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ANNOYANCE CAUSED BY ROAD TRAFFIC NOISE

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A large scale survey dealing with annoyance caused by road traffic noise was carried out in Antwerp, Belgium. In the first part of this study some general aspects of the survey are presented, and the relationship between mean annoyance scores and noise is discussed. The second part examines the relationship between individual annoyance scores and noise levels and the influence of personality variables, the lay-out of the residence, sensitivity to noise and some demographical variables upon this relationship. Finally, the findings of this research are compared with results of other studies.

In 1975 and 1976 a large scale survey dealing with annoyance, caused by traffic noise was carried out on residents of forty streets in Antwerp, Belgium. The first part of this study deals with some general aspects of this survey; in the second part the relationship between individual annoyance scores and noise, and the variables that significantly affect this relationship will be discussed.

GENERAL ASPECTS OF THE SURVEY

METHOD

The names and addresses of all residents involved were obtained from the city administration and an invitation for participation was mailed to every household explaining the purpose and the design of the research. It was our intention to interrogate at least 25 subjects per street. This number was reached in 39 out of a total of 40 streets after mailing a second letter, again urging participation and, when this second mailing failed, by ringing the bell of every house. In this way, contact was established with 9,386 residents, of which 1,412 (15%) replied to our letter and 1,279 (13.6%) were actually questioned.

The measurements of traffic noise were carried out by the Laboratory for Accoustics and Thermal Conductivity of the Catholic University of Leuven. At each site a microphone (Bruel & Kjaer type 4161) was placed 1.5 meters above the ground on the edge of the sidewalk. The signal was conducted through an amplifier (B & K type 2608) to a level recorder (B & K type 2307), which in turn was connected to statistical analysers (B & K type 4420) sampling at a rate of one tenth of a second into 2dB (A) classes. Every ten minutes a picture of the counters was taken automatically. In the laboratory, the exact position of the counters was fed into a computer in order to calculate the noise indices. The measurement period was 24 hours at every measuring point.

In the abundant literature on noise, many noise parameters are

TAB. 1. L_{10}, L_{50} AND L_{eq} IN THE DIFFERENT STREETS DURING THE DAY (07:00-19:00) AND THE NIGHT (23:00-07:00)

street	L_{10}Day	L_{10}Night	L_{50}Day	L_{50}Night	L_{eq}Day	L_{eq}Night
01	67.7	50.3	55.5	43.2	66.4	53.5
02	68.5	54.0	58.7	43.0	66.3	56.0
03	67.2	—	55.4	—	64.9	—
04	77.0	70.4	70.5	55.5	73.9	65.9
05	70.7	51.4	55.8	44.6	68.0	56.7
06	63.2	52.1	55.0	44.1	63.3	50.9
07	71.5	55.4	61.5	47.1	68.9	56.9
08	77.7	68.0	69.9	53.3	73.9	66.1
09	76.5	63.7	66.5	52.1	73.3	63.2
10	67.1	—	55.3	—	65.5	—
11	69.4	54.8	58.2	44.2	68.1	57.1
12	65.5	48.0	55.5	38.0	64.3	52.0
13	76.8	67.2	70.0	48.6	73.8	64.4
14	74.6	59.6	64.9	48.6	71.9	61.7
15	73.5	55.3	60.6	43.7	70.6	58.0
16	69.1	50.2	56.0	43.0	66.2	53.0
17	63.6	48.2	50.9	40.2	63.2	50.1
18	77.4	65.0	69.3	53.0	74.1	64.0
19	78.6	59.3	69.1	39.5	74.4	60.9
20	65.1	52.0	54.4	41.0	64.4	55.0
21	77.9	67.6	70.7	51.4	74.4	65.3
22	76.9	68.0	69.7	56.0	73.6	66.0
23	78.0	69.8	72.5	57.0	75.3	66.7
24	79.8	74.4	72.6	53.9	76.1	70.8
25	79.5	72.0	72.5	61.0	76.3	69.0
26	71.6	52.3	58.8	44.5	68.0	56.8
27	79.5	68.6	68.6	48.5	75.1	66.9
28	75.8	64.1	66.3	45.4	72.6	63.5
29	69.6	61.5	60.7	52.7	67.0	62.6
30	75.6	65.6	67.7	47.5	72.5	64.4
31	77.5	68.6	69.2	56.1	74.6	66.8
32	74.4	62.6	64.3	47.2	71.0	63.3
33	72.7	62.6	62.6	47.1	69.7	62.0
34	74.7	68.8	67.6	54.4	71.2	64.9
35	74.8	66.0	66.8	55.0	71.3	65.0
36	63.9	54.3	54.2	45.5	64.2	52.9
37	77.8	65.5	68.2	49.2	74.7	64.7
38	81.7	64.5	72.4	46.9	77.3	65.8
39	78.2	71.0	70.8	53.6	74.6	67.7
40	76.3	71.7	69.9	53.6	73.0	67.6

