table 2). On viewing this table, one would expect some documented research to support setting higher acceptable noise levels for multi-family dwellings. However, the only justification given was the following statement: "for multi-unit dwellings, the LC_u is chosen 5 dBA higher under the *assumption* that the majority of persons will accept higher noise levels than those in single family dwellings" (Rackle et al., 1975, p.3-8).

Galloway and Bishop (1970) also made a distinction between sensitivity to aircraft noise (measured by NEF contours)[1] and dwelling type in drawing up their land use guidelines. It is evident that multi-family units were

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[1] NEF: Noise Exposure Forecast is a methodology for predicting a single number rating of the noise intruding into airport communities from aircraft operations.

Table 2

Wyle Laboratories' Criterion Levels for Community Noise

Land Use	Indoor Criterion Levels (dBA) Lower Criterion (LC_L)		Upper Criterion (LC_u)	
	Day	Night	Day	Night
Residential-Single Family	40	32	74	67
Residential-Multi-Family	40	32	79	72
Commercial, Industrial	38	38	66	66
Schools	38	--	66	--
Hotels	40	35	74	65
Hospitals	33	30	63	60

Land Use	Outdoor Criterion Levels (dBA) Lower Criterion (LC_L)		Upper Criterion (LC_u)	
	Day	Night	Day	Night
Residential-Single Family	50	42	85	77
Residential-Multi-Family	55	42	90	77
Commercial, Industrial	55	55	90	90
Schools	50	--	85	--
Hotels	55	50	90	85
Hospitals	53	50	88	85

Source: Rackle et al., (1975), p.3-10.

judged as less sensitive to noise and thus required less stringent planning regulations (table 3). The considerations which the authors used to arrive at their guidelines were:

(i) accumulated case history experiences of noise complaints near civil and military airports

(ii) speech interference criteria

(iii) subjective tests of noise acceptability and relative noisiness

The Canadian Air Transportation Commission (1972) has also published land use guidelines for communities next to airports. For each land use category, acceptable noise level criteria were established on the basis of NEF levels. Residential uses were subdivided into: i) detached and semi-detached, ii) townhouses and iii) apartments. In this case, the guidelines specified that all three categories had the same acceptable noise level criteria.

Hence, some land use regulations do distinguish between house types in setting acceptable noise levels. However, there is little accompanying empirical evidence to support the distinctions made by the authors in their reports. That land use zoning is being conducted on the basis of subjective assumptions is disappointing. It is evident once again, that there is a need for a rigorous investigation to determine the effects of tenure and house type on disturbance due to traffic noise.

A final consideration is that certain socio-economic variables may co-vary with certain house type and tenure characteristics (e.g. owners may be more likely to come from higher income brackets than are renters). It may be that it is the socio-economic variables which are directly related to the varying responses to noise, rather than the dwelling type

Table 3

Excerpt From Galloway and Bishop's Land Use Guidelines

Land Use Category	Land Use and Community Response Interpretation[a] Noise Exposure Forecast Value 20 25 30 35 40 45 50 55
Residential - Single and Two Family Homes, Mobile Homes	AI, BII, CII, CIII
Residential - Multiple Family Apts., Dormitories, Group Quarters, Orphanages, Retirement Homes	AI, DII, BII, CIII

Source: Galloway and Bishop (1970)

[a] General Land Use Recommendations

A. Satisfactory, with no special noise insulation requirements for new construction.

B. New construction or development should generally be avoided except as possible infill of already developed areas. In such cases, a detailed analysis of noise reduction requirements should be made, and needed noise insulation features should be included in the building design.

C. New construction or development should not be undertaken.

D. New construction or development should not be undertaken unless a detailed analysis of noise reduction requirements is made and needed noise insulation features included in the design.

Community Response Predictions

I. Some noise complaints may occur, and noise may, occasionally, interfere with some activities.

II. In developed areas, individuals may complain, perhaps vigorously, and group action is possible.

III. In developed areas, repeated vigorous complaints and concerted group action might be expected.

or tenure.

Galloway, Clark and Kerrick (1968) concluded that socio-economic variables were influencing their respondents' disturbance from freeway noise. In their study, the average noise levels ranged from 77 dBA to 58 dBA. Yet more residents in the quiet area volunteered that they were annoyed by the freeway noise than did the residents in the noisy area. The result reflects the nature of the two sample populations. Proportionally, the quiet area had nine times the number of professional people, five times the college graduates and five times the average home values as the noisy area.

Bolt, Beranek and Newman Inc. (1971b) also found that some personal factors were an influence on people's response to noise. They concluded that for equivalent noise levels, the more annoyed respondents are likely to be concentrated among the younger, better educated, higher income and higher status occupations. Taylor and Hall (1977a) found that socio-economic variables showed a stronger relationship with *actions* directed against noise than with *attitudes* towards traffic noise. As socio-economic variables do appear to influence response to traffic noise, it will be necessary to consider how they co-vary with the tenure and house type variables.

The basic conclusion from the review of existing literature is that there is an absence of strong empirical findings and that there exists a definite need for a rigorous evaluation of the influence of dwelling type and tenure on people's response to noise. Too much has been assumed about these two factors, with little attempt to actually investigate their influence.

CHAPTER THREE

THE RESEARCH HYPOTHESES

On the basis of the literature review and the preliminary results from the 1975 study of community response to noise conducted by Hall and Taylor (1975), it is possible to develop a number of research hypotheses. They can be divided into three groups, each of which is headed by a major hypothesis, followed by a number of sub-hypotheses. The three major hypotheses concern the effects of 1) dwelling type, 2) tenure and 3) a combination of the previous two factors, on people's response to highway noise.

The conceptual model, which is the basis for the hypotheses, is outlined in Figure 2. The basic relationship being studied is the effect of the *intervening variables*, tenure and house type, on the individuals' attitudes towards traffic noise. The influence of the *noise stimulus* will be controlled for by choosing sample sets with similar noise environments. However, one can hypothesize as to the *related factors* which may co-vary with the intervening variables and thereby contribute to the attitudes about noise.

The following example should clarify this outline of the conceptual model (figure 3). As noise exposure is controlled, its effect on response to noise will not vary and does not need to be considered. However, it is hypothesized that house type is related to attitudes towards traffic

Figure 2

The Conceptual Model

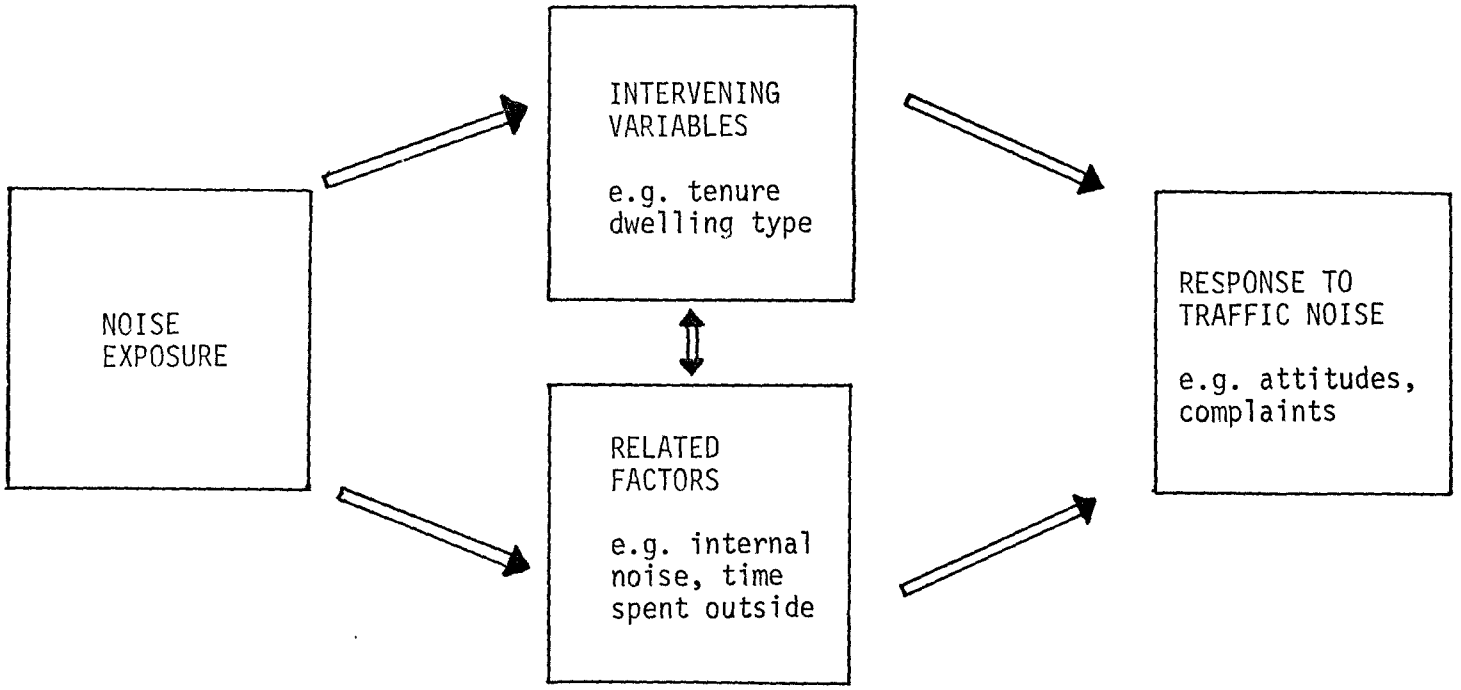
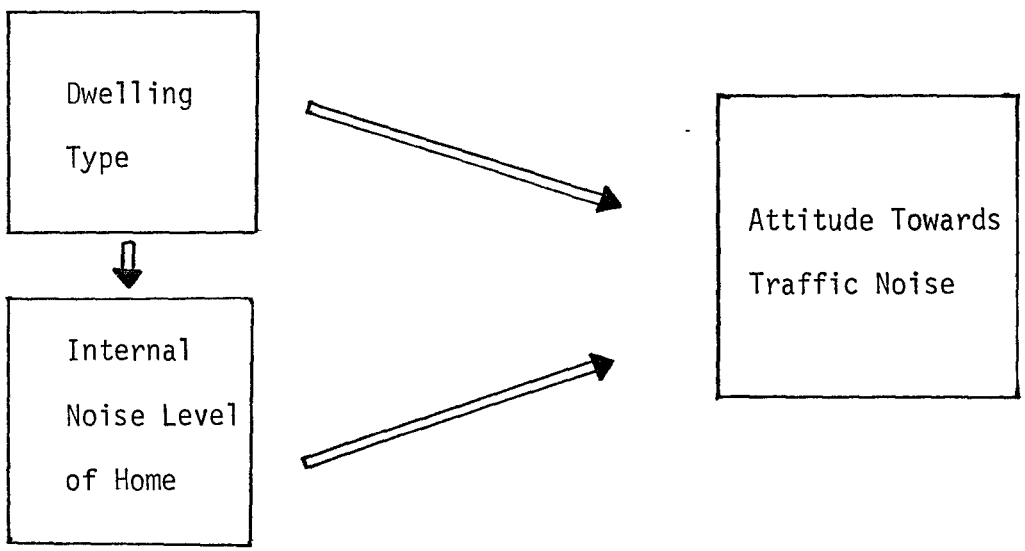


Figure 3

An Example of the Model's Application



noise, such that multi-unit dwellers are less disturbed by equivalent noise levels than are residents of single, detached units. It is then possible to consider the role of a related factor, level of internal noise. One would predict that higher internal noise levels are associated with multi-unit dwellings, which could in turn contribute to the difference in levels of disturbance from external noises. It is also possible that internal noise levels may have a direct effect of their own on attitudes towards traffic noise, regardless of dwelling type. Thus, in the example depicted in Figure 3, three separate hypotheses are derived.

Hypotheses Related to Dwelling Type

Preliminary findings (Taylor and Hall, 1976) suggest that in similar noise environments, residents of single, detached homes are more disturbed by highway noise than residents of multi-unit dwellings, such as townhouses and apartments. One factor which might aid in explaining such a finding is that multi-unit dwellings have higher internal noise levels, which may mask any intruding noises from external sources, such as a highway. A second factor is that single, detached unit dwellers are likely to be home more due to their life style and their stage in the life cycle. A longer time period spent at home will mean greater exposure to the disturbing influence of traffic noise. Similarily, detached unit families, with their backyards, will likely spend more time outdoors where the noise levels from the highway are likely to be higher. This is given some support from Taylor and Hall's work with the 1975 data. Residents reported being disturbed by traffic noise more often outdoors than indoors (Taylor and Hall, 1976). This indicates that disturbance outdoors is a more

frequent problem and certainly a situation which will face townhouse and detached unit dwellers more frequently than apartment dwellers.

In addition, there is an hypothesis which directly relates each of the explanatory factors to annoyance due to traffic noise. It is predicted that disturbance from traffic noise is inversely related to the level of internal noise and directly related to the time spent at home and the time spent outdoors. These hypothesizes are summarized in Figure 4.

