NASA TECHNICAL MEMORAND""" NASA TM-75492

NASA-TM-75492 19850011234

CONSTRUCTION AND APPLICATION OF A QUESTIONNAIRE FOR THE SOCIAL SCIENTIFIC INVESTIGATION OF ENVIRONMENTAL NOISE EFFECTS

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Translation of: "Konstruktion und Anwendung eines Fragebofens zur sozialwissenschaftlichen Untersuchung der Auswirkungen von Umweltarm," Zeitschrift fur Sozialpsychologie, Vol. 9, 1978, pp. 50-65.

NATIONAL AERONAUTICS AND SPACE ADMINSITRATION
WASHINGTON, D.C. MAY 1980

STANDARD TITLE PAGE

1. Report No. NASA TM-75492	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Construction and Application of a Questionnaire for the Social Scientific Investigation of Environmental Noise Effects		5. Report Date May 1980
		6. Performing Organization Code
7. Author(s) R. Guski, U. Wichmann, B. Rohrmann & H.O. Finke		8. Performing Organization Report No.
		10. Work Unit No.
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, Ca. 94063		11. Contract or Grant No. NASw-3199
		13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Konstruktion und Anwendung eines Fragebogens zur sozialwissenschaftlichen Untersuchung der Auswirkung von Umweltlärm," Zeitschrift für Sozialpsychologie, Vol. 9, 1978, pp. 50-65.

16. Abstract

A social psychological questionnaire has been developed to study the effects of environmental noise and was applied to 636 people living in 19 different areas of Hamburg. The theoretical foundations and the statistical means employed in its development are described. Four main reactions to noise are isolated statistically, and it is determined that these are moderated by several intervening variables, chief of which are coping capacity for noise, the perceived dangerousness of the noise source, other daily loads and the individual's lability.

17. Key Words (Selected by Author(s)) Noise effects; questionaire construction; environmental stress; field study	18. Distribution Statement Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	29	

N80-27835#

NASA-HQ

Construction and Application of a Questionnaire for the Social Scientific Investigation of Environmental Noise Effects

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Introduction

The social psychological field studies published to date dealing /50* with the effects of environmental noise (chiefly airplane and traffic noise) on people have emphasized that annoyance and disruption of communication functions (conversation, radio, t.v.) are viewed as the two major effects of noise. They are major effects in that, of the variables considered, these disturbances correlated highest with the physical paramaters of the noise burden (see BORSKY 1954; McKENNELL & HUNT 1966; BOLT, BERANEK & NEWMAN 1967; TRACOR INC. 1970; AUBREE et al. 1971; GALLOWAY & JONES 1973; GRIFFITHS & LANGDON 1968; GRAF et al. 1973; SCHÜMERKOHRS & SCHÜMER 1974; JENKINS et al. 1974; RELSTER 1975; LANGDON 1975, 1976a, 1976b; RUCKER 1975; ROHRMANN 1976; BUCHTA & KASTKA 1977; LANGDON 1975 summarized; ROHRMANN et al. 1978). Nevertheless, the variance amongst individuals with regard to these and other effects of environmental noise is exceptionally large, being determined on the average only 10 to 35 percent by the degree of noise burden. Roughly one-third of the variance can be explained by a series of factors called "moderators". Referred to are influences acting as contributory determinants to the quality and degree of noise effects, without themselves being determined by the degree of the noise strain (e.g. individual sensitivity to noise, advantages and disadvantages of the residential area, assessment of the noise source, etc.). Consequently, it is assumed that moderators correlate,as a rule, with reaction variables and not /51 with stimulus variables. In regression analysis terms, they should have high beta-weights in the prediction of reactions--in terms of the analysis of variance, they should lead to high levels of interaction (see GUSKI & ROHRMANN 1974). On the other hand, it is possible that certain variables are stimulus-dependent(e.g. feeling at the mercy of noise)

*Numbers in the margin indicate pagination in the foreign text but in turn moderate other reactions to sound (e.g. the annoyance experienced due to noise).

In order to thoroughly clarify the variability of environmental noise effects within the context of a social scientific investigation, a comprehensive, standardized interview for the determination of potential reactions to, and moderators of, noise is indicated. Supplemental information regarding the living conditions of those questioned as well as the acoustical parameters of the setting is vital. Amongst other things, it is necessary for the subsequent control of demographic similarity within the subgroups of the total population ("control variables"). Equally important for stimuli is the utilization of an acoustical measurement technique permitting determination of the noise characteristics present at the time of the different investigations (For information on the methodological problems of questionnaire construction in the field of noise and noise effects, see LINDVALL & RADFORD 1973; ROHRMANN 1974 and the recommendations of The International Organization for Standardization ISO-TC43/SC1/W615 from 1975).

Those variables which can be considered REACTIONS in the sense of "attitudes and behavior patterns influenced by environmental noise" include:

- the spontaneous statement "Noise is a negative environmental factor"
- the rank of noise amongst negative environmental factors
- the perceived loudness of certain noise sources (e.g. trucks, cars, factories)
- anger about certain noise sources
- communication disturbances due to noise
- impedance of activities
- disturbance of rest, relaxation and sleep
- the experience of vegetative or somatic consequences of noise
- behavioral activities used to reduce noise (e.g. closing a window)
- anger regarding the consequences of noise
- physical measures to reduce noise (e.g. installing double-windows)
- social measures to reduce noise (e.g. filing complaints)
- considering moving out due to noise
- assessment of the total annoyance.