described (Kryter 1970). For this study only those three are selected (L_{10}, L_{50} and L_{eq}) which show the best relationship with traffic noise annoyance as proven by several specific studies on this topic (Aubree et al. 1973; Langdon et al. 1976; Rylander et al. 1976; Myncke et al 1977). L_{10} and L_{50} are the noise levels exceeded 10% or 50% of the time in

a given area. L_{eq}, or the equivalent continuous noise level, indicates how loud a continuous sound should be to reach the same energy as the fluctuating traffic noise.

In Table 1, values of L_{10}, L_{50} and L_{eq} are shown as they were calculated for the different streets during day (07:00-19:00) and night periods (23:00-07:00).

THE QUESTIONNAIRE

The questionnaire used in examining the residents during interviews at their homes was based on a previous version, designed for a survey in Leuven (Belgium) and reported earlier in Gambart et al., 1976. A factor analysis on the Leuven data yielded four factors: 1. Disturbance of diurnal activities by traffic noise; 2. Satisfaction with the environment; 3. General statements on traffic noise; 4. Nocturnal disturbance.

Questions that failed to reach a loading higher than .500 on one of the four factors were omitted for the Antwerp survey. Five new questions on the influence of the traffic noise upon perceived health were added.

The final questionnaire consisted of 70 questions; 49 questions dealt with matters such as annoyance caused by traffic noise during day and night, general satisfaction with the environment, general opinions on traffic noise, and perceived health. The subject had to answer these questions on bipolar scales having short phrases at their extremities as in the following example:

Not disturbing at all Very disturbing

The remaining questions solicited biographical or other relevant information such as whether the subject has a television, or whether his bedroom is near the street.

THE REPRESENTATIVENESS OF THE SAMPLE

It was pointed out above that residents were to a large extent free to decide whether they would cooperate or not. Moreover, they knew the topic of the research from the letter mailed to them. The question remains whether the decision to co-operate, is related to the variables under research: It might be that only highly annoyed residents tend to cooperate. However, some data are available to show that this is not true:

1. For control purposes the survey was carried out in two streets where the residents were not previously informed: the interviewers simply went from door to door. This method resulted in a higher percentage of participants (57% and 45%, respectively instead of 15%) and their mean annoyance score was higher than that obtained from the participants of the survey in a similar noise environment.
2. If only highly annoyed subjects had cooperated, a significant relationship should be obtained between the percentage of participants

and the noise levels. The correlation between the percentage of replies to a. the first letter and $L_{eq(Day)}$: 0.05 (40 streets). b. the first letter and $L_{eq(Night)}$: 0.02 (40 streets). c. the second letter and $L_{eq(Day)}$: 0.21 (20 streets). d. the second letter and $L_{eq(Night)}$: 0.15 (19 streets). Some of these correlations are significant.