It is also possible that there may be a relationship between dwelling type and certain socio-economic variables such as age and income. For example, residents in single, detached homes may have a higher mean income than residents in apartments. This may confound the results for the intervening variable may actually be income rather than house type. To prevent this, an attempt was made in the selection of the sample sites to ensure they had similar socio-economic characteristics. As a further check, the relationship of the socio-economic variables to both dwelling type and attitudes towards highway noise is also examined.

Hypotheses Related to Tenure

It is a common belief that home-owners take a much more active role in protecting their residential environment than do tenants (Hitchcock and Waterhouse, 1974). However, the two studies discussed in the literature review did not find the own/rent distinction to be an important influence on people's response to noise (Toshio et al., 1973; TRACOR, 1971). There were however, a number of confounding influences within these studies. Therefore, despite their findings, the major hypothesis here is that renters are less disturbed than are owners, by equivalent levels of highway noise (figure 4).

Figure 4

Research Hypotheses

Hypotheses Related To Dwelling Type

A (Major) Residents in multi-unit dwellings are less disturbed than residents in single, detached dwellings, by similar traffic noise levels.

AI. Residents of multi-unit dwellings report higher internal noise levels than do residents in single, detached dwellings.

AII. Residents who report higher internal noise levels, report less disturbance due to traffic noise.

AIII. Residents of multi-unit dwellings are home far less time each day than are residents of single, detached dwellings.

AIV. Residents who are home for greater lengths of time each day report greater disturbance due to traffic noise.

AV. Residents of multi-unit dwellings spend less time outside their homes than do residents of single, detached dwellings.

AVI. Residents who spend more time outside their homes report greater disturbance due to traffic noise.

Hypothesis Related To Tenure

B (Major) Residents who own their dwelling unit are more disturbed by equivalent levels of traffic noise than are residents who rent their dwelling.

Owners, who have made a long term investment in their homes are likely to be more concerned about the quality of the neighbourhood and hence, more disturbed by intruding traffic noise. It is probable that owners, in comparison to renters, will view their home as permanent and be less likely to have considered moving. Renters on the other hand, are freer to move when faced with unwanted noise.

Again, as in the case of dwelling types, there may be a relationship between tenure and certain socio-economic variables such as income. It is possible that the socio-economic variables, and not tenure, may be the moderating influence on attitudes towards noise. Therefore, the relationship of the socio-economic variables, to both tenure and attitudes towards noise will be examined.

Interaction Effect Between Dwelling Type and Tenure

It is likely that there is some interaction between the effects of dwelling type and tenure. It is hypothesized that residents in owned, detached homes will report the greatest disturbance due to highway traffic noise. In turn, it is predicted that residents of rented, multi-unit homes will be the least disturbed by traffic noise. Residents living in rented, detached homes or owned, multi-unit homes will fall somewhere between the two extremes with respect to annoyance over traffic noise. This hypothesized relationship is summarized in Figure 5. A two-way analysis of variance will allow further comparison of the joint effects and the interaction effects of dwelling type and tenure on disturbance due to traffic noise.

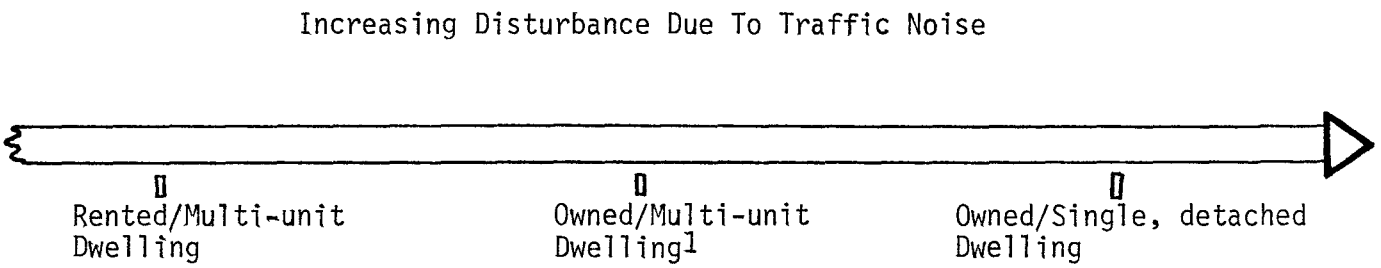
The set of hypotheses described in this chapter represents the framework that is used to investigate the effects of tenure and type of

Figure 5

Interaction Effect Between Tenure and

Type of Dwelling

Basic Hypothesis: Tenure and dwelling type interact to affect disturbance due to traffic noise.



[1] The hypothesis would predict that rented, single detached units would also be placed here. However, there were no data available to test this.

dwelling on subjective response to traffic noise. The means by which these hypotheses are examined is presented in the following chapter.

CHAPTER FOUR

THE RESEARCH DESIGN

A data base to test the hypotheses listed in the previous chapter was available as part of the noise study conducted in the summer of 1976 by the McMaster University Geography Department, in conjunction with the Ontario Ministry of the Environment. The information available included a set of personal interviews conducted with residents in selected areas of the Hamilton-Toronto corridor and secondly, measurements of the physical noise levels in each of the areas. The project, as a whole, was directed at a wider variety of questions than are being considered in this paper. Therefore, the following sections will describe only the portion of the research design and data collection which is relevant to this specific study of the effects of house type and tenure.

Personal Interviews

The interviews were conducted throughout the summer by a team of nine interviewers who had been trained specifically for this purpose. A set of dwelling units were selected at various sites and interviews were achieved by going door-to-door until the goal of thirty interviews was achieved or the sample was exhausted. Interviews were also conducted in the evening in an attempt to balance male and female respondents as well as to ensure the sample included people who worked during the day.

The average interview ranged 15 to 25 minutes in length and was

administered by the interviewer. Each person interviewed remained anonymous, although it was noted which houses within the site had been interviewed. The complete questionnaire is included as Appendix A. The questions utilized for the purposes of this paper are described fully in the following section.

Question 3: Rating of Specific Noise Sources

Questions 3, 4, and 5 are the key questions in the interviews as they ask the respondent to rate the noise disturbance created by various sources, as well as the overall neighbourhood noise. Question three begins by asking the respondent to list the sounds he notices when at home and then to rate each of the noticed sounds on a nine point bipolar scale, ranging from extremely agreeable to extremely disturbing. In the third part of the question, a list of common noises is presented and the respondent is asked if he ever notices any of them, and if so, how would he rate them on the nine point scale.

This question duplicates a question from the 1975 study and provides the researcher with a list of noises which the respondent is disturbed by (i.e. rated from six to nine). These disturbing noise sources become the basis for most of the subsequent analysis.

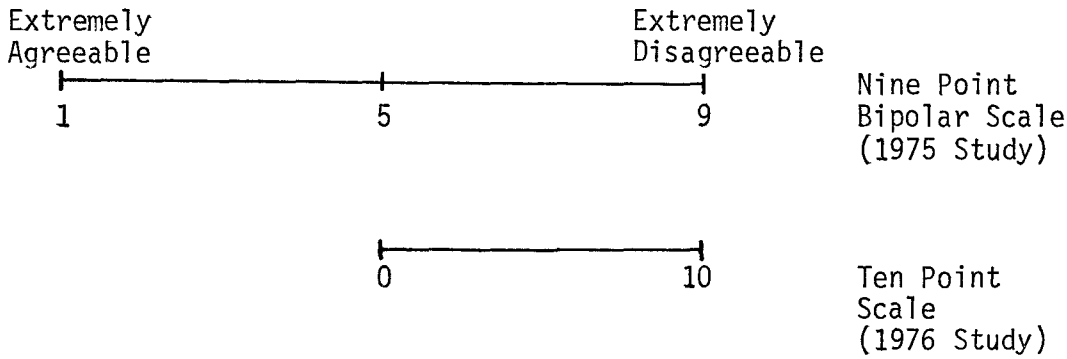
Question 4: Overall Neighbourhood Noise

Using the same nine point scale, this question asks for a rating of the overall neighbourhood noise.

Question 5: Additional Ten Point Rating Scale of Noise Disturbance

Question five seeks to expand on the findings of question three

by requesting an additional rating of any noises mentioned as disturbing in question three. This scale was a new addition to the 1976 questionnaire and expands the disturbance end of the old scale to 10 points.



Each of the noises mentioned as disturbing is rated for their overall disturbance effect on the ten point scale. This provides an *interval* measure of the respondent's response to noise. Each noise source is also rated for its disturbance when the respondent is indoors and outdoors. If the noise source is main road traffic or trucks, two outdoor ratings are obtained - an outside rating for the exposed side of building and an outside rating for the side of the building shielded from the noise source.

To expand on question four, the respondent is also asked to rate the neighbourhood noise, overall, inside and outside, on the ten point scale. Thus, for each site, it is possible to collect a total of sixteen different noise ratings.

Question 7: Time of Year

This question is asked for each noise which the respondent rated as disturbing. The question asks which time of year the noise source is most disturbing. The responses should aid in studying the relationship

between time spent outside in different types of dwellings and how the residents respond to noise.

The second part of the questionnaire is concerned with the characteristics of both the respondent and his home. This portion of the questionnaire is filled in by the respondent himself. The basic socio-economic data is collected: age (Q.2), level of education (Q.3) and income (Q.8). However, certain questions are also directed at the habits and attitudes of the respondent.

Question seven asks the respondent for a five point rating of the internal noise level of his home. This will be useful in analyzing differences between noise levels of various house types and for studying the role of internal noise in the rating of externally-generated noise.

Respondents are also asked to estimate how much time they spend at home on the average weekday and weekend in question nine. These data should indicate if time spent at home affects rating of traffic noise and if time at home varies significantly between residents of different types of housing. In a similar fashion, question ten asks for an estimate of the time spent outdoors on weekdays and weekends. Question eleven is aimed at measuring whether the respondent's use of outdoor space is affected by the noise levels. Finally, two basic items were recorded - the type of dwelling (Q.3) and whether it was owned or rented (Q.12). The data on the questionnaire were coded, keypunched and stored on computer tape.

Measurement of Sound Levels

The actual sound levels which residents are exposed to will play an important role in determining their annoyance ratings. Therefore, it

was necessary at the sample sites to ensure that the sites being utilized to test the effects of house type and tenure, were not also being affected by varying noise exposure.

The unit for sound measurement is dBA or decibels measured on an 'A' weighted scale. It allows for condensing the two characteristics of noise, intensity and frequency, into a single number. Decibels measure the absolute loudness of a noise in terms of sound pressure units. However, the ear has different sensitivities to various frequencies. The 'A' weighted scale gives greater weight to the high and medium frequencies which the human ear finds most disturbing (Alberta Transportation, undated).

The sound levels were measured in two stages. In the initial stage, an estimate of the noise level was made using a small, hand held sound meter. The results of this survey were used to select the sample sites. Following the completion of the interviews at a site, a measure of the sound level over a 24 hour period was made using a time-calibrated analogue monitor. The time switched the monitor on for 55 seconds and off for 12 minutes. The monitor was left at a site for 24 hours and each site was monitored once. The monitoring was conducted by the 1976 summer research staff. The tape recording from the monitor was analyzed in the Mechanical Engineering Department at McMaster University.

The raw data from the analysis of the noise levels were then available to be converted into an index to describe the noise environment at each site. Unfortunately, there is no consensus among noise researchers as to the most appropriate noise index. The need for the noise measurement in this study was to ensure some comparability in the noise environment of the sites being compared. Therefore, it was decided to utilize two of the more commonly accepted indexes - daytime L_{eq} and L_{den}.

Both measures are an averaging of the noise levels over a period of time. Daytime L_{eq} provides a measure of the average noise between 7 a.m. and 7 p.m. L_{eq} gives a number which is equivalent to "the non-fluctuating noise level that would result in the same energy entering our ears" as is contained in the actual varying noise levels being measured (Alberta Transportation, undated, p.I-12). L_{den} provides an average measure of the noise for the full 24 hour period. The calculation involves averaging the L_{eq} for daytime, evening and night. However, each time period is weighted according to assumed differences in the intrusiveness of noise for the different time periods. Thus, L_{den} provides an index which is sensitive to the increased impact of loud noise at night, by giving greater weight to the nighttime L_{eq} (i.e. 5 dBA penalty for the evening and 10 dBA penalty for the nighttime).

The measurement of the noise exposure and the calculation of the two noise indices made it possible to give each site two values to describe its noise environment. This, in turn, enabled the grouping of sites which had similar noise environments.

Site Selection

The selection of sites to be used for the 1976 study was based largely on the following five guidelines:

(i) a uniform noise environment within any one site

(ii) a range of house types across sites; single house type within site

(iii) a range of tenure for each house type

(iv) comparable socio-economic characteristics between sites

(v) the major noise source is main road or highway traffic noise.