Since field study inquiry is relevant to the general strain and bother due to noise (and not for the assessment of an immediate incident of noise, as in an experiment), it deals with long-term, mediated reactions. The individual, partly cognitive, partly emotional aspects--perceptions, disturbances, assessments and behavioral means--form a negative general attitude ("Interference and Annoyance due to Noise").

The following entities are expected to moderate the effects of environmental noise, or explain individual variance in the reactions to like stimulus conditions:

- -perceived advantages of the residential area (e.g. proximity to work, shopping opportunities)
- -experienced advantages of the home (e.g. rent, comfort)
- -attitude towards technology and progress
- -the person's experience of his/her state of health
- -emotional or vegetative lability
- -general sensitivity to noise
- -capacity to cope with noise
- -environmental awareness
- -assessment of the noise source (advantages and disadvantages)
- -the resonant quality of the sound experienced (shrill, thudding, etc.)
- -beliefs regarding the harmfulness of environmental noise for health
- -level of daily strain experienced (e.g. time pressure)
- -location of the home relative to the noise source
- -hour of the noise incident.

The reactions listed above are "validated" in that they have been repeatedly investigated in international social science inquiries into the effects of environmental noise on daily life and, as a rule, have correlated significantly with its level (see LANGDON 1975; ROHRMANN 1977). Moderators of noise effects have been less frequently studied, but those which have been repeatedly tested include: /52

- -advantages of the home and residential area
- -attitude towards technology and progress
- -sensitivity to noise
- -location of the home relative to the noise source
- -assessment of the noise source

- state of health of the person being interviewed
- emotional or vegetative lability
- resonant quality of the sound
- beliefs regarding the harmfulness of environmental noise for health
- duration and time of the noise incident

(Besides those studies mentioned above, the following authors also discuss the influence of moderating variables: CEDERLOEF et al. 1967; FRANKEN & JONES 1969; ATHERLEY et al. 1970; ANDERSON 1971; SØRENSON 1971; BRYAN 1973; SCHÜMER 1974; GRAEVEN 1974; LAZARUS-MAINKA et al. 1976 and GUSKI 1976a).

To our knowledge, three further moderators have not been employed in field studies until now: "environmental awareness", "strain from other daily factors" and "coping capacity for noise".

Regarding "environmental awareness", it is common knowledge that, over the course of the last few years, thoughts to the protection of nature and the environment have assumed increasing importance in the population at large. We have assumed these ideas covary with a sensitization to harmful environmental effects, and thus also moderate the relationship between the degree of environmental encumberment and the reaction to it. ANDERSON (1971) posits a similar concept with his "social awareness of the noise problem", a construct independent of "personal sensitivity to noise" but working together to moderate noise reactions. We have therefore developed an environmental awareness scale, whose final form is presented as Factor 12 in Tab. 1.

The two other concepts, "perceived daily strain" and "coping capacity" originate in general psychological and psychophysiological stress research (see GUSKI 1976a; WICHMANN in press). With reference to the views of R.S. Lazarus and the Berkeley group, we see "stress" as an imbalance between the demands a situation poses to an individual and his reaction capacity (LAZARUS 1966; McGRATH 1970). Crucial for the question of whether an individual finds a noise burdensome or not is which behaviors or cognitive restructuring skills he possesses (e.g. if a person can signal his neighbor to lower his stereo in the evening by pounding on the heating pipes, he will tolerate that stereo longer than someone who has had no luck with such a technique). In applying this concept to laboratory noise research, GLASS & SINGER (summarized 1972) showed that direct effects or after effects of loud sounds were strongly moderated by their "predictability" and "potential for control" (directable; manipulable). Since environmental noise (from trains, cars, planes, factories) is, as a rule, predictable (since it is present the whole day through), we have concentrated on the control aspect and drafted questionnaire statements that express both cognitive and behavioral means for "manipulation" of noise (see Factor 9 in Tab. 1).

Furthermore, we have assumed that different (even qualitatively different) strains can add together and that a burden which could be adequately dealt with, as for example a moderately loud environmental noise, becomes a stress in the presence of another strain not sufficiently handled (as, for example, constant work overload). Therefore, we have constructed a statement block concerned with daily work-related and financial burdens (see Factors 6 and 10 in Tab. 1).

Operationalization in a Questionnaire /53

The first step in a field study of the effects of environmental noise was to formulate questions on aspects of the reaction- and moderator complexes. Utilizing an instruction manual, these were presented in a pilot study to 30 persons in different residential areas exposed to noise. Following a rough analysis of these interviews (which were stored on tape), systematic content analysis of noise complaints filed with public agencies and the perusal of questionnaires already constructed for the study of noise, a total of 382 items were formulated as a prototype of the questionnaire. Some of the items were in the form of open-ended questions, but most were in the form of intensity-, frequency- and agreement scales with five stepped-responses(ROHRMANN, in preparation). Fourty persons took part in the pilot study, representing 5 residential areas of Hamburg burdened with noise, some being exposed to two forms of noise pollution (e.g. traffic and train noise). Statistical item-analysis and practical interview experience led to a reduction and revision of the questions, so that, in the main study, a form with 87 questions (roughly 270 items plus 20 additional assessments made by the interviewer) was presented to 636 people living in 19 different residential areas of Hamburg. The areas investigated included those exposed purely to traffic noise of varying intensity, areas with rail, industrial and construction noise, as well as sections exposed to combinations of these latter types with traffic noise.

