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SOCIO-PSYCHOLOGICAL AIRPLANE NOISE INVESTIGATION IN THE DISTRICTS OF THREE SWISS AIRPORTS, ZURICH, GENEVA BASEL, BENEVD BASEL

R. GRAF, R. MUELLER and H.P. MEIER

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16. Abstract The extent of airplane noise and its effect were investigated in 1971/72 in the vicinity of three civil airports in Switzerland, in Zurich, Basel and Geneva. The results of noise measurements and calculations are available in the form of noise maps for each of the three areas. To measure the stress due to airplane noise the Noise and Number Index (NNI) was applied. In the vicinities of the airports 400 households were randomly selected in each of the three noise zones (of 10 NNI intervals each). A total of 3939 questionnaires could be evaluated, one quarter of which came from areas without airplane noise. Concurrently traffic noise was measured in areas of Basel and expressed in sum-total levels L_{50} and the reaction of 944 persons was elicited by interrogation.

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Investigation of Airplane Noise and its Effects in the Vicinity of Three Swiss Airports 1971/72

Appendix:

Execution

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SOCIO-PSYCHOLOGICAL INVESTIGATION OF AIRPLANE NOISE IN THE VICINITIES OF THREE SWISS AIRPORTS IN ZURICH, GENEVA, BASEL. - MAY 1974

Study Group for the Investigation of Airplane Noise.

I Summary of the results

The extent of airplane noise and its effect were investigated in 1971/72 in the vicinity of three civil airports in Switzerland, in Zurich, Basel and Geneva. /1*

The results of noise measurements and calculations are available in the form of noise maps for each of the three areas. To measure the stress due to airplane noise the Noise and Number Index (NNI) was applied. In the vicinities of the airports 400 households were randomly selected in each of three noise zones (of 10 NNI intervals each). A total of 3939 questionnaires could be evaluated, one quarter of which came from areas without airplane noise. Concurrently traffic noise was measured in areas of Basel and expressed in sum-total levels L_{50} and the reaction of 944 persons was elicited by interrogation.

Most Important Results

- The extent of disturbance showed a close and assured relationship to the level of airplane and traffic noise based on the method of self evaluation.

- With increased airplane or traffic noise the following leisure activities or symptoms were found to be disturbed: conversation, T.V. watching, radio listening, vibration of houses, recreation, sleep, alarm, work. Airplane noise was found to be most interruptive to conversation while traffic noise affected sleeping and leisure activities most often.

- The spontaneous mentioning of airplane noise as a disturbing factor did increase with higher airplane noises. Analogously increased traffic noise led to more frequent statements of it as a factor of disturbance; in these cases the complaints about airplane noise decreased. /2

- Behavior, sleep and satisfactory housing conditions were influenced negatively by airplane noise. Especially noteworthy was the

*) Numbers in the margin indicate pagination in the foreign text.

increased consumption of sleeping medications, use of ear plugs and frequency of medical consultations as well as the closing of windows, a decreased spending of time out of doors and satisfaction with housing conditions in areas of higher airplane noise.

- The frequency of psychosomatic symptoms or chronic fatigue, however, did not show a direct dependency on airplane noise.

- The analysis of noise sensitivity showed that a number of personal or social factors had a weak but significant influence on the results. Thus, for instance, the noise sensitivity was increased in persons who had an increased fear of airplane disasters or who had lived in the areas for a long period of time. It was reduced in persons with greater flying experience or with professional connections to the airport. The results showed that sensitivity to noise increases with the length of exposure.

- Taking all effects referred to into account, the following relations between airplane noise and disturbance become obvious:

  - <u>Below 34 NNI:</u> little stress due to airplane noise, quality of life is little affected. /3

  - <u>35 to 44 NNI:</u> medium stress due to airplane noise, quality of life is affected

  - <u>Above 45 NNI:</u> intense stress due to airplane noise. Quality of life is strongly affected.

These relationships could provide the basis for laws and directives of the administration in regional and air traffic planning.

II General Commission and Plan of Research /4

On December 18, 1967 the Swiss Federal Council appointed a study group for socio-psychological airplane noise research and commissioned it to plan and prepare an investigation into the extent of airplane noise and its effect on the population living near airports.

On July 1969 the study group submitted two documents to the Swiss Federal Council:

- A report of the extent of airplane noise in the areas of the airports Basel-Mulhausen, Geneva-Cointrin and Zurich-Kloten, prepared by expert group I (consisting of Prof. K. Battig, Dr. A. Gilgen, Dip. ing. J.R. Hediger and Prof. A. Lauber). In this report the noise capacity was calculated, the effects, however, were estimated, based on results of research in foreign countries.

- A detailed study plan for the three civilian airports and a cost estimate.

Based on the report the study group concluded that socio-psychological research in Switzerland is needed for the following reasons:

- The results of foreign studies can not simply be applied to conditions in Switzerland since the location of the airports and the reaction of the affected population are only partly comparable. /5

- In the Swiss research project - contrary to foreign studies - the surrounding noise, especially that of street traffic, should be considered. This would make it possible to correlate airplane noises with those of other traffic systems.

- Exact measurements of airplane noise in the surrounding areas of the three airports are needed to either confirm or correct the mathematically established noise zones.

- The results of the socio-psychological research should permit the evaluation of measures which had been taken before the completion of the research project.

The goals of the planned psycho-social research by the study group are as follows:

- Determination of the degree of airplane noise the areas surrounding the airports of Basel-Mulhausen, Geneva-Cointrin and Zurich are subjected to.

- The results of the research should provide the basis for legislative measures, for regional planning and for noise abatement in air traffic.

For the execution of the project the following plan was suggested: /6

- Measurement of noise and calculation of noise zones will be transferred to the department of Acoustic and Noise Abatement of the EMPA (Swiss Federal Material Testing and Research Institute for Industry, Building Industry, and Trade). (Dir.: Prof. A. Lauber).

- The Sociological Institute of the University of Zurich (Dir.: Prof. Dr. P. Heintz) will be commissioned to conduct the sociological phases of the project. The institute will be responsible for the theoretical part, the selection process, the design of the questionnaire, the satisfactory conduct of the interviews and the evaluation of the results. A test institute will be commissioned with the actual conducting of the interviews in Zurich, Basel and Geneva.

- The study group will appoint a study committee under the direction of Prof. Dr. E. Grandjean for the coordination of the acoustical and sociological work which will also be responsible for the execution of research according to the general plan.

On December 8, 1969 the Swiss Federal Government issued the order to the study group to proceed with the project according to the proposal of July 31, 1969. The Air Administration of the Swiss Federation was charged with the supervision of the study and the study group. Half of the expenditure of Fr. 700,000 was to be paid by the cantons of Zurich, Basel City, Basel County, and Geneva, the other half by the Swiss Federal Government.

III RESEARCH REPORT /7

by Peter Graf, El. ing. HTL; Hans Peter Meier, Lic. phil
Richard Muller, lic. phil.

1. Noise and reaction - some Basic Concepts /8

1.1. Introduction

Noise is sound evaluated as undesirable. Consequently, from what point on sound becomes noise depends on the evaluation of an individual and his own frame of reference. The reaction of individuals to sound, therefore, has to be based on and explained in reference to the stimulation and information processing system in the human organism.

Although there is no definitive theory of organismic stimulation and information processing in existence [1], it is quite clear, based on early research [1]: the conversion of stimuli into sensations and reactions, e.g. the stimuli-reaction-transformation, is a complex transmutation or coding process of physical energy, first into sensory activation and then into internal repertories of interpretations, evaluations and reaction, dependent on previous experiences with such stimuli [2, 3].

Therefore, the reactions of an individual to sound cannot simply be considered as a simple function of the energy of sound pressure and other physical parameters of sound propagation. Rather, it has to be seen as an association process in which the stimuli, caused by sound waves, are converted into excitation energy, redirected into an internal association system and there explained, evaluated and interpreted.

Finally, as consequence of the stimulus interpretation, in an additional association process reactions are determined /9
which represent the behavioral reply of the individual to the stimuli of his environment.

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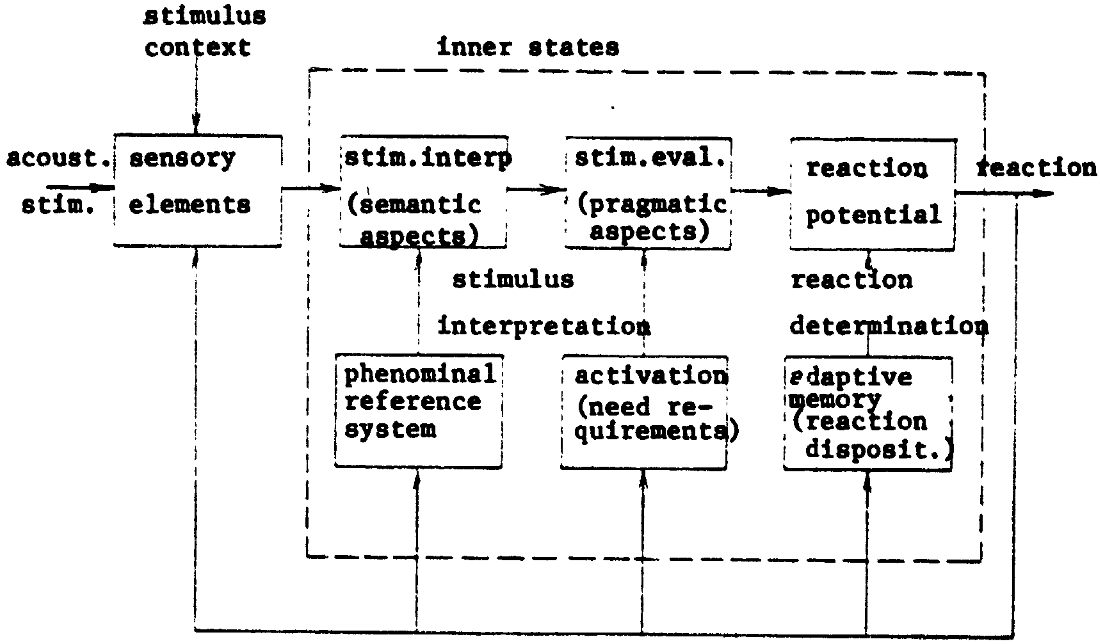
1) The basis of organismic stimuli and information processing has to be such that it, firstly, does not limit itself to the human organism but includes all organic systems in the biosphere and, secondly, that it does not concern itself only with certain aspects of the human organism e.g. conscious cognitive information perception and evaluation.

Stimulus interpretation as well as the choice of reactions is determined by phylo and onto-genetic conditions but also by acquired interpretations and reactions, e.g. previous experiences of the individual. These previous experiences are especially based on social interactions. Therefore, the stimulus-reaction-transformation complex is always to be seen in the context of the social environment.

Figure 1.1. illustrates the steps of stimulus-response formation schematically.



- activation of sensory elements in dependence on the stimulus context, /10
- stimu'us interpretation in the phenomenal reference system,
- stimulus evaluation in context of needs,
- determination of a reaction in the adaptive memory as a behavioral answer to the acoustical stimulus.

It is obvious that the schematic, as presented, shows a highly simplified concept of an extremely complex process. The four different steps of the stimulus-response process which are represented are actually connected to each other by a manyfold feed-back system [1].

1 2. The Interpretation of Stimuli

All of the empirical studies show the remarkable range of variability of individual reaction to sound. To clarify these variations both the processes of stimulus interpretation as well as response development have to be researched.

A differentiation has to be made between internal and external conditions which determine the interpretation of stimuli. The resulting interpretation of a stimulus, e.g. its sensory perception, interpretation and evaluation, are not only dependent on the internal frame of reference of the individual but also in the context in which the stimulus is emitted and perceived. /11

1.2.1. External Conditions of Stimulus Interpretation

Already the first measurements of psycho-physics showed that the reaction to any given acoustical stimulus is dependent on

- stimulus background
- stimulus sequence
- stimulus frequency (how often).

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1) It is to be emphasized that the terms "stimulus" and "response" are not to be understood in the meaning of Skinner's Behaviorism. The behaviorist's concepts of stimulus and response (reaction) are abstractions of the inner states as a relevant mediation factor in the stimulus-response-transformation. Consequently the essential property of individuals, to be able to change inner states and thereby the results of stimulus-reaction conversions qualitatively and quantitatively, is not recognized. With adequate models the behavioristic reduction of the individual to a mechanical automaton of stimulus and response is to be avoided because it eliminates the recognition of the relatively autonomous mediator function of inner states and coordination processes in the stimulus-response-transformation. (For positivistic, operational scientific theoretical suppositions of behaviorism and its critique see especially Klans [4] and Chomsky [5].)

1.2.1.1. The Stimulus - Stimulus Background Relationship

All receptors of organic stimulus and information processing systems are forever exposed to a theoretically infinite number of stimuli. The processing of a "focal" [6] stimulus is dependent on this stimulus background. That means that sound-perception transformation, too, is dependent on permanent and situational background sounds. There is, however, no unanimity in empirical research, whether the basic sound or a median surrounding sound represents the reference point for the evaluation of an acoustical stimulus [7].

It is evident that the context "acoustical stimulus" /12
has to be considered as including the whole ensemble of physical and social stimuli which represent the total sensory input at a given time. E.g. physical and especially social stimulus background complexes exert an influence on the evaluation of a focal stimulus. The study of this context dependent processing of a stimulus presents an especially difficult methodological problem in the area of non-homogeneous stimulus situations. In an experimental situation it is possible to consider a specific stimulus relatively independent of any context. The transfer of this experimental method becomes impossible if a specific stimulus, such as airplane sounds or any other surrounding sound are to be isolated while holding all other background sound stimuli constant. Assuming that similar physical-geographical areas share similar acoustical and social stimulus complexes it is possible, albeit rather crudely, to control a specific environment.

1.2.1.2. The Stimulus Sequence

As has been shown in many psycho-physical studies [8] the kind of stimulus sequence exerts a considerable influence on sound-perception transformation. The subjective perception of intensity of a certain momentarily given acoustical stimulus is dependent on the acoustical stimulus context which has been formed previously.

The interpretation and evaluation stored in the short term memory of the individual also influences the interpretation and evaluation of the present experience. (So is, for instance, the subjective impression of the sound intensity of a Caravelle influenced if shortly before a squadron of Mirages passed the same individual at close range). It can be assumed that a person is basing his evaluation of stimuli on previous experiences under special consideration of the most frequent and thus most typical stimulus sequences.

Depending on mobility in space and time (course of the day) individuals and groups are exposed to different stimulus sequences. A person who returns home into a quiet leisure situation after a day's work at a noisy job is obviously exposed to a different sequence of stimuli than a person whose situation is exactly reversed. /13

The modal stimulus sequence varies among different indivudals and has to be taken into consideration as an additional variation producing factor in the sound-perception-reaction process. It is also important to differentiate between stimulus sequence and stimulus frequency.

1.2.1.3. The Stimulus Frequency

It is clear that the evaluation of a stimulus - be it a negative or positive one - is also a function of stimulus frequency. This simple theoretical fact, however, does not include the empirical situation. For the concrete problem of individual judgement current research is suggesting a logarithmic course of influence, e.g. in the case of airplane noise an upper saturation point is postulated beyond which the influence of the frequency of disturbances has no longer an effect. In comparable foreign studies of the same problem there is, however, no unity in the precise evaluation of this influence.

1.2.2. Internal Conditions for Stimulus Interpretation

Each acoustical stimulus becomes of a relevant magnitude only in respect to the stimulus interpreting organism .

Stimuli sent out and transferred by the environment are converted by organisms into a proprietary part of the system; e.g. they are perceived sensorily, interpreted and evaluated because only then are the conditions created which are necessary for a reaction. The differences among individuals and their systemic states is at the root of this variance causing component of the individual reaction to sound. /14

The three reference systems which represent the systemic states of the individual are:

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1) Every stimulus can be seen as a snapshot of some event in the environment. A partial aspect of the the illustrative function of stimuli relative to their origin is the physical carrier process which transfers illustrations of environmental events to receptive, stimulus processing organisms. Each stimulus is the symbol of a social or physical event in the environment that can only be transferred by carrier processes (e.g. signals) to organismic systems.

a) the long-term memory which serves as the phenomenal reference system of stimulus interpretation. This is the semantic aspect of stimulus interpretation.

b) the action or tension potentials which are stored up in the individual as a result of his social and individual needs which determine the stimulus evaluation. This is the pragmatic aspect of stimulus interpretation.

c) the adaptive memory which contains the reaction disposition as a reference system for behavioral responses to stimuli from the environment.

To be capable of reacting in response to a stimulus its interpretation along semantic and pragmatic aspects is a prerequisite. [1).]

1.2.2.1. The Semantic Aspect of Stimulus Interpretation

This includes:

a) The Qualitative Determination of a Stimulus - e.g. the determination of the type of stimulus (for instance acoustic versus visual). /15

b) The Quantitative Determination of the Stimulus - to which degree and specificity a stimulus applies (for instance the volume of an acoustical stimulus). The stored stimulus base line serves as a point of reference for the evaluation of the specificity of the stimulus. Each individual develops his own scale of measurement from this base line stimulus thus allowing him to appraise each given stimulus. It is modified by the experience and especially by the type of stimulus the individual is subjected to.

Individually different base lines of acoustical stimuli mean that the origins of these scales are different among individuals. Consequently, the calibration of these individualistic scales for the measurement of stimuli would not be standardized. Origin and calibration of scales are only then commensurate when base line and unit are known. This standardization has to be measured.

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1) Every processing of information does not only involve semantic and pragmatic aspects but is also based on measured and structural components. The basis of the presented concept of the individual as an information processing system is further discussed in [9] and [10].

Assuming that different levels of stimulus backgrounds act on the baseline it is of extreme importance in field work to control backgrounds and to evaluate every systematic change in the judgement of a given stimulus.

c) <u>The Association of a Stimulus to a Stimulus Source.</u> The reception of a stimulus or stimulus complex, such as sound, and its active processing does not only include the associaton of stimulus specific memory banks but also the stimulation of memory contents /16 which are associated to the source of the stimulus. It is only this association which creates the basis for an interpretation of the environment. This association of stimulus and source, respectively from sound and sound source, is a differentiating effort of recognition. If this effort can not be produced, as in the case of a toddler, fear reactions can follow, especially if the stimulus has a high degree of specificity [11]. One of the shortcomings of other studies into the effects of airplane noise is their limitation to the psycho-social effects on adults. (A study of the effects of airplane noise on small children or adults in critical life phases would, however, require an entirely different methodology).

Incomplete or undifferentiated recognition efforts can lead to inadequate behavioral responses to stimuli or to their sources.

The differing interpretations of stimulus sources by different individuals is another cause of variability in the stimulus-perception-reaction process. They are influenced by the projected interpretation of the stimulus source and by the attitudinal complex towards it.

Positive projective interpretations which, for instance, could be associated with the object "airplane" - possibly as positive identification with the pilot, symbolic participation in worldwide mobility or the visually and acoustically perceived image of the power of an airplane experience - do influence the evaluation of the degree of specificity of the air sound. Likewise does the attitude towards the source of stimulus effect the evaluation of the received stimulus. Attitudes embrace, on the one hand, the cognitive relationships which a person recognizes between the source of the stimulus and its social and political implications and which are stored in the memory bank, but also modernistic or traditional as well as retro - or prospective temporal orientations. The latter is especially evident in the evaluation of airplane noises.

The semantic evaluation of the stimulus is the prerequisite for the pragmatic evaluation of a stimulus. /17

1.2.2.2. The Pragmatic Aspect of Stimulus Interpretation

While in semantic stimulus interpretation of stimulus and source the reference is to the phenomenal system, the pragmatic interpretation of this relationship is based on the concept of individual and social usefulness. This utility is dependent on individual and societal needs. These, again, depend on social class situation and time.

Consequently, stimuli which are compatible with those needs represent the domain of desirable stimuli, the incompatible ones create the undesirable domain of disturbing stimuli of an individual. The result of pragmatic stimulus evaluation is determined by needs, dependent on class, situation time which are connected to the characteristic evaluation of stimuli by the individual[1]. Therefore the sound level is subject to differing evaluations, according to situation, time and need.

In analogy to the semantic stimulus interpretations the pragmatic interpretation includes the source of the stimuli in the evaluating calculation. The differences in the evaluation of a given degree of strength of a stimulus are based on the usefulness the stimulus emitter (source) is representing to the individual or the group, modified by the temporary perceptions of a specific need:

The same sound level is perceived differently if a different value is associated with the sound source. The /18
objective use aspect of the stimulus source has to be differentiated from the subjective perception of usefulness. On the one hand it deals with the class bound accessibility of the use to the individual (mobility) and on the other hand with the class specific exposure to the social costs of the stimulus source (noise exposure). Variances between the objective value and perceived value influence the stimulation-perception-reaction transformation. This variability of usefulness is practically limitless and is only very coarsely and rather approximately controlled in a survey analysis.