(i) A uniform noise environment within the site was a primary consideration in the selection of sites. The goal was that every home within a site should be exposed to the same level of noise. Ideally, this would mean a line of houses parallel to a highway or main road, which would ensure that they were all exposed to the same noise levels. In selecting sites for the study, this criterion was met, for in all cases it was a linear set of homes or townhouses. For the apartment sites, the apartments chosen were all on one face of the building.

(ii) It was necessary to include a range of dwelling types within the sample sites. Residents in three categories of housing types were used - single, family detached homes, townhouses and high-rise apartments.

(iii) To fully test the effect of tenure on response to noise it was necessary to control for dwelling type and then compare owners and renters. Ideally, this would mean owners and renters from each of the three dwelling types, or six different site combinations. Unfortunately, sites of rented, detached houses are rare and none were available for this study. Therefore, only 5 combinations of tenure and dwelling type were available.

		Dwelling Type		
		Single, Detached	Townhouse	Apartment
Tenure	Own	X	X	X
	Rent		X	X

(iv) As discussed in the literature review, there is some indication that socio-economic variables may influence how one responds to noise. In order to isolate the effects of the intervening variables being considered,

it was essential that other influences such as socio-economic variables be controlled. Therefore, an attempt was made during the initial site selection to choose sites which seemed to fall into middle class neighbourhoods. While this could be done only at a superficial level, a check was made on the degree of control achieved, based on the socio-economic data collected in the interview.

(v) As the total study was concerned with response to traffic noise, it was important that each site border on a main road. For all sites chosen, the main road source was either a highway or a major arterial route within the Toronto-Hamilton corridor.

These were the five basic criteria used for selecting sites for the total 1976 study. The decision as to which of the sites investigated in the 1976 study should be included in the sample for this research was a key issue. In addition to meeting the five previous criteria, it was necessary that there be comparable noise levels between the sites. As the concern was to analyze the effects of tenure and dwelling type on response to noise, it was important that the physical noise levels at all the sites be controlled for. Therefore, only sites within a small range of noise levels were chosen.

The other consideration was that preliminary findings had indicated that most variations in response to traffic noise occur within neighbourhoods with average (L_{eq} of 59 dBA to 64 dBA) noise levels (Taylor and Hall, 1977a). In the extremely noisy areas, the majority of respondents will be disturbed by the noise, regardless of their tenure or house type. Similarly, in the very quiet neighbourhoods, most respondents will simply report no disturbance due to traffic noise. Therefore, one would expect

that any variation in response due to intervening factors, will arise in neighbourhoods exposed to moderate noise levels (figure 6).

The range of noise exposures available from all of the sites studied, was from an L_{eq} of 56.5 dBA to an L_{eq} of 80.1 dBA (or L_{den} of 56.9 to 84.1 dBA). The range of noise levels chosen for this study, and to which the selection of sites was restricted, was an L_{eq} of 67 to 74 dBA (or L_{den} of 70 to 77 dBA). Within any comparison of pairs of sites, the range was never more than 5 dBA with one exception. (For the comparison between owned and rented townhouses, the range was 7 dBA.) This range of 5 dBA had been considered acceptable by Taylor and Hall (1977a). Ideally, it would have been preferred if the range of noise levels had been smaller to ensure less variation in noise exposure. However, this would have severely reduced the sample size and, in turn, reduced the confidence in the results. Therefore, it was felt that increasing the range of acceptable noise levels was a worthy trade-off in order to increase the sample size.

On the basis of this criteria, ten of the total set of thirty-seven sites were selected for this analysis. A summary table of the sites is presented here (table 4), while a more complete description of each site is provided in Appendix B. Also provided is a list of the various combinations of sites which can be used to test the research hypotheses (figure 7).

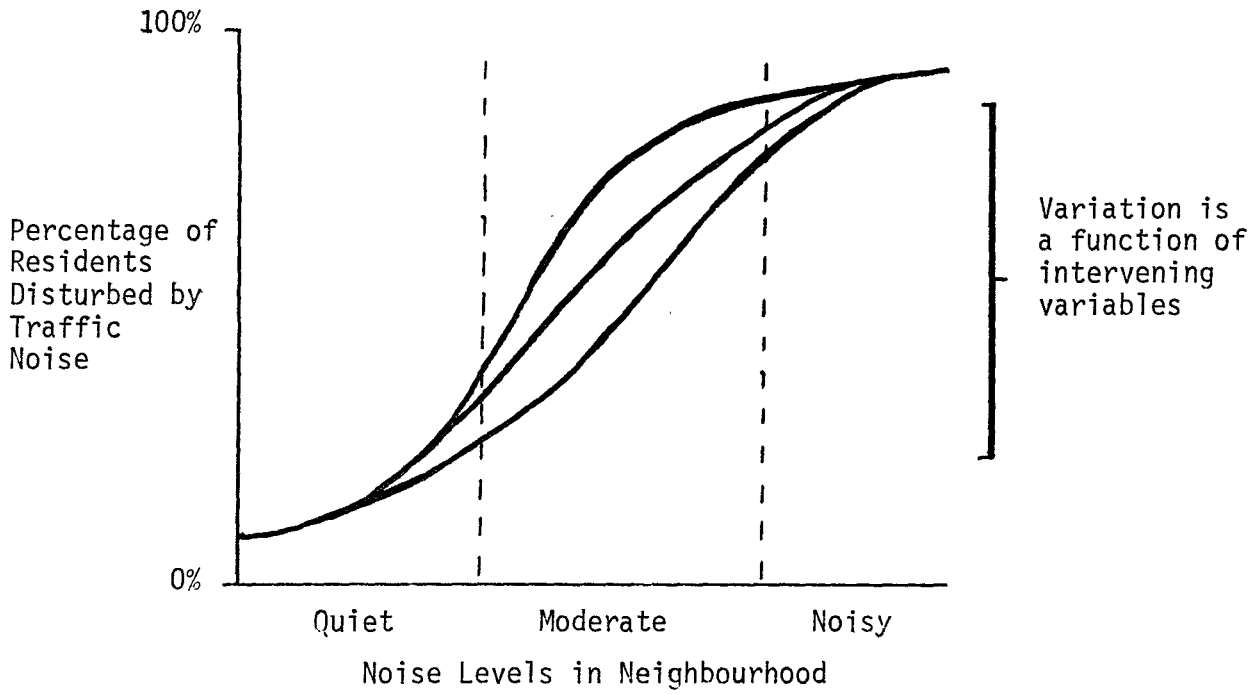
Methods of Analysis

As a prelude to the following chapter, it is necessary to mention briefly the methods of analysis chosen as most appropriate. Most of the research hypotheses required testing the significance of the relationship

Figure 6

Suggested Relationship Between Noise Level,

Percentage of Residents Disturbed, and the Intervening Variables



Each line represents a different combination of intervening variables.

Table 4

Summary Table of Selected Sites

Name of Site	Site Classification	L_{den}	Daytime L_{eq}	No. of Respondents
Islington-South	single family/owned	75.8	74.1	29
Islington-North	single family/owned	76.2	74.0	24
Ancaster	single family/owned	74.1	68.9	31
Guelph Line	townhouse/owned	74.7	73.9	20
Burnhamthorpe	townhouse/owned	73.4	72.2	26
Golfways	townhouse/owned	77.4	74.4	22
5 Shady Golfways	apartment/owned	77.4	74.4	28
Citadel	townhouse/rented	73.2	70.0	26
Horizon	townhouse/rented	70.4	66.5	30
Beverly Hills	apartment/rented	71.8	69.1	27

Figure 7

Site Combinations Available to Test Hypotheses

Effect of House Type

Controlling for Owners - Single, detached (N = 84) vs Townhouse (N = 68)

Townhouse (N = 68) vs Apartment (N = 28)

Single, detached (N = 84) vs Apartment (N = 28)

Controlling for Renters - Townhouse (N = 56) vs Apartment (N = 27)

Effect of Tenure

Controlling for Townhouse - Owners (N = 68) vs Renters (N = 56)

Controlling for Apartment - Owners (N = 28) vs Renters (N = 27)

between two variables, such as tenure and rating of main road noise. The choice of which test of significance is most appropriate is dependent upon the level of measurement of the variables. The variables used in the analysis presented here represent the full range of numerical characteristics.

Thus, a variety of methods of analysis were utilized (figure 8). Each method begins with the assumption of a null hypothesis and calculates the probability of a type 1 error in rejecting the null hypothesis (i.e. the significance level of the test). As in most social studies research, a significance level of .05 or less was considered sufficient to reject the null hypothesis and instead accept the research hypothesis. In some cases in chapter five, significance levels of .051 to .10 are shown to aid in determining which relationships are approaching significance.

In general, the level of measurement of each variable is obvious. For example, tenure (own/rent) is nominal. The only debatable decision concerned the noise ratings. The scale which presented the respondent with nine labelled scale points, ranging from extremely agreeable to extremely disturbing,was considered to be ordinal. The scale values indicate only the order of the responses to the noise, and not that the interval between each scale point is equal.

However, the score on the ten point scale was considered to have interval properties. It deals with only the disturbance end of the bi-polar scale and labels only the end points, allowing the respondent to choose virtually any position along the scale (i.e. a decimal based rating was permitted e.g. 2.5). It was therefore felt that the ratings on the ten point scale could confidently be treated as having interval properties.

Figure 8

The Statistical Methods Utilized[a]

	Nominal Variable	Ordinal Variable	Interval/Ratio Variable
Nominal Variable	Chi-square	Mann-Whitney U	Student t
Ordinal Variable		Kendall's tau	Kendall's tau
Interval/Ratio Variable			Pearson's rho

[a] The null hypothesis tested for each statistic is as follows:

Chi-square: There is no difference between groups defined on one nominal variable with respect to groups defined on a second nominal variable.

Mann-Whitney U: There is no difference between the median scores of group one and group two on an ordinal dependent variable.

Student t: There is no difference between the mean scores of group one and group two on an interval dependent variable.

Kendall's tau: There is no relationship between two ordinal variables.

Pearson's rho: There is no relationship between two interval variables.

The other consideration involved the choice of which non-parametric correlation coefficient to employ - Kendall's tau or Spearman's rho. As there was a small number of possible values for the ordinal variables, this meant when rank ordering the individual cases, there would be a large number of tied ranks. In this case, Kendall's tau is the more appropriate statistic to use (Blalock, 1960, p.321).

In the final section of chapter five, a method is used to evaluate the overall combined effects of tenure and dwelling type. Two-way analysis of variance enables the researcher to evaluate the combined effects of one or more nominal independent variables on an interval dependent variable. In this study, the two independent variables are tenure and house type, while the dependent variable is any one of the noise ratings on the ten point scale. The method decomposes the total variation of the noise rating with respect to the categories of tenure and house type. It enables one to measure i) the *separate effects* of tenure (controlling for house type) and house type (controlling for tenure), ii) the *joint effect* of tenure and house type (which is the sum of the separate effects), iii) the *interaction effect* (how does tenure influence the effect of house type and in turn, how does house type influence the effect of tenure on the rating of noise) and iv) *the total effect* (the joint effect plus the interaction effects).

Only a brief summary of the statistical methods utilized in the following chapter has been presented here. The actual formulae used were those provided by the programs outlined in Nie et al. (1975) *Statistical Package for Social Sciences*. This set of computer programs was used for all the analysis in this study.

CHAPTER FIVE

THE ANALYSIS AND THE RESULTS

The results from the testing of the research hypotheses are presented in this chapter. The separate effects of housing type and tenure are dealt with first and then the interaction effect of the two variables is considered. The overall conclusions, and their relationship to some of the common assumptions concerning tenure and dwelling type effects on response to noise, will be discussed in the final chapter.

Effect of Dwelling Type

A (Major) Residents in multi-unit dwellings are less disturbed than residents in single, detached dwellings, by similar traffic noise levels.

The major hypothesis was tested using the Student t test to compare ratings of noise between pairs of dwelling types. For the nine point annoyance scale, the Mann-Whitney U test was used.