3. If only highly annoyed subjects fill in the questionnaire, no significant correlation would be obtained between noise levels and annoyance, since everyone would pretend to suffer the same high annoyance.
4. Our selection procedure of participants, however, had a definite influence upon the socio-economical variables of the sample. A comparison with data on the total city population provided by the Belgian National Institute for Statistics shows that, in our sample, the following biases are present:
   a. Too few subjects younger than thirty five, and too many older than forty years cooperate ($p < 0.001$);
   b. Too few single persons are included in the sample ($p < 0.001$);
   c. Highly educated subjects cooperate more than others ($p < 0.001$);
   d. The proportion between the number of men and women has been respected.

It is important to note that a survey is in fact a rather poor investigation method, although its application is necessary in research topics as the one covered here. But the question remains unresolved whether some demographical subgroups of the sample cooperate more because they are more annoyed or because they are more inclined to cooperate. With this type of research, it is also difficult to distinguish the cognitive, emotional and behavioral component of the attitude, although this might influence the results.

CORRELATIONS BETWEEN QUESTIONNAIRE SCORES AND NOISE LEVELS

In Table 2, correlations are shown between the mean questionnaire scores and L_{10}, L_{50} and L_{eq} for the day, except for the questions dealing with nocturnal disturbance (questions 6, 22, 23, 24, 25, 26, 31D, 31E, 31F and 32, all marked with *) where the same noise units for the night were used. The content of the questions is briefly mentioned in Table 2.

Table 2 shows that high correlation coefficients are obtained for questions concerning the disturbance caused by traffic noise of specific activities during the day. The correlation between the annoyance level when reading a book in a room facing the street while the windows are open, and L_{eq} is 0.89, while this correlation is 0.80 when the windows are closed. Interference with radio and television when windows are left open shows correlations of 0.88 and 0.87. The relationship between traffic noise and problems at the telephone is only 0.68, probably because in many residences the telephone is placed in rooms not facing the street.

TAB. 2. CORRELATIONS BETWEEN MEAN QUESTIONNAIRE SCORES PER NEIGHBOURHOOD AND L_{10}, L_{50} AND L_{eq}

question	L_{10}	L_{50}	L_{eq}	content of the question
5	0.78	0.80	0.80	Opinion about traffic noise during the day.
6*	0.57	0.59	0.61	Opinion about traffic noise during the night.
7	0.89	0.87	0.89	Reading in a room facing the street, windows open.
8	0.80	0.78	0.80	Reading in a room facing the street, windows closed.
11	0.87	0.88	0.88	Listening to the radio, windows open.
12	0.80	0.83	0.81	Listening to the radio, windows closed.
15	0.86	0.88	0.87	Watching television, windows open.
16	0.77	0.79	0.78	Watching television, windows closed.
17	0.75	0.78	0.78	Annoyance when there are guests.
18	0.74	0.79	0.76	Annoyance when having dinner.
19	0.66	0.68	0.68	Annoyance when telephoning.
22*	0.47	0.34	0.48	Difficulties with falling asleep.
23*	0.55	0.49	0.56	Annoyance when falling asleep.
24*	0.40	0.38	0.40	Waking up during the night due to traffic noise.
25*	0.49	0.41	0.46	Abrupt waking up during the night.
26*	0.53	0.45	0.51	Waking too early in the morning.
28	0.39	0.46	0.39	Satisfaction with the neighborhood.
29A	−0.27	−0.26	−0.23	Damage to the human organism due to noise.
29B	−0.09	−0.09	−0.06	Use of tranquilizers as related to noise levels.
29C	0.13	0.10	0.13	Imperceptible influence of noise on people.
29D	0.05	0.01	0.06	Nervous reactions as related to noise levels.
30	0.74	0.78	0.77	Rated disturbance by noise during the day.
31A	0.54	0.53	0.53	To what extent does the subject become oblivious to noise levels when reading.
31B	0.63	0.61	0.62	To what extent does the subject become oblivious to noise levels when listening to the radio.
31C	0.59	0.57	0.59	To what extent does the subject become oblivious to noise levels when having dinner.
31D*	0.24	0.31	0.27	To what extent does the subject become oblivious to noise levels when falling asleep.
31E*	0.18	0.21	0.21	To what extent does the subject become oblivious to noise levels when sleeping.
31F*	0.25	0.32	0.27	To what extent does the subject become oblivious to noise levels when waking.
31G	0.62	0.61	0.63	To what extent does the subject become oblivious to noise levels when watching television.
32*	0.59	0.32	0.60	Rated disturbance by noise at night.
33	0.76	0.78	0.78	Rated disturbance 24-hour-period.
34	0.68	0.71	0.69	Intention to move into another house.
35	0.37	0.43	0.38	Do you enjoy living here?
36	0.58	0.63	0.60	Do you prefer a previous residence?
37A	0.54	0.61	0.56	Are you satisfied with the public services?
37B	0.00	0.03	0.03	Are you satisfied with the shops?
37C	0.20	0.20	0.20	Are you satisfied with the doctors?
37D	0.53	0.51	0.52	Are you satisfied with the noise in the dwelling?
37E	−0.06	−0.11	−0.07	Are you satisfied with the recreation?
41	0.50	0.49	0.50	I don't feel fit because of traffic noise.
42	0.56	0.57	0.56	Traffic noise irritates me.
43	0.41	0.42	0.39	I have headaches because of traffic noise.
44	0.46	0.45	0.45	I get more tired because of traffic noise.
45	0.53	0.51	0.53	Without traffic noise I would feel more relaxed.
48	0.17	0.19	0.19	Are you concerned about the situation in the future?