1.2.2.3. Generalization Effects in Stimulus Interpretation

Interpretation and evaluation of a stimulus or a stimulus source are to be considered as associated to stimulus specific memories which

1) Impressive examples for the important roll class differential needs and thereby class specific evaluations of esthetic sound experiences are shown in musicology. Sound experiences of high intensity, however, seem to be rather class invariant in the evaluation.

have been acquired and stored by the individual in a long learning process. Since, however, stimulus and source are always seen in context with other stimuli and their sources (for instance airplane noise in context with other physical and social stimuli of the environment) it is obvious that the association, interpretation and evaluation of these stimuli and sources in the memory is also in reference to such contexts.

This means that not only stimulus specific memory contents are activated but also the ones that are associated to the stimulus content. These stimulus contextual memory contents are therefore associated with the stimulus specific memory contents. The activation of contextual memory contents by a specific stimulus can lead to generalization effects. Two directions of generalization are apparent:

- The interpretation or evaluation of a specific stimulus or of a source affects those of the context stimuli or sources.

- The interpretation or evaluation of context stimuli or their sources influences those of a specific stimulus or its source.

Applied to the problematic of the effects of sound this means on the one hand: the evaluation of the background noise is also dependent on the evaluation of the physical and social properties of this environment. On the other hand, the evaluation of the background noise also affects the evaluation of the physical and social environment's properties. This, for instance, can go so far as to make the background noise in the individual's perception the scapegoat for all inadequacies of the physical and social environment and decrease the disturbing effect of sound. /19

Semantic and pragmatic stimulus interpretations result in a certain action and tension potential. This value is the starting point for the study of reactions activated by sound.

1.3. The Investigation of Environment Related Reactions

Analogous to the interpretation of stimuli the respective reactions are established in the adaptive memory - a further reference system in the process of stimulus reaction formation.

1.3.1. The Adaptive Memory

The adaptive memory as a reference point is a store house of reaction dispositions. Reaction dispositions are reaction patterns which are coordinates of the stimulus specific reaction potentials. They are based partially on experience previously acquired by the individual, partially on conditional and unconditional reflexes which are genetically preordained. Reaction dispositions can lead to conscious as well as subconscious reactions. In addition it is important to differentiate between reaction dispositions which lead to internal and those which lead to external reactions. Internal reactions lead to modification of the inner parameter (individually internalized quantifications, while external reactions affect external parameters individual external quantifications).

In reference to the reactions of individuals to noise, e.g. negatively evaluated sound, the following reaction dispositions can be differentiated:[1)] /20

1.3.1.1. Internal Reaction

a) Physiological Reactions will not be discussed any further in the following because physiological measurements are needed for their determination. For results of physiological reaction to sound compare especially Lehmann [12], Jansen [13], Kryter [14].

b) Psychosomatic Reactions are effects on the psychic health of an individual which are expressed in somatic symptoms and which can be established in the form of self-evaluation. That means that we have to assume a judgement plateau in addition to stimulus and reaction level. (Measurements are not executed directly on the action level but indirectly on the judgement level which is established during the interview by means of the questionnaire).

The unequivocal assignment of a perceived somatic symptom, e.g. the change of an internal parameter to a verbal judgment, requires cognitive effort /21

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1) The following discussion refers especially to the adaptation of individuals to disturbing stimuli (negatively perceived stimuli in interpretation). It has to be emphasized, however, that exposure to sound also has a necessary, simply stimulating effect. Defense reactions to sound result only in the presence of a certain degree of disturbance. It has been shown in many studies that there is the necessity of a differentiated acoustical stimulus environment for protection and, connected with that, efficiency, for mental health a.s.f. (See especially the comments in Chapter 5 & 6 of this report).

and introspective abilities which are not evenly distributed in all social strata of society. Nevertheless, psychosomatic self-evaluation has proven to be a usable instrument in the measurement of psychosomatic reactions to disturbing stimuli. In addition there was validation of such self-evaluation with the presence of effective clinical symptoms [15]. However, this connection can hardly be causal but is further dependent on intervening predispositions of individuals.

c) Psychological Reactions are chiefly subconscious reactions in which an individual compensates for disturbing effects by changing internal reference values, e.g. an adaption to the disturbing influence is attempted by reinterpretation of stimuli and stimuli sources, by generalization of meanings and evaluation of stimuli as well as of reaction dispositions. Thus a change in the attitude towards a stimulus source or a projective interpretation can influence the perceived disturbing effect of a sound. Likewise the negative evaluation of an environmental property can be transfered to some other environmental property.

1.3.1.2. External Reactions

In this case the reaction potential is interpreted as degree of a perceived disturbance. This interpretation is not unproblematic, because it requires:

- that the individual is aware of the reaction potential
- that a known cause and effect relationship exists so that the individual can trace a certain reaction potential to a stimulus and stimulus source
- that the individual is in possession of an internal yardstick and is capable of translating the perceived disturbance unequivocally into a verbal judgement
- that the yardstick of the individual can be adequately understood by the researcher

b) Adaptive Behavior is chiefly a conscious external response to a reaction potential. This is an attempt to eliminate the disturbing effects of sound by a conscious influence on the environment or the own person. The intended or realized goal of these efforts can range from small quantitative modifications all the way up to qualitative changes of the environmental stimuli fields. Besides, these external reactions can be limited to the physical environment but they could also include the /22 social and political dimensions of the environment. Prerequisites for the adaptive behavior are:

- that the individual has a repertory of adaptive behavior dispositions available
- that a certain behavior is considered appropriate and realizable
- that a certain behavior is considered to be effective in compensating for the disturbing effect
- that the improvement caused by the action on the environment shows a favorable relationship to its costs.

The extent of this repertory and the accessibility of realizable and efficient reactions correlate with the social position of an individual and to individual psychological states.

1.3.2. The Process of Triggering Concrete Reactions

This process shows a three step structure.

1. activation of the adaptive memory
2. determination of reaction dispositions
3. triggering of concrete reactions

1.3.2.1. The Activation of the Adaptive Memory /23

It is very obvious that an individual can not react simultaneously to every reaction potential which is available at any given time but is forced to treat all simultaneously available stimulus-specific action potential selectively. That means that the reaction triggering state of certain reaction potentials has to be disregarded and/or that simultaneous reaction potentials will react sequentially. If an individual action is to follow as the result of a number of simultaneous reaction potentials there have to be internal priorities. These priorities are in direct dependence on the relevant weights of simultaneously present action potentials. This again means, in respect to the reaction to sound, that in the case of an equally high degree of disturbance by means of noise and in the case of similar personality types the reactions do not necessarily have to be indentical if different behavior relevant reaction potentials are present. In other words, the triggering of a reaction due to noise is also dependent on the presence of other behavior relevant disturbances.

1.3.2.2. The Determination of Reaction Dispositions

As mentioned previously, the adaptive memory stores reaction dispositions which are assigned more or less uniquely to specific reaction potentials. The more single minded this association is, the greater is also the reaction assurance and the speed of stimulus response. As second important factor in the determination of reactions functions the supply of different reaction dispositions - the variety of reaction dispositions.

The sure and differentiated reaction to environmental stimuli depends on those two factors. A high degree of association confusion and a lack of variety of reaction dispositior increases the probability of inadequate reactions. /24
Inadequate reactions are those which lead to an irrational, rather than a rational adaptation to a certain reaction potential. The rationality is related to an optimal adaptation of an individual and society to an environmental disturbance. In the case of sound, too, those segments of the population show the highest probability of inadequate reactions which are exposed to abrupt changes of their environmental stimulus fields. This is especially true of developmental phases of early childhood and of segments of the population which are extremely mobile. Generally there is a substitution relationship between conscious adaptive behavior and psychological or psychosomatic reactions. That means, that internal unconscious reactions inhibit external conscious reactions to disturbances from the environment and, vice versa, prevent external reactions of subconscious adaptations.

The probability of inadequate reactions is not only increased as a cause of association confusion but, to the same degree, by the perceived powerlessness, the recognition that the available reaction dispositions can not be converted into reactions because they are either not accessible, of little effectiveness, or too expensive. The subjectively perceived powerlessness is frequently the triggering cause for the conversion of conscious external reactions, for instance in the form of political activity, into dispositions for more individualized or even internal individual reactions.

1.3.3. The Triggering of Concrete Reaction

Reaction dispositions represent nothing but the necessary conditions for the triggering of concrete reactions in the conscious process of reaction generation. The following conditions suffice:

a) The Internal Simulation of Chances of Success of Concrete Reaction which is Able to Minimize a Certain Reaction Potential

Criteria of success for the simulation of concrete reactions are on the one hand a prognosis of the effectiveness and on the other the prognosis that the individual can successfully execute such actions. Whether a reaction can be accomplished or not depends, on a subjective factor, the self-evaluation of the individual's ability and the objective factor of material resources. These, however, are not distributed evenly among the members of different social strata. /25

b) The Internal Simulation of Newly Developing Reaction Potentials as the Consequence of Triggered Reactions

The criterion for this simulation is that the predicted reaction potential, which was caused by the triggered reaction, is smaller than the presently available triggering potential.

Is, as a consequence of the perceived disturbance by noise, a certain reaction disposition- for instance a change of residence - associated, the corresponding concrete reaction, namely the actual moving, will only be triggered after it has been accepted as effective and feasible and, in addition, is not expected to cause the development of new reaction potentials like the loss of social contacts due to the change of residence.

If no options for external reactions seem viable the degree of perceived powerlessness (frustration) and the probability of internal reactions is growing. A limitation of the study of the disturbing effects of sound and the reaction of individuals to the consideration of external reactions only is an indefensible simplification of the phenomenon. It therefore is absolutely necessary to include internal reaction in the research of the effects of airplane and traffic noise.

1.4. Social Effects of Individual Reactions

In the preceding the analysis of the reaction to disturbing stimuli was limited to the level of the individual. It is, however, of decisive importance to realize that individual reactions have immediate and indirect effects on the social level.

That means, that individual reaction are not only socially determined but again show their effect in personal as well as societal areas. It is evident that internal reactions, which affect the well being of the individual, also lead to disturbances in the social fields of reference in his personal life, such as family and his work environment. Likewise, internal reactions which transfer the negative evaluation of a disturbing stimulus to other physical or social environmental properties are not only the cause of individually perceived reductions of the environmental quality. Rather, they also represent an impairment of the social quality of life of the segments of the population which are exposed to this environment. External, individually determined reactions to disturbing stimuli are attempts with limited solutions because they are reactions to the conditions of exposure to disturbing stimuli only in an ego centered and not in a social centered way. The consequence of ego centered actions, for instance the change of residence, is a social detachment process in the social macro-sphere since the individual remedy of moving is generally not available to all social strata of the population; in other words, the change of residence is easier for socio-economically higher classes than for the lower ones. The results of these processes are actually "noise slums". /26

Since the exposure of individuals to disturbing stimuli is a phenomenon caused by society the problem must be resolved by socially oriented actions. Therefore, actions against these disturbing stimuli and their exposure conditions can be considered as desirable if they are society related. Consequently, external collective reactions in form of spontaneous and organized political actions are not only efficient and prospective possibilities for the individual, but also for society as a whole in an attempt to solve their enviromental problems.

2. APPROACH AND ORGANIZATION OF THE STUDY /27

2.1. Development of the Questionnaire

The basis for the development of the questionnaire is the concepts of stimulus processing as described in the previous chapter. The questionnaire of the first English Noise Report [16] served as a model for the operational translation of theoretical concepts. The same report was also the basis for the questionnaire which had been recommended by the OECD (Organization for Economic Cooperation and Development). Other instruments were the questionnaires of the American study by P.N. Borsky [17], the French study inquiry into the noise that surrounds airports [18] and the Swedish airplane noise studies [19]. The additional intervening variables which were considered here as relevant were included in the form of scales, quasi scales and simple indicators. Special emphasis was put on a relatively extensive inventory of psychosomatic symptoms. In a first pretest the questionnaire was tried on a quota sampling of 100 people. Two translators, independent of each other, prepared a translation of the corrected German version of the questionnaire into French and Italian. A third translator was employed to develop a third version of the two translations. In a second pretest the corrected German version as well as the French translation were tested on a sample of 50 persons each and the Italian translation on a sample of 20 persons each. The corrected versions, based on this second pretest, became the questionnaire which was used for the study (see also appendix 2).

2.2. The Execution of the Survey

The survey was conducted by a private opinion research institute on the following dates: for the Zurich region from April 28 to May 16, 1971, in Geneva from May 4 to June 6, 1971, and in Basel from May 8 to June 29, 1972. To control for the effects of different mobilization factors in the three survey areas, all newspaper reports under the headings "noise, airport noise, airport" in the most important dailies were collected. In respect to numbers and distributions of these press reports there were no differences found among the three survey areas. While differing mobilization effects for the sample populations of both Zurich and Geneva should not be expected they can not be excluded for the sample population of Basel, since during the period from spring 1971 to spring 1972 there were referendums on building projects at the local airports in the canton of Zurich (Sept. 1970), in the canton of Geneva, (Feb. 1971) as well as in the canton of Basel City, (in Sept. 1972). (The time shift in the conducting of interviews in the Basel region was technically necessary to allow the synchronization with acoustical measurements. To eliminate the chance of seasonal differences, the same season was chosen for the survey). /28

All in all there was a total of 1600 interviews in the test area of Zurich of which 120 were conducted in Italian; 1557 in the test area of Geneva; 1000 in the test area of Basel of which 40 were conducted in Italian. The percentage of usable interviews was 82.7% for Zurich, 73.0% for Geneva and 54.3% in Basel. 56 of the total of 4157 interviews could not be included in the analysis. The average time per interview was 49 minutes.

The relatively high proportion of usability, with the exception of Basel is partially due to the mailing of advance notices to the participants and partly to the relatively great interest of the interviewees in environmental subjects. The latter were given as the reason for the interview. To avoid any bias any reference to specific noise questions was avoided.

The relatively great interest in the interview was confirmed in the results of the evaluation of the interviewer protocols, in which the interviewer, among other things, had to evaluate the interest of the subject during the interviews:

Reaction of the Interviewees /29

	test areas			
	Zürich	Genf	Basel	Total
Lively, interested	54,4	71,9	73,1	69,4
ambivalent	24,9	17,5	15,6	19,8
reserved	9,4	8,7	8,9	9,0
negative	1,3	1,9	2,4	1,8
N	(1471)	(1524)	(946)	(3941)

The evaluation of the honesty of the answers obtained from the interviewees is equally positive:

	test areas			
	Zürich	Genf	Basel	Total
completely honest	60,6	86,7	71,9	73,4
generally honest	36,4	12,3	25,6	24,5
doubious	3,1	1,0	2,5	2,1
N	(1471)	(1524)	(946)	(3941)

2.3. Selection Process

Conditions for the test areas of Zurich and Geneva:

- 400 interviews each in zones over 50 NNI
- 400 interviews each in zones between 40 and 50 NNI
- 400 interviews each in zones between 30 and 40 NNI
- 400 interviews each in zones below 30 NNI

Conditions for the test area of Basel: /30

- 400 interviews each in zones between 40 and 50 NNI
- 400 interviews in zones between 30 and 40 NNI
- 200 interviews each in zones below 30 NNI

2.3.1. Selection Process for the Test Areas Zurich and Geneva for Zones with more than 30 NNI

Three levels according to house types layered random sampling

Basis: ISO*NNI - curves as established by the Department of Acoustics and Noise Abatement of the EMPA * for the airport regions of Zurich and Geneva (ratio 1;50,000). These were transfered to survey maps of communities which are situated in the individual noise zones (map ratio 1;5,000). (The four communities which lie in the Canton Aargau as well as the community Mies in Canton Waadt were not included in the study. The test area of Geneva is limited to territory within the Swiss boundaries). All dwellings were differentiated by the criterion: one family or multiple family dwelling. (* ISO = International Organization for Standardization EMPA = Swiss Federal Institute of Material Control and Testing Institute for Industry, Building Industry and Trade.)

Level 1 the primary unit "house" is chosen on a random basis, proportionately to its frequency in the specific community.

Level 2 (only in multiple family dwellings) the secondary unit "household" was chosen on a random basis from all households. For economical reasons two secondary families were chosen from each selected multiple family dwelling.

Level 3 Choice of tertiary units, the "target person", by the interviewer according to preselected random logarithms (see also the selection instructions for the interviewer in appendix 2).

The distribution of primary units in the individual noise zones forms the basis for the distribution of acoustical measuring points in both test areas (see chapter 3).

2.3.2. Selection Process for the Test Area of Basel with more than 30 NNI /31

The analysis of data of the test areas of Zurich and Geneva resulted in a relatively poor representation of acoustical street traffic noise data so that the selection process for the test area of Basel was changed. This led to a considerable reduction in the geographical area for which acoustical data were as representative as possible. Unfortunately this improvement in validity of sociological data as well as a consideration added expense for acoustical measurements.

Basis: The same as for the test areas of Zurich and Geneva (Limited to Swiss territory).

Level 1 The primary unit "house" is chosen on a random basis proportionately to its frequency in the specific community. The number of houses chosen is not proportionate to the number of houses available in the area of testing. Every randomly selected primary unit was associated with two and five additional primary units. This grouping is based on the criterion of the highest possible acoustical homogeneity of the individual clusters.

Levels 2 and 3 Same as in the test areas of Geneva and Zurich.

2.3.3. Selected Process for Control Groups (Zones with less than 30 NNI

To obtain a control population which is socio-demographically as well socio-economically analogous to the test population all communites situated in the test cantons were compared according to the following structural data:

- Occupational structure /32
- number of inhabitants
- taxable income per person
- population increase between 1960 and 1970
- functional distance to metropolitan areas.

For each community situated in zones above 30 NNI a comparative community was chosen which is situated outside of this noise zone on the basis of the above criteria. Target persons were chosen on four levels, according to stratified house types:

Level 1 Random selection of areas (200 x 200m).

Level 2 The secondary units "household" are chosen proportionately to their frequency (one-family dwellings versus mulitple-family dwellings) in the control community.

Level 3 and 4 are analogous to the second and third level of the control populaton.

2.3.4. Interviewed Communities

Kloten

Kloten
Opficon
Ruemlang
Oberglatt
Niederglatt
Hoeri
Buelach
Bachenbuelach
Niederhasli
Hochfelden
Regensdorf
Buchs
Daellikon
Glattfelden
Winkel
Dielsdorf
Dietlikon
Wallisellen
Daenikon
Huettikon
Weiningen
Geroldswil
Oetwil
Dietikon
Nuerensdorf
Bassersdorf
Lufingen
W erenlos
Embrach
Schlieren
Urdorf
Bonstetten
Langnau
Adliswil
Thalwil
Obfelden

/33

Geneva

Geneva
Versoix
Satigny
Genthode
Bellevue
Pregny
Gr. Saconnex
Meyrin
Vernier
Cartigny
Air La Ville
Chancy
Avully
Petit Saconnex
Petit Lancy
Carouge
Chene Bourg
Thones
Jussy
Hermence
Perly
Anieres

Basel

Basel
Allschwil
Binningen
Birsfelden
Riehen

2.4. Samples Received for each Noise Zone

NNI-zones	Test Areas Zurich	Geneva	Basel	Total
< 30	379	414	420	1213
30 - 39	174	355	566	1094
40 - 49	761	382	---	1143
≥ 50	281	373	---	654
Total	1595	1524	986	4104

The final selection for each noise zone differs considerably from the conditions which were obtained theoretically. This is due to the fact that the actual airplane paths deviate from the ideal air routes as established on the basis of calculations of the ISO-NNI-curves. This is especially true for departure operations.

2.6. Selection of Measurement Locations /36

Basis for the choice of a locaton for measuring purposes was the distribution of primary units (houses) in the test area. (See chapter 2.3.1., 2.3.2.). Deciding factor is the best possible representation of acoustical conditions for a limited number of interviewees.

- For the precise determination of measuring locations, areas with similar airplane noise and traffic noise patterns to be studied, were combined into so called noise zones.

- Each noise zone contains only one measuring point. The point chosen within the noise zone has to deliver results which are representative for the whole noise zone (choice of a location within a zone).

- The locationof the microphones has to be chosen in such a way that neither airplane nor street noises will be shielded too much by obstacles. (Prefered microphone location is the balcony railing on the second floor).

A map with all measuring points is included in the appendix.