It appears that house type does have some effect on response to noise (table 5). It was predicted that the greatest differences in response to noise would be between detached unit and apartment dwellers, and so these will be examined first. The overall neighbourhood and main road ratings vary as predicted and the relationship with the rating of overall truck noise is approaching significance. These findings give some support

Table 5

Basic Hypothesis: The Relationship Between Dwelling Type and Rating of Noise

Significant Results

Site Combination	Noise Rating	Value of Statistic
I. Detached vs Apartments: Owned	Neighbourhood - Overall	t = 2.12*
	Main Road - Overall	t = 2.48*
	Main Road - Inside	t = 2.08*
	Truck - Overall	t = 1.96
II. Detached vs Townhouses: Owned	Neighbourhood - Overall	t = -2.08*
	Neighbourhood - Inside	t = -2.10*
	Neighbourhood - Outside	t = -1.72
	Main Road - Outside	(t = 2.69)*
	Main Road - Outside, Exposed	t = -1.78
	Truck - Outside, Shielded	t = -1.79
III. Townhouses vs Apartments: Owned	Main Road - Inside	t = 1.86
IV. Townhouses vs Apartments: Rented	Neighbourhood - Intensity (9 point scale)	(U = 573)
	Neighbourhood - Overall	(t = -2.11)*
	Neighbourhood - Inside	(t = -1.71)
	Neighbourhood - Outside	(t = -2.18)*
	Truck - Outside, Exposed	(t = -2.11)

Statistical Tests: Student t test (t); Mann-Whitney U test (U)

Significance Levels: S = .099 - .051 (minimum level of significance to be reported in table)
S = .050 - .011*
S = .010 - .0011**

Brackets indicate the relationship is in the opposite direction to that which was hypothesized.

to the hypothesis that the multi-unit residents are not as disturbed by the equivalent traffic noise level as detached unit residents. However, the majority of the noise ratings (12 out of 16 ratings) do not vary significantly between the two types of residents.

The second comparison, between residents in detached homes and townhouses, also provided a number of significant results. Two neighbourhood ratings and one main road rating vary significantly with house type and three other ratings are approaching significant relationships. However, the relationship between the rating of outside main road noise and dwelling type is not in the predicted direction, for the townhouse owners appear to be more disturbed than the detached home residents. It is not immediately apparent why this reverse relationship arises. However, five of the six relationships are in the predicted direction - that the residents in the detached houses are more disturbed by traffic noise than residents in multi-unit dwellings.

The final comparison is between townhouse and apartment dwellers. There are no significant differences in the way noise is rated by *owners* in townhouses and apartments. However, among the *rented* dwellings, there are two significant relationships between the rating of neighbourhood noise and dwelling type. They are not in the predicted direction, for the residents in apartments are more disturbed than are the residents in townhouses. There are three other ratings which are approaching significant relationships and also indicate that apartment dwellers are more disturbed than townhouse dwellers. This relationship appears to apply mainly to the neighbourhood ratings.

It is difficult to explain this reversed relationship. There are three sites involved in this sample - two townhouse complexes and one

apartment building. The apartment building is *not* an adult building and there is no reason to believe its internal noise level varies greatly from the average apartment building. However, the Horizon townhouse site does have a slightly lower noise level (L_{eq} = 66.5 dBA as compared to L_{eq} = 69.1 dBA (Beverly Hills Apartments)) which may be resulting in the lower reported disturbance. Also, the Horizon townhouses are shielded from the highway, which according to recent research (Hall, Birnie and Taylor, 1976) can lead to a reduction in perceived disturbance. Thus, the noise environment at the Beverly Hills apartments may not be totally comparable to that of the Horizon townhouses, which may be leading to the surprising results.

In conclusion, the only significant differences in noise ratings consistent with the research hypothesis occur between detached house residents compared with both townhouse and apartment residents. However, these significant relationships arise for only a minority of the noise ratings. This leads to a number of conclusions. First, for a given noise situation, one may expect single, detached dwellers to indicate greater disturbance from the noise than other types of residents on some of the noise rating scales. A second conclusion is that the differences between residents of townhouses and apartments in their response to noise are minimal. For example, the mean scale value for overall neighbourhood noise among townhouse dwellers was 4.9, while the mean value for apartment dwellers was 3.8. This can be compared to the mean value for single, detached residents, which was 6.5. It can also be noted that although the difference in response between the two groups (multi- vs single units) is significant, the difference in mean values is relatively small.

The difference between the rented townhouses and apartments response to noise remains something of a puzzle. It may result from unique sites or the change to rental status, as this is the only combination of sites which are rented. As the discussion of the results continues, it will become again evident that this rental site combination produces some puzzling relationships.

AI Residents of multi-unit dwellings report higher internal noise levels than do residents in single, detached dwellings.

This hypothesis was first examined by considering non-traffic noises which residents mentioned as disturbing. Are there some house types which are consistently subject to more of these extra noises? This was tested by comparing each house type and whether each specific noise was mentioned or not. Thus, the appropriate statistical test was chi-square (table 6).

In general, the results are not surprising. People report noises which are typical of their type of building. Apartment residents more often mention mechanical and plumbing noises, detached unit residents mention garden machinery, while townhouse residents mention children, pets and garden machinery.

One could perhaps conclude that townhouses have the greatest problem with internally generated noises, especially children. This would suggest that townhouses, in comparison to apartments, are subject to the equivalent, if not greater, internal noise levels. This may also provide some insight into the previous puzzling results arising from the rented townhouses and apartments. It appears that the townhouse residents mention other noises

Table 6

Comparison Between Dwelling Type and Noises Mentioned

Significant Results

	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
Children		X^2 = 7.0628** T.H.	X^2 = 4.4949* T.H.	X^2 = 13.6676*** T.H.
Other People				
Handyman Tools				
Air Conditioner				
Pets		X^2 = 3.3230 T.H.		X^2 = 3.6518 T.H.
Garden Machinery	X^2 = 2.9308 Det.			X^2 = 5.4743* T.H.
T.V./Radio		X^2 = 3.0768 Det.		
Musical Instruments				X^2 = 3.6601 Apt.
Mechanical/Plumbing	X^2 = 3.2623 Apt.			

Statistical Test: Chi-square (also indicated is which house type had the largest percentage of residents who mentioned noise).

Significance Levels: S = .099 - .051
S = .050 - .011*
S = .010 - .0011**
S = .001 or less ***

more frequently than do the apartment renters. This indicates that perhaps the townhouses have the higher internal noise levels and thus, as predicted, rate external noise as less disturbing. However, that townhouses are subject to a greater number of internal noises is only suggested by the results. The majority of site comparisons indicate that there is no difference in the number of internal noises mentioned.

The other attempt to measure differences in internal noise levels was accomplished by comparing responses to question 7, which asked respondents to rate the internal noise in their home. The ratings were compared for each pair of house types using the Mann-Whitney U test (table 7). Among the owned homes, none of the tests showed any significant differences between dwelling types in the rating of internal noise.

The only significant difference arose in the rented home comparison, where the townhouse residents rated their home as noisier than apartment dwellers. This is in keeping with the comparison of "noises mentioned" which also found that townhouse dwellers mentioned more disturbing noises than apartment dwellers. It also possibly aids in explaining the results of Table 1, for among the rented homes, the apartment residents were more disturbed by the external traffic noise.

However, these results do not provide any support for the overall hypothesis that single, detached unit residents are the most disturbed by traffic noise due to lower internal noise levels. Table 7 does not indicate any difference in internal noise levels between detached homes and multi-unit homes.

Unfortunately, there appears to have been some variation in the interpretation of question 7, which casts doubt on any of the results

Table 7

Internal Noise Rating by House Type

Significance Levels

Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
U = 806.5	U = 2438.0	U = 700.0	U = 553.5
S = .3466	S = .4974	S = .9666	S = .0334 (Rating greater in T.H.)

Statistical Test: Mann-Whitney U

based upon it. The question, phrased as "How would you rate the internal noise in your home?", was aimed at measuring the level of noise generated within the total residential building. However, it appears the respondents may have interpreted the question in two other fashions.

They may understand 'internal noise' to be the actual noise heard inside their home, including any noise penetrating from outside, such as traffic noise. The second possibility is that the question was interpreted so as to consider only the noise generated from within the respondent's own home unit. In this case, a respondent with a quiet home may rate the internal noise as very quiet, although there may be noises from outside their own unit, such as elevators, which are disturbing to them.

In general, it appears that the findings with respect to the internal noise question are somewhat ambiguous. As it is possible that the question may have been misinterpreted, it was decided to give little weight to the results and rely more heavily on the results in Table 6.

The only conclusion which can be reached is that townhouse residents are aware of more internal noise sources, which would aid in explaining their reporting less disturbance due to traffic noise. However, internal noise levels do not appear to provide any explanation for a difference in noise responses between residents in detached homes and apartments.

AII Residents who report higher internal noise levels, report less disturbance due to traffic noise.

The testing of this hypothesis also relied on the results of the ambiguous question 7. The ratings of internal noise were correlated, using Kendall's tau, with each of the noise ratings. For the hypothesis

to be supported, it was expected that there would be significant negative correlations. However, as in the previous section, it is doubtful whether the results from the question can be treated with much confidence.

The correlation coefficients and their significance levels are presented in Appendix C for the sake of completeness. They provide further support for the lack of confidence in the data, for while there are a fair number of significant correlations, they are largely positive. It is difficult to provide a logical explanation as to why higher internal noise ratings are associated with high traffic noise ratings. This is especially true in light of Tables 5 and 6, which suggest that detached unit residents are less disturbed than apartment and townhouse dwellers, whose buildings generally have higher internal noise levels. These positive correlations support the conclusion that many people included the external noise penetrating into their home when they rated internal noise.

AIII Residents of multi-unit dwellings are home for less time each day than are residents of single, detached dwellings.

This hypothesis was tested by comparing, for pairs of house types, the hours spent at home on weekdays and weekends. As only ordinal categories of hours spent at home were used, the Mann-Whitney U test was chosen as the most appropriate statistical test.

In general, there does not appear to be a significant difference between residents of various types of dwellings and the time they spend at home (table 8). The only relationship approaching significance is that residents in detached homes are home more during the week than are residents in owned townhouses. Thus, it appears that time spent at home does not provide any explanation for variations in response to traffic noise between

Table 8

Time Spent at Home by Dwelling Type

Significance Levels

	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
Time Spent at Home on Weekdays	U = 861 S = .6243	U = 2170 S = .0737 (detached)	U = 645.5 S = .5281	U = 615.5 S = .1537
Time Spent at Home on Weekends	U = 769.5 S = .2165	U = 2596 S = .9868	U = 592 S = .2491	U = 724 S = .7493

Statistical Test: Mann-Whitney U (also indicated, where applicable, which dwelling type had residents who spent more time at home).

different types of dwellings.

AIV Residents who are home for greater lengths of time each day report greater disturbance due to traffic noise.

This hypothesis tested whether the time spent at home affects response to noise. It was tested by correlating, using Kendall's tau, the hours spent at home (ordinal categories) with each of the noise ratings (table 9). Given that hypothesis AIII was not supported and people in different house types do not vary in the time spent at home, the results of the testing of this hypothesis may not appear to be immediately relevant. However, the results are important to test the hypothesis that time at home can have an effect on response to noise, which is independent of dwelling type.

The complete results are presented in Table 9. However, as hypothesis AIII has not been accepted, only the overall results for all sites will be considered. The table indicates rather mixed results among the different site combinations and it is not surprising that the overall correlations do not prove to be highly significant. The few correlations which are significant are in both positive and negative directions. There is some indication that the influence of time spent at home may vary depending on whether it is on a weekday or a weekend. The direction of the correlations indicate that the more time spent at home on weekdays, the less the respondent is disturbed by traffic noise, while the reverse is true on weekends.

The general conclusion though, is that time spent at home appears to play a minimal role in contributing to the rating of disturbance due to traffic noise. Looking at the results from testing both hypotheses AIII

Table 9

Noise Rating by Time Spent at Home

Significant Correlations

Noise Rating	Detached vs Apartments: Owned		Detached vs Townhouses: Owned		Townhouses vs Apartments: Owned		Townhouses vs Apartments: Rented		All Sites	
	Week-days	Week-ends	Week-days	Week-ends	Week-days	Week-ends	Week-days	Week-ends	Weekdays	Weekends
Neighbourhood										
Intensity (9 pt.)	.1123 (.046)	.1095 (.050)		.1226 (.015)		.1818 (.007)				.0929 (.013)
Overall						-.2293 (.038)				
Inside							-.2289 (.029)		-.1243 (.042)	
Outside										
Main Road										
Intensity		.1523 (.011)								
Overall			.1367 (.041)				-.2301 (.007)			
Inside							-.2231 (.010)			
Outside										
Outside, Exposed			.1337 (.044)				-.2670 (.004)			
Outside, Shielded								-.2413 (.031)		

Statistical Test: Kendall's tau (significance level in brackets).

Table 9 (cont'd)

Noise Rating	Detached vs Apartments: Owned		Detached vs Townhouses: Owned		Townhouses vs Apartments: Owned		Townhouses vs Apartments: Rented		All Sites	
	Week-days	Week-ends	Week-days	Week-ends	Week-Days	Week-ends	Week-days	Week-ends	Weekdays	Weekends
Truck										
Intensity										
Overall		.3298 (.003)		.2892 (.003)			-.3550 (.024)			
Inside		.2011 (.045)		.1967 (.030)			-.4470 (.007)			
Outside	-.5431 (.021)								-.3350 (.023)	
Outside, Exposed		.1981 (.045)		.2346 (.013)						
Outside, Shielded		.2736 (.017)		.2144 (.025)						.2003 (.025)

Statistical Test: Kendall's tau (significance level in brackets).

and AIV, one can conclude that time spent at home does not appear to play a major role in explaining the variations in response to road traffic noise between the residents of different dwelling types.