Among the questions on nocturnal disturbance, the highest correlation is found for difficulties with falling asleep insofar as they are due to traffic noise ($r = 0.56$). Specific disturbances during the night yield lower correlations ($r = 0.40$ and 0.46).

The correlation between expressing the wish to move into another more quiet residence and the noise level is also relatively high: $r = 0.69$. The answer to the question whether the subject preferred his previous residence seems to be related to the actual noise level ($r = 0.60$). If the subject is asked in a more general way to what extent he enjoys living in his current residence, the answer is obviously determined by other factors than noise: the correlation is only 0.38.

It may be noted that the answer to a general question, asked before the disturbance of specific activities was mentioned, correlated fairly well with the noise measures. A correlation of 0.80 is obtained between L_{eq} and the mean answer on the question, "We would like to know your opinion about the traffic noise you hear in your residence during the day".

Finally, a moderate correlation is obtained between noise levels and subjective perceptions of health (correlations around 0.50 on questions 41-45).

THE RELATIONSHIP BETWEEN INDIVIDUAL ANNOYANCE AND NOISE LEVELS

INTRODUCTION

In all studies on the relationship between noise levels and annoyance, a fairly strong relation is found when the correlations are based on mean or median annoyance scores per area. This same correlation, however, considerably decreases when individual annoyance scores are used. It is our purpose to discuss this phenomenon.

During the survey many data were gathered reflecting variables which might affect the individual annoyance experience. A first series of data were obtained from the personality questionnaires that were presented to all subjects (Amsterdam Biographical Questionnaire of Wilde). This instrument provides scores for neurotic potential (N), neurotic potential manifested in somatic and functional complaints (NS), social extroversion (E), test attitude (T), masculinity-feminity (MF), the tendency to answer questions in a popular way (V_{ja}, V_{nee}, V_{tot}), the tendency to answer questions in a socially desirable way (SW), and the tendency to leave questions unanswered (question-mark-score). This questionnaire was correctly filled in and remailed to the researchers by 1,110 out of 1,279 subjects or 86.8%.

The questionnaire dealing with annoyance caused by traffic noise also contained different variables supposed to be related to annoyance. In this way it was determined during which periods of the day and the night the subjects were at home, how many rooms and windows were facing the street, and whether radios and televisions were placed in the front room of the building. The subjects were also asked for their

opinion regarding general statements about traffic noise and about its influence on their health. They rated their sensitivity to noise, and expressed how concerned they were about noise problems in the future. Finally the researchers had at their disposal the following biographical data: age, sex, educational level, and marital status. They knew for every subject whether he or she owned or rented his or her residence and what type of dwelling it was.