2.5. Socio-Economical Characteristics of the Population Under Study

	Surveyed Regions														
	Zurich NNI				Geneva NNI				Basel NNI			Total NNI			
	<30	30-49	>50	N	<30	30-49	>50	N	<30	30-49	N	<30	30-49	>50	N
SEX															
- male	46.1	45.3	48.1	(677)	46.9	48.3	47.7	(728)	42.2	43.1	(404)	45.1	45.8	47 9	(1809)
- female	53.9	54.7	51.9	(794)	53.1	51.7	52.3	(796)	57.8	56.9	(541)	54.9	54.2	52.1	(2131)
AGE															
- 18-20 years	25.1	26.8	28.2	(392)	14.3	18.3	14.7	(247)	14.1	21.6	(174)	17.5	22.5	20.3	(811)
- 30-49 years	42.8	49.4	46.9	(696)	38.9	44.6	34.9	(618)	42.2	48.4	(433)	41.2	47.5	39.8	(1747)
- 50 and over	32.0	23.8	24.8	(382)	46.9	37.2	50.4	(655)	43.7	30.0	(338)	41.2	30.0	39.8	(1375)
FAMILY STATUS															
- married	80.7	83.3	80.8	(1208)	72.2	80.1	71.6	(1156)	72.1	76.6	(705)	74.8	80.5	75.4	(3069)
- single	9.9	10.3	11.5	(153)	11.8	11.0	10.2	(168)	11.8	11.5	(110)	11.2	10.9	10.7	(431)
- divorced	1.7	2.7	4.2	(40)	4.3	3.0	2.9	(51)	4.0	4.2	(39)	3.4	3.2	3.5	(130)
- widowed	7.7	3.7	3.4	(68)	11.6	6.0	15.3	(149)	12.1	7.7	(90)	10.6	5.5	10.4	(307)
Education															
- primary	35.4	34.2	30.5	(498)	50.7	44.5	48.8	(720)	40.7	38.0	(370)	42.6	38.8	41.3	(1588)
- secondary	39.5	43.1	45.0	(626)	32.9	29.9	34.6	(485)	32.2	35.8	(324)	34.7	36.6	38.9	(1435)
- tertiary	25.1	22.7	24.4	(347)	16.4	25.6	16.6	(319)	27.1	26.1	(251)	22.7	24.6	19.8	(917)
INCOME PER HOUSEHOLD															
- up to Fr. 2000	46.2	43.4	48.9	(619)	58.2	49.9	61.6	(705)	48.0	40.5	(363)	51.0	44.8	55.8	(1687)
- Fr.2000 - 3000	41.4	43.4	39.1	(580)	29.8	35.7	27.6	(413)	39.9	45.4	(359)	36.9	41.4	32.6	(1352)
- over Fr. 3000	12.3	13.2	11.9	(175)	12.0	14.4	11.3	(167)	12.1	14.2	(111)	12.1	13.8	11.6	(453)
EMPLOYMENT															
- yes	56.6	60.3	60.3	(874)	55.6	57.7	49.3	(839)	54.5	57.4	(531)	55.5	58.7	53.9	(2244)
- no	43.4	39.7	39.7	(597)	44.4	42.3	50.7	(685)	45.5	42.6	(414)	44.5	41.3	46.1	(1696)

												Total			
	<30	30-49	>50	N	<30	30-49	>50	N	<30	30-49	N	<30	30-49	>50	N
Occupation															
- farming	1.5	2.8	3.8	(23)	0.9	2.4	3.2	(18)	0.5	0.3	(2)	0.9	2.0	3.5	(43)
- unskilled, semi skilled office workers	17.5	16.4	15.8	(142)	18.6	12.8	15.1	(124)	14.4	14.7	(77)	16.8	14.7	15.5	(343)
- skilled workers, blue collar	22.5	23.2	19.0	(191)	21.7	22.0	25.9	(190)	23.7	20.1	(114)	22.6	22.0	22.7	(495)
- skilled workers, white collar	26.0	22.6	27.8	(209)	28.8	26.5	24.9	(223)	34.9	34.5	(183)	30.0	27.0	26.2	(615)
- managerial, civil service, trades people, technicians	19.0	21.0	20.3	(175)	18.6	17.5	19.5	(152)	14.4	16.0	(81)	17.3	18.6	19.8	(408)
- professionals, university trained, artists	9.0	5.8	9.5	(62)	5.3	13.5	6.5	(81)	9.8	12.1	(59)	8.0	10.0	7.9	(202)
- business men, top management	4.5	8.0	3.8	(55)	6.2	5.2	4.9	(45)	2.3	2.2	(12)	4.4	5.6	4.4	(112)
Children under 18															
- none	32.7	23.5	21.7	(277)	50.0	38.7	48.7	(490)	45.4	32.6	(251)	43.0	31.0	37.7	(1018)
- one	25.7	25.6	27.0	(281)	21.5	27.0	23.4	(273)	18.9	27.1	(156)	22.0	26.4	24.9	(710)
- two	31.2	31.1	31.7	(340)	20.1	23.6	20.1	(242)	25.0	26.1	(169)	25.3	27.3	24.9	(751)
- three	7.1	15.1	14.3	(141)	7.4	9.1	5.5	(86)	7.9	9.7	(59)	7.4	11.7	9.1	(286)
- four plus	3.3	4.8	5.3	(49)	1.0	1.5	2.2	(17)	2.9	4.5	(25)	2.4	3.6	3.5	(91)
Length of residence															
- one year or less	4.4	8.1	6.5	(102)	1.7	3.9	2.1	(44)	2.5	4.8	(36)	2.8	5.8	3.9	(182)
- one to two years	6.4	9.1	8.0	(121)	5.1	9.6	4.8	(110)	4.5	6.8	(55)	5.3	8.7	6.1	(286)
- two to ten years	34.5	37.8	48.5	(572)	23.7	44.4	28.4	(531)	25.6	31.3	(273)	27.7	38.4	36.7	(1376)
- ten or more years	54.7	45.0	37.0	(676)	69.6	42.1	64.6	(839)	67.3	57.2	(581)	64.2	47.1	53.2	(2096)
Ownership situation															
- home owner	26.0	21.7	29.4	(315)	37.0	27.7	60.1	(581)	30.2	20.3	(231)	31.3	23.4	47.4	(1367)
- renter	74.0	78.3	70.6	(1116)	63.0	72.3	39.9	(943)	69.8	79.7	(714)	68.7	76.6	52.6	(2773)

/35

2.7. Execution of Acoustical Measurements

2.7.1. Airport Kloten

Sound measurements in the area of the airport of Kloten were conducted during the time from the beginning of January 1971 to the middle of June 1971. During this time a total of 108 positions were measured. 69 of these measurements were extended over a period of one week and they were supplemented by 40 short term measurements of 20 min. each. The short term measurements were always conducted on workdays in the time between 8:00 and 12:00am and 2:00 and 5:00 pm in such areas where the airplane noise was relatively constant, the street and surrounding noise, however, very variable from location to location.

2.7.2. Airport Geneva /37

The measurements in Geneva were conducted between the middle of September 1971 and the end of February of 1972. A total of 140 measurement locations were used. 60 of the measurements were week long measurements and 80 were short term measurements.

The sprawling building structure of Geneva made it necessary to spread the interview locations over a larger area. Therefore a greater number of short term measurements was necessary. The selection process of the measuring location was the same as in Kloten.

With the aid of transversal measurements the airport noise in Geneva could be examined especially thoroughly. (See chapter 3.4.4.). These measurements were executed in January and February 1972. A total of nine transversals was laid so that the results of approximately 600 indiviudal sound level measurements could be used in the construction of the NNI-curves.

2.7.3. Airport Basel

As discussed in chapter 2.3.2., the selection process for the research in Basel was changed and the number of measuring points was doubled. The measuring time was reduced to 24 hours per measuring location.

The choice of measuring locations within the noise zones which had been established by the new process could be constructed along the same lines as in Zurich and Geneva.

2.8. THE DISTRIBUTION OF INTERVIEWS BY MEASURING LOCATIONS /38

	Test areas in Zurich		Test areas in Geneva		Test areas in Basel	
	noise	no noise	noise	no noise	noise	no noise
Size of area with air noise 30NNI (m^2)	138'000'000	---	81'000'000	---	13'000'000	---
Tested areas (m^2) total, all noise zones	12'600'000	700'000	8'400'000	930'000	250'000	54'000
median area per measuring point	375 x 375m 144'000 m^2	180 x 180m 33'000 m^2	260 x 260m 68'000 m^2	240 x 240m 58'000 m^2	42 x 42m 1760 m^2	37 x 37m 1350 m^2
median area per interview	100 x 10[illegible]m 10'500 m^2	42 x 42m 1'750 m^2	87 x 87m 7'500 m^2	48 x 48m 2'300 m^2	18 x 18m 340 m^2	15 x 15m 220 m^2
median no. of interv. per measuring point	14	19	9	25	5	6
number of interviews	1196	275	1125	399	736	208
number of measuring points	87	21	124	16	142	40

During the time from March 1972 until July 1972 noise measurements were conducted at a total of 182 locations. Approximately 250 individual sound level peaks from airplane movements were measured for the determination of curves of an equal PNdB.

3. NOISE MEASUREMENTS /39

3.1. Introduction

As discussed in chapter 1, the reaction to an acoustical stimulus is dependent on the following external physical conditions:

1. on the acoustical stimulus intensity
2. on the acoustical stimulus background
3. on the frequency of the acoustical stimulus
4. on the sequence of acoustical stimuli.

The intensity of stimulus is normally not a strictly physical measure but takes into account already psycho-physiological aspects, like the annoyance caused by the wavelength distribution or the frequency distribution of a sound level. Wavelength and frequency distribution can be determined by measurement with evaluation filters and sound level statistics.

The stimulus background refers to the acoustical stimulus situation without the consideration of vocal acoustical stimuli. A generally accepted operational definition for the acoustical background, however, is presently not in existence.

The stimulus frequency, that means the number of acoustical stimuli in a certain time interval can be determined in the case of airplane noise by the counting of the airplane noise peak values, established by measurement. In the case of traffic noise this is not possible. The traffic density has to be determined by actual traffic count. In the present study the traffic density was only estimated.

The stimulus sequence is the temporal course of stimulus intensity and stimulus frequency. In the following discussion stimulus frequency is considered by differentiating three time-of-day periods. To this day many noise measurements have been developed, which address themselves to certain of the many aspects or to certain noise situations (street or airplane noise, etc.).

Some of the approximately 60 different noise scales will be discussed in the following. Since the intercorrelation between airplane and surrounding noise was not known at the /40 beginning of the study, the selection of the optimal noise scale could only occur after the measurements were concluded. Therefore a noise measurement method was chosen which is capable to deliver the most comprehensive acoustical basic data.

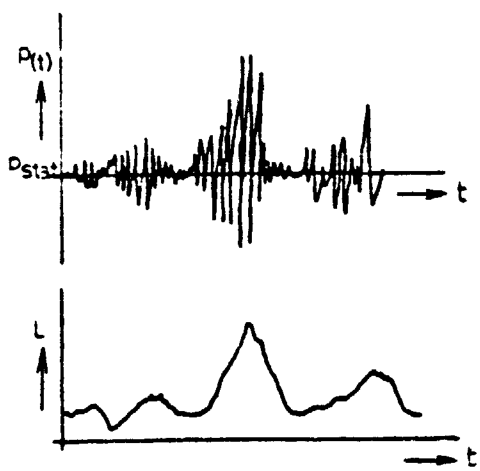
3.2. DEFINITION OF PHYSICAL QUANTITIES

All noise measurement is based on measurable physical quantities which are evaluated by empirically developed methods. Therefore the scales used in the technique of sound measurement have to be initially defined and explained.

3.2.1. Sound Pressure and Sound Pressure Levels ISO R 131

The term sound pressure is referring to the effective value of pressure fluctuations which are superimposed on the air pressure.

Figure 3.1: Sound pressure as a function of time



$$p = \sqrt{\frac{1}{T} \int_0^T p(t)^2 dt}$$

p = effective value of sound pressure
P(t) = momentary value
T = constant of time
L = sound pressure level
t = time

μ bar = 10 $^{-6}$ is commonly used as a measuring unit for sound pressure. /41

1 bar = 760 mmHg. The human ear is capable of processing sound pressures from 2 · 10 $^{-4}$ μ bar (hearing threshold) to 200 μ bar (pain threshold). It therefore seems sensible to use the logarithmic measure decibel (dB) to cover this wide range of variations. Therefore the sound pressure level was defined as follows·

$$L = 10 \cdot \log \left(\frac{P}{P_o}\right)^2 = 20 \cdot \log \frac{P}{P_o} \quad (dB)$$

Reference sound pressure Po is the pressure Po = 2×10^{4} bar (sound threshold). Thus the sound pressure range goes from 0 to approximately 120 dB.

3.2.2. The Sound Frequency Distribution of Sound Pressure

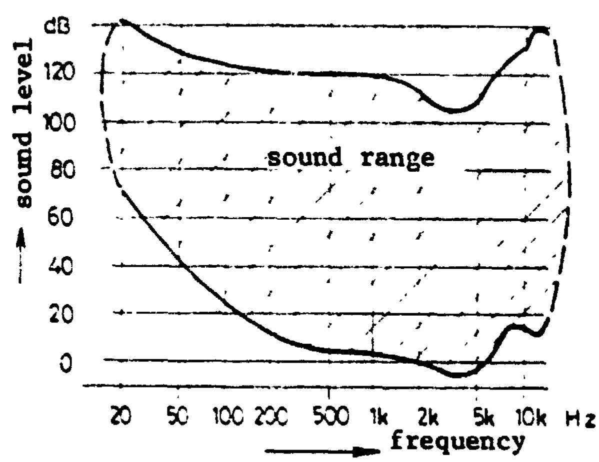
The frequency range of sound pressure is divided into three areas:

1. <u>Infra Sound Range</u>
   Frequency area below the capabilities of the human ear, e.g. below 16 Hz.

2. <u>Sound Range</u>
   The frequency area corresponding to the human range of hearing, e.g. 16 Hz to 20 Hz.

3. <u>Ultra Sound Range</u>
   Frequency area beyond the capability of the human ear, e.g. over 20 KHz.

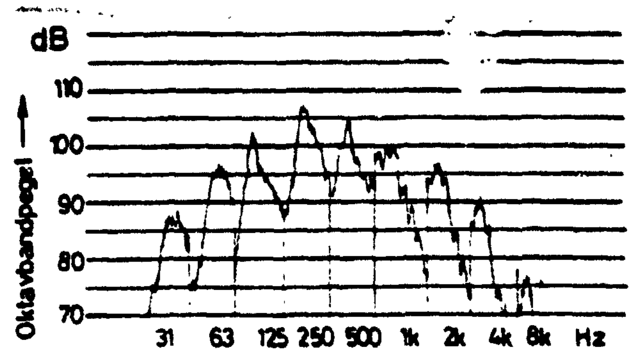
Figure 3..2 **Sound range of the human ear** /42



The sound range was subdivided into thirds and octaves, whereb the median band frequency changes from octave to octave by the factor of two.

The frequency course of a sound is the course of the sound level of individual filters as the function of the frequency. Such a frequency analysis is usually conducted with the aid of octave, third or narrow band filters.

Figure 3.3.: Frequency analysis start of DC-9 at 200m

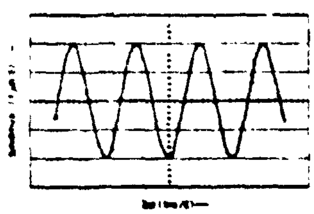


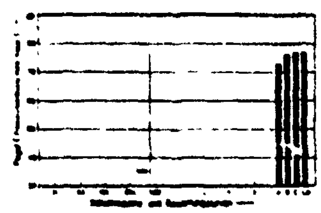
Because of the differing constellations of frequency spectra tone, sound and noise can be defined. /43

pure tone:

400 Hz

pressure variations have pure sine shape

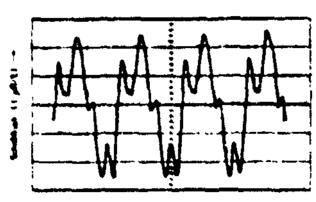


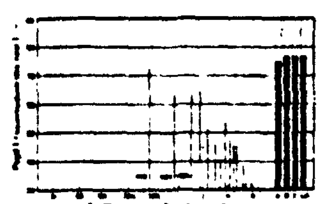


sound:

violin "a"

harmonics are added to sinus vibrations (line spectrum)

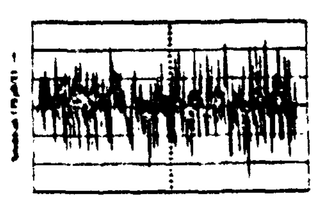


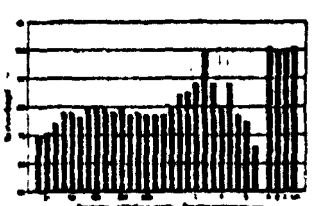


noise:

Boing 707

in this sound event a theoretically unlimited number of different frequencies are involved (band spectrum)



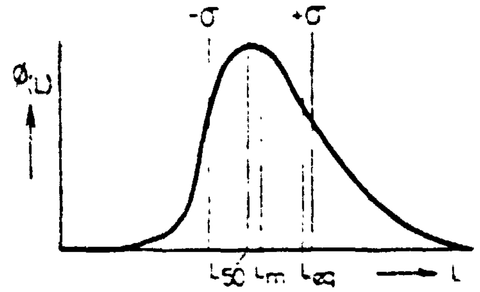


Generally, in the case of street and airplane noise studies we are concerned with noises which usually contain a single dominating frequency. /44

3.2.3. Frequency Distribution of Sound Levels

The sound pressure level is a non stationary value. It fluctuates in a certain range around its median value. This fluctuation can be evaluated by means of sound level statistics, in which case the temporal frequency distribution of sound levels is determined.

Figure 3.5.frequency distribution of sound level L



$$\int \phi_{(L)}\ dL = 1$$

The frequency distribution $\phi(l)$ is used for the determination of median values L_m and L_{eq} or of sound level scatter during a certain measuring period, for instance an hour or a day.

$$X = \int_0^{L_x} \phi_{(L)}\ dL$$

$$L_m = \int L \cdot \phi_{(L)}\ dL$$

$$\sigma = \sqrt{\int (L - L_m)^2 \phi_{(L)}\ dL}$$

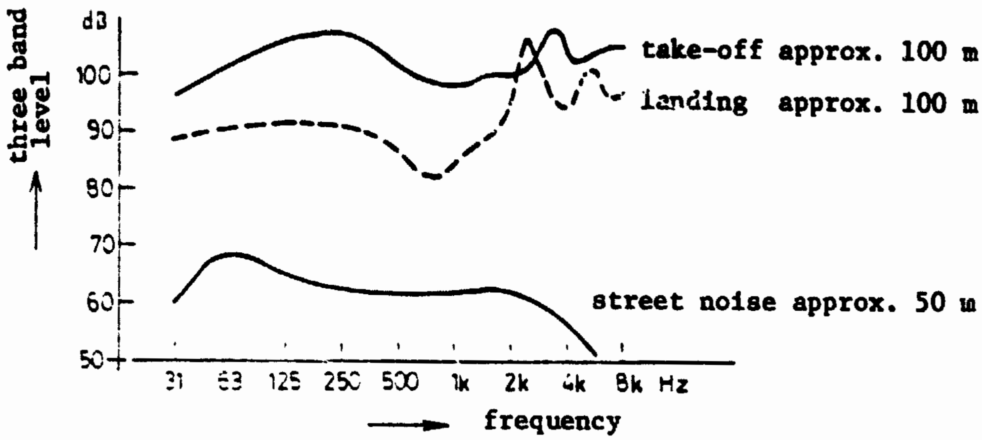
$$L_{eq} = 10 \cdot \log \int \phi_{(L)} \cdot 10^{L/10}\ dL$$

3.2.4. Sound Sources /45

In this investigation airplane and traffic noises are of special importance. Both of these sound sources differ in some very essential points.

In todays jet propelled airplanes the sound is essentially produced by the turbulence created by the emission of hot gases. The sound of traffic noise is chiefly produced by vibrating solid bodies or air columns. Therefore there is a very essential difference in the frequency composition and intensity between airplane and street traffic noises.

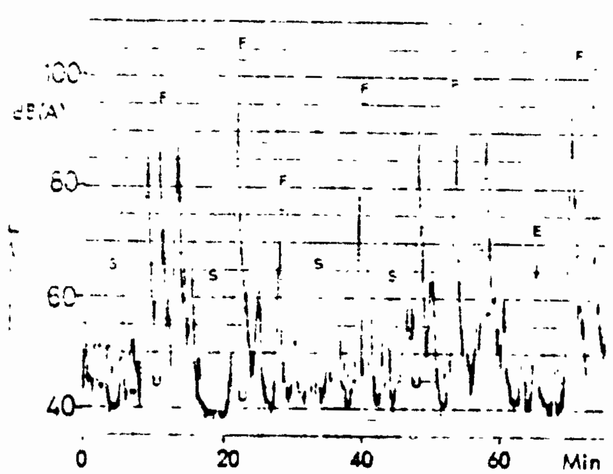
Figure 3.6. Frequency spectrum of airplane and street noise



While airplanes appear practically always as point sources of sound, street ~~coveny~~ances can, depending on traffic density and distance to the receiver, produce either point or line sources. (Single vehicle or traffic column). The geometrical expansion conditions are therefore also different for airplane and street noise.