AV Residents of multi-unit dwellings spend less time outside their homes than do residents of single, detached dwellings.

This hypothesis was tested in a number of ways. The first test of the hypothesis involved comparison between residents of different house types and the time they spend outdoors on both weekdays and weekends (table 10). Seven of the eight Mann-Whitney U tests show significant differences between dwelling type and the time spent outdoors. The only relationship which is not significant is the difference in time spent outdoors on weekends between residents of townhouses and detached homes.

The second approach used to test the hypothesis was to compare responses to question 11, asking if the respondent would likely increase their use of outdoor space if the noise was reduced. These findings are interesting as a number of significant relationships arise, but not in the direction predicted (table 11). It is generally the apartment dweller who would increase his use of outdoor space if there was a noise reduction.

Percentage of Respondents Who Would Increase Use of Outdoors

	Owners	Renters
Detached	38%	--
Townhouse	31%	36%
Apartment	68%	59%

Table 10

Time Spent Outside the Home by Dwelling Type

Significance Levels

	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
Time Spent Outside on Weekdays	U = 429.5 S = .0001 (detached)	U = 2000.0 S = .0129 (detached)	U = 425.5 S = .0032 (townhouse)	U = 581.5 S = .0807 (townhouse)
Time Spent Outside on Weekends	U = 548.5 S = .0026 (detached)	U = 2547.5 S = .8296	U = 394.0 S = .0016 (townhouse)	U = 583.0 S = .0851 (townhouse)

Statistical Test: Mann Whitney U (also indicated, where applicable, which dwelling type had residents who spent more time outside).

Table 11

Increase Use of Outdoor if Noise is Reduced

Significance Levels

	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
Chi-square Significance Level (Yes/No vs Dwelling Type)	X^2 = 7.5203 S = .0233	X^2 = 1.6360 S = .4413	X^2 = 8.6023 S = .0034	X^2 = 4.3667 S = .1127
Percentage From Each Dwelling Type That Stated 'Yes'	Det.= 38% Apt.= 69%	Det.= 38% T.H.= 31%	T.H. = 30% Apt. = 68%	T.H. = 36% Apt. = 59%

Statistical Test: Chi-square.

The explanation for these results is not immediately obvious. However, it may arise since people with yards (detached and townhouse units) appear to use them, and of necessity care for them, regardless of the noise. However, apartment dwellers are not 'forced out' into their outdoor space (balconies). They only use their space for sitting, relaxing etc., activities which are particularly sensitive to noise. Therefore, an apartment resident would be the one most likely to increase his use of outdoor space if the noise was reduced.

Perhaps this is the reason for the lack of difference between house types in their rating of outdoor noise. Detached and townhouse dwellers use their outdoor space and are thus annoyed by the noise they are exposed to. Apartment residents are annoyed by traffic noise because it restricts the use of what little outdoor space they have.

The third method used compared the residents in terms of when they found the traffic noise most disturbing, summer or winter. One would expect that residents in townhouses and detached homes would find the noise most disturbing in the summer when they are outside using their yards. This is largely confirmed by the chi-square test results (table 12). There are two pairs of house types which differ in the time of year the noise is most disturbing - townhouses versus apartments (main road and truck noise) and detached homes versus apartments (main road noise).

Looking at the percentage of residents who find the traffic noise most disturbing in the summer, confirms that the residents most disturbed in the summer are those with access to yard space.

Table 12

Comparison Between Dwelling Type and the Season Noise is Most Disturbing

Significance Levels

	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
Time of Year Notice Main Road Noise	X^2 = 12.6009 S = .0018	X^2 = 0.0192 S = .8898	X^2 = 8.6944 S = .0129	X^2 = 0.7661 S = .6818
Time of Year Notice Truck Noise	X^2 = 2.3626 S = .3069	X^2 = 0.4613 S = .7940	F.E.T.=0.9559[a] S = .0441	F.E.T.=0.4842[a] S = .5148

Statistical Test: Chi-square

[a] small size of sample required use of Fisher's Exact Test in place of chi-square test.

Percentage of Residents Most Disturbed in Summer

Main Road Noise -	Owned Detached	90%
	Owned Townhouse	88%
	Owned Apartment	50%
Truck Noise -	Owned Detached	84%
	Owned Townhouse	85%
	Owned Apartment	60%

Thus, in contrast to the findings concerning internal noise, it appears that when considering time spent outdoors, townhouse residents behave more like detached unit dwellers than like apartment dwellers. A significantly larger number of detached and townhouse unit residents spend more time outdoors and find the noise most disturbing in the summer, in comparison to apartment residents.

AVI Residents who spend more time outside their homes report greater disturbance due to traffic noise.

It was hypothesized that attitude towards noise varied with house type, particularly due to the differences in time spent outdoors. Hypothesis V was shown to be generally true - there are differences between house types in terms of time spent outdoors. However, is time spent outdoors a factor related to noise disturbance?

If the hypothesis is to be supported, one would expect a large number of positive relationships between time spent outdoors and the rating of noise. However, there are actually few significant correlations and indeed, there is only one *outside* rating (truck noise - exposed) which significantly varies with time outdoors (table 13). If there is any pattern at all, it is that time outside varies positively with ratings of overall truck noise. This relationship appears to have a number of positive cor-

Table 13

Noise Rating by Time Spent Outside

Significant Correlations

Noise Rating	Detached vs Apartments: Owned		Detached vs Townhouses: Owned		Townhouses vs Apartments: Owned		Townhouses vs Apartments: Rented		All Sites	
	Week-days	Week-ends	Week-days	Week-ends	Week-days	Week-ends	Week-days	Week-ends	Weekdays	Weekends
Neighbourhood										
Intensity (9 pt.)							-.1935 (.006)			
Overall										
Inside						-.2873 (.025)				
Outside										
Main Road										
Intensity							-.1951 (.005)			
Overall	.1604 (.034)						-.2054 (.013)			
Inside	.2376 (.005)						-.2770 (.002)			
Outside										
Outside, Exposed										
Outside, Shielded										

Statistical Test: Kendall's tau (significance level in brackets).

Table 13 (cont'd)

Noise Rating	Detached vs Apartments: Owned		Detached vs Townhouses: Owned		Townhouses vs Apartments: Owned		Townhouses vs Apartments: Rented		All Sites	
	Week-days	Week-ends	Week-days	Week-ends	Week-days	Week-ends	Week-days	Week-ends	Weekdays	Weekends
Truck										
Intensity			.2368 (.006)	.2743 (.002)	.2811 (.034)					
Overall	.3088 (.005)	.2600 (.013)	.2236 (.016)						.1584 (.028)	
Inside	.2218 (.031)									
Outside										
Outside, Exposed			.2327 (.013)							
Outside, Shielded										

Statistical Test: Kendall's tau (significance level in brackets).

relations within the sample sites and is the only significant relationship when all ten sites are combined. This again points to the distinct differences in the way people respond to overall traffic noise in comparison to specific noises such as truck noise.

Again, the rental sites have a surprising trend - the less time spent outdoors, the more the residents are disturbed. This result is the exact opposite to that which was expected. However, as with the other sites, there are few significant relationships.

It is now possible to make a general conclusion with respect to the hypotheses AV and AVI. It appears that although time outside does vary with house type, it does not in turn appear to greatly influence the reported disturbance from traffic noise. Again, as was the case with the discussion concerning the time spent at home, length of exposure to the noise does not appear to greatly influence ones response to traffic noise.

The Influence of Socio-Economic Factors

As discussed in the research hypotheses, it was felt it would be wise to check the influence of the socio-economic characteristics of the residents on their responses. It was hoped that this additional set of intervening variables would not vary greatly between house types, or if they did vary, that they would not be shown to have any significant influence on response to noise. Fortunately, for the reliability of the results of this paper, the socio-economic factors did not appear to play a large role.

There was some variation between house types and certain socio-economic variables (table 14). Generally, the owners of single, detached homes were older than either townhouse or apartment owners. The only

significant difference in education levels between dwelling types occurred when comparing townhouse and detached unit residents, with the townhouse residents having the higher education. There were two significant differences between income levels. Townhouse owners had higher incomes than detached unit owners and townhouse renters had higher incomes than apartment renters. Though there are some differences between house types, the differences will not be a major influence unless it is shown that socio-economic variables do vary consistently with the rating of traffic noise.

The relationship between age and noise rating was tested using Pearson's correlation coefficient while education and income, being ordinal variables, were tested using Kendall's tau. The results are presented in Appendix D.

It was found that in general, age appeared to have little relationship to the rating of noise. This was reassuring for there had been some observed differences between certain house types in the age of their residents. However, these differences should not influence the results.

Education levels did not vary greatly between house types and so one can be reassured that it is unlikely that education is influencing the results discussed previously.

Only income appears to have an effect which must be reckoned with. Table 14 indicates that townhouse dwellers had higher incomes in comparison to both detached unit and apartment dwellers. The results in Appendix D-3 point to income having a negative relationship with the rating of overall neighbourhood noise - in other words, the lower the income, the greater the disturbance.

It is difficult however, to evaluate if the residents' income is

Table 14

Socio-Economic Variables by Dwelling Type

Significant Correlations

	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented
Age:				
Significance Level	t = 2.18 S = .031	t = -2.45 S = .016	t = .68 S = .501	t = -2.18 S = .032
Mean (in years)	Det: 40 Apt: 31	Det: 40 T.H.: 34	T.H.: 34 Apt: 31	T.H.: 30 Apt: 38
Education:				
Significance Level	U = 826 S = .4419	U = 2034 S = .0208	U = 645.5 S = .5517	U = 753 S = .9762
Dwelling Type with Higher Education	Apt.	T.H.	T.H.	--
Income:				
Significance Level	U = 849.5 S = .5705	U = 1936 S = .0074	U = 565.5 S = .1648	U = 324.5 S = .0000
Dwelling Type with Higher Income	Apt.	T.H.	T.H.	T.H.

Statistical Tests: Age - Student's t test (t)

Education, Income - Mann-Whitney U test (U)

influencing the results for the previous hypotheses. Table 14 indicates that there is a significant difference between the income of residents in owned townhouses as compared to owned, detached units, and in turn Appendix D-3 indicates that for these sites, income is negatively related to the rating of neighbourhood noise. However, Table 14 also indicates a significant difference in income between rented townhouse and apartment dwellers, yet for these sites, Appendix D-3 shows that income is not related to noise rating.

It is not possible to determine which factor is the key one as greater noise disturbance is associated with *lower income*, *detached* homes, while lower disturbance is associated with *higher income*, *townhouses*. The relationship in Appendix D-3 may arise simply because income co-varies with dwelling type within our sample and it is dwelling type, and not income, which is the crucial factor. It is certainly not the relationship which is often hypothesized - that detached unit residents would have the higher incomes and be more disturbed by noise.

With the exception of the relationship of income and noise ratings among townhouse and detached unit residents, it was generally shown that the socio-economic factors of age, education and income were *not* a confounding influence on the relationship between dwelling type and response to noise.

Summary of Dwelling Type Effects

Despite the common assumption made in the literature that response to noise will vary with dwelling type, there is no *strong* evidence to support this. The only indication of a difference in response to noise

was that residents in single, detached homes were slightly more disturbed by equivalent traffic noises than were either townhouse or apartment residents. However, the difference was only in 8 out of a possible 64 ratings of noise and certainly not enough to warrant the differences in noise planning guidelines as outlined in the literature review.

Unfortunately, the question concerning internal noise did not appear to be a reliable measure of the noises generated within the building. Neither time spent at home nor the time spent outside appeared to significantly influence response to noise. Thus, the reasons often suggested for the assumed decline in disturbance from traffic noise in multi-unit buildings, are not strongly supported. Finally, it does not appear that socio-economic factors, such as age, education or income, are confounding the results.

Effect of Tenure

Studying the effect of tenure on response to noise proved to be a much simpler task due to both the smaller number of categories (own versus rent) and the much more conclusive result following the testing of the major hypothesis.

> *B (Major) Residents who own their dwelling unit are more disturbed by equivalent levels of traffic noise than are residents who rent their dwelling.*

The relationship was tested by comparing the rating of noise by owners and renters in both townhouses or apartments. The statistical test used was the Student's t test, unless the rating scale was the nine point scale, in which case the Mann-Whitney U test was used.

As the accompanying table indicates (table 15), it appears that there is little variation in the disturbance from traffic noise between renters and owners. This limited relationship should not be surprising as the reasons suggested for the hypothesized relationship were not as concrete as those which had been suggested as leading to type of dwelling effects. This, in turn, is supported by the data, for though there is some indication of a dwelling type influence, one can conclude with some confidence that tenure plays no major role in influencing response to noise.