Following are a few examples quoted from the questionnaire to give a feel for its character:

-Open-ended question: "Can you please list the external noises which impinge on your home?" Key words are noted by the interviewer and the answer is coded later according to empirical criteria.

-Qualitative alternatives: The interviewer presents the person with a list of possible answers, e.g.

schreeching brakes (1)
loud acceleration from a stop (2)
an engine starting up (3)
loud mopeds/motorcycles (4)
cars accelerating from an intersection (5), etc.

and asks: "Which of the items from this list of possible traffic noises bothers you the most here in the home?" The answer is noted as the number of the questionnaire alternative.

-Ranking process. The interviewer gives the person a list, e.g.

polluted air
ugly houses
too much noise
unpleasant smells

and says: "I have a list here of problems for which complaints are received. Please tell me which one is the most noxious and disturbing for you here in the home." This answer receives the code 1, second and third place being ascertained later.

-Dichotomous answers: "Have you ever contemplated moving out of this area because of noise?" The answer (Yes/No) is recorded as a 0 or 1 in the questionnaire.

-Five step intensity scales. This--as well as the following scales--stems from a supplemental psychometric study (ROHRMANN, in preparation) and is the most frequently used form of question. Example: "Considering the aforementioned disturbances, all in all, how angry are you about traffic noise?" A differently colored card denotes each of the five answers (1) not at all (2) a little (3) moderately (4) rather (5) very.

-Five step frequency scale. Example: "How often do you turn up the t.v. or radio because of the noise level here?" The answers (1)never (2) seldom (3)occasionally (4) often and (5) always are likewise color-coded.

-Five step agreement scale. Example: "Here is a list of answers from /54 an earlier questionnaire designed to ascertain people's reactions to specific noises. Using this scale, please tell me whether you agree with the following not at all, a little, moderately, rather or strongly:

Continual typewriter noise gets on my nerves.

The sound of a schreeching train can irritate me.

Again, reference is made constantly to the five alternatives available.

The use of this form of answer scale (whose verbal gradations were tested for subjective equidistance) is intended to facilitate differentiated responses from the interviewee and to increase the data fit for parametric analysis.

Construction of the Questionnaire

The questionnaire items are ordered in such a way that, at first, the purpose of the interview remains equivocal to the interviewee. This is done in order to illicit the most spontaneous listing of noise problems according to this individual. Initially, data regarding the living situation and assessment of the residential area is collected. The interviewer then goes into general environmental strains (partially through open-ended questions) before asking about the rank of noise as a disturbing factor in the living situation. The following aspects of the theme "environmental noise" are inquired about successively: "Type of noises impinging on the home", "The experienced loudness of these noises", "The effect of noise on household or free-time activities and well-being (for 15 noise effects, divided in each case according to type of noise, in case the residential area under consideration is exposed to two types of noise)", "The frequency of use of usual behaviors to deal with noise (e.g. close windows)", "Knowledge and rating of the authorities responsible for complaints", "Experiences with and prospects for complaints", "Assessment of the main noise sources (useful, necessary, dangerous, etc.)", "Time of the noise disturbance", "Rating of the noise problem relative to other daily strains" and "Shock from noise at work."

Interspaced with the different clusters of noise and environment questions are statement blocks, with 4 to 8 items each, designed to register personality traits and attitudes relevant to noise: "Attitude regarding technological progress", "Emotional lability", "Sensitivity to noise", "Coping capacity", "Environmental awareness", "Fears of health damage due to noise" and "Daily burdens". Gathered first at the end of the interview are demographic variables and control data, such as year of birth, socioeconomic status (separate values for interviewee and head of the household)and utilization of transportation, etc.

After concluding the interview, the interviewer uses a five-step intensity scale to rate additional aspects of the session. These include: the interviewee's willingness to participate, comprehension of the questions, time pressure, participation by a third party, suitability of the interviewee for further study, disruption of the interview by different types of sound and his impression of the noise burden on the individual.

In those areas exposed to only one type of noise or hardly any at all, the interviewer utilizes a shorter form of the questionnaire. For example, in quiet areas, the questions regarding behaviors used to deal with noise drop out. Likewise, in areas exposed to only one type of noise, the question blocks concerned with a second type of noise are deleted. These omissions naturally create missing-data problems, but are considered necessary to avoid boring the interviewee with irrelevant questions. In those areas with two types of noise, the question blocks /55
regarding traffic noise are presented first, followed by those relevant to other noise types (e.g. airplane, train, industry, factory noise). The responses of the interviewee are placed in the questionnaire sample provided for each individual, in boxes which are part of a punch card on the edge of the form--that is, the interviewer notes predominantly numbers which can be directly punched out.

Structural Analysis of Questionnaire Data

In August and September of 1976, 21 interviewers (mostly psychology, sociology and political science students with relevant interviewing experience and two days of special schooling) carried out the interviews. Addresses were culled from the sample study. The interview areas included four with traffic noise, areas with air traffic, street car, railway, industry, trade and construction noise, seven combining one of these special noises with traffic noise and two control areas free of noise burden. The completed questionnaires were checked and rechecked, when necessary, with further inquiries, while the open-ended questions were coded using a key based on the data of the first 80 interviews. The first set of punch cards was scrutinized for encoding and punching errors and the distribution characteristics of the variables was checked. It was discovered that only rarely did the frequency distribution correspond exactly to the normal distribution; combination of fringe categories in rare cases helped approximate the normal distribution.