Besides the effective duration of both of these sound sources is quite different.

Figure 3.7. Sound level diagramm

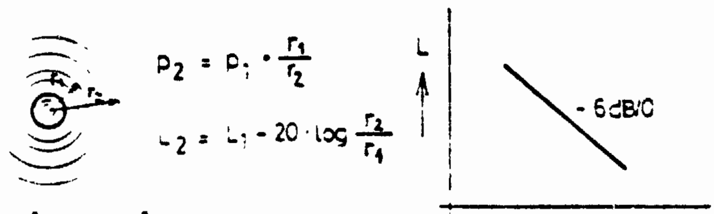


/46

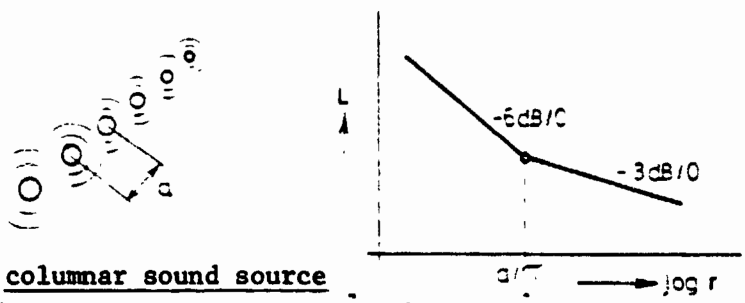
3.2.5. Sound Muffling

Sound muffling refers to the reduction of the sound level by the geometric spreading, by absorption and by mechanic muffling. The geometrical muffling is dependent on the size and shape of the sound source and of the distance to the receiver. It is a frequency independent unit.

Figure 3.8. Geometrical damping of sound propagation for point and columnar sound sources



squeric sound source
(e.g. airplane)

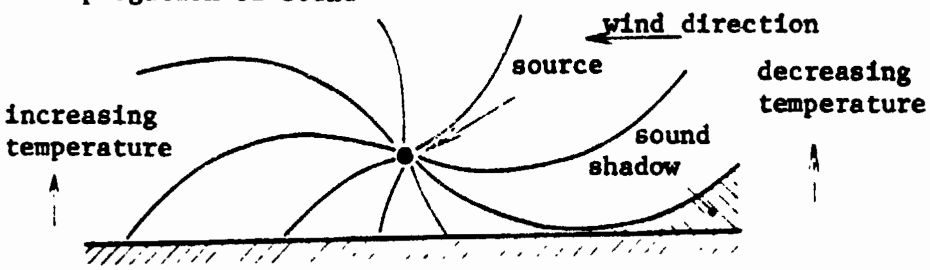


columnar sound source
(e.g. column of automobiles)

The sound loss which occurs in the case of the spreading of sound by means of air absorption and ground absorption is frequency dependent and decreases proportionally to the distance between source and receiver. /47

Wind direction and temperature gradient influence the spreading of sound, especially over greater distances. It is possible to find sound level increases as well as sound level decreases.

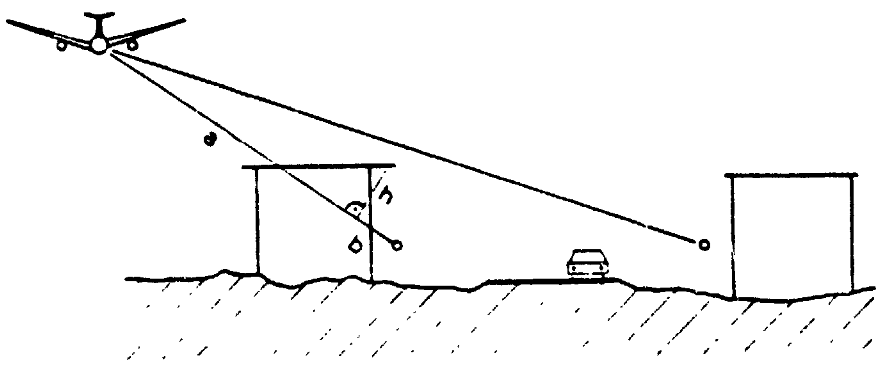
Figure 3.9. Influence of wind and temperature gradiants on the progation of sound



3.2.6. Sound Obstruction

In field tests sound obstructions through hills, walls, dams and buildings, are of great importance. Besides, it affects the frequency spectrum at the point of reception. The selection of microphone positions is therefore of special importance.

Figure 3.10. Obstacle damping



Sound interference through obstacles is dependent on the distance from the obstacle source "A", the obstacle receiver "B", from the effective height of the obstacle and from the vibration intensity "F". It varies within a range from five to twenty-four dB [24]. /48

3.3. SUBJECTIVE EVALUATION OF SOUND PRESSURE

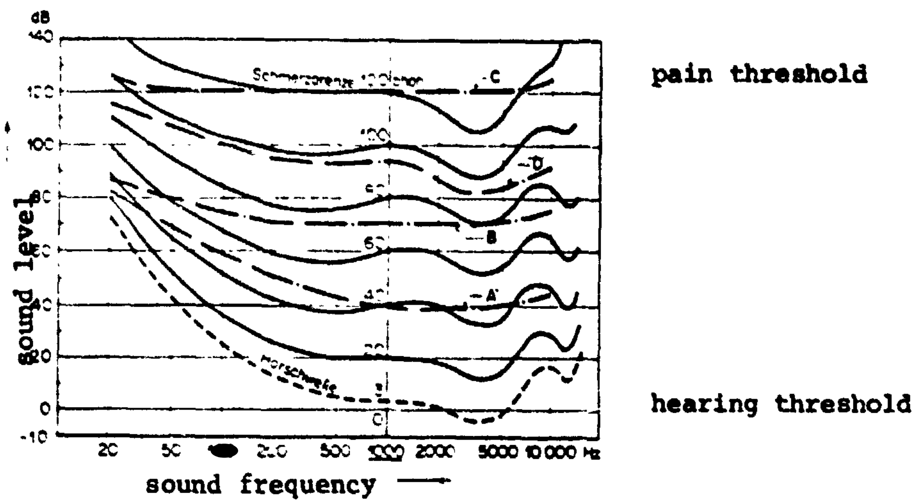
The translation of a sound pressure into a hearing perception is not completely explained to this day. Many factors play an important part in the process which can not be physically explained. Physiological properties of the ear have partially been explored by comparing the sound process with a reference sound, for instance the standardized curves for pure tones of equal volume [25] (Figure 3.11). From these curves it becomes obvious, how exceptionally complex the context is between hearing sensation and sound pressure of a variable sound. Different methods make such an evaluation of the sound process possible and are able to indicate subjective sensations quite well.

3.3.1. Evaluation of Sound Frequency Distribution

3.3.1.1. The Evaluated Sound Pressure Level

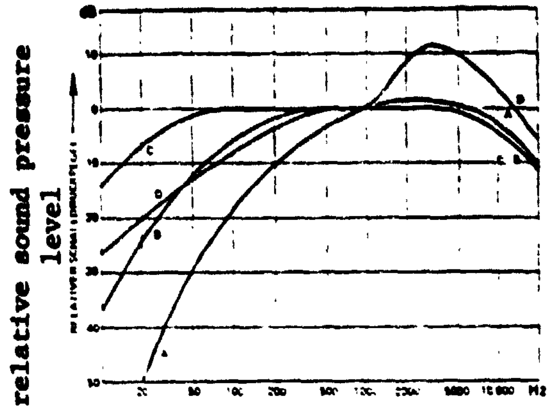
The sound level, evaluated by means of a filter curve A, is one of the oldest and most widely used scales of the physiological evaluation of sound. It can easily be determined with the help of a standardized sound level meter and a standardized filter curve. [40]. The acoustical sensitivity curves in figure 3.11 show that sound levels below approximately 400 Hz are perceived less loudly when the frequency is decreasing.

Figure 3.11. Curves of equal sound volume as the function of the frequency /49



The evaluation curve A in figure 3.12 takes this fact into account and muffles the lower frequencies during sound level measuring. Especially in the lower sound level regions it corresponds approximately with the acoustical sensitivity curves, while curves B and C are suitable for comparison between th: middle, respectively higher ranges. See figure 3.11. However, for general noise metering today the A curve is used increasingly for middle and higher sound levels without leading to essential discrepancies between sound level and perceived disturbance.

Figure 3.12: Evaluation Curves A,B,C and D



The D-Curve deals especially with the annoying frequencies between 2,000 and 4,000 Hz. They are somewhat more suitable for airplane noise measurements than the A curve [21]. /50

3.3.2. Loudness, Volume and Annoyance of Sounds

This process considers the frequency distribution of sound levels, the volume and the loudness functions as well as the over lap effects. They permit a volume calculation of continuous sounds without direct auditory comparison.

3.3.2.1. The Zwicker System [26]

The measured three band harmonic frequency curve levels are entered into a special diagram and under consideration of the overlap effect connected with each other. The resulting area below this curve is a measurement for volume.

This process is rather involved and not very suitable for field work.

3.3.2.2. The ISO Curves N [34]

Sound evaluation curves can be used to determine the annoyance of disturbing influences on verbal communication. They are especially suitable for the evaluation of noise disturbance in industry and office. They are not suitable for airplane noise research.

3.3.2.3. Speech Interference Level SIL [38]

This measuring system is used predominantly in America but it does not represent a volume annoyance or stress measurement. It simply gives the sound level within the frequency range from 600 to 4,800 Hz which is very important for verbal communication. For this sociological study of airplane noise it has no importance since the frequency spectrum of 600 to 4,800 Hz is too narrow for airplane noise.

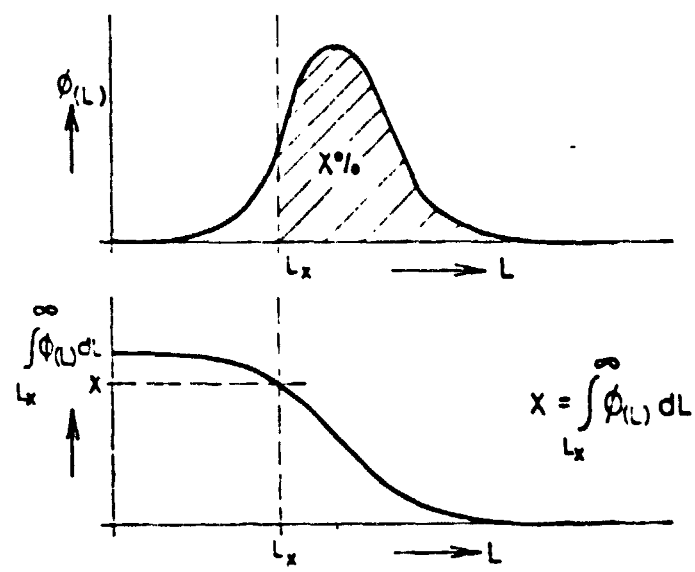
3.3.3. Evaluation of Frequency Distribution /51

3.3.3.1 The Sum Total Level L_X

The standardized sum total level which is contained in ISO Doc. 1996 is based on statistical median values of a sound that fluctuates over time.

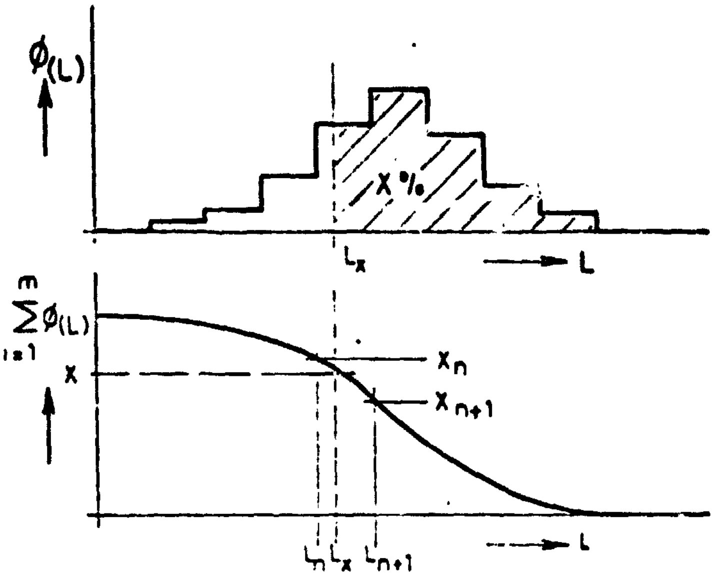
To the evaluation of the sound frequency spectrum, which has already been discussed, we now add the distribution of the repetitiveness of the sound level. The sum total level L_X indicates the sound level border which has been exceeded during X% of the total metering time.

Figure 3.13: Frequency and sum total distribution of sound level L



Generally the frequency distribution is expressed in M classes of a sound level statistic. And the sound frequency results are expressed in the A-curve. /52

Figure 3.13a: Frequency and sum total distribution of Sound level L



$$L_x = L_n + \frac{L_{n+1} - L_n}{X_{n+1} - X_n} \cdot (X - X_n)$$

L_x = **sum frequency level**

L_n = **lower limit of class n**

X_n = **sum frequency at the low end of class n**

3.3.3.2. Energy median value L_{eq}

In establishing a median value from a number of individual measurements the "distorting influence" of the logarithmic scale has to be taken into consideration. That means that a median value has to be developed not only for sound level L but also for the sound level energy.

/53

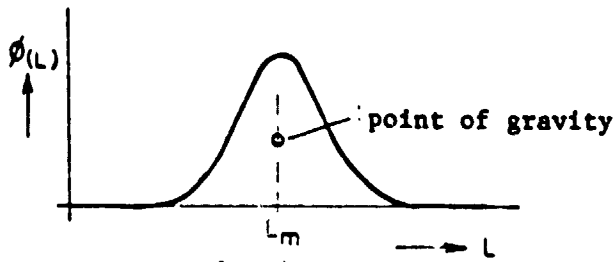
$$L_{eq} = 10 \cdot \log \frac{1}{N} \cdot \sum_{i=1}^{N} 10^{L_i/10}$$

With a Gaussian distribution of sound levels the mean value of energy will always lie higher than the sum total level L_{50}.

3.3.3.3. Arithmetic Mean Value L_m.

The arithmetic mean value is a purely theoretical measurement which is only used to establish the frequency distribution if the values are widely scattered and skewed.

Figure 3.14: Arithmetic mean value of sound levels L



$$L_m = \frac{\int L \cdot \emptyset_{(L)}\, dL}{\int \emptyset_{(L)}\, dL}$$

Falls $\int \emptyset_{(L)}\, dL = 1$

$$\Rightarrow \quad L_m = \int L\, \emptyset_{(L)}\, dL$$

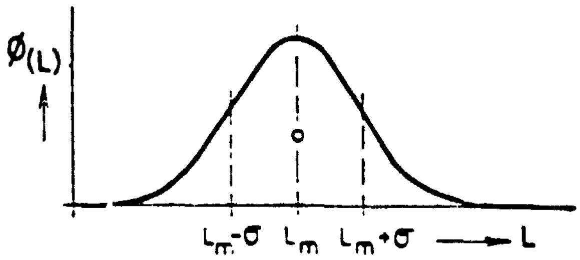
The arithmetic mean value no longer agrees with the L_{50} value in the case of a skewed frequency distribution. Generally in a positively skewed curve the L_m is smaller than L_{50}.

3.3.3.4. Sound Level Scatter σ /54

A typical value in the description of a sound situation is sound level scatter σ. It has, for instance, been used by W. Robinson in Noise Pollution Level.

Figure 3.15: Sound level scatter

$$\text{Definiton:} \quad \sigma = \sqrt{\int (L-L_m)^2 \phi_{(L)} dL}$$



$$2\sigma \approx L_{16} - L_{84}$$

2 σ therefore is that sound level range which contains approximately 68% of all sound events. In territories of airplane noise the sound level scatter is correspondingly quite close to the distinguishability of airplane sounds over the surrounding noise.

3.4. Airplane and Street noise measuring units

Noise measuring units have the purpose to express the perceived disturbance of individuals who are exposed to a certain noise exposure. Since the connection between subjective perception and physically measured units is dependent to a large degree on the noise situation and the noise source specific noise measuring units were developed frequently for particular noise situations. Principally these can divided into three groups:

1. Group: Measurements which describe the general background and street noise which are little or not at all influenced by airplane noises. /55

2. Group: Measurements of airplane noise which is not at all or hardly affected by street or surrounding noise.

3. Group: Measurements which contain both components, surrounding noise and airplane noise in a suitable manner.

3.4.1. Measuring units for surrounding noise

With airplane noise playing a dominant role in the areas chosen for the study, it can be expected that the median values and especially the noise peaks are influenced by airplane noise. Street and surrounding noises which are established by means of sound level statistics must, therefore, be checked for their independence from airplane noise. This control of independence and the selection of optional traffic noise measuring units are discussed in chapters 3.6 and 4.4.

3.4.1.1. Basic Sound

The basic sound is a sound level which is created by sum of all sound sources in the surrounding environment of the location of measurement in the absence of the dominant, noise source to be researched. It is in the range of the sum total level between L_{90} and L_{99} and belongs to the lowest noticable sound levels

3.4.1.2. Measuring Units for Surrounding and Street Noises /56

All possible street noise measurements were included in the sum total levels L_{80}, L_{70}, L_{60}, L_{50}, L_{40}, L_{30}, and L_{20}. A range of such great extent in the sum frequency was chosen for two reasons. First, it helps establish which measurement agrees best with the preceived disturbance by traffic noise. Second, it shows which measurement is still relatively dependent on airplane noise. Street noise measurements which put too much emphasis on noise peaks like the traffic noise index TNI are not suitable for these studies because they are affected too much by airplance noise. Unfortunately it is not possible to separate street noise from other surrounding noises by means of measurements alone. This requires additional traffic counts. In the study and following discussion the traffic density was, however, estimated.

3.4.2. Measuring Units for Airplane Noise

All presently known measuring systems of airplane stress contain more or less complete information about the intensity and the sound spectrum of the sound sources as well as the frequency and the course of the sound occurences. Principally they can be measured as well as calculated. For the purpose of planning the calculation process is of special importance. For psychological research as in the study presented however measurements have to be preferred because they make it possible to take into account additional variables like air route distribution, topography etc.

3.4.2.1. Sumtotal Levels

As already mentioned in chapter 3.4.1., especially the noise peaks (L_{10}, L_5, L_1, $L_{0.1}$) are effected by airplane noise. The degree of influence, however, is very much dependent on the noise situation as such, e.g. how the airplane noise compares to the surrounding noise situation. Because of this interdependence of sum total levels these are only conditionally suited for the characterization of airplane noise in different areas. /57

3.4.2.2. Perceived Noise Leve PNL [27]

The noise level is one of the most frequently used measurements for the determination of airplane noise. Often it is used as a noise component in stress measurements. For the exact determination of the noise level it is necessary to conduct a sound frequency analysis, in which case only the peak value in every frequency band of a passing airplane is used. The individual three band levels are converted to noise levels Noy and added up to receive a total Noy value.

$$N_{tot} = n_{max} + 0,15 \times \left(\sum_{i=1}^{24} n_{(i)} - n_{max} \right) \quad \text{(Noy)}$$

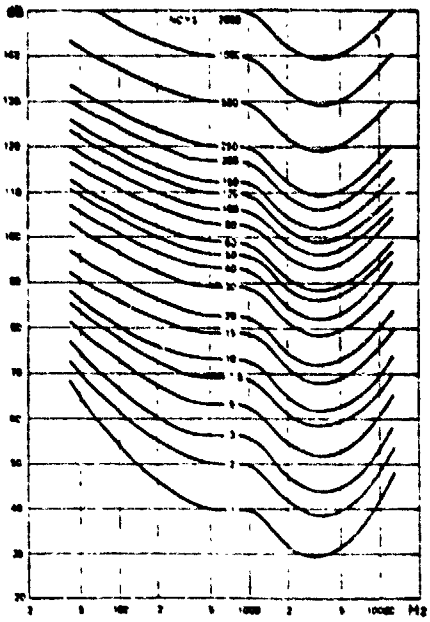
n_{max} = maximal noise value of all three band frequencies

$n_{(i)}$ = Noy value of the three band i

N_{tot} = Total Noy value

Figure 3.16: Curves of equal noise /58

three band level



frequency

To calculate the noise level based on the resulting noisiness we use the following formula.

$$PNL = 40 + 33{,}3 \cdot \log N_{tot} \qquad (PNdB)$$

This process for the determination of the PNL is only suitable for individual tests or for tests in the laboratory. For field research it is possible to use an approximation process which gives an approximately equally valid agreement of noise level and perceived disturbance.