Summary of Tenure Effects

The conclusions concerning the effect of tenure on response to traffic noise are fairly straightforward. Whether a person owns or rents his home does not appear to influence his response to traffic noise. It is really not a surprising result, for the arguments in support of owners being more disturbed are less tangible (e.g. a sense of permanence) than those used in the type of dwelling discussion. As before, socio-economic factors did not appear to be confounding the results (Appendices E, F). The key finding is that tenure has little effect on residents' response to road traffic noise.

Interaction Effect Between Dwelling Type and Tenure

The results from the testing of the previous two basic hypotheses should provide some indication of what the results of this third set of hypotheses will illustrate.

The first hypothesis was that the combination of owned, detached homes would produce the greatest disturbance ratings, with rented, multi-

Table 15

Basic Hypothesis: The Relationship Between Tenure and the Rating of Noise

Significant Results

Site Combinations	Noise Rating	Value of Statistic
I. Owners vs Renters: Townhouses	Main Road - Intensity (9 point scale)	(U = 154.6)
	Main Road - Outside	t = -2.01
II. Owners vs Renters: Apartments	Neighbourhood - Intensity (9 point scale)	(U = 262)
	Main Road - Overall	(t = 2.12)*
	Main Road - Inside	(t = 2.00)

Statistical Tests: Student t test (t); Mann-Whitney U Test (U)

Significance Levels: S = .099 - .051
S = .050 - .011*
S = .010 - .0011**

Brackets indicate the relationship is in the opposite direction to that which was predicted.

unit dwellings having the lowest noise disturbance ratings. On the basis of the results discussed to this point, one would be forced to conclude that (i) tenure has little influence, (ii) the responses from multi-unit dwellings can be grouped together, (iii) residents in multi-unit dwellings are less disturbed than residents in detached units by traffic noise and that (iv) the difference in average annoyance between the two groups is small, though significant. Figure 9 presents schematically the basic conclusions reached and is interesting to compare with Figure 5 which is a schema of the hypothesized relationship.

The second step was to investigate the interaction between the two effects, tenure and type of dwelling. This was accomplished using a two-way analysis of variance. Given the results of the two previous sections, the results of this test should be easily predicted. The conclusions to this point have indicated that dwelling type has a small influence on response to noise, while tenure has apparently no effect on response to noise. Thus, one would now predict that their combined effects would not be significant either.

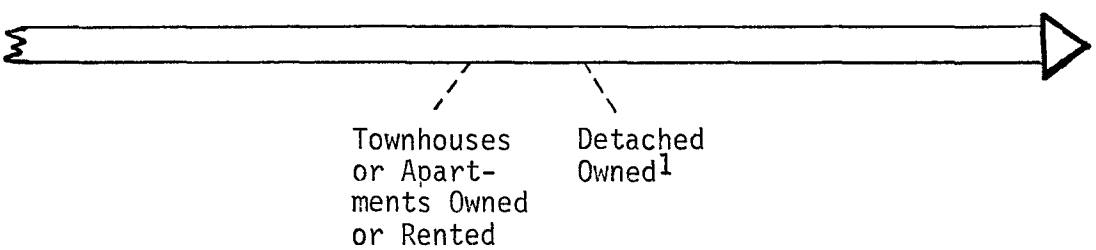
The accompanying table indicates that there are indeed, no significant interaction effects from combining the two intervening variables (table 16). The two variables, tenure and house type, are not each influencing the effect of the other variable. The low R^2 values indicate that the combined influence of dwelling type and tenure explain very little of the total variation in people's reaction to traffic noise.

Thus, the analysis of variance confirms the previous conclusions that type of dwelling and tenure have little effect on response to traffic noise.

Figure 9

Interaction Effect Between Tenure and Type of Dwelling

Conclusions



[1] On the basis of the lack of a relationship between tenure and response to traffic noise, one would predict that detached, rented units would be included here as well.

Table 16

Interaction Effect: Results of Two Way Analysis of Variance

Noise Rating	Joint Effect	Interaction Effect	Total Effect	R^2
Neighbourhood				
Overall	NS	NS	NS	.005
Inside	NS	NS	NS	.017
Outside	NS	NS	NS	.015
Main Road				
Overall	f = 2.574 (S = .082)	NS	NS	.058
Inside	f = 2.747 (S = .070)	NS	NS	.065
Outside	NS	NS	NS	.083
Outside, Exposed	NS	NS	NS	.020
Outside, Shielded	NS	NS	NS	.035
Truck				
Overall	NS	NS	NS	.095
Inside	NS	NS	NS	.010
Outside	NS	NS	NS	.010
Outside, Exposed	NS	NS	NS	.015
Outside, Shielded	NS	NS	NS	.014

Statistical Test: Two Way Analysis of Variance

NS = not significant

CHAPTER SIX

CONCLUSIONS AND REFLECTIONS

The absence of any strong relationships arising from the analysis presented here is an important finding. This paper began with a review of the common beliefs held concerning the effect that type of dwelling and type of tenure have on a resident's response to traffic noise. Though there was little documented evidence, it had certainly been assumed that these two variables were influencing factors. Some had suggested noise level criteria which permitted higher noise levels in multi-unit dwellings because they would "accept higher noise levels than those in single family dwellings" (Rackl et al., 1975, p.3-8).

Yet the conclusions based on the research presented here belie those common assumptions. The difference between residents who own or rent their homes in response to traffic noise is negligible. There does not appear to be any evidence of greater concern over neighbourhood noise levels among owners. Unfortunately, it was not possible to test for a variation between owners or renters with respect to their sense of permanence. However, whether or not such a difference exists appears to play little role in affecting how a resident responds to his immediate noise environment. The results quite strongly confirm that tenure does not significantly influence one's response to traffic noise.

The results of the study concerning the role of dwelling type were not as conclusive. There was some indication that residents in single, family homes were slightly more disturbed by equivalent noise levels than were the residents in either of the multi-unit dwellings.

However, the differences in responses were not clear cut. Out of 64 possible ratings of noise, there were only 8 for which there was a significant difference between responses from residents in different dwelling types. The difference is only slight and certainly is not strong enough to warrant differences in acceptable noise levels between two types of buildings. This is in addition to doubts over the ethics of such discriminatory guidelines, which would allow residents of multi-unit buildings to be exposed to greater noise levels.

The noise perception of townhouse residents, in comparison to single, family houses and high rise apartments residents, is interesting. Although residents of townhouses have access to outdoor space in a fashion similar to single, family homeowners, their perception of noise is more similar to that of apartment residents. It appears that the multi-unit distinction is more important than outdoor exposure to noise. It is unfortunate that the measure of internal noise was so unreliable, for it may be playing a role in this pattern of responses. Certainly, when comparing the number of non-traffic noises, such as children, radios or pets, the townhouse residents mentioned the greatest number.

The other explanatory factor considered was time spent at home and surprisingly, despite common assumptions concerning the life style differences between residents of the three building types, there was little variation in their time spent at home. Therefore, it appears that length

of daily exposure to the traffic noise is not playing a role in the differences in response to noise in different house types.

The basic conclusion is that there is an indication that residents in single, family units would be slightly more disturbed by traffic noise than residents in either of the multi-unit dwellings. However, the difference is not as great as previous assumptions would have led one to believe.

Though this research has provided some important results, some questions remain to be answered. Some refinements of the methods utilized within this paper could also be undertaken.

The role of internal noise within different dwelling types remains a key question. To deal with it would involve a reworded question so that the respondent would rate the noise generated within his/her building. Added validity could be given to such questions, if it were possible to measure the actual internal noise levels. However, it would be difficult to separate from the internal noise rating, the component which could be attributed to external traffic noise penetrating into the building.

Certainly, as with most studies, a larger number of sites would have provided greater confidence in the results. The difficulty was most evident in the comparison of residents in rented townhouses and rented apartments. The surprising results were often difficult to explain and possibly arose from using only one apartment site as representative of the rented apartments. However, a recent paper by Taylor and Hall (1977b) using a different combination of sites, found a similar relationship with regard to rented townhouses and apartments.

Extensions of the hypotheses studied within this research are also

possible. The method utilized here to study residents from different dwelling types and with different tenure status, has been to compare their ratings of main road and truck noise. Thus, only those residents who mentioned that they noticed the noise were compared. It may be that no matter what the dwelling type or tenure, if the noise is mentioned it is likely that the ratings of it will be similar.

A different approach to the problem would have been to compare the actual numbers of people from each dwelling type who stated that they noticed the traffic noise. It is possible that for one dwelling type, a greater percentage of respondents would volunteer that they noticed traffic noise, than for any other dwelling type. This would indicate a difference in response to noise between dwelling types, which might not be indicated by comparing the mean ratings for those who did mention the noise. Yet in a forthcoming paper, Taylor, Birnie and Hall (1978) report no major differences between dwelling types in awareness of traffic noise.

Further extensions of the question of the role of dwelling type and tenure are possible. The analysis could have extended beyond simply considering response to noise as an attitude concerning disturbance, to other measures of response such as health effects. It is also possible to examine the selection of sites, aiming for a slightly quieter noise environment. It may be that the noise levels of the sites utilized here are too great to be influenced by the intervening variables. This concept was considered but the only group of sites, with the other required characteristics, fell into this somewhat loud noise environment (L_{eq} = 67 dBA - 74 dBA).

However, analysis performed concurrent with this paper incorporated some of these extensions and found that similar relationships emerged.

Taylor and Hall (1977b) found that reports of health effects or interference with activities did not differ between types of dwelling or types of tenure status. They also conducted an analysis similar to the one presented here, but used a set of sites from a quieter noise environment (L_{eq} = 58-63 dBA). They found that house type and tenure had even less influence on response to traffic noise in the quieter environment.

Overall, the various extensions of the research presented here lead to similar conclusions.

The goals of this research have been met. The short-comings of prior research were overcome in three respects. First, the role of tenure and dwelling type were empirically examined rather than simply speculated upon. Secondly, through careful selection of sites, it was possible to isolate the effects of dwelling type and tenure separately. Finally, by using physical noise measurements in conjunction with site selection, it was possible to control the actual noise environment.

Having achieved these goals, it is possible to conclude that tenure is not a significant intervening factor affecting response to traffic noise. There is some indication that one may expect greater disturbance reported among residents in single, family homes as opposed to residents of multi-unit dwellings. However, the difference is not great, and certainly does not support the strong assumptions and discriminatory noise guidelines which had been published prior to this research.

APPENDIX A

COPY OF QUESTIONNAIRE

SITE NUMBER _____ (1-4)

RESPONDANT NUMBER _____ (5-7)

INTERVIEWER NUMBER _____ (8)

INTRODUCTION: Hello, I'm from the Geography Department at McMaster and I'm interviewing people to find out what they think about this area. Could you spare me about 10 minutes? Thanks very much.

1. What are the important things you like about living in this neighbourhood?

2. What are the important things you don't like about living in this neighbourhood?

	Item	Like V (1)		Like E (2)		Don't Like V (1)		Don't Like E (2)	
(01)	Schools	____	9	____		____	28	____	
(02)	Shopping	____	10	____		____	29	____	
(03)	Open Space	____	11	____		____	30	____	
(04)	Recreational Facs.	____	12	____		____	31	____	
(05)	Bus Service	____	13	____		____	32	____	
(06)	Proximity to Work	____	14	____		____	33	____	
(07)	Noise	____	15	____		____	34	____	
(08)	Quietness	____	16	____		____	35	____	
(09)	Air Quality	____	17	____		____	36	____	
(10)	Landscaping	____	18	____		____	37	____	
(11)	Cost of Housing	____	19	____		____	38	____	
(12)	Quality of Housing	____	20	____		____	39	____	
(13)	Neighbours	____	21	____		____	40	____	
(14)	Safety for Children	____	22	____		____	41	____	
(15)	Crime	____	23	____		____	42	____	
(16)	Maintenance	____	24	____		____	43	____	
(17)	Privacy	____	25	____		____	44	____	
(18)	Parking	____	26	____		____	45	____	
(19)	Other (specify)	____	27	____		____	46	____	

For 1 and 2 check all non-volunteered items using card. Here are some other things that have been mentioned, are any of them important to you?

Transition: You have mentioned noise; I'd like to ask you a little more about that. (or) One of the items we're particularly interested in is noise and I'd like to ask you about that.

Coding: put number of noise sources mentioned in question 3 in column 47 _____(47)

put number of disturbing noises in column 48 _____(48)

Coding: skip to question 4.

3. a. What sounds do you notice when you are at home?

   b. How would you rate each of the sounds you have mentioned?

   Hand respondent the card listing the intensity scale:

   1. *Extremely agreeable*
   2. *Considerably agreeable*
   3. *Moderately agreeable*
   4. *Slightly agreeable*
   5. *Neutral*
   6. *Slightly disturbing*
   7. *Moderately disturbing*
   8. *Considerably disturbing*
   9. *Extremely disturbing*

   c. Here is a list of common sounds (you have already mentioned some). Do you ever particularly notice any of these (any of the others)?

   d. *Repeat* b *for elicited noises.*

   e. *For each noise with an intensity rating between 6 and 9.*

   You mentioned that _____ (source) was disturbing. How often does it disturb you?