INFLUENCE OF THE LAY-OUT OF THE RESIDENCE

In a first analysis of the data, it was important to know if the subject's living rooms or bedrooms were in the front rooms of the building. For this purpose the total group was split up in two ways: A first subdivision was made between 617 subjects who had their radio and television in the front rooms and 493 subjects having their radio and television at the rear of the house; another subdivision was made between 434 subjects who slept in front rooms and 676 subjects sleeping in the rear of the house.

The annoyance score for every subject was his or her mean answer on questions that dealt most with annoyance during the day or during the

TAB. 3. CORRELATION BETWEEN INDIVIDUAL DIURNAL ANNOYANCE AND L_{10}, L_{50} AND L_{eq} IN THE GROUP WITH RADIO AND TELEVISION IN THE FRONT ROOMS (group 1) OR AT THE REAR OF THE BUILDING (group 2)

	group 1	group 2
L_{10} Day	0.47	0.26
L_{50} Day	0.47	0.28
L_{eq} Day	0.48	0.27

night, as was calculated in a factor analysis. For diurnal annoyance, the questions numbered 5, 7, 8, 11, 12, 15 and 16 in Table 2 were taken into account, and for nocturnal annoyance questions 6, 22, 23, 24, 25, 26 and 32 were considered.

Table 3 shows that, in the group of subjects having radio and television in the front rooms, correlations are significantly higher than in the group which spent their waking hours in the rear ($p < 0.001$, Fisher's z-test). Similar results were obtained for nocturnal annoyance

TAB. 4. CORRELATIONS BETWEEN INDIVIDUAL NOCTURNAL ANNOYANCE AND L_{10}, L_{50} AND L_{eq} FOR SUBJECTS SLEEPING IN THE FRONT ROOMS (group 3) OR AT THE REAR OF THE DWELLING (group 4)

	group 3	group 4
L_{10} Night	0.29	0.20
L_{50} Night	0.23	0.18
L_{eq} Night	0.30	0.19

(Table 4). In Table 4, only the difference between the correlation with L_{eq}, is significant ($p < 0.05$).

It may be concluded that the lay-out of the residence has an important influence upon the relationship between individual annoyance and noise parameters. It was decided, therefore, to make further calculations separately for subjects living in the front rooms during the day, for subjects sleeping in a room facing the street, and, finally, for all subjects, irrespective of the outlook of their residence.

RELEVANCE OF OTHER VARIABLES

In order to reach clear conclusions, further analyses have been performed on variables showing a significant correlation with annoyance but failing to relate significantly to noise levels.

For this reason, the correlation with annoyance and noise levels was calculated separately for different groups for all variables enumerated in the introduction of this part.

The personality questionnaire scores for social extroversion, test attitude, and the tendency to answer questions in a popular or socially desirable way were not selected because they failed to show a significant relationship with annoyance. This was also true for the period of the day during which the subject was at home and for his level of education.

Further calculations revealed that the proportion of windows facing the street could not be used since this proportion significantly increased with noise levels ($p < 0.05$), probably because of the presence of more apartment buildings in noisy environments ($p < 0.001$). Consequently, an important result of the study of Aubrée et al. (1973), showing that the proportion of rooms in the front part of the building significantly strengthened the relationship between annoyance and noise levels, could not be verified. The age of the participants also correlated significantly with noise, suggesting that older residents remain in busier neighbourhoods while younger people tend to move away ($p < 0.001$). There was no significant correlation between age and noise for subjects sleeping in front rooms. It was also obvious that a significantly greater proportion of owners live in their own houses if they are situated in quieter neighbourhoods ($p < 0.001$).

MULTIPLE CORRELATIONS

In this section four multiple correlation coefficients will be discussed.

The multiple correlations were obtained by means of a computer program for stepwise building up multiple regression equations. First, the variable showing the best correlation with the annoyance data under investigation is selected. Further the β-value of every remaining variable is calculated assuming that it too would be selected. An F-test shows which β-values are significantly different from zero. The variable with the highest F-value is selected for the multiple regression, and a new multiple correlation is calculated. This procedure is repeated until all variables appear in the multiple regression equation or until no further

β-coefficients significantly different from zero are left (criterion: $p \leq 0.05$).