The D-Curve discussed in chapter 3.3.1.1. corresponds relatively well to the Noy values, however, the D-Curve has to be raised by seven (7) dB.

$$PNL \approx L_{(D)} + 7dB = L_{(N)}$$

This leads to a new evaluation curve N. Prior studies have shown very good agreement between noise level and sound levels based on the N-Curve. Also the correlation between sound levels based on the N-Curve and the perceived disturbance is practically equally high, just as these between the perceived noise level and the perceived disturbance. /59

$$r_{PNL,PA^{1)}} = 0{,}880 \qquad \sigma = 3{,}32$$
$$r_{L(N),PA} = 0{,}879 \qquad \sigma = 3{,}33$$

The approximation method by means of sound levels which is based on the A-Curve leads to equally good results. It also makes the simultaneous determination of surrounding noises possible.

$$PNL \approx L_{(A)} + k$$

The factor K is dependent of the frequency spectrum. For most of the airplanes which are in use today it can be assumed that the K value equals 12 dB in the closer proximity to airports in which case the error does not exceed ±1 dB [21].

$$r_{L(A),PA} = 0{,}867 \qquad \sigma = 3{,}48$$

3.4.2.3. Effectively preceived noise level EPNL

Based on prior research the PNL was developed into the EPNL. This takes into consideration the influence of pure tones and the duration of the noise disturbance.

$$EPNL = PNL\,T + D \qquad (EPNdB)$$
$$PNLT = PNL + C \qquad (TPNdB)$$

D = Duration correction ca. -10 to +10 dB

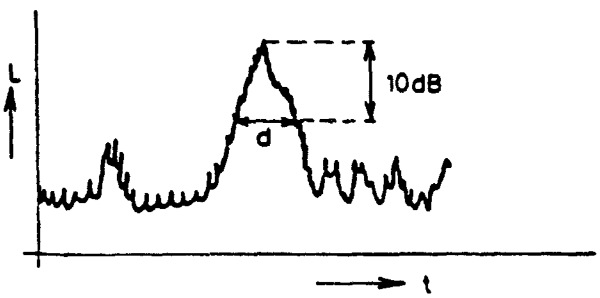
C = Tone correction 0 to $6\frac{2}{3}$ dB

1) PA = Directly perceived disturbance by airplane noise

The process to determine the tone correction is rather complicated and is explained in the ISO-Recommendation R 507 [27]. /60

An approximate "Duration correction" can be achieved with the following formula: [21]

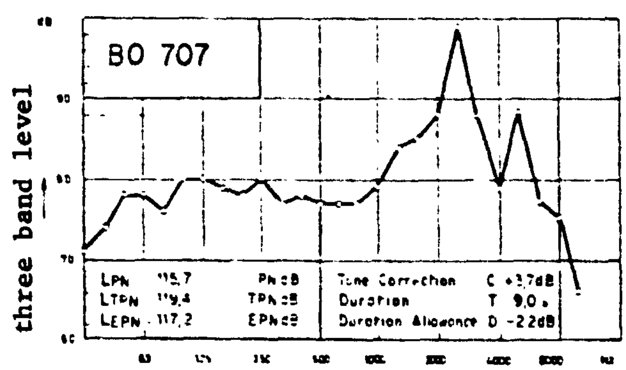
Figure 3.17: Effective duration of airplane noise



$$D \approx 10 \cdot \log \frac{d}{15}$$

This EPNL-Process is so complex and expensive that the evaluation of tape recordings can only be executed in a specially equipped sound laboratory.

Figure 3.18: Frequency spectrum of a Boeing 707



Besides, the results of American studies do not show a significant improvement of the following correlation coefficient between noise measurements and perceived disturbance by airplane noise.

/61

$$\left.\begin{array}{llll} r_{PNL,PA} = 0,880 & \sigma & = 3,32 \\ r_{L(N),PA} = 0,879 & \sigma & = 3,33 \\ r_{L(A),PA} = 0,867 & \sigma & = 3,48 \\ r_{EPNL,PA} = 0,846 & \sigma & = 3,73 \end{array}\right\} [21]$$

$$\left.\begin{array}{ll} r_{NEF,PA} = 0,32 & \text{(mit EPNL)} \\ r_{CNR,PA} = 0,37 & \text{(mit PNL)} \end{array}\right\} [17]$$

3.4.2.4. Total Noise Exposure TNEL

To calculate the total noise exposure the following formula which is taken from ISO R 507 can be used:

$$TNEL = 10 \cdot \log \sum_{i=1}^{n} 10^{EPNL(i)/10} + 10 \cdot \log \frac{T_0}{t_0}$$

T_0 = 10 sec
t_0 = 1 sec
i = index of n airplane movements

The TNEL gives the energetic sum level of a sequence of noise events during a certain observation time. Observation times can be one hour, one day, one week etc.

Above formula can be easily changed to obtain an analogy to the usual noise exposure values like CNR, R, NEF etc.,

$$TNEL = \underbrace{10 \cdot \log \frac{1}{n} \sum_{i=1}^{n} 10^{EPNL(i)/10}}_{\text{mean airplane noise}} + 10 \cdot \log n + 10 \cdot \log \frac{T_0}{t_0}$$

Here the EPNL measurement is used as "Mean Airplane Noise".

3.4.2.5. Equivalent Continuous Noise Level ECPNL [27] /62

Since the TNEL is dependent on the measuring time the observation time was standardized in the ECPNL to make the comparison of these measurements with other types of measurements possible.

$$ECPNL = TNEL \quad 10 \ X \log \frac{T}{to}$$

T = Observation time in seconds

3.4.2.6. Weighted Equivalent Continuous Perceived Noise Level WECPNL

This measurement was developed by the ICAO but was not accepted by the ISO. Compared to the ECPNL, the WECPNL contains corrections for the time of day, evening, night and for the season (Temperature).

$$WECPNL = \log \frac{4}{8} .10 \ \frac{ECPNLD}{10} \ \frac{1}{8} \ .10 \ \frac{ECPNLE+5+}{10} \ \frac{3}{8} \ .10 \ \frac{ECPNLN+10}{10} \ +S$$

ECPNLD = ECPNL (Day) for time between 7:00 am and 7:00 pm
ECPNLE = ECPNL (Evening) for time between 7:00 pm and 10:00pm

ECPNLN = ECPNL (Night) for time between 10:00 pm and 7:00 am
S = Correction for temperature (± 5 db)

3.4.2.7. Composite Noise Rating CNR [30]

The CNR-Process is based on the use of PNdB-Curves for every flight maneuver.

Based on the sound curves and the movement numbers for day and night a CNR_j-Number is calculated.

$$CNR_j = PNL_j \quad + 10 \cdot \log (N_{Dj} + N_{Nj}) \ -12$$

N_{Dj} number of movements between 7 a.m. and 10 p.m.
N_{Nj} = number of movements between 11 p.m. and 7 a.m.

The resulting CNR-Number represents the energetic sum of the CNR_j-Numbers of all occuring M flight maneuvers. /63

$$CNR = 10 \cdot \log \sum_{j=1}^{M} 10^{CNR_j/10} + K$$

K is a factor for the evaluation of different flight maneuvers and their time of day. It lies between -15 and +10 for starts and landings at between -5 and +10 for idling runs and for movement on the ground. The CNR can be calculated approximately by the following formula: [17]

$$CNR = PNL + 10 \cdot \log N - 12$$

$$N = N_D + 20 \cdot N_N$$

Prerequisite for this approximation is homogenous airplane traffic.

3.4.2.8. Noise Exposure Forecast NEF [31]

The NEF-Process is a refinement of the CNR-Process. The noise curves were

1. Based on effective perceived noise level, rather than on perceived noise level, and
2. Drawn for different flight paths instead of different airplane types.

$$NEF_{ij} = EPNL_{ij} + 10 \cdot \log(N_{Dij} + 16\tfrac{2}{3}\, N_{Nij}) - 88$$

The resulting NEF-Value is obtained by summation of the individual NEF_{ij} values according to the following formula:

$$NEF = 10 \cdot \log \sum_i \sum_j 10^{NEF_{ij}/10}$$

The calculation of the NEF-Values can be somewhat simplified with the following formulas: /64

For the day between 7:00 am and 10:00 pm

$$NEF = EPNL + 10 \cdot \log N_D - 88$$

For the night between 10:00 pm and 7:00 am

$$NEF = EPNL + 10 \cdot \log N_N - 76$$

3.4.2.9. Isopsophic Indices, Index R

The isopsophic index gives the sum of the individual noise volumes during a day between 6:00 am and 10:00 pm. The following components are considered:

- Sound pressure level of individual airplane typ and their individual flying maneuvers.
- Duration of sound events
- Number of airplane movements

The total exposure is composed of individual values for different airplane types and different flying maneuvers.

$$N_i' = PNL - 10 \cdot \log \frac{T}{t} \quad (1)$$

PNL = sound level in PNdB

T = reference time (16 hours)

t = total duration of airplane noise exposure

It is assumed that the total exposure for one (1) individual flying maneuver is an average of thirty (30) seconds. Under these conditions the formula (1) is simplified and changes to :

$$N_i' = PNL - 10 \cdot \log \frac{950}{n} \qquad (2)$$

$$N_i' = PNL \bullet 10 \cdot \log n - 30 \qquad (3)$$

The resulting index is calculated by the addition of the energy values of the individual indices N_i . /65

$$R - 10 \cdot \log \sum 10^{N_i'/10} \qquad (4)$$

The French literature [32] uses a number of different terms for the word general index: INDICE isopsophique, INDICE R or INDICE ISOPSOPHIQUE R. Besides the formula used in psychological research to calculate R deviates from formula three by four units.

$$R = PNL + 10 \cdot \log n - 34$$

To guarantee the comparability of the results of psychological research the index R in the study and the discussion is calculated by this formula.

3.4.2.10. Noise and Number Index NNI

The noise and number index also uses the median peak noises and the median movement number of airplanes in the calculation of total noise exposures. This movement number is defined as the number of airplane movements perceived acoustically during the time of the measurements (6:00 am-10:00 pm). An exact process to measure the median peak noises in PNdB is, however, not given.

For the establishment of airplane noise exposure zones within the range of 30 NNI and above, it is usually sufficient to consider airplane movements above approximately 80 PNdB. In the process of technical determination of airplane noise exposure curves it is, however, often necessary to include airplane movements with levels from approximately 60 PNdB. The reason is to be seen in the big sound level differences which are caused by the scattering of air waves in horizontal /66
as well as vertical direction.

An English psychological study of 1961 [16] led to the following formula:

$$NNI = 10 \cdot \log \sum_{i=1}^{N} \frac{1}{N} 10^{PNL_{(i)}/10} + 15 \cdot \log N - 80$$

$PNL_{(i)}$ = perceived noise level of the i airplane movement

N = number of audible airplane movements between 6 a.m. and 10 p.m.

It was observed, that a doubling of the number of moves resulted in an increase of the level of about 4.5 dB. By definition of the number of moves this correlates closely with the PNL.

In a second sociological study in England in 1967 [33] it was found that with the formula:

$$NNI = PNL + K \cdot \log N - C$$

for different K-Values correlations coefficients of equal magnitude were obtained as in 1961. In addition, it has been shown that the following formula also correlates with the perceived disturbance;

$$NNI = PNL + K \cdot N - C$$

However, contrary to 1961 the NNI-Values in 1961 were based on measurements that were oblique to the flight direction.

3.4.2.11. The Disturbance Index [7]

In Germany the disturbance index $\bar{Q}$ is in use. It can be considered as

a) for a sequence of discrete sound events which ignores the base line sound or

b) a continually fluctuating sound level course which takes the periods of quiet into consideration. /67

The two methods are not identical and lead to values which can deviate from each other by about five dB [39].

Method a) is useful in the description of airplane noise, method b) is useful in the description of general noise situations. It is described in chapter 3.3.3.

The disturbance index $\bar{Q}$ of method a) is followed

$$\bar{Q} = \frac{1}{\alpha} \cdot \log \frac{1}{T} \sum_{i=1}^{k} 10^{\alpha \cdot PNL(i)} \cdot \tau_{(i)}$$

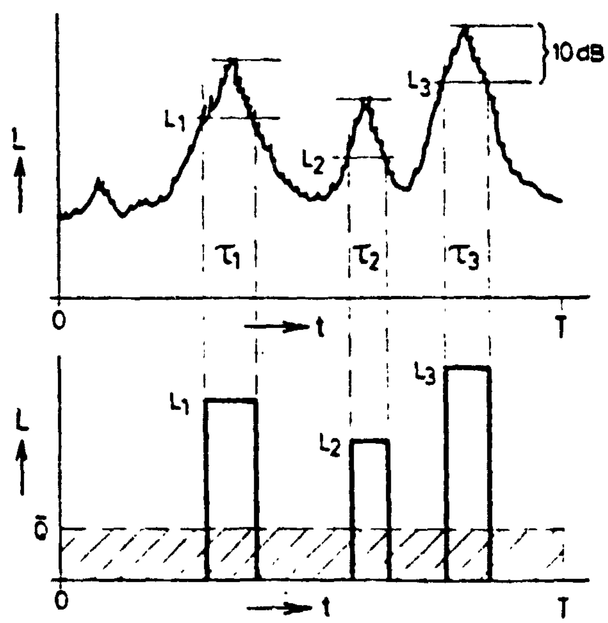
α = equivalency parameter, for instance $\frac{3}{40}$ or $\frac{1}{10}$

$PNL_{(i)}$ = maximally valued sound level of the i sound event, for instance PNdB

τ_i = duration of exposur to sound event i (10 dB below maximum value)

T = length of observation, for instance 12 or 15 hours

Fig. 3.19. Determination of disturbance index $\bar{Q}$ with method c).



/68

The disturbance index $\bar{Q}$ was further developed, based on the above formula, so that the total influence on sound level intensity, movement number, duration and flight path deviations could be taken into consideration. Besides it is possible to assess the baseline noise/peak value ratio by the factor α.

For the simplest case without considering flight path deviations and only one airplane category the formula is:

$$\bar{Q} = PNL + \frac{1}{\alpha} \cdot \log N + \frac{1}{\alpha} \log \frac{\tau}{T}$$

Here the analogy to ECPNL if obvious. The disturbance index is one of the most complete airplane noise measurements which is also suitable for sociological airplane noise studies, since it is based on dB (A) or PNdB measurements.

3.4.2.12. Comparison of the Approximation Formulas of the Most Important Airplane Noise Exposure Measurements

In summation the airplane noise exposure measurements given in chapter 3.4.2. can be calculated with the following approximation formulas. These approximation formulas are valid only if the range of sound levels and the frequency of different flight maneuvers is not too extensive. In cases where different airplane operations with high levels and low frequency, or low levels and high frequency coincide, the exact formulas of chapter 3.4.2. are to be used because the approximation formulas could lead to big errors.

fm 0600 – 2200 hrs

$$NNI = PNL + 15 \cdot \log N - 80$$

$$CNR = PNL + 10 \cdot \log (N_D + 20 \cdot N_N) - 12$$

$$R = PNL + 10 \cdot \log N - 34$$

$$NEF = EPNL + 10 \cdot \log (N_D + 16\tfrac{2}{3} \cdot N_N) - 88$$

$$\bar{Q} = PNL + 13\tfrac{1}{3} \cdot \log N + 13\tfrac{1}{3} \cdot \log \frac{T_{ist}}{T}$$

The most important deviations between the individual airplane noise exposure measurements and the NNI-principle must meet the following characterization: /69

R — Flight sound frequency is less prominently considered. The increase in the case of a doubling of the movement number is only three dB instead of 4.5 dB.

CNR — Night flight movement number is especially stongly considered. Three dB per doubling of movement number.

NEF — Analogous to CNR. In addition it contains the noise component EPNL, the correction factor for the effect of duration and the pure tone components.

4 dB per doubling of the movement number. Consideration of total effective noise exposure duration.

3.4.3. Noise Measurements which are Influenced by Street and Airplane Noises.

A number of noise measurements were developed, to characterize the noise situation with one single figure. This is possible with an evaluation of sound level distributions (Leq) or by the evaluation of the difference:peak values/basic sound level (TNI), or by a combination of median value and sound level range (L_{NP}).

These measurements consider surrounding noise, street noise, and airplane noise. The basis for these calculations is in all cases the sound level statistic.

3.4.3.1. Equivalent Long Term Sound Level L_{eq} [34]

The equivalent long term sound level of a fluctuating sound is a constant sound level of an equal median energy value. The internationally standardized formula, based on the lapse of time in a sound level is:

$$L_{eq} = \frac{1}{\alpha} \log \frac{1}{T} \int_0^T 10^{\alpha L(t)}\, dt$$ /70

α = equivalency parameter

$L_{(t)}$ = valued sound level as a function of time

T = total time of observation

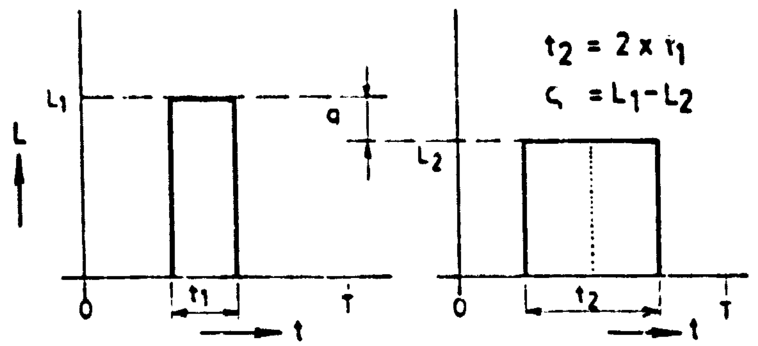
Frequently, however, the L_{eq} is calculated in k sound level classes based on frequency distribution.

$$L_{eq} = \frac{1}{\alpha} \log \frac{1}{T} \sum_{i=1}^{k} 10^{\alpha L(i)} \tau_{(i)}$$

τ_i = length of exposure to the sound level within class i

k = number of sound level classes

The importance of equivalence parameters α or the halved parameters q is demonstrated by the following example. It represents the comparison of two signals with the levels L_1 L_2 with an effective duration t_1 and t_2 while comparing the measurement time T with each other.



/71

$$\frac{1}{\alpha} \cdot \log\left(\frac{1}{T} 10^{\alpha L_1} t_1\right) = \frac{1}{\alpha} \log\left(\frac{1}{T} \cdot 10^{\alpha L_2} t_2\right)$$

$$\log 10^{\alpha L_1} t_1 = \log 10^{\alpha L_2} t_2$$

$$\log 10^{\alpha L_1} - \log 10^{\alpha L_2} = \log t_2 - \log t_1$$

$$\log 10^{\alpha \underbrace{(L_1 - L_2)}_{q}} = \log \frac{t_2}{t_1}$$

$$\alpha q = \log \frac{t_2}{t_1}$$

$$\frac{1}{\alpha} = \frac{q}{\log \frac{t_2}{t_1}}$$

α is therefore dependent on the desired sound level reduction with a doubled effect duration of the sound events. As energy equivalence is given(q = 3 dB)

$$\frac{1}{\alpha} = \frac{3\,dB}{\log 2} = \frac{3\,dB}{0,3} = 10$$

For airport noise q = 4 dB is frequently used,

$$\frac{1}{\alpha} = \frac{4\,dB}{\log 2} = \frac{4\,dB}{0,3} = 13\,\frac{1}{3}$$

For this study, however, it was calculated with q = 3 dB.

The following formula can be used for the evaluation of measurements of sound level statistic counters.

$$L_{eq} = \frac{q}{\log 2} \cdot \log \left(\frac{1}{N} \cdot \sum_{i=1}^{k} n(i) \cdot 10^{\frac{\log 2 \cdot L(i)}{q}} \right)$$

g = bisecting parameter
n = total number of measuring impulses
mi = number impulses in sound level class i
k = number sound level classes
$L_{(i)}$ = median sound level of class i

L_{eq} is a good noise measure to determine the total exposure which is caused by varied noise sources such as airplane noise, street noise, and surrounding noise. Noise peaks are especially emphasized so that the base line noise no long is affecting the L_{eq} in airplane noise areas. /72

3.4.3.2. Traffic Noise Index TNI [35] [36]

The Traffic Noise Index is a noise measure which is especially suited for the description of street noises.

The weight factors of the individual variables in the TNI were determined by multiple correlation analysis.

After some simplification the TNI was defined as:

$$TNI = 4(L_{10} - L_{90}) + L_{90} - 30$$

L_{10} = median noise peaks

L_{90} = median basic sound

The TNI reacts strongly to sound level differences between base line noise and peak noise. Changes of the base line sound are almost as strongly weighted as changes in the noise peaks.