   Hand respondent the card listing the categories:

   1. *Less than once a day*
   2. *Once or twice a day*
   3. *Several times a day*
   4. *Almost continuously*

	Source	V 1	E 2	Intens. (1-9)	Freq. (1-4)	Over.	*For Coding Only* Intensity IN	OUT	OEX	OSH
(01)	Children	—	—	—	—	—	—	—	—	—
(02)	Other People	—	—	—	—	—	—	—	—	—
(03)	Handyman tools	—	—	—	—	—	—	—	—	—
(04)	Air conditioner	—	—	—	—	—	—	—	—	—
(05)	Domestic pets	—	—	—	—	—	—	—	—	—
(06)	Garden Machinery	—	—	—	—	—	—	—	—	—
(07)	TV/radio/records	—	—	—	—	—	—	—	—	—
(08)	Musical instruments	—	—	—	—	—	—	—	—	—
(09)	Local Traffic Noise	—	—	—	—	—	—	—	—	—
(10)	Main Road Traffic Noise	—	—	—	—	—	—	—	—	—
(11)	Motorcycles	—	—	—	—	—	—	—	—	—
(12)	Trucks	—	—	—	—	—	—	—	—	—
(13)	Snowmobiles	—	—	—	—	—	—	—	—	—
(14)	Mini-bikes	—	—	—	—	—	—	—	—	—
(15)	Trains	—	—	—	—	—	—	—	—	—
(16)	Aircraft	—	—	—	—	—	—	—	—	—
(17)	Industrial Noise	—	—	—	—	—	—	—	—	—
(18)	Construction Noise	—	—	—	—	—	—	—	—	—
(19)	Institutional noise	—	—	—	—	—	—	—	—	—
(20)	Mechanical or Plumbing noise	—	—	—	—	—	—	—	—	—
(21)	Other (specify)	—	—	—	—	—	—	—	—	—
		11		12	13	14-16	17-19	20-22	23-25	26-28

Coding: each source mentioned will appear on a separate card. Duplicate the identification in cols (1-8). *The noise source code goes in cols* (9-10). *Proceed with data from questions* 3, 7, 9, 10, 11, *for that noise source. Repeat as needed for additional noise sources. When coding response to question* 5, *record number to one decimal place (F 3.1), but do not punch the decimal. If the particular location is not applicable, punch 999.*

4. Considering all you have mentioned, how would you rate the overall noise?

(1)	Extremely agreeable	
(2)	Considerably agreeable	
(3)	Moderately agreeable	
(4)	Slightly agreeable	
(5)	Neutral	_____ (49)
(6)	Slightly disturbing	
(7)	Moderately disturbing	
(8)	Considerably disturbing	
(9)	Extremely disturbing	

Coding: *Question* 5c, *Neighbourhood rating:* *Overall* _____(50-52)
Inside _____(53-55)
Outside _____(56-58)

Coding: *go to question* 6.

5. We would like to obtain an additional rating for the noise sources which you indicated are disturbing.

   a. Please indicate the level of disturbance caused by the noise source by rating your disturbance on a scale of 0 to 10, where 0 indicates not at all disturbed, and 10 indicates unbearably disturbed. Please put your rating in the first box, marked overall.

   b. We would like to know if your disturbance varies depending on where you are. Please show your level of disturbance when you are indoors by placing the appropriate number in the box marked inside.

      For main road and truck sources. Now please indicate in the appropriate boxes your disturbance when you are outside on the side of the building which is exposed to the noise source, and then on the shielded side.

      For other than main road and truck sources. Now please indicate your level of disturbance when you are out of doors, at home, by placing the number in the box marked outdoors.

      Repeat a *and* b *for each noise rated 6 to 9.*

   c. *Ask* c *only if neighbourhood rating on question* 4 *was disturbing.*

      We would like to obtain a similar rating to describe your level of disturbance from the general neighbourhood noise. Please indicate your disturbance in the first box of the set marked neighbourhood. Now please indicate your disturbance when you are inside and outside of your residence.

6. a. Did any noises listed on the card which don't disturb you now, ever disturb or threaten to disturb you in the past, in this location?

_____ (59-60) _____

_____ (61-62) _____

_____ (63-64) _____

b. Why are these noises no longer (potentially) disturbing?

EXTERNAL AGENCIES	SOURCES		
	_____	_____	_____
(11) Newspaper	☐	☐	☐
(12) Noise source stopped or moved	☐	☐	☐
(13) Police	☐	☐	☐
(14) Politicians	☐	☐	☐
(15) Other government officials	☐	☐	☐
(16) Protest group	☐	☐	☐
(17) Other (specify)	☐	☐	☐
PERSONAL ACTIONS			
(21) Got used to noise	☐	☐	☐
(22) Installed extra insulation	☐	☐	☐
(23) Installed double glazing	☐	☐	☐
(24) Planted trees	☐	☐	☐
(25) Other (specify)	☐	☐	☐
	(65-66)	(67-68)	(69-70)

Coding: skip to question 13.

Transitional statement: The next several questions relate to those noises which you previously mentioned are disturbing.

7. a. What time of the year are you disturbed most by these noises?

Sources	(1) more in summer	(2) more in winter	(3) no difference	
_____	☐	☐	☐	____(29)
_____	☐	☐	☐	____(29)
_____	☐	☐	☐	____(29)
_____	☐	☐	☐	____(29)

b. What days and times are you disturbed most?

Sources	no difference, or			
_____	☐	_____	_____	_____
_____	☐	_____	_____	_____
_____	☐	_____	_____	_____
_____	☐	_____	_____	_____

Coding:

Sources				
_____	_____	_____	_____	Su (30-31)
_____	_____	_____	_____	M (32-33)
_____	_____	_____	_____	Tu (34-35)
_____	_____	_____	_____	W (36-37)
_____	_____	_____	_____	Th (38-39)
_____	_____	_____	_____	F (40-41)
_____	_____	_____	_____	Sa (42-43)

8. Are there any activities which these noises interrupt?

Volunteered answers only.

Source	Sleeping	Relaxing In	Relaxing Out	Conversing In	Conversing Out	Working In	Working Out	T.V.	Telephone Convers.	Eating
_____	____	___	___	___	___	___	___	___	___	____
_____	____	___	___	___	___	___	___	___	___	____
_____	____	___	___	___	___	___	___	___	___	____
_____	____	___	___	___	___	___	___	___	___	____
	44	45	46	47	48	49	50	51	52	53

Blank = 1, check = 2.

9. When you are disturbed by _____ do you: *read list.*

	Sources				
	_____	_____	_____	_____	
Close your window	☐	☐	☐	☐	(54)
Use air conditioning	☐	☐	☐	☐	(55)
Stay indoors	☐	☐	☐	☐	(56)
Turn on/up TV/radio/records	☐	☐	☐	☐	(57)
Wear earplugs	☐	☐	☐	☐	(58)
Contact noise source	☐	☐	☐	☐	(59)
Wait for noise to stop	☐	☐	☐	☐	(60)

Blank = 1, check = 2.

10. What effects on you and your family have these noises had? *Read list.*

Source	Nervousness	Hearing Loss	Irritability	Headaches	Interrupt Sleep	Kept Awake
_____	____	____	_____	___	____	____
_____	____	____	_____	___	____	____
_____	____	____	_____	___	____	____
_____	____	____	_____	___	____	____
	(71)	(72)	(73)	(74)	(75)	(76)

Black = 1, check = 2.

11. Have you ever taken any of these actions in response to these noise sources? *Read List.*

	Sources				
Written to newspaper	☐	☐	☐	☐	(61)
Contacted noise source	☐	☐	☐	☐	(62)
Contacted police	☐	☐	☐	☐	(63)
Contacted politician	☐	☐	☐	☐	(64)
Contacted other gov't official	☐	☐	☐	☐	(65)
Signed petition	☐	☐	☐	☐	(66)
Attended meeting	☐	☐	☐	☐	(67)
Joined protest group	☐	☐	☐	☐	(68)
Organized protest group	☐	☐	☐	☐	(69)
Other (specify)	☐	☐	☐	☐	(70)

Blank = 1, check = 2. Coding: if there are more noise sources, return to question 3.

12. Which of the following actions have you considered to avoid unwanted noise? Have you taken any of them?

	Considered	Taken
Keep windows closed	☐ (71)	☐ (72)
Install air conditioning	☐ (73)	☐ (74)
Do not ask remainder in apartments:		
Install extra insulation	☐ (75)	☐ (76)
Keep storm windows on	☐ (77)	☐ (78)
Install double glazing	☐ (79)*	☐ (9)
Construct barrier (e.g. fence)	☐ (10)	☐ (11)
Plant trees	☐ (12)	☐ (13)
Other (specify	☐ (14)	☐ (15)

Blank = 1, check = 2.

When coding, col (80) *= 1; start a new card by duplicating the identification code in cols* (1-8)*; then punch cols* (9-15) *as above, and proceed to question* 14.

13. How would you rate this neighbourhood for noise compared with other residential parts of this urban area? *Read first five on list.*

(1) Very quiet ☐

(2) Fairly quiet ☐

(3) Average ☐ _____ (16)

(4) Fairly noisy ☐

(5) Very noisy ☐

(6) Cannot answer or don't know ☐

Coding: skip to the first question of the next section.

14. Do you have any suggestions for helping to reduce noise? *Volunteered only.*

☐ Enforce by-laws

☐ Improve muffler regulations

☐ Build barriers

Others:

In order to understand more about how people assess their environment, we would appreciate the following information about yourself. This information will be used only in looking at groups of people, we will not be using it on an individual level. In fact, we do not keep any record of where a particular interview comes from. If there are any questions you would prefer not to answer, please say so. Your answers to the other questions will still be appreciated.

1. Sex (1) Male ☐ (2) Female ☐ (17) ____

2. Please write down your age. _____ years. (18-19)

3. What level of education have you completed?

(1) Some public school ☐
(2) Public school graduation ☐
(3) Some high school ☐
(4) High school graduation ☐ ____ (20)
(5) Some university or college ☐
(6) University or college graduation ☐
(7) Post-graduate work ☐

4. What is your main occupation? _____ (21-22)

5. What is the occupation of the head of the household _____ (23-24)

6. If employed outside the home, how would you rate your place of work for noise?

(1) Very quiet ☐
(2) Fairly quiet ☐
(3) Average ☐ ____ (25)
(4) Fairly noisy ☐
(5) Very noisy ☐
(6) Not applicable ☐

7. How would you describe the internal noise in your home?

(1) Not noisy at all ☐
(2) A little noisy ☐
(3) Moderately noisy ☐
(4) Considerably noisy ☐
(5) Extremely noisy ☐

____(26)

8. Please indicate which range most closely describes the income before taxes of this household in the past year?

(1) Less than $5,000 ☐ (5) $20,000 - $25,000 ☐

(2) $ 5,000 - $10,000 ☐ (6) $25,000 - $30,000 ☐

(3) $10,000 - $15,000 ☐ (7) More than $30,000 ☐

(4) $15,000 - $20,000 ☐ _____(27)

9. How many hours do you normally spend at home each day?

	(1) less than 10	(2) 10-15	(3) 15-20	(4) more than 20	
Weekdays	☐	☐	☐	☐	(28)____
Weekends	☐	☐	☐	☐	(29)____

10. In the summer, how many hours do you normally spend outside at home?

	(1) 0	(2) 1-2	(3) 3-5	(4) 6-10	(5) more than 10	
Weekdays	☐	☐	☐	☐	☐	(30)____
Weekends	☐	☐	☐	☐	☐	(31)____

11. If noise levels were reduced, would your use of outdoor space increase?

(1) Yes ☐

(2) No ☐ _____(32)

12. Do you rent or own your residence?

(1) Rent ☐

(2) Own ☐ _____(33)

13. How long have you lived in this house/apartment? _____ (34-36)
(months)

14. a. Have you ever considered moving to a quieter neighbourhood to avoid unwanted noise here?

(1) Yes ☐

(2) No ☐ _____(37)

b. If yes, how much longer do you expect to stay in this house/apartment?

_____ _____(38-40)
(months)

The following questions concern the type of dwelling which you inhabit. Your help in filling them out is appreciated.