The investigative plan and the initial descriptive analyses of data at this primary level are reported in FINKE, GUSKI and ROHRMANN (1977). We turn now to the description of a few of the analyses which have led to data at the secondary level.

The main modes of analysis employed were rank correlations, product-moment correlations, item analysis, cluster analysis and factor analysis. To begin with, it should be mentioned that, in spite of the obliqueness of the frequency distribution, the product-moment correlations did not differ substantially from the raw correlation coefficients. Cluster analysis on the basis of raw- and product-moment coefficients produced almost identical results. Furthermore, the coefficients of both methods were tested and found to be stable both for variation in subjects (determined in tests on two independent subgroups of the total population) and variation in distribution (through normalization of the distribution per the McCall-transformation). The discussion to follow is predicated on item-, cluster- and factor analysis based on product-moment correlations (using the formula, which in special cases identifies Phi and r_{pbi}). The variables were assumed to have inveral scale levels.

The apparently bimodal raw score distribution of responses to the question block dealing with attitudes relevant to noise (sensitivity to noise, coping capacity for noise, habituation to noise, health risks due to noise), prompted the positing of the hypothesis, the variables under consideration identified two groups who varied fundamentally in their attitudes about noise-one might call the first group "sensitive" and the other "robust" (or at least "not sensitive"). This hypothesis

was tested utilizing the summed distribution of the dichotomized variables lying at the median of the raw score distributions: the attitude variables in question were reduced to 0-1 scores and subsequently summed. If one axis of the raw score distribution is populated predominantly by "sensitive" people, the other side by "robust" persons, then the summed distribution of the (subsequently dichotomized) variables would also have to be bimodal, if the variables are intercorrelated (which is the case with our data). Checking the distribution of the summed scores /56
showed roughly normally distributed values, so we must assume that the hypothesis does not hold and that the deviations from a normal distribution are explained by another construct, if not purely chance phenomena. Moreover, phi-correlations between the dichotomized attitude variables showed no substantial deviations from the product-moment correlations on the untransformed, raw data.

Additionally, the issue was considered whether the style of the interviewer (measured by the length of his interviews) and his routine (measured by the number of interviews completed) tends to produce <u>response sets</u> with subjects, in terms of an inclination to choose a certain level of answer independent of question content. To this end, variables were generated (separately for the first and second half of the interview) indicating the frequency of "runs" of like answers, the number of middle-level answers as well as the number of extreme answers. However, these values did not correlate significantly with the interviewer data, so the hypothesis of response-sets induced by interviewer style was not confirmed.

In order to investigate the internal structure of the correlatable primary data set, cluster analyses using the B-coefficient method (FRUCHTER 1954) were carried out. Rank- and product-moment correlation matrices for 173 variables served as the foundation for these analyses.

The B-coefficient process is concerned, on the one hand, with the relationship of the correlations between the variables within a cluster and, on the other hand, with the variables outside the cluster. The criterion for cluster extension is relatively strict and was modified for the purpose of our analyses. To answer particular questions, specific item blocks were singled out for cluster analysis, again using both rank- and product-moment correlations. The stability of the cluster structures in the face of variations in sample composition was tested through repitition of the analysis on two indipendent smaples of the total group. Since the level of stability was not always satisfactory, factor analysis on the basis of normalized raw scores was instituted as a further control.

We hoped to receive information on the following three questions through structural analysis:

-Do the item blocks constructed for the measurement of personality and attitude variables turn out to be statistically consistent?

-Are there any items, which contrary to original design intent, integrate into new complexes?

-Is it possible to discover variables whose addition leads to meaningful and empirically-based secondary variables?

Using very strict criterion for the formation of variable-clusters, cluster analysis of all 173 correlatable variables produced 50 variable groups, which turned out to be smaller than intended. The cluster expansion criterion demanded that, before integrating a variable into a cluster, the B-coefficient value has to be at least 86% of its previous value. The 6 questions on "emotional -vegetative lability"split into two clusters (nervous/irritated--racing heart/difficulty falling asleep), which was also true of the questions regarding "sensitivity to noise" (loud radios/slamming doors/baying dogs--typewriters/screeching trains), "daily strain" (costs--time pressure) and "copting capacity for noise" (close windows--relax). Since the analysis contained numerous trivial variable groups and, moreover, because the discrimination level was appropriate for the questions on noise-related attitudes but insufficient for the marginal variables, the data set for the next structure analyses was reduced to those 74 variables in item blocks thematically related to the reaction- or moderator complexes. In order to diminish chance effects from distribution abnormalities, the variables were normalized through plane transformation.

Carrying out cluster analysis on the 74 variables in item blocks, /57 and varying the cut-off point for cluster formation in half-percent steps between 84% and 80.5%, yielded a structure of 21 to 24 essentially stable clusters. Utilizing a cut-off criterion of 80% yielded still only 4 clusters, whereby 65 variables were combined in one group.

Since this last solution was unsatisfactory from a content perspective, a comparison was made between the 21 stable clusters of the 80.5% solution and the 50 clusters of the first large analysis, although, in light of our needs for the reduction of the data set, they appeared too undifferentiated. Among other things, this comparison validated the consistency of the scales "Attitude towards technology and progress" and "Fears of health risks due to noise." With the exception of one, the six items regarging perceived "coping capacity for noise" constituted a cluster, while the items relevant to "sensitiviy to noise", "emotional-vegetative lability" and "daily strain" were again divided into two clusters.