Since the formula of TNI was optimally determined on the basis of pure street noise tests it cannot be used in areas of airplane noise without modification. The results of the study and the discussion confirm this suspicion.

3.4.3.3. Noise Pollution Level L_{NP} [37]

/73

The noise pollution level which was developed by D.W. Robinson is a measure which is supposed to be usable for street as well as airplane noise. In the choice of factors the following three criteria were considered which influence the perceived disturbance.

- energy equivalence of the measurement
- influence of the frequency of the disturbance
- weight of the sound level range.

As definition of the L_{NP} Robinson gave the following formula:

$$L_{NP} = L_{eq} + k \cdot \sigma$$

L_{eq} = equivalent continuous sound level where q = 3

k = empirically established constant

σ = scattering of sound levels

The L_{eq} is evaluating the A or D filter curves. As measurement periods fairly homogeneous time periods like one day or one night are to be chosen.

3.4.4. Choice of Noise Measures

In the choice of measures the degree of agreement between perceived disturbance and noise measurement and the independence of street noise measures and airplane noise measures are taken into account.

More in chapters 4.2. and 4.4.

3.5. METHODS OF MEASUREMENTS

3.5.1. The Measuring Equipment

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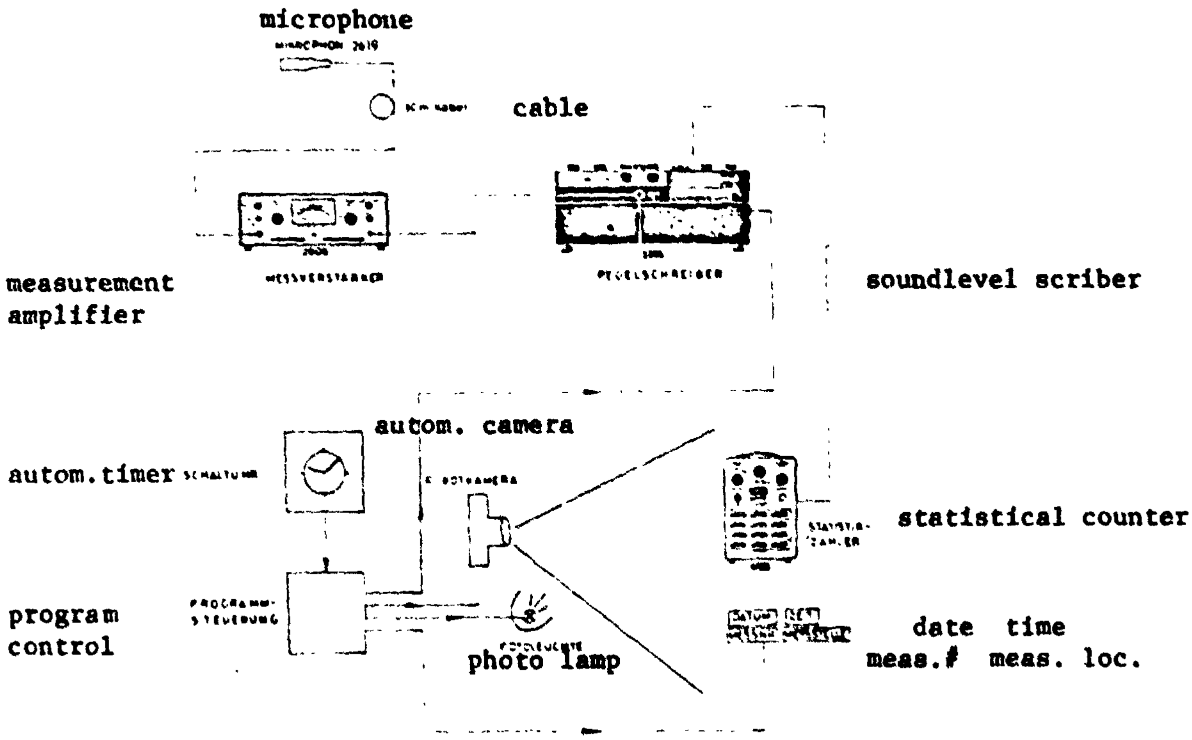
As discussed in chapter 3.4, the frequency of the distribution of sound levels and the airplane noise peaks PNdB have to be measured. The frequency distribution of the sound level is evaluated by means of filter curves A or D. This leads to the PNdB values by approximation.

$$L_{(PN)} = L_{(A)} + 12$$

$$L_{(PN)} = L(D) + 7$$

The equipment used to fulfill these requirements is shown in figures 3.20.

Figure 3.20 Switch schematic of acoustical measuring equipment



3.5.1.1. Microphones used for measurement

/75

Condensor microphones were used since they are especially suitable for measurements outside.

Type B and K 2619 one (1) inch
with Microphone capsule B and K 4145 (Sealed)
with Silica gel spacer ring
with Wind Cover UA 0207
with Humidity Protection EMPA
Frequency range 2-20 kHz
Measuring range 16-144 dB(A)

3.5.1.2. Measurement Amplifier

The amplifier increases the electrical signal and evaluates it with the filter curve A respectively D. Special requirements in respect to dynamic range had to be fulfilled by the amplifier. It was necessary to obtain measurements of base line sounds from between 30 and 40 dB(A) and airplane noise peaks up to 110 dB(A) with the same volume setting.

Type B and K 2606 (Modified EMPA)
Evaluation curves A-D
High and Low Pass
Interferance distance 90dB
Used measuring range 35 dB(A) to 110 dB(A).

3.5.1.3. Curve Writer

The evaluated electrical signal which up to this point is still proportional to sound pressure is transformed in a sound pressure level and then registered by the scribing pen. In this transformation the logarithm of the squared median value of the sound pressure is drawn.

/76

$$P_{eff} = \sqrt{\frac{1}{T} \cdot \int_0^T P(t)^2 \, dt}$$

$$L = 10 \cdot \log \left(\frac{P_{eff}}{P_o} \right)^2$$

The time constant T in the calculation of the effective value can be important, since it influences the peak values and sound level range. Theoretically T should strive for a correct effective evaluation in the infinity range. Practical time constants are chosen, however, which take the physiological properties of the human ear into consideration. Commonly used values are:

- for impulse like sound 35 ms (Imp)
- for normal sound level measurements 100 ms (Fast)
- for measurements in which short term peaks are not of importance 500 ms (Slow)

Type B and K 2305
Indication range 75 dB
Instrument adjustment according to time constant
Fast or 100 dB/s

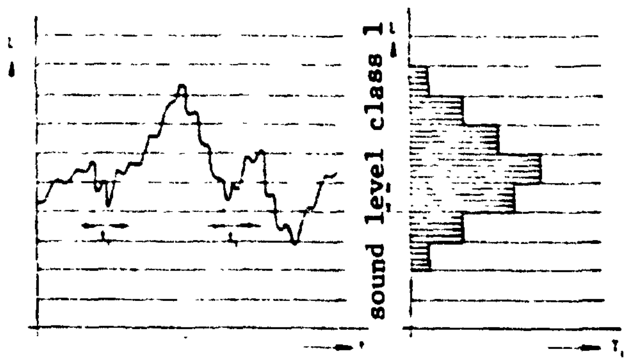
Writing speed 125 mm/s
Potential meter range 40
Lower frequency limit 20 Hz
Paper speed 0.03 mm/s
Paper width 100mm

3.5.1.4. Sound Level Frequency Counter

The complete sound level range was divided into twenty-three (23) classes and the time period of each class was accumulated in a counter system. The scanning frequency was 1Hz, so that even relatively short sound level peaks could be registered. /77

This permitted the calculation of a sum-frequency level of $L_{0,1}$ (infrequent peaks) which, with approximately 7,000 sound level scans, was able to differenciate $L_{0,1}$ from L_0 with an accuracy of 99%. That means that with a scanning sequence of one (1) second the minimum measuring time was approximately two (2) hours. With a scanning sequence of 0.1 seconds, respectively 10 Hz, the measuring time has to be at least 15 minutes.

Figure 3.21: Exposure time of sound levels in class i



t=duration of sound in individual sound level classes

To enable a statistical sound level measurement to deliver representative results the measurement period has to be adequately chosen, e,g. depending on the frequency of sound events, it cannot just be measured for two (2) hours, but a day, an evening, a night or even several days.

Type B and K 4420
2 Counters for 12 classes each = 24 classes
Impulse frequency 1 Hz (10 Hz)
Width of classes up to 71 dB(A) 4,5 dB
Width of classes above 71 dB(A) 3 dB

3.5.2. Evaluation of Measurements

3.4.2.1. Registration and Evaluation of Frequency Distribution /78

During the course of a day, depending on the activity, the attitude of a individual towards noise or the sound situation can change. Therefore the study was conducted during the following three (3) time periods.

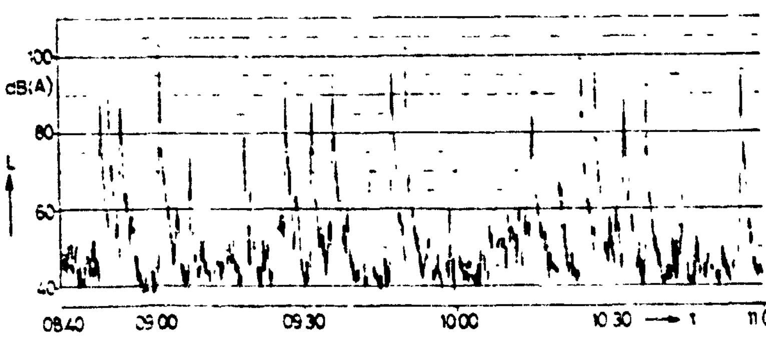
- Day, from 6:00 am to 6:00pm
- Evening from 6:00 pm to 10:00 pm
- Night from 10:00 pm to 6:00 am

Therefore, readings of the frequency distribution of sound levels were taken daily at 6:00 am, 6:00pm and 10:00 pm. This was done with a photographic system. The photographs were directly transfered to key punch cards to be evaluated by machine later on.

3.4.2.2. Evaluation of Airplane Noise Peaks

To calculate the prevailing NNI-Values the airplane noise peaks were read off the sound diagram. Figure 3.22 shows that they are easily distinguished from surrounding or street noises.

Figure 3.22: Sound level diagram



measuring point # 210902, date: 1/22/71 time: 11 a.m.

sound level statistic **peaks of airplane noise**

In this evaluation the following criteria were considered: /79

1. In the case of longer lasting flight noise peak the highest value is to be read.

2. Intermittend or accidentally superimposed peaks are to be ignored.

3. The values obtained are to be rounded off to the next lowest whole dB value.

To permit a comparison between momentary NNI values and median NNI values the momentarily measured flight frequencies for the day and evening periods were standardized to sixteen (16) hours:

$$N\ \mathrm{day(standardized)} = \mathrm{Nday(measured)} \times \frac{16\ \mathrm{hours}}{\mathrm{measuring\ time}}\ \mathrm{(Day)}$$

$$N_{\mathrm{eve(standardized)}} = \mathrm{Neve(measured)} \times \frac{16\ \mathrm{hours}}{\mathrm{measuring\ time}}\ \mathrm{(evening)}$$

3.5.3. Curves of Equal Airplane Noise PNdB

3.4.3.1. Methods

The measurements for the determination of median airplane noises have to stretch over a longer period since intermittent fluctuations, for instance in the combination of airplane types or flight paths used, tend to falsify the results of the measurements. Since especially in Geneva and Basel the measuring times would have had to be extended for several weeks the method of measurement had to be changed.

The modified process was similar to the CNR-Process. For certain flight maneuvers the median sound level progress was measured on a straight line at right angles of flight direction. This allowed construction of curves of an even, median noise level.

The comparison of both measuring methods showed that the transversal measurements lead to a greater precision. /80

For correct execution of airplane noise measurements and the determination cf measuring locations and measuring times the following information had to be obtained from the respective airport administration:

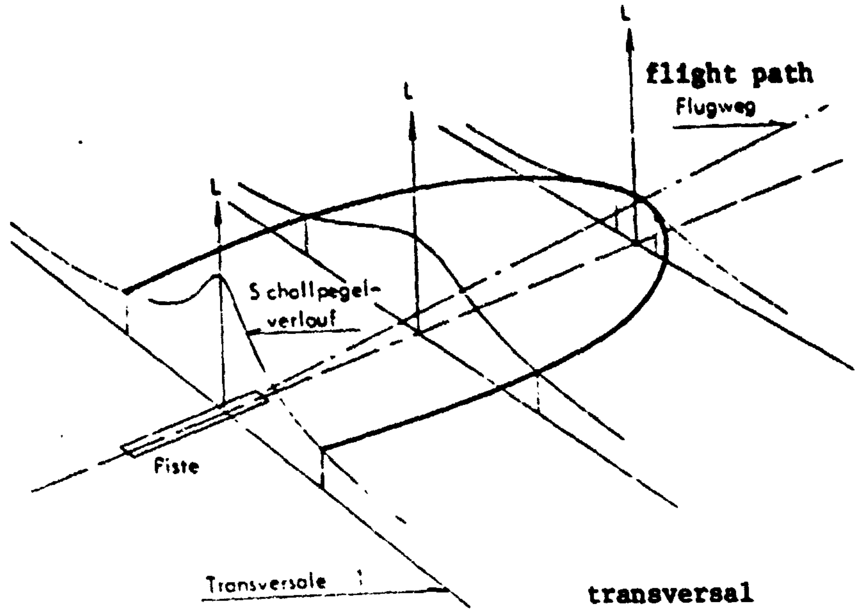
- Flight frequency and flight paths of the individual flight maneuvers.
- Information about deviations from the theoretical flight paths.
- Orientation about special flight maneuvers, for instance in case of sharp (North-Easterly) winds, fog or at night
- Composition of airplane types frequenting the airport
- Course of monthly air traffic numbers during the course of the year.

I possible the respective flight route of the measured airplanes was to be recorded during the measuring time to permit the determination of the influence of air route deviations on the median sound level course. In addition meterological data and the effective number of airplane movements on all runways during the measuring time were to be registered.

3.5.3.2. Execution and Evaluation of Transversal Measurements

The purpose of transversal measurements is the determination of airplane noise. In this study the frequencies were determined by the D-Curve. This leads to more exact results in the conversion of PNdB values. Besides, for transversal measurements only locations without noticeable or surrounding noise were chosen. Since a total of five (5) complete measuring kits were available sometimes five (5) noise measurements could be conducted simultaneously. This led to an improved determination of the course of the sound level along the tranversal. In Geneva, six hundred single sound levels of passing airplanes were measured on nine transversals.

Figure 3.23. Sound level course on a transversal



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Optimally one hundred noise measurements per each transversal and about four transversals for each main flight route would be required.

Based on consecutive noise measurements on a transversal the median sound level course can be established as a function to the lateral distance from the theoretical flight route. By connecting the geographical locations with those of the airplane noise levels the median measured noise curves of PNdB can be obtained. Those noise curves contain the influence of the flight route deviations in horizontal and in vertical direction and the influence of the topography on the spread damping. The deviation of the proportion of certain airplane categories from the yearly averages was considered in the establishment of the median value. The estimated exactness of these noise curves is approximately ±3 PNdB.

3.6. Results of Acoustical Studies /82

3.6.1. Airplane Noise Exposure Curves

In the areas of the three Swiss airports air noise exposure is described by the noise and number index. These NNI Curves connect those geographic locations with equal noise exposure. The determination of these exposure curves can be done either by calculation based on noise curves and median airplane movement numbers or by means of considerable noise measurements in the total study area.

3.6.1.1. Calculated NNI Curves

NNI Curves, based on EMPA calculations were used in the determination of study areas. They also are used by legislative bodies as guides to zone planning.

By definition NNI is dependant on the energetic median value of the airplane noise peaks of all airplane movements (over 80 PNdB) and the average daily number of airplane movements established over a one (1) year period. The noise curves established by the FAA for different airplane types in PNdB serve as the basis for the calculation of noise components. Information about the number of airplane moves, their distribution on the different runways, about start and landing routes,. and information about the proportional share of different airplane types were obtained by the respective airport administrations. The calculation now can be done in four (4) steps.

1. For every airway the energetic sum level is calculated according to the proportional share of different airplane types.
2. A noise curve is chosen which is representitive of the energetic sum level.
3. Based on the resulting noise curves and the corresponding number of movements the NNI curves are established for each air route.
4. In areas which are exposed to noise from several air paths the NNI value is calculated according to the dominant noise source and the sum of all airplane movements. /83

The NNI Curves thus obtained are median values for the whole years. Temporary deviations from the median value can happen because of a number of airplane movements which deviates from the median value, by a different composition of airplane types, by deviation from normal air paths or because of meteorological conditions. This leads to an estimated precision factor of ±5 NNI for the calculated NNI Curves. Figures 3.25 and 3.26 show the calculated NNI Curves for the airports Zurich, Geneva, and Basel.

3.6.1.2. NNI Curves Determined By Measurements /86

To obtain the most accurate data for airplane noise and street noise exposure of each survey location acoustical data were obtained by measurement. As in the case of the calculation

Figure 3.25. Airplane noise exposure curves NNI Airport-Zurich Kloten for 1970 (±5NNI) /84