Diurnal annoyance and noise and other variables for the total group: In the first step of the calculations, $L_{eq\ Day}$ is chosen. The correlation with the annoyance data is 0.479. Next selected is question 48: "How concerned are you about a possible noise increase in the future?" suggesting that persons concerned about the future situation are more annoyed irrespective of the actual noise level. The multiple correlation is 0.555. Question 46 — "How sensitive are you to noise?" — is the

TAB. 5. MULTIPLE CORRELATION (R) BETWEEN DIURNAL ANNOYANCE AND NOISE AND OTHER VARIABLES FOR THE TOTAL GROUP

variable		R	R^2
step 1	$L_{eq\ Day}$	0.479	0.229
step 2	+ concern future	0.555	0.308
step 3	+ noise sensitivity	0.565	0.319

last variable reaching a significant β-coefficient in the multiple regression. The multiple correlation increases slightly to 0.565. Table 5 is a schematic representation of the different steps in the calculations.

Diurnal annoyance and noise and other variables for subjects having radio and television in the front rooms: The same variables are selected for the multiple regression equation in this subgroup as for the total group. The multiple correlation coefficients, however, are higher. The corre-

TAB. 6. MULTIPLE CORRELATION (R) BETWEEN DIURNAL ANNOYANCE AND NOISE AND OTHER VARIABLES FOR THE SUBGROUP WITH RECEIVING SETS IN THE FRONT ROOMS OF THE BUILDING

variable		R	R^2
step 1	$L_{eq\ Day}$	0.511	0.261
step 2	+ concern future	0.591	0.349
step 3	+ noise sensitivity	0.608	0.370

lation between $L_{eq\ Day}$ and diurnal annoyance becomes 0.511. Taking into account the subject's concern about a future noise increase and his sensitivity to noise yields multiple correlation coefficients of 0.591 and 0.608 respectively (see Table 6).

Nocturnal annoyance and noise and other variables for the total group: It is interesting to note that in the first step the sensitivity to noise ($r = 0.224$) is selected instead of the noise level, which appears in the second place ($R = 0.306$). For the variables of masculinity-feminity (MF), marital status and concern about a future noise increase, significant β-coefficients are obtained in the following steps, resulting in a multiple correlation of 0.384.

The MF-score correlates negatively with nocturnal annoyance ($r = -0.20$; $p < 0.001$) suggesting that people with more feminine response patterns show a significant tendency to be more annoyed.

TAB. 7. CONTINGENCY TABLE: DISTRIBUTION OF THE SUBJECTS ON THE VARIABLES OF NOCTURNAL DISTURBANCE AND MARITAL STATUS

	nocturnal annoyance			
	group 1	group 2	group 3	total
maried	32.9	34.0	33.1	65.2
single	36.6	36.6	26.9	28.6
divorced	34.6	19.2	46.2	2.4
widow(er)	7.3	31.7	61.0	3.8
total	33.0	34.3	32.7	100.0

A contingency table shows the relationship between nocturnal disturbance and marital status (see Table 7). The annoyance scores were divided into three groups: the first group consisted of the 33% lowest scores, the third group of the 33% highest scores, and the second group is composed of the 33% scores in between. In this way it is possible to check the distribution of married, single, divorced and widowed subjects over these three categories (in Table 7 only percentages are used for reasons of clarity). On the data in Table 7, $\chi^2 = 26.4$ ($p = 0.0002$). The contingency coefficient is 0.155. This highly

TAB. 8. MULTIPLE CORRELATIONS (R) BETWEEN NOCTURNAL ANNOYANCE AND NOISE AND OTHER VARIABLES FOR THE TOTAL SAMPLE

variable		R	R^2
step 1	noise sensitivity	0.224	0.050
step 2	+ $L_{eq\ Night}$	0.306	0.093
step 3	+ MF-score	0.338	0.114
step 4	+ marital status	0.368	0.135
step 5	+ concern future	0.384	0.148

significant value is explained by the strong representation of divorced subjects and widow(er)s in the group with high annoyance scores. Table 8 shows the multiple correlation coefficients in the five subsequent steps of the calculations.