Varying the method of factor analysis on the 74 normalized variables (e.g. main axis-/main component-/image solutions; different cutoff criteria fro factor extraction) produced quite varied solutions. For reasons of content, we opted for 16 VARIMAX-rotated factors, of which 14 could be interpreted. The smallest actual value was 1.11 and the factor structure remained adequately stable with variations in sample groups (two random splits). The factor structure deviated from the results of the cluster analysis thanks to the different levels of specificity involved, but agreed quite well with the hypotheses used to construct the item blocks. Following is a characterization of the interprable factors and the acronym assigned to each for the purpose of subsequent regression analysis:

1) STAK--Disturbance of Activities (communication, relaxation)
2) LABI--Vegetative Lability (satisfaction with one's state of health; all six lability items)
3) LEMF--Sensitivity to Noise (all six items, as well as habituation to noise)
4) TECH--Attitude towards Technology and Progress (all six items)
5) EINK--Satisfaction with Shopping and Transportation Alternatives
6) BELA--Experienced Daily Strain (time pressure;daily routine)
7) GESU--Beliefs regarding Health Risks due to Noise
8) IREV--Behaviors for Reducing Emissions (closing the window, etc.)
9) BEWA--Coping Capacity for Noise (five items)
10) KOST--Financial Burden Experienced Daily

11) VEGL--The Vegetative and Somatic Noise Effects Experienced
12) UMWE--Environmental Awareness (all four items)
13) WOHN--Satisfaction with the Home and Residential Area
14) LUEV--Behaviors for "Drowning Out" Noise

Together with information from the cluster analyses and retests, the 14 interprable factors were used as the basis for the formulation of secondary variables. Moreover, secondary variables were generated for the purpose of comparison with studies similar to this one (e.g. communications disturbances were separated from rest disturbances).

Initially, in the process of secondary variable construction, studies were undertaken to decide empirically on the most productive way to formulate them. In a series of regression analyses utilizing reaction variables as criteria and stimulus- and moderator variables as predictors, the following methods were compared with an eye to their predictive efficiency:

- Variables weighted according to hypothesis and summed
- Variables weighted according to commonality and summed
- Unweighted variables with factor loadings greater than 0.35 summed
- Unweighted variables with factor loadings greater than 0.50 summed /60
- Variables with factor loadings greater than 0.35 weighted and summed
- Variables with factor loadings greater than 0.50 weighted and summed
- "True" Varimax-rotated factor scores

Little difference was seen in the secondary data produced by these various forms of multiple regression, with one exception: as expected, the "true" factor scores did not correlate with each other at all or, for that matter, with any variables not directly involved in the factor analysis--such as the external value "the acoustical level of the residential area".

We opted for the process utilizing an unweighted additon of variables belonging to one factor theorectically and empirically, possessing a loading of at least 0.35 for that factor and falling predominantly in the same cluster when moderate cut-off points were used. Moreover, selectivity data was culled from item analysis as a further criterion for decisions. Further information was provided by three supplemental studies, with 30 to 50 persons from the total population participating in additional investigations and answering a few question blocks again. The reliability analyses for these questions showed quite good stability for "copting capacity", but poor stability for a few items in the block regarding "sensitivity to noise". The retest-coefficients ran anywhere from 0.00 (!) to 0.80, lying generally between 0.50 and 0.60. This appears small, but it must be remembered that the question context in the supplemental studies was different and, furthermore, only a portion of the questionnaire could be replicated. In constructing secondary variables according to the method outlined here, we chose only items with a reliability coefficient of at least 0.21.

One questionnaire subscale, excluded from the factor analysis results for reasons of lack of space, dealt with the assessment of noise sources as "useful"/"dangerous"/"interesting"/"necessary"/"typical for this area"/ and "unhealthy for residents". Item and cluster analysis produced two stable variable groups and we formulated two secondary variables from this scale, one of which proved to be useful in subsequent regression analysis: the unweighted sum of the answers "dangerous" and "unhealthy". This sum is included in the data set as "Risk of the Noise Source" (GESU).

As has already been mentioned, the interviewers omitted certain parts of the questionnaire (i.e. those items concerning coping with noise) in quiet areas (66 persons total). The secondary variable BEWA was determined for these people using a regression estimate (see GUSKI 1974), drawing on the fact that the correlation of this variable to others does not vary between the total population (N=636) and a sample (excluding quiet areas, N=570).

The Results of Multivariate Analysis on Secondary Data /61

After checking for a satisfactory normalcy of distribution, the 15 secondary variables were correlated with each other and the external acoustical level. The term "external acoustical level" used here is defined as the "average daily sound level" (LGTW). This value was determined through measurements (over a period of a week, 24 hours a day), with separate values for weekends and weekdays. The average sound level (average level according to DIN 45641) was calculated for day, evening and night hours. The value employed in this study is the level of sound encroaching on people living in area affected by two types of sound from the pool of traffic- and additional noises, between the hours of 6 a.m. and 6 p.m. on a weekday. In the 19 areas investigated, this value lay between 53 and 79 db. It is assumed that each of the roughly 30 persons living in the residential areas receives a like exposure to noise. However, in a few larger areas and in places where houses were located disadvantageously, subgroups were formed with different acoustical values. Supplementary measurements were made to correct these values. Since calculation of final acoustical values (specified for type of sound, time of day, weekend or weekday) is not yet completed, the level LGTW is a trial value and not final. Changes will probably fall in the direction of fewer dBs and we assume that the correlation coefficients considered here will not change substantially.