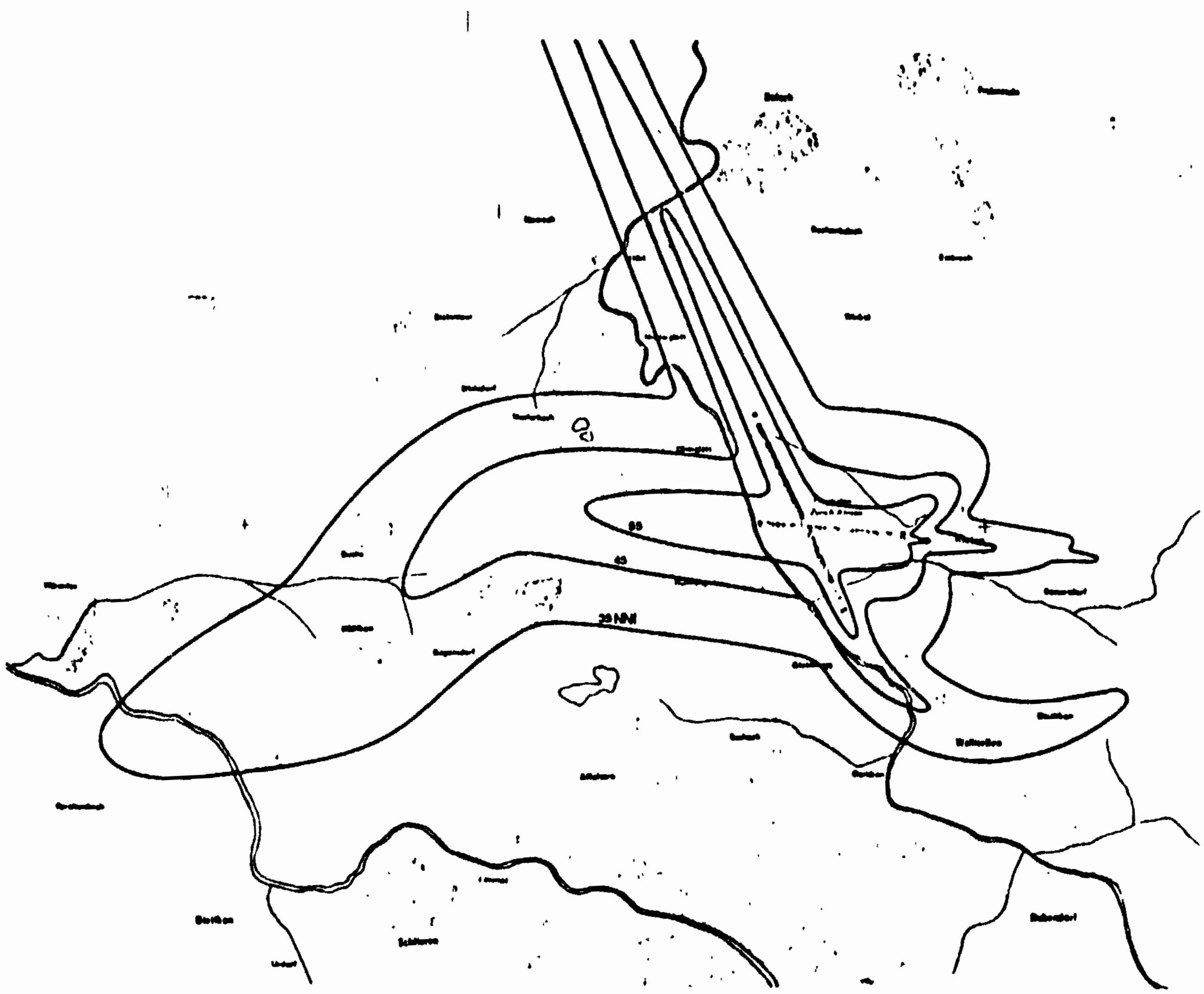

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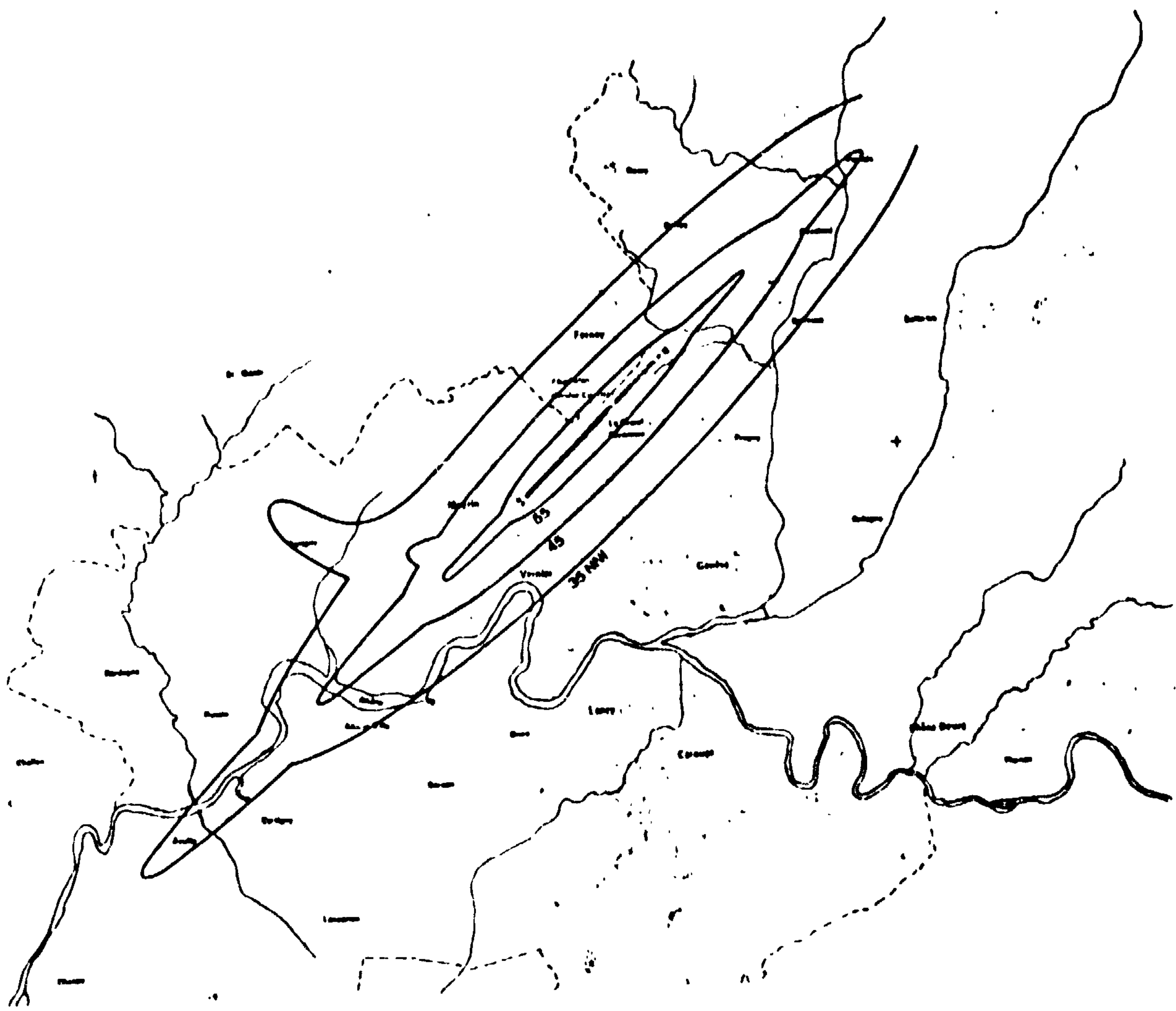
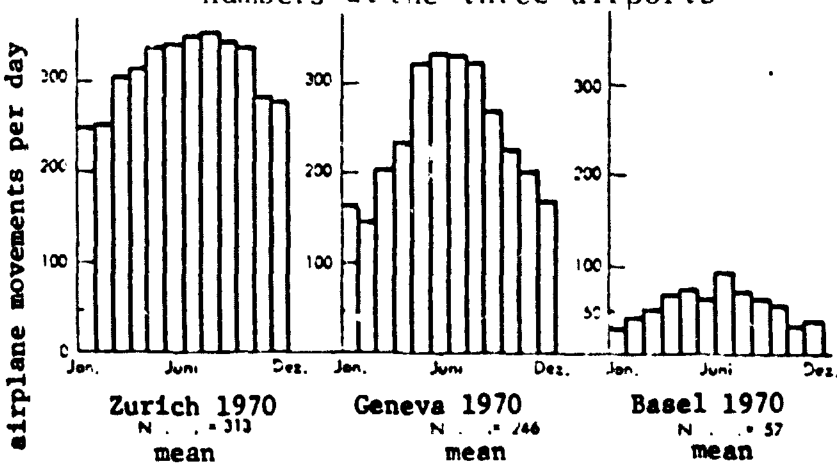
Figure 3.26. Airplane noise exposure curves NNI Airport Geneva-Cointrin for 1970 (±5 NNI) /85



process here too the energetic median values of airplane noise peaks and the coordinated median airplane movement number were used as basis for the calculation of the NNI. The measuring process was also able to take the influences of air route deviations as well as ground muffling of sound waves into consideration.

The average daily number of airplane moves which is obtained by actual count over the course of a year cannot be exactly established by means of noise measurements since the relatively short duration of the measured period, in comparison to one (1) year, cannot give any representative information about the yearly averages. Reasons for the fluctuation of the number of airplane movements are on the one hand the yearly increase in flight frequency, seasonal fluctuations and momentary deviations from the yearly average. Therefore the statistical data of airplane movement number and runway usage which had been supplied by the airport administrations were used.

Figure 3.28: Statistical data of airplane movement numbers at the three airports



The calculation of NNI Curves can only be done analogously to a mathematical process. Special problems occurred, however, in areas in which the noise disturbance was caused by flight operations of differing noise levels. In the case of CNR, NEF, and the Index R, this problem was solved by energetic summation of the individual indices. This leads to the following formula for the NNI: /87

$$NNI = 10 \log \sum_{j=1}^{M} 10^{NNI_j/10}$$

$$NNI = 10 \log \sum_{j=1}^{M} 10^{\frac{10 \log \frac{1}{N_j} \sum_{i=1}^{N_j} 10^{\frac{L_{PN_j}}{10}} + 15 \log N_j - 80}{10}}$$

$$= 10 \log \sum_{j=1}^{M} \left(10^{\frac{L_{PN}}{10}} \cdot 10^{1.5 \log N_j} \right) / 10^{8}$$

$$= 10 \log \sum_{j=1}^{M} \left(10^{\frac{L_{PN_j}}{10}} \; N_j^{1.5} \right) / 10^{8}$$

$$\underline{NNI = 10 \log \sum_{j=1}^{M} \left(N_j^{1.5} \cdot 10^{\frac{L_{PN_j}}{10}} \right) - 80}$$

M = Number of different flight operations involved

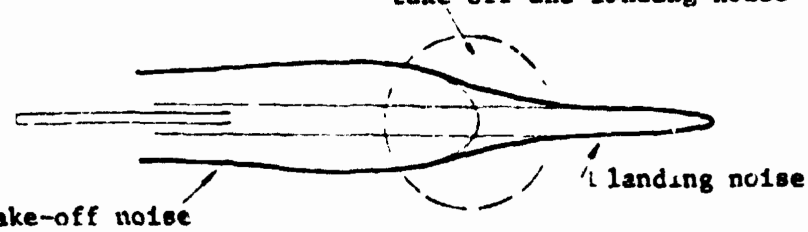
N_j = Mean movement number of operation j

L_{PNj} = Energetic median value of j flight operation

This formula illustrates that in the case of several flight operations at different noise levels the dominating one is the one with the greatest $N_j^{1.5} \times 10^{L_{PN_j}/10}$. In other words the decreasing sound level of flight operation j also decreases the statistical weight of the flight movement number.

In the constructions of the NNI Curves it became apparent that those areas where several operations had to be considered according to the formula above were in relatively narrowly defined areas. /88

Figure 3.29. Effective area of flight operations of different noise levels



The measured NNI Curves of the airports Zurich, Geneva, and Basel are in figure 3.30 and 3.31. Their precision is estimated at about ±5 NNI.

Figure 3.30: Airplane noise exposure curves NNI /89
Airport Zurich--Kloten
Measured 1971
Margin of error ±5NNI

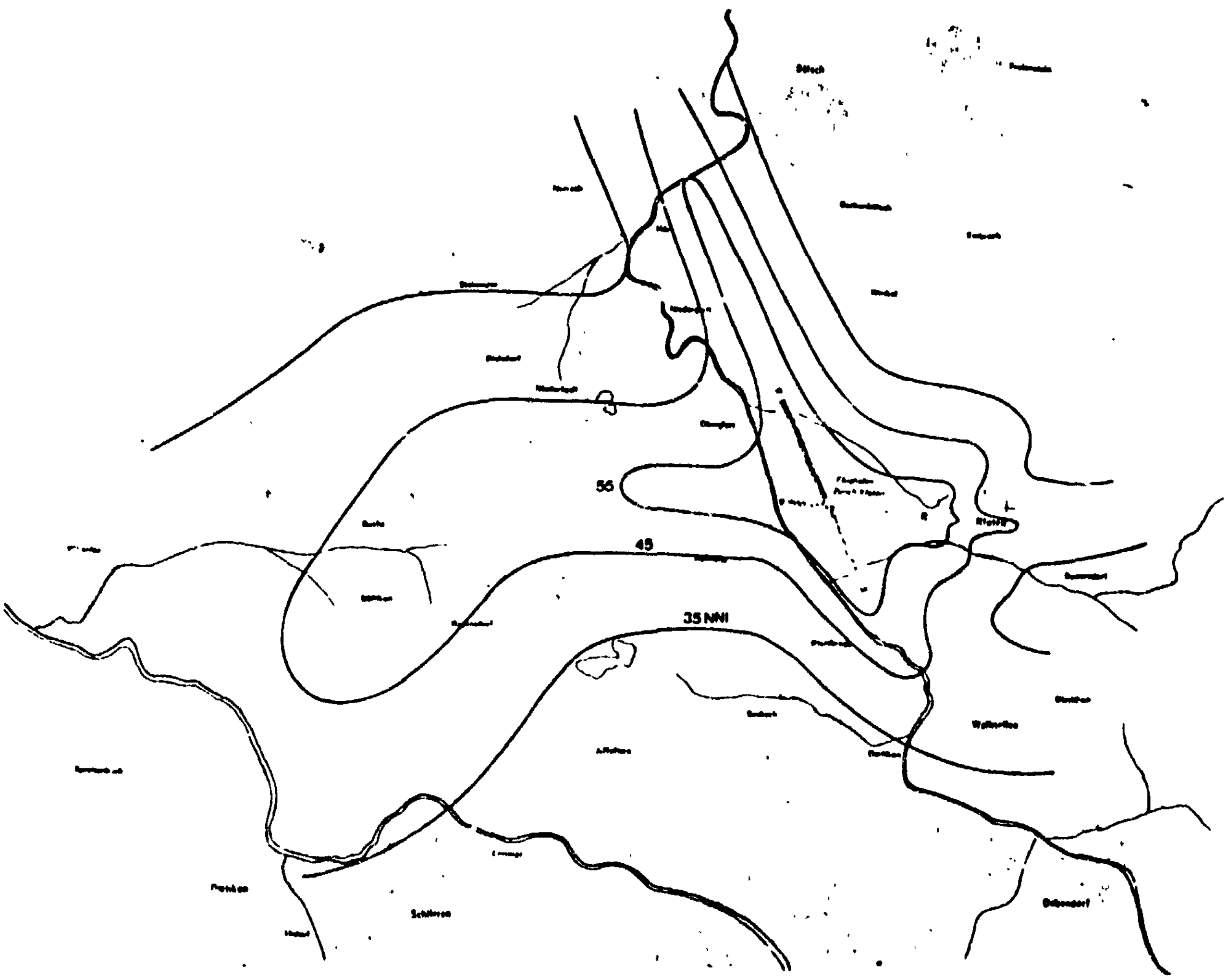


Figure 3.31: Airplane Noise Exposure Curves NNI
Geneva-Cointrin
Measured 1972
Possible margin of error ±5 NNI

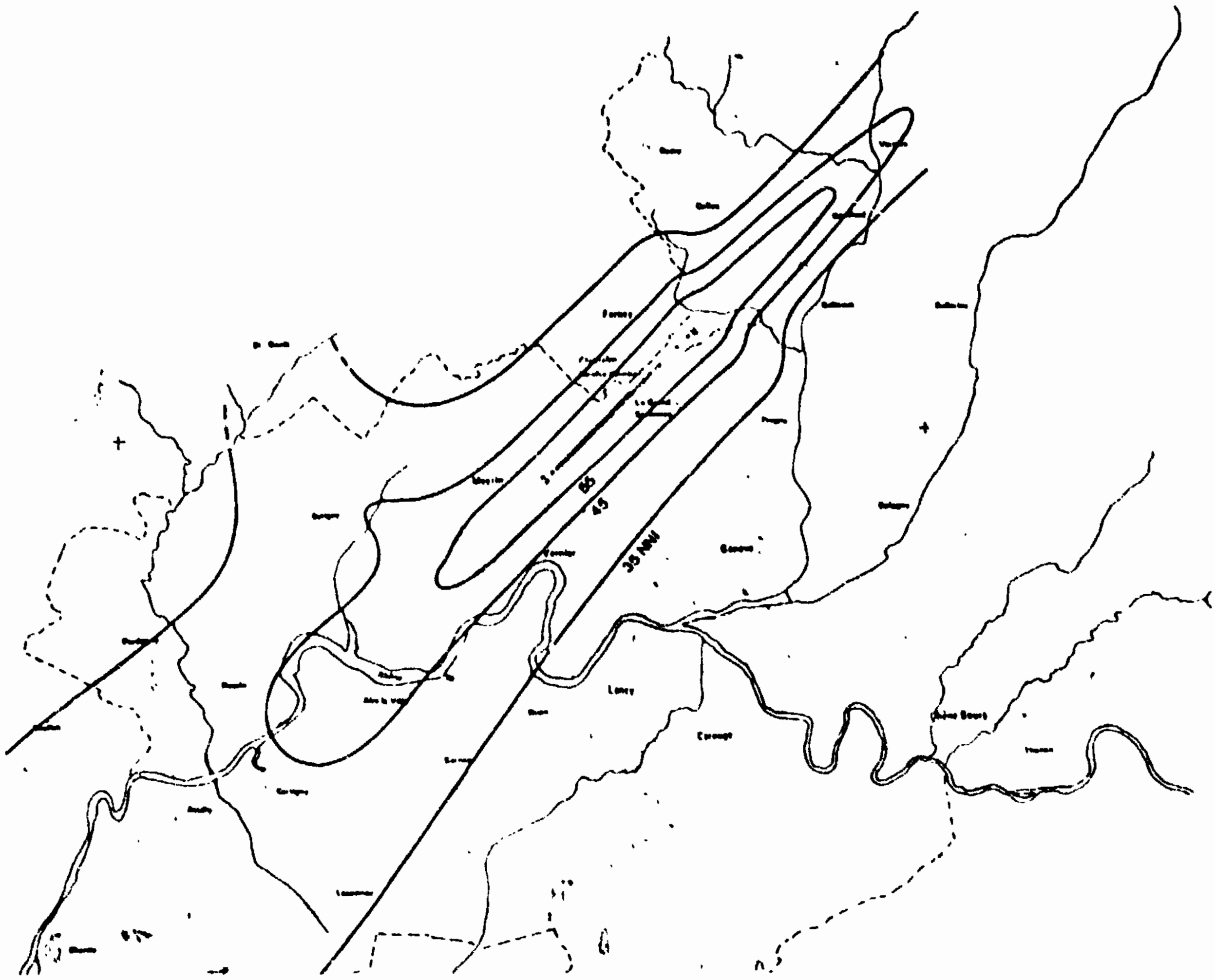
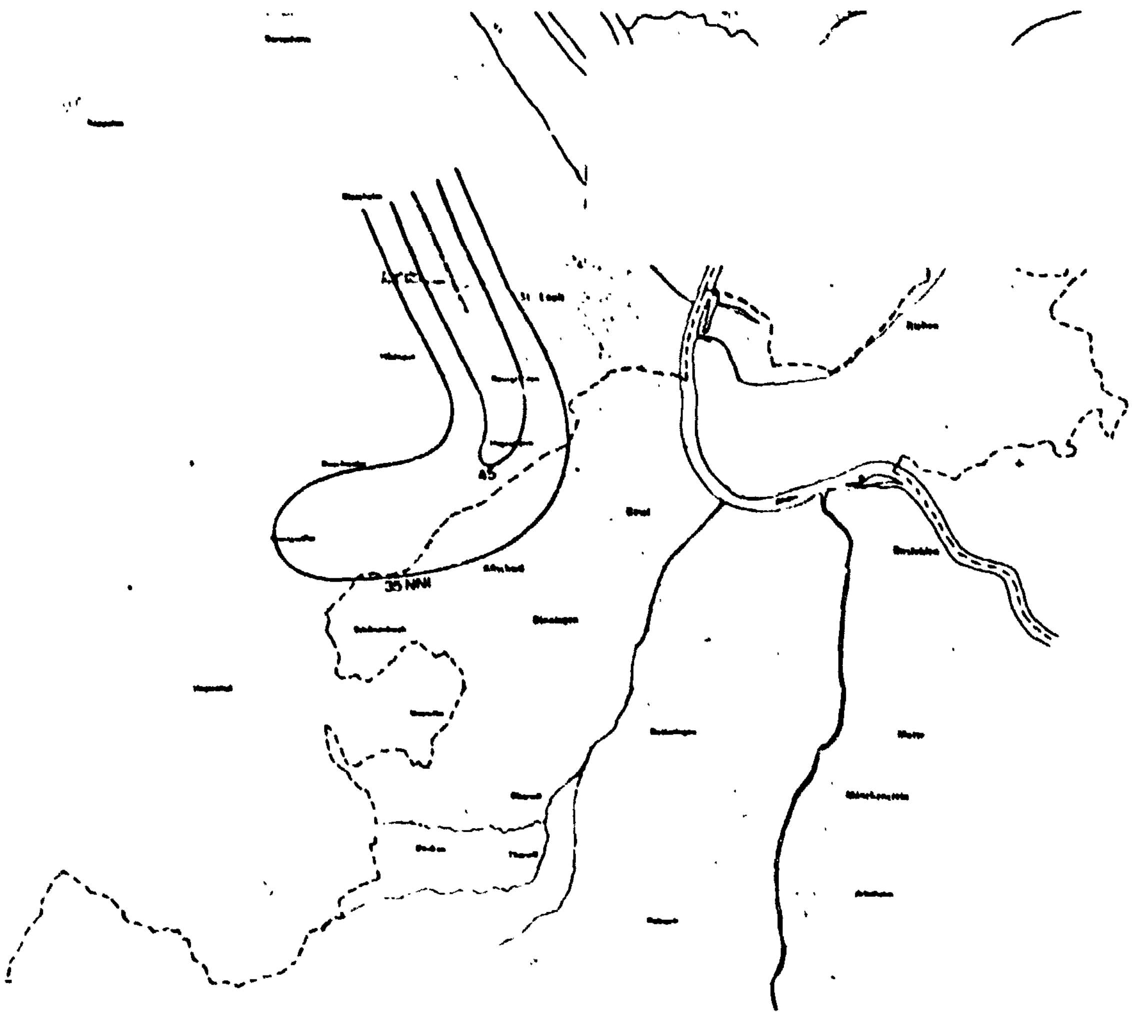


Figure 3.32 Airplane Noise Exposure Curves NNI /91
Airport Basel-Mulhausen
Measured 1972
Possible margin of error ±5 NNI



3.6.1.3. Comparison between Calculated and Measured NNI Curves /92

As explained in chapter 3.5.3. and 3.6.1. the expense for the measured determination of airplane noise exposure curves is considerably greater than for the theoretical determination.

Both noise exposure curves to be compared have, as mentioned, a margin of error of ±5 NNI. In an extreme case deviations as high as 10 NNI must be tolerated. Near the landing strips the agreement is rather close. In distant areas, however, there is a systematic deviation between calculated and measured curves. Contrary to the calculated curves the width of the measured curves increases as the distance from the airport increases.