1. Building constructions:

   a. Number of stories in building _____ (41-42)

   b. Building material:

      (1) Brick ☐
      (2) Frame ☐
      (3) Stucco ☐ _____ (43)
      (4) Asbestos panels ☐
      (5) Other (specify) ☐

   c. Type of windows: *Approximate percent of each on dwelling, if necessary.*

      (1) Single pane (openable) ☐ (44-46)
      (2) Thermal pane (not openable) ☐ (47-49)
      (3) Two panes (e.g. aluminun combination storms-openable) ☐ (50-52)
      (4) Double glazing (approx. 4" between panes, not openable) ☐ (53-55)

   d. Air conditioning:

      (1) Central ☐
      (2) Window unit ☐ _____(56)
      (3) None ☐
      (4) Don't know ☐

2. Buffer features with reference to major noise source: *blank = 1, check = 2*

   Shrubs ☐ (57)
   Trees (Deciduous) ☐ (58)
   Trees (Coniferous) ☐ (59)
   Hedge ☐ (60)
   Wall/Solid fence ☐ (61)
   Earth Berm ☐ (62)

3. Type of dwelling unit:

   (1) Apartment ☐

   (2) Flat ☐

   (3) Row/Townhouse ☐ _____(63)

   (4) Semi-detached ☐

   (5) Detached ☐

4. If an apartment or flat, which floor? _____ (64-65)

5. Date _____ (day/month) _____ ____(66-69)
   day month

6. Hour of day _____ (70-73)

0	to	10
not at all disturbed		unbearably disturbed

Site No. _____

Respondent _____

Interviewer No. ___

Source: _____

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: _____

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: _____

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: _____

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: NEIGHBOURHOOD _____

Overall	Inside	Outdoors

APPENDIX B

SITE DESCRIPTIONS

Site: Islington - South

Location: Islington Avenue, south of Dundas Street, between Bering Street and Meadowvale, Toronto.

Classification: Single family detached/owned

Number of Respondents: 29 Male: 14 Female: 15

Dwelling Type:
Apartment: 1
Townhouse: 1
Detached: 27

Tenure:
Own: 27
Rent: 2

Mean Age: 38 years

Level of Education:

Public School:	5
High School:	18
University/College:	6
Post-graduate work:	0

Length of Residence:

Less than 1 year:	1
1 to 3 years:	7
4 to 10 years:	6
Over 10 years:	15

Income:

0 - $10,000:	5
$10,000 - $20,000:	11
$20,000 - $30,000:	2
Over $30,000:	2

Site: Islington - North

Location: North end of Islington Avenue, Toronto.

Classification: Single, family detached/owned

Number of Respondents: 24 Male: 6 Female: 18

Dwelling Type:

Apartment:	0
Townhouse:	0
Detached:	24

Tenure:

Own:	24
Rent:	0

Mean Age: 43 years

Level of Education:

Public School:	6
High School:	14
University/College:	4
Post-graduate work:	0

Length of Residence:

Less than 1 year:	0
1 to 3 years:	1
4 to 10 years:	5
Over 10 years:	18

Income:

0 - $10,000:	2
$10,000 - $20,000:	12
$20,000 - $30,000:	2
Over $30,000:	4

Site: Ancaster

Location: Halton, Miller and Oneida Drives; along Highway #403 in Ancaster.

Classification: Single, family detached/owned

Number of Respondents: 31 Male: 5 Female: 26

Dwelling Type:

Apartment:	0
Townhouse:	0
Detached:	31

Tenure:

Own:	31
Rent:	0

Mean Age: 40 years

Level of Education:

Public School:	0
High School:	21
University/College:	10
Post-graduate work:	0

Length of Residence:

Less than 1 year:	2
1 to 3 years:	3
4 to 10 years:	13
Over 10 years:	13

Income:

0 - $10,000:	2
$10,000 - $20,000:	15
$20,000 - $30,000:	8
Over $30,000:	1

Site: Guelph Line

Location: Guelph Line, north of Plains Road, Burlington.

Classification: Townhouse/owned

Number of Respondents: 20 Male: 9 Female: 11

Dwelling Type:

Apartment:	0
Townhouse:	20
Detached:	0

Tenure:

Own:	19
Rent:	1

Mean Age: 30 years

Level of Education:

Public School:	4
High School:	10
University/College:	5
Post-graduate work:	1

Length of Residence:

Less than 1 year:	7
1 to 3 years:	10
4 to 10 years:	3
Over 10 years:	0

Income:

0 - $10,000:	1
$10,000 - $20,000:	8
$20,000 - $30,000:	7
Over $30,000:	2

Site: Burnhamthorpe

Location: Along Burnhamthorpe Road, east of Mill Road, Torono.

Classification: Townhouse/owned

Number of Respondents: 26 Male: 9 Female: 17

Dwelling Type:

Apartment:	0
Townhouse:	26
Detached:	0

Tenure:

Own:	24
Rent:	2

Mean Age: 38 years

Level of Education:

Public School:	1
High School:	13
University/College:	11
Post-graduate work:	1

Length of Residence:

Less than 1 year:	5
1 to 3 years:	15
4 to 10 years:	6
Over 10 years:	0

Income:

0 - $10,000:	3
$10,000 - $20,000:	11
$20,000 - $30,000:	8
Over $30,000:	2

Site: Golfways

Location: Golfways and Linkways developments; along the Don Valley Parkway, Toronto.

Classification: Townhouse/owned

Number of Respondents: 22 Male: 9 Female: 13

Dwelling Type:

Apartment:	0
Townhouse:	22
Detached:	0

Tenure:

Own:	21
Rent:	1

Mean Age: 33 years

Level of Education:

Public School:	2
High School:	9
University/College:	9
Post-graduate work:	1

Length of Residence:

Less than 1 year:	2
1 to 3 years:	15
4 to 10 years:	5
Over 10 years:	0

Income:

0 - $10,000:	0
$10,000 - $20,000:	3
$20,000 - $30,000:	10
Over $30,000:	1

Site: 5 Shady Golfways

Location: South of Eglington Avenue; along the Don Valley Parkway, Toronto.

Classification: Apartment/owned

Number of Respondents: 28 Male: 5 Female: 23

Dwelling Type:	Apartment:	28
	Townhouse:	0
	Detached:	0

Tenure:	Own:	22
	Rent:	6

Mean Age: 31 years

Level of Education:	Public School:	3
	High School:	16
	University/College:	9
	Post-graduate work:	0

Length of Residence:	Less than 1 year:	7
	1 to 3 years:	21
	4 to 10 years:	0
	Over 10 years:	0

Income:	0 - $10,000:	4
	$10,000 - $20,000:	13
	$20,000 - $30,000:	5
	Over $30,000:	3

Site: Citadel

Location: Citadel Village, just south of York Mills Road; along the Don Valley Parkway, Toronto.

Classification: Townhouse/rented

Number of Respondents: 26 Male: 7 Female: 19

Dwelling Type:
Apartment: 0
Townhouse: 26
Detached: 0

Tenure:
Own: 0
Rent: 26

Mean Age: 31 years

Level of Education:

Public School:	2
High School:	7
University/College:	14
Post-graduate work:	3

Length of Residence:

Less than 1 year:	12
1 to 3 years:	6
4 to 10 years:	8
Over 10 years:	0

Income:

0 - $10,000:	1
$10,000 - $20,000:	10
$20,000 - $30,000:	9
Over $30,000:	3

Site: Horizon

Location: Horizon Village, along Don Valley Parkway, Toronto.

Classification: Townhouse/rented

Number of Respondents: 30 Male: 7 Female: 23

Dwelling Type:
Apartment: 0
Townhouse: 30
Detached: 0

Tenure:
Own: 0
Rent: 30

Mean Age: 29 years

Level of Education:

Public School:	2
High School:	20
University/College:	7
Post-graduate work:	1

Length of Residence:

Less than 1 year:	10
1 to 3 years:	10
4 to 10 years:	9
Over 10 years:	1

Income:

0 - $10,000:	0
$10,000 - $20,000:	8
$20,000 - $30,000:	14
Over $30,000:	1

Site: Beverly Hills

Location: Beverly Hills Apartment Building; between King Street and Main Street, Hamilton; beside Highway #403.

Classification: Apartment/rented

Number of Respondents: 27 Male: 11 Female: 16

Dwelling Type:		
	Apartment:	27
	Townhouse:	0
	Detached:	0

Tenure:		
	Own:	0
	Rent:	27

Mean Age: 38 years

Level of Education:		
	Public School:	1
	High School:	14
	University/College:	10
	Post-graduate work:	2

Length of Residence:		
	Less than 1 year:	4
	1 to 3 years:	13
	4 to 10 years:	10
	Over 10 years:	0

Income:		
	0 - $10,000:	8
	$10,000 - $20,000:	8
	$20,000 - $30,000:	2
	Over $30,000:	0

APPENDIX C

EXTERNAL NOISE RATING BY INTERNAL NOISE RATING

Table C1

External Noise Rating by Internal Noise Rating

Significant Correlations

Noise Rating	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented	All Sites
Neighbourhood Intensity (9 pt.)	.1842 (.003)	.1869 (.001)			.1340 (.001)
Main Road Intensity		.1202 (.016)		.1676 (.013)	.1231 (.002)
Overall	.1955 (.013)	.1574 (.023)	.3244 (.001)		.1718 (.001)
Inside	.1594 (.042)	.1677 (.019)	.2152 (.020)		.1406 (.007)
Outside		.1421 (.035)	.2597 (.007)		.1311 (.010)
Truck Intensity					
Overall					
Inside					
Outside					
Outside, Exposed					
Outside, Shielded			-.4803 (.020)		

Statistical Test: Kendall's tau (significance level).

APPENDIX D

NOISE RATING BY AGE, EDUCATION AND INCOME

Table D1

Noise Rating by Age

Significant Correlations

Noise Rating	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented	All Sites
Neighbourhood					
Intensity (9 pt.)		.1098 (.025) K	.1567 (.017) K		.0818 (.025) K
Overall					
Inside					
Outside					
Main Road					
Intensity					
Overall					
Inside					
Outside					
Outside, Exposed					
Outside, Shielded					
Truck					
Intensity					
Overall		.2789 (.032)			.2655 (.014)
Inside					
Outside				.6313 (.034)	
Outside, Exposed				.7000 (.006)	.2783 (.014)
Outside, Shielded					.2485 (.048)

Statistical Test: Pearson's rho (significance level) unless followed by 'K' which indicates Kendall's tau.

Table D2

Noise Rating by Education

Significant Correlations

Noise Rating	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartment: Rented	All Sites
Neighbourhood					
Intensity (9 pt.)		.1722 (.002)	.1384 (.030)	.2152 (.003)	.1634 (.001)
Overall					
Inside					
Outside					
Main Road					
Intensity	.1481 (.013)	.0942 (.046)		.2255 (.002)	.1367 (.001)
Overall					
Inside					
Outside					
Outside, Exposed					
Outside, Shielded			.2236 (.045)		
Truck					
Intensity					
Overall	-.3168 (.004)	-.2091 (.022)			
Inside	-.2065 (.041)				
Outside		-.8944 (.015)		.4669 (.040)	
Outside, Exposed	-.3863 (.001)	-.2854 (.004)			-.2391 (.003)
Outside, Shielded	-.2244 (.041)				

Statistical Test: Kendall's tau (significance level).

Table D3

Noise Rating by Income

Significant Results

Noise Rating	Detached vs Apartments: Owned	Detached vs Townhouses: Owned	Townhouses vs Apartments: Owned	Townhouses vs Apartments: Rented	All Sites
Neighbourhood					
Intensity (9 pt.)					
Overall		-.2614 (.003)	-.2320 (.036)		-.1353 (.022)
Inside		-.1806 (.034)			
Outside	-.2515 (.017)	-.2228 (.009)			-.1747 (.006)
Main Road					
Intensity					
Overall					
Inside					
Outside					
Outside, Exposed					
Outside, Shielded					
Truck					
Intensity					
Overall					
Inside					
Outside					
Outside, Exposed	-.2234 (.028)	-.2305 (.014)			-.1614 (.031)
Outside, Shielded					

Statistical Test: Kendall's tau (significance level).

APPENDIX E

SOCIO-ECONOMIC VARIABLES BY TENURE STATUS

Table E1

Socio-Economic Variables by Tenure Status

Significance Levels

	Owners vs Renters: Townhouses	Owners vs Renters: Apartments
AGE (Student T test)	S = .248	S = .286
INCOME (Mann-Whitney U test)	S = .6497	S = .006 (owners have higher income)

APPENDIX F

NOISE RATING BY AGE, INCOME

Table F1

Noise Rating by Age, Income[a]

Significant Correlations

Noise Rating	Townhouse Sites		Apartment Sites	
	AGE	INCOME	AGE	INCOME
Neighbourhood				
Intensity (9 pt.)				-.1981 (S = .017)
Overall				
Inside				
Outside				
Main Road				
Intensity				
Overall				
Inside				
Outside				
Outside, Exposed				
Outside, Shielded				
Truck				
Intensity				
Overall		.3170 (S = .026)		
Inside	.3790 (S = .050)	.3194 (S = .025)		
Outside				
Outside, Exposed				
Outside, Shielded				

Statistical Test: Correlations with age: Pearson's rho/Correlations with income: Kendall's tau (significance level).

[a] For correlations from combining all sites see Appendix D.

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