The matrix of intercorrelations between the 16 variables (15 secondary variables and the noise level) is presented in Tab. 2--for reasons of space, the correlation coefficients have been multiplied by 100. If one contemplates the level of covariance between variables, it becomes clear that "Disturbance of Activity" (STAK) and "Vegetative Noise Effects /62
Experienced" (VEGL) covary relatively strongly with other secondary variables; then come the variables "Daily Strain" (BELA), "Coping Capacity for Noise" (BEWA) and "Behavior for the Reduction of Emissions" (IREV). Those variables indicating living situation satisfaction showed the smallest covariation: "Satisfaction with Shopping Opportunities" (EINK), "Satisfaction with the Home" (WOHN) and "Environmental Awareness" (UMWE). The highest individual correlations exist between those variables which can be designated "reactions to noise", since they correlate simultaneously at a significant level with external acoustical values: between "Disturbance of Activities" (STAK) and "Vegetative Noise Effects Experienced" (VEGL) at r=0.59, "Disturbance of Activities" and "Behavior to Drown Out Noise" (LUEV) at r=0.55, "Disturbance of Activities" and "Behavior to Reduce Emissions" (IREV) at r=0.54 and "Behavior to Reduce Emissions" and "Vegetative Noise Effects Experienced" at r=0.45.

The main reactions to the daily level of environmental sound (LGTW) are: STAK at r=0.53, IREV at r=0.49, LUEV at r=0.35 and VEGL at r=0.33. It is certainly true that still other variables, such as BELA and WOHN, correlate significantly with the LGTW. However, because of their relatively small determination by noise and their hypothesized moderating character, they are not considered as reactions here. Together with those variables correlated even more weakly with the LGTW, we will investigate the degree to which, in linear combination with stimulus variables, they help to explain the variance of the four main reactions. It is assumed that moderators work at the stimulus level to "strengthen" or "weaken" the reaction (see GUSKI & ROHRMANN 1974).

Table 3 portrays the results of the multiple regression analysis carried out to this end. Comparision of the beta-weights indicates clearly that certain variables play a very subordinate roll in the explanation of reaction variance within the context of the remaining ones. Included are: "Sensitivity to Noise", "Satisfaction with Shopping Opportunities", "Environmental Awareness" and "Beliefs about Health Risks due to Noise". As expected, the most powerful predictor of the reaction to noise is the "degree of acoustical burden" (LGTW), followed by "Coping Capacity for Noise" (BEWA), the estimation of the "dangerousness" of the respective noise source (GEFA), the "Daily Financial Burden" (KOST), "Vegetative Lability" (LABI) and "Daily Strain" (BELA). Looking at the /63
strongest predictors, the beta-weight signs (and therefore the direction of variable effects) are constant for different reactions: the acoustical burden posed by the environment leads to increased "Disturbance of Activities", "Behavior to Reduce Noise Emissions", "Behavior to Drown Out Noise" and "Vegetative Lability Experienced." In the presence of higher "Coping Capacity for Noise", these four reactions become smaller. With a higher perceived level of "Dangerousness" of the noise source, they become greater. Likewise, this holds as "Daily Strain" increases.

Comparing the 4 reactions with an eye to the order of the beta-weights, it is apparent that "Vegetative Noise Reactions" (VEGL) are less strongly affected by the level of environmental noise than by the attribute "Vegetative Lability" (LABI). Furthermore, this reaction increases with decreased "Coping Capacity for Noise" (BEWA), with increased belief in the dangerousness of the noise source (GEFA) and with an increase in "Daily Strain" (BELA). In contrast, the more "concrete" (not somatic) reactions STAK, IREV and LUEV are hardly at all determined by the degree of "Vegetative Lability", but rather by the noise level itself and perceived "Coping Capacity for Noise."

Discussion of Results

Although the results presented here are not final because of the tentativeness of the acoustical values and the limitations on a few of the main variables, there are nonetheless some points which will weather the modification and extension of the data set and therefore warrant discussion. In concurrence with other environmental noise studies (a representative cross-section of which includes: McKENNELL 1963; TRACOR INC. 1970; GRAF et al. 1973 and the DFG Research Report "EFFECTS OF AIR TRAFFIC" 1974), we see the main effects as disturbance and impairment of communication and relaxation. In our analysis, these two effects covary so highly with each other that, in spite of content considerations, they could be combined into a sort of "global reaction". Similar to the aforementioned English and American studies, the assessment of the "Harmfulness" of a sound plays an important role as a moderator of these reactions. However, in contrast to other studies (e.g. the DFG project, in which three of the four authors of this report took part), "Sensitivity to Noise", "Satisfaction with Shopping Opportunities" & "Beliefs about the Health Risk due to Noise" played no significant role as predictors. In attempting to explain the differences between these two German environmental noise studies in the predictive power of these moderators for virtually identical reactions, one must heed two conceptual differences and one empirical divergence. The DFG project studied only one type of noise (we consider 7 types) and a choice of moderators not founded on stress theory (as described below, aours are so founded). The empirical difference lies chiefly in the reliability of the previous predictor "Sensitivity to Noise" (or "Robustness for Noise"): the scale was changed slightly from the previous studies and it achieved substantially poorer reliability. This can be traced either to an unsatisfactory operationalization of the variable or, at least, to one not adequately geared to those aspects of the variable relevant to traffic noise. Regarding the different ranking of the remaining moderators it is important to remember that the beta-weights in a regression equation are dependent in each case on the remaining variables in context with the value in question. Furthermore, in the present study, concepts were employed which, first of all, were not contained in the previous study and, secondly, were validated in the present study. The consequence of this validation might be a relatively smaller predictive power for the "old" variable. /64