Nocturnal annoyance and noise and other variables for subjects sleeping in the front rooms: In this subgroup, the sensitivity to noise is also the highest correlating variable with nocturnal annoyance ($r = 0.334$). The second variable, $L_{eq\ Night}$, increases the correlation to 0.465. The third variable in the multiple regression is the age of the subjects: older people seem to be more annoyed at night by traffic noise. The multiple correlation coefficient reaches a level of 0.542 after the addition of neurotic potential and the sex of the subject. The positive correlations

TAB. 9. MULTIPLE CORRELATIONS (R) BETWEEN NOCTURNAL ANNOYANCE AND NOISE AND OTHER VARIABLES FOR THE GROUP OF SUBJECTS SLEEPING IN FRONT ROOMS

	variable	R	R^2
step 1	noise sensitivity	0.334	0.112
step 2	+ $L_{eq\ Night}$	0.465	0.216
step 3	+ age	0.513	0.263
step 4	+ neurotic potential	0.535	0.286
step 5	+ sex	0.542	0.294

of these last two variables with nocturnal annoyance shows that potentially neurotic subjects are more annoyed and that women are more sensitive to noise than men. Table 9 is a synopsis of the different multiple correlations obtained in the subgroup of subjects sleeping in front rooms.

DISCUSSION AND CONCLUSIONS

It is clear that the lay-out of the dwelling has an important influence on individual annoyance. The correlation between diurnal annoyance and $L_{eq\ Day}$ is almost twice as high in the subgroup of subjects who have radios and televisions in front rooms, in comparison with the subgroup who arranged their residences in other ways. Better results are also obtained for nocturnal disturbance if only the data of subjects sleeping in rooms facing the street are taken into account. However, this increase is not very significant. A similar result has been obtained by Langdon and Buller (1977), who obtained a correlation of 0.82 between noise levels and the percentage of subjects sleeping with closed windows in the summer in the subgroup of residents sleeping in the front rooms; this correlation was 0.32 for subjects sleeping at the rear.

A personality questionnaire does not provide interesting information for this kind of research. Diurnal annoyance shows little correlation with personality variables. A closer investigation of nocturnal annoyance however shows that neurosis prone subjects are more likely to be disturbed at night (in the subsample sleeping in front rooms). In the total sample it was found that people have a tendency to become more annoyed at night insofar as their response pattern is more feminine. Further research is needed, however, to confirm these results. Griffiths and Delauzun (1977) for example, found no relationship between annoyance and personality characteristics.

Little evidence can be found to prove the importance of demographical or biographical data. Educational level fails to reach significant correlation with annoyance. Sex and marital status are of small importance for the prediction of nocturnal annoyance. Other biographical data correlate significantly with annoyance but show an even higher correlation with the noise parameter. Consequently, the relationship with annoyance could find its origin in the correlation with noise.

Noise level is the most important predictor of diurnal annoyance. Concern with the future situation and noise sensitivity explains another 10% of the variance in individual annoyance. Langdon (1976) and Griffiths and Delauzun (1977) have also pointed out the importance of noise sensitivity.

An important result is obtained for nocturnal annoyance: as in the study of Langdon and Buller (1977), sensitivity to noise is a better predictor of nocturnal disturbance than the noise level. Age is probably also an important variable, but this could not be verified in a satisfying way because of the significant correlation between age and noise levels in different subsamples. The other variables in the multiple regression equations for nocturnal annoyance differ in the two groups under investigation, making any generalization impossible.

It may be important, however, to note the presence of the variable of sex or a connected variable (the masculinity-feminity score) in the two equations for nocturnal annoyance. Women seem to be more susceptible to noise annoyance. Langdon and Buller (1977) have been able to throw light upon the importance of age and sex for nocturnal disturbance by using a different method (Automatic Interaction Detector).

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