The two concepts used for the first time in this study, and which were relatively well validated therein, are "Coping Capacity for Noise" and "Degree of Daily and Financial Strain". These concepts stem from general- and social psychological stress research and their predictive power softens the disappointment which usually follows the incorporation of academic concepts into problem-oriented research.

In a discussion of the theoretical foundation of the DFG air traffic noise study, IRLE (1975) noted that no comprehensive concept was used and that this problem-oriented research had to be considered basically a collection of data. Indeed, isolated personality and physiological concepts were attended to, but the results of clinical psychology-oriented and its associated theory (see LAZARUS 1966) were hardly drawn upon. The theoretical base has clearly improved here: Lazarus' concept of "Control Alternatives in Threatening Situations" was tested by GLASS & SINGER (1972) in the lab and by us in the field. The results find the notion sound, the reaction to a burdensome stimulus can more or less be deleted, depending on the extent of control possibilities relative to that stimulus (or the extent of the person's behavior repetoire). Less well confirmed but still important is the "capacity for strain", whereby stresses in one area lower the individual's capability to deal with stress in another area.

The small covariation of the variable "environmental awareness" with other, especially reaction, variables was disappointing in light of social potential for changing the physical level of noise strain. Three of the four items in this block covaried well with each other, but the summed variable showed noteworthy interrelations only with the variables "Aversion to Technology and Progress" and "Beliefs regarding the Health Risks of Noise". This variable did not contribute to the /65 explanation of reaction variance and was not influenced by the degree of environmental noise. It may be that it was not satisfactorily operationalized, or further, the so-called "growing environmental awareness" spoken of in contemporary opinion polls is purely a matter of lip service.

TABLE 1: DESIGNATION OF THE 14 FACTORS COMPOSED OF ITEMS WITH FACTOR LOADINGS GREATER THAN 0.50

Factor 1: Value = 13.84; 8.8% of variance
Disturbance of activities (STAK)

Item	Content	Loading
31.5	Disturbs conversation outdoors	.83
31.7	Impairs relaxation outdoors	.77
31.4	Disrupts conversation at home	.75
31.9	Disturbs guests	.75
31.8	Is disturbing when one is underway	.73
31.6	Impairs relaxation after work (home)	.67
31.3	Impedes work, reading & concentration	.67
31.2	Disturbs T.V., radio and music	.60

Factor 2: Value = 4.12; 5.16% of total variance
Vegetative lability (VEGL)

Item	Content	Loading
13	How satisfied are you with your health?	-.72
14.3	My heart occasionally beats irregularly	.68
14.4	I am rather nervous	.65
14.2	I often have trouble falling & staying asleep	.62
14.6	I am often rather tired	.62
14.1	I frequently have headaches	.57
14.5	I often react in an irritable way	.52

Factor 3: Value = 3.28; 4.19% of total variance
Sensitivity to noise (LEMF)

Item	Content	Loading
17.6	Doors slamming disturb me	-.74
17.5	Loud radios (T.V.) playing at once get to me	-.69
17.7	Dogs constantly barking get to me	-.65
17.3	I get angry when cars honk in unison	-.58
17.1	Constant typewriter noise bothers me	-.52

Factor 4: Value = 2.80; 3.89% of total variance
Attitude re/technology and progress (TECH)

Item	Content	Loading
12.3	Technological progress brings problems	.78
12.1	Modern technology has made life more complicated	.70
12.5	Without it, people would be happier	.70
12.4	Technical modernization is unhealthy	.66
12.2	Technology determines the character of life so strongly, it is hard to feel at ease	.64

TABLE 1 Continued

Factor 5: Value = 2.44; 2.23% of total variance
Satisfaction with shopping and transportation (EINK)

Item	Content	Loading
10.5	How satisfied are you with the shops	.68
10.4	Are you satisfied with the transportation system?	.66

Factor 6: Value = 2.08; 3.31% of total variance
General level of strain (BELA)

Item	Content	Loading
67.4	I'm usually under time pressure at work ..	-.80
67.6	I feel strongly overburdened	-.71
67.1	I feel sometimes like I'm not permitted to rest	-.54
67.3	I wish I could leave this stifling daily routine	-.53

Factor 7: Value = 2.03; 3.21% of total variance
Beliefs re/health risk of noise (GESU)

Item	Content	Loading
66.2	Noise is a strong burden for the heart and circulation	-.81
66.1	Residents of noisy areas are more often sick	-.80
66.3	Concentration capacity is cut	-.65
66.4	Noies creates no lasting health effects .	.55

Factor 8: Value = 1.87; 3.18% of total variance
Behavior for the reduction of noise emissions (IREV)

Item	Content	Loading
36.2	Keeping windows closed during the day	.71
36.1	Closing windows for the duration of the noise	.68
36.3	Closing windows at night	.59

Factor 9: Value = 1.55; 5.51% of total variance
Coping capacity for noise (BEWA)

Item	Content	Loading
25.5	When it is loud, I tune it out	-.72
25.2	I close the window and it is fine	-.71
25.4	I hardly hear it any more	-.68
25.1	I can deal with the noise well	-.66

TABLE 1 Continued

(Factor 9, continued)

Item	Content	Loading
25.6	I have resigned myself to it	-.62
25.3	Sometimes I feel in its clutches	.50

Factor 10: Value = 1.56; 2.49% of total variance
Financial burden (KOST)

Item	Content	Loading
67.5	We seldem eat out, due to cost	-.72
67.2	My current expenses are so high	-.61

Factor 11: Value = 1.38; 5.32% of total variance
Vegetative or somatic effects of noise (VEGL)

Item	Content	Loading
31.15	Noise makes me tired and weak	.70
31.11	It wakes me up at night	.69
31.10	It is hard to fall asleep	.67
31.14	I get headaches from it	.63
31.12	It startles me	.62
31.13	It makes me nervous and irritable	.57

Factor 12: Value = 1.31; 2.52% of total variance
Environmental awareness (UMWE)

Item	Content	Loading
40.3	I am ready to relinquish something for the sake of the environment	-.70
40.2	Environment is more important than economic growth	-.68
40.4	Build less streets and more parks	-.59

Factor 13: Value = 1.16; 2.60% of total variance
Satisfaction with the home (WOHN)

Item	Content	Loading
10.1	How well do you like your home?	-.69
11	How strongly do you feel a part of this area?	-.63
10.3	How well do you like this area?	-.61

TABLE 1 Continued

Factor 14: Value = 1.18; 2.21% of total variance
Behavior to drown out noise (LUEV)

Item	Content	Loading
36.7	Playing T.V. louder or radio louder	.71
36.8	Speaking louder	.63

TABLE 2 : INTERCORRELATIONS AMONG SECONDARY VARIABLES

	1 STAK	2 LABI	3 LEMF	4 TECH	5 EINK	6 BELA	7 GESU	8 IREV	9 BEWA	10 KOST	11 VEGL	12 UMWE	13 WOHN	14 LUEV	15 GEFA	16 LGTW
STAK	–	19	16	12	−07	35	22	54	−40	11	59	16	−25	55	41	53
LABI	19	–	25	22	−13	38	22	18	−22	26	46	04	−13	17	16	10
LEMF	16	25	–	14	−10	22	29	11	−30	16	24	17	−02	10	16	−05
TECH	12	22	14	–	−13	22	15	14	−10	19	18	27	−10	09	15	03
EINK	−07	−13	−10	−13	–	−17	−14	−06	18	−17	−21	−01	16	−05	−10	07
BELA	35	38	22	22	−17	–	29	27	−28	29	38	19	−20	23	24	14
GESU	22	22	29	15	−14	29	–	12	−30	00	25	31	02	10	23	−03
IREV	54	18	11	14	−06	27	12	–	−29	10	45	05	−10	34	30	49
BEWA	−40	−22	−30	−10	18	−28	−30	−29	–	−09	−43	−17	19	−23	−29	−07
KOST	11	26	16	19	−17	29	00	10	−09	–	19	01	−23	17	07	05
VEGL	59	46	24	18	−21	38	25	45	−43	19	–	06	−22	38	39	33
UMWE	16	04	17	27	−01	19	31	05	−17	01	06	–	−01	08	21	00
WOHN	−25	−13	−02	−10	16	−20	02	−10	19	−23	−22	−01	–	−17	−14	−16
LUEV	55	17	10	09	−05	23	10	34	−23	17	38	08	−17	–	19	35
GEFA	41	16	16	15	−10	24	23	30	−29	07	39	21	−14	19	–	17
LGTW	53	10	−05	03	07	14	−03	49	−07	05	33	00	−16	35	17	–

N=636. COEFFICIENTS HIGHER THAN 10 ARE SIGNIFICANT AT THE 1% LEVEL.

TABLE 3 : EXPLANATION OF REACTION VARIANCE BY MULTIPLE REGRESSION

Criteria	STAK	IREV	LUEV	VEGL
Multiple correlations	0.70	0.59	0.43	0.68
Chance probability	0.00	0.00	0.00	0.00
Predictor	**Beta-weights**			
Lability	−.02	.01	.03	.28
Sensitivity to noise	.03	.02	.01	.05
Aversion to technology	.00	.07	.00	.03
Shopping opportunity satisfaction ...	.01	−.02	.00	−.09
Daily strain	.13	.11	.08	.09
Perceived health risk of noise	.07	.01	.02	.05
Coping capacity	−.23	−.18	−.14	−.23
Financial burden	.00	.01	.10	.01
Environmental awareness	.03	−.06	.02	−.08
Satisfaction with the home	−.08	.06	−.05	−.04
Assessed danger of sound source	.20	.14	.05	.19
LGTW=level of environmental noise ...	.45	.44	.31	.24

N=636. CORRELATIONS HAVE BEEN CORRECTED FOR SHRINKAGE

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This investigation (Project City Noise Burdens) was funded through the Federal Ministry of the Interior. A comprehensive report (in which the supplemental studies will also be described) is to appear in Fall 1978.