This can be chiefly explained through the large diffusion of actual airplane paths and partially through the decrease of the muffling effect in these areas. Since the increasing air path diffusion leads to a wider sound level range between the individual flight events an increase of the energetic sound level median values occurs. The area of noise exposure is increased considerably if airplanes closely adhere to their flight paths. The decrease of muffle effect due to spreading in greater distances can be attributed to the loss of ground absorption and muffling by obstructions due to greater flight altitudes.

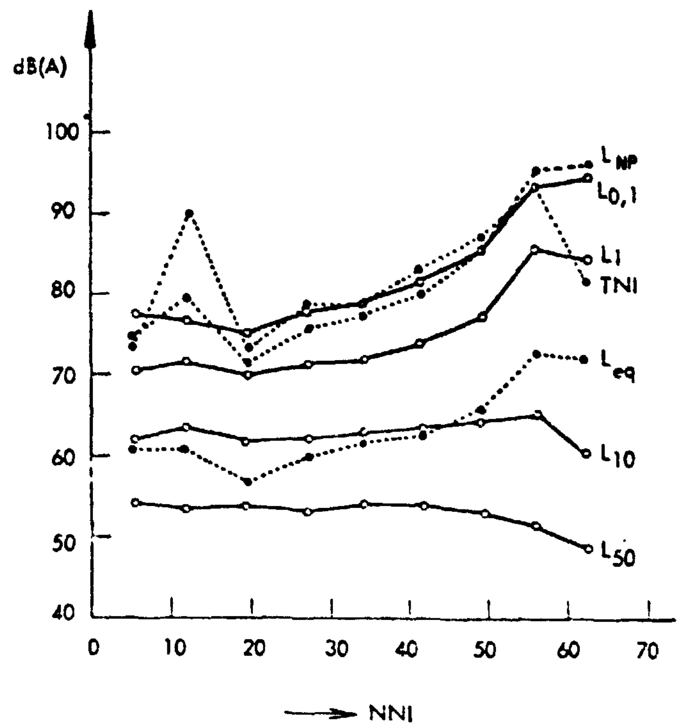
To improve the NNI calculating process the diffusion of the flight paths and the ground and obstacle damping effects would have to be taken into account to a greater extent. However, this would also require the supplying of much more complex statistical information about the use of the different flight paths, the flight path deviations and so forth from the airport administration.

3.6.2. Dependents of the Surrounding Noise Measurements of Airplane Noise /93

Most of the measurements of surrounding noises are calculated on the basis of sound level statistics. They represent the sum of all sounds. They do not give any information on the sources of these sounds. As shown in figure 3.33 correlation analysis alone would not deliver any useful results because of the bend shapes of the curves.

In this figure all noise measurements which are entered were obtained by sound level statistics, the airplane noise results, however, were obtained independently of statistics.

Figure 3.33: Different noise measurements in dependence on air noise exposure in NNI.



It has been found that the sum total levels L_{50}, and L_{10}' are hardly influenced by airplane noise, but that the sound level peaks $L_{0.1}$ are strongly influenced by it. In contrast L_{NP}, TNI and L_{eq} are ambivalent measurements /94

because they are, in the presence of low airplane noise exposure under 30 NNI, chiefly influenced by street noise, while in the case of greater airplane noise exposure over 30 NNI the influence of airplane noise is clearly noticeable.

For the areas of Zurich and Geneva under study the following connections between airplane noise and statistical sound level measurements were established:

$L_{eq} = 0.833\,NNI - 33.3$

		$NNI = 1.2 \cdot L_{eq} - 40$	$r = 0.513$
		$L_{PN} = 0.97 \cdot L_{eq} + 28$	$r = 0.466$
$NNI = 1.1 \cdot L_{01} - 57$	$r = 0.586$	$NNI = 0.73 \cdot L_{NP} - 24$	$r = 0.400$
$L_{PN} = 0.95 \cdot L_{01} + 12$	$r = 0.546$	$L_{PN} = 0.52 \cdot L_{NP} + 47$	$r = 0.394$
$NNI = 1.1 \cdot L_1 - 50$	$r = 0.532$		
$L_{PN} = 0.77 \cdot L_1 + 32$	$r = 0.403$		

The agreement of the median values of NNI and the noise measurements $L_{0.1}$, L_1, L_{eq}, and L_{NP}, is quite good, however, it is dependent on the noise situation, that means on the intensity and the frequency of noise sources like airplane traffic and street traffic.

3.6.3. Comparison of Noise Situations in Zurich, Geneva, and Basel /95

Based on the different findings it can be assumed that the noise situation is not identical in the tested areas of Zurich, Geneva, and Basel. Since the noise situation is only a second consequence of primary phenomena in the surroundings of the measuring location, it is attempted to find direct causes for the differing noise situations as objectively as possible. This process includes the consideration of building patterns, the comparison of flight frequency and flight noise peak values, and an evaluation of the share of street noise in the total picture of noise exposure, the sum total of noise exposure by airplane and street noise.

The following table lists traffic function and building patterns in areas surrounding the measuring locations. They were classified according to the following criteria;

UEBERBAUUNGSART	FUNKTIONSART	VERKEHRSART
Geschlossene Ueberbauung - keine Grünflächen oder Abstellflächen zwischen den Gebäuden. Lockere Ueberbauung - grössere Flächen die als Spielplatz, Garten oder Erholungsfläche dienen liegen zwischen den Gebäuden. Streubauweise - keine weiteren Gebäude in der Nähe.	Industriezone - Quartiere mit mehreren Fabrikationsunternehmungen, grössere Werkstätten, Lagerhäuser usw. Kernzone (Geschäftszone) - Quartiere mit vorwiegender Geschäftstätigkeit (Dorfkern oder Citygebiet) Gemischte Zone - grössere Dörfer oder städtische Quartiere mit Gewerbebetrieben, Verkaufsläden, Wohnhäusern, Wirtschaften, etc. Wohnzone - Wohnhäuser, Bauernhäuser, ev. mit Quartierverkaufsläden oder Schulhäusern. Freie Zone oder Erholungszone - Gebiete die der Erholung oder ausschliesslich der Landwirtschaft dienen.	Hauptverkehrsader - stark befahrene Verbindungsstrassen zwischen Gemeinden; Eisenbahnlinien. Durchgangsverkehr - Verbindungsstrassen in bebauten Gebieten, zwischen verschiedener Quartieren. Quartierstrassen - nur Anliegerverkehr Kein Verkehr

see next page

Density of Development	Zoning	Type of Traffic
very dense development	industrial	main traffic arteries
- no green areas or open space between buildings	- living quarters with several factories, larger production facilities, warehouses	- heavily used highways, connecting cities as well as railroad lines
loose development	central areas (business zones)	main streets
- open space and play grounds, gardens or other recreational areas between buildings	- living quarters and prdominating business activities (down town areas)	- main connecting streets in developed areas between different zones
scattered development	mixed zones	city streets
- no other buildings nearby	- larger farming towns, urban areas containing trade and retail establishments, residential areas etc.	- local traffic only
	residential areas	no traffic
	- apartment houses farm houses (poss. with retail stores, schools	
	open space or recreational areas	
	- exclusively rural or recreational areas	

Figure 3.34 Sum frequency level under consideration of building patterns type of use and traffic patterns /96

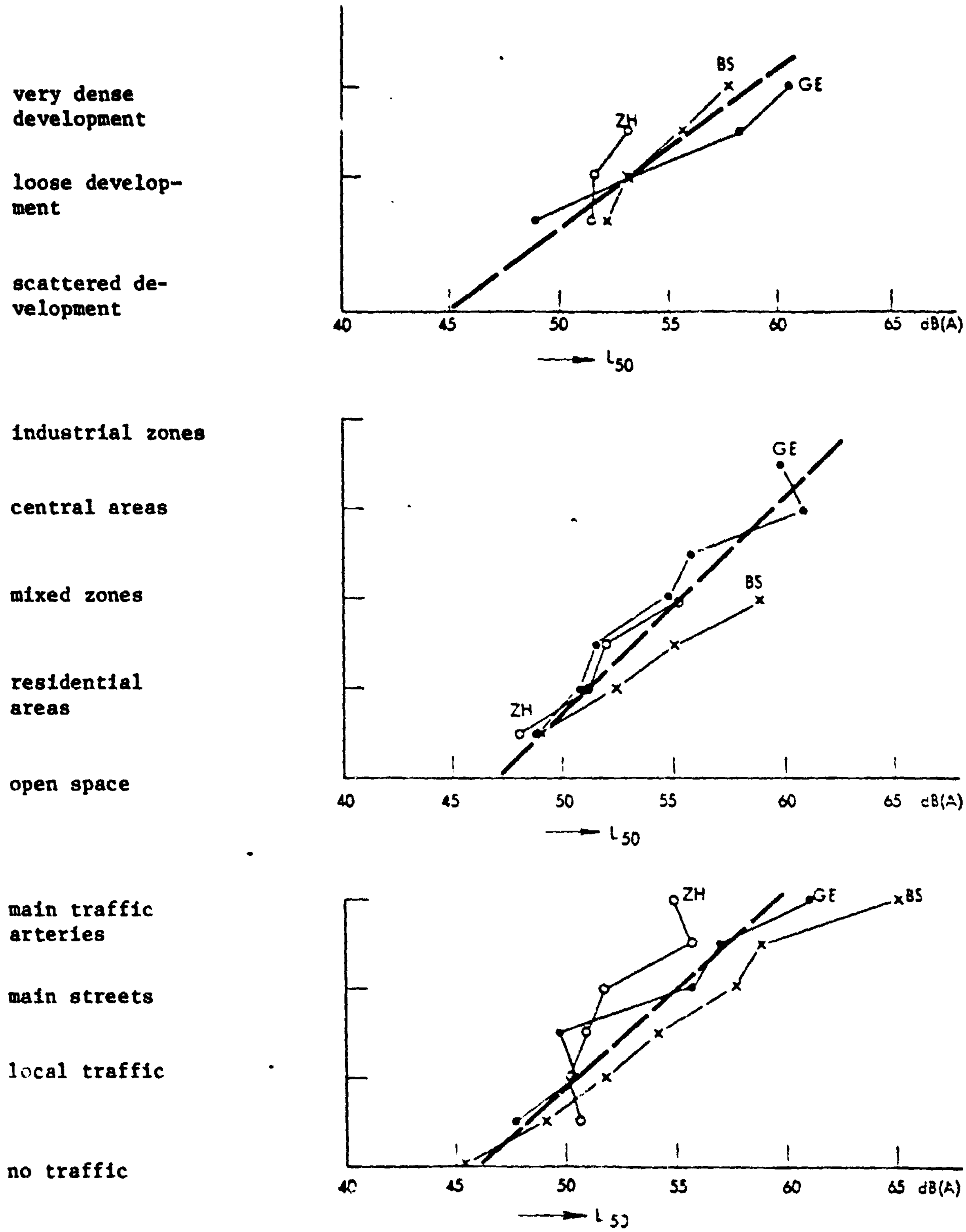
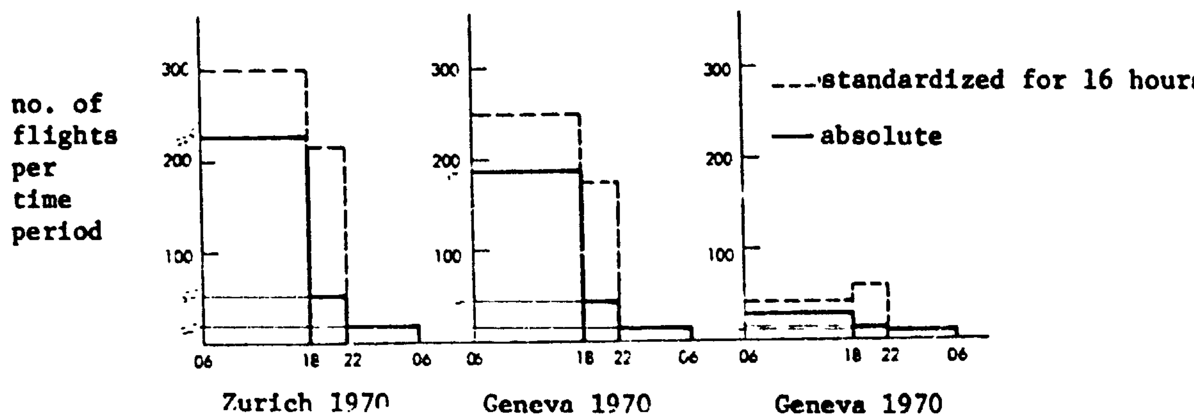


Figure 3.34 shows the strong relationship between building, usage, and traffic patterns and the level L_{50}. /97

Number of airplane movements and airplane noise peak values

The number of airplane movement on which NNI calculations are based is the average daily frequency per measuring period, standardized for sixteen (16) hours. (Chapter 3.5.2.2.).

Figure 3.35: Statistical information of median numbers of airplane movements around the three airports.



The big difference between the number of airplane movements in Zurich and Geneva as opposed to Basel is very obvious. In addition, the airport of Basel shows a greater median density of airplane movements during the four evening hours from 6:00 pm to 10:00 pm than during the daytime from 6:00 am to 5:00 pm.

The table 3 36 shows the variations of median airplane noise peaks in PNdB as well as NNI values. Here too a distinct difference can be seen between Basel and the two other areas under study. The upper limit of L_{PN} to approximately 105 PNdB is due to the limitation of the study to Swiss territory. In Basel the minimum distance between measuring locations and airport is approximately 3 km, in Zurich and Geneva, however, it is only approximately 0.5 to 1 km. /98

Table 3.36: Variations of airplane noise peaks in PNdB as well as airplane noise exposure in NNI. /98

Test area	Airplane noise peaks in PNdB			Airplane noise exposure in NNI		
	Min.	Max.	Std. Dev.	Min.	Max.	Std. Dev.
Zurich	65	111	12.3	10	58	13.0
Geneva	53	118	15.0	5	69	15.0
Basel	76	101	6.4	0	3.9	11.3

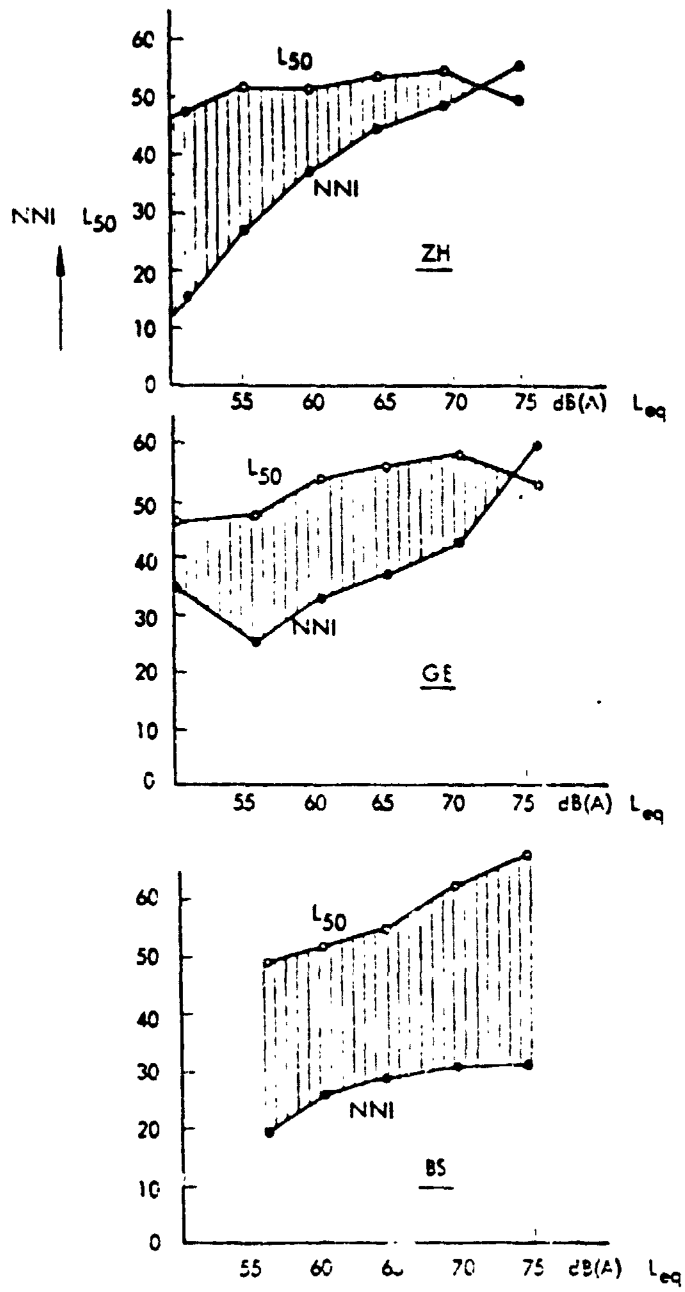
The Ratio of Street Versus Airplane Noise in the Total Noise Exposure

The total noise exposure is an objectively measurable unit and should not be mistaken for the perceived annoyance or disturbance by individuals. It can be given with the ambivalent noise measure L_{eq} which is influenced by both street and airplane noise.

To compare the respective shares of both noise sources in the total noise exposure for the three study areas, sum total levels L_{50} and the NNI in function of the equivalent continuous sound level L_{eq}, were illustrated in Figure 3.37. /100

The extensive independence of the sum total level L_{50} of airplane noise was already noted in chapter 3.6.2.. It is clearly evident that in Zurich and Geneva the share of airplane noise as compared to street noise increases with increasing total noise exposure. In Basel, however, the share of street noise increases with increasing total noise exposure. This essentially different noise situation is clearly expressed in the shape of the filled in areas (L_{50}-NNI as fct. of L_{eq}) in Fig. 3.37.

Figure 3.37 Airplane noise (NNI) and street noise L_{50} as function of total noise exposure L_{eq}



4. PERCEIVED DISTURBANCES BY NOISE /101

4.1. Introduction

The goal of this chapter is to empirically establish and describe the perceived disturbances by airplane and street noise which the populations of the airport areas of Zurich-Kloten, Geneva-Cointrin, and Basel-Mulhausen are exposed to. There are 2 main problems. (a) How can the actual state of an individual disturbance by noise be adequately determined? (b) Which of the measured acoustical noise exposure measurements contains properly weighted physical parameters in a suitable combination to permit a rather exact prediction of individual disturbance due to exposure to noise.

How the realistic state of individual disturbance by noise is established in a interview situation is first of all a question of the validity and the dependability of the questionnaire which is used in the questioning.

The most important limitation is that this chapter deals chiefly with the reaction type to noise, namely the consciously perceived disturbance as a state of reality, measured by verbal self-evaluation according to a given reaction evaluation scale. This reaction type, however, is not exhaustive in the sense that it is often postulated in problem specific discussions: mainly as a measure of disturbance in itself, but is limited to the consciously perceived disturbance which represents the necessary prerequisite for the verbalization in the interview situation. Other conscious, semi-conscious or subconscious reactions and behavior responses to a noise stressor are initially excluded. Thus the interpretation of the verbally measured, perceived disturbance is by no means an exhaustive categorization of the reactions. It can only be considered as a first conscious but limited comparison of the disturbance against a verbalized model supplied by the interviewer to permit self rating by the interviewee.

The extent of the verbal reaction to noise can be measured /102
either directly or indirectly. In the direct method the interviewee gives information about the degree of his disturbance in the form of a qualitative judgement. A numerical value for the degree of disturbance is immediately obtained. However, the assumption on which the direct method is based, namely, that the interviewed person is able to express his reaction more or less isomorphically within a given reaction scheme, is not always possible. That means that it cannot automatically assume that the quantitative judgement of the interviewed person truly represents the subjective degree of his disturbance because he may not be able to interpret figures properly or react like a linear measuring instrument [41]. However, psycho-physics has shown that in the case of sensory continua valid results can be obtained by the direct method.

Nevertheless, it has to be emphasized that an individual is exposed to a great number of physical and social stimuli which, in contrast to the psychophysical laboratory tests, can hardly be controlled in sociological field studies. On the other hand sociological field research is able to include exactly those somatic and pragmatic stimuli which are of special interest in the study and discussion, a situation which is only possible to a very limited degree in psycho-physical experimentation.[1)]

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1) The following system was used in the direct method of evaluation of noise exposure: "Let us assume this is a thermometer (interviewer shows card with a thermometer) with which you can measure how much you are disturbed at home by airplane or traffic noise. The number 10 indicates that you find the airplane or traffic noise unbearable, the number 0 that it does not disturb you at all. Now tell me the number which would apply to you".

In the indirect method the interviewee gives his reply to the degree of his disturbance in the form of an answer category which he does not have a numerical association with. The numerical value is established in the evaluation by the application of certain measuring models like the scalogram analysis and other processes. A numerical value for the degree of disturbance is obtained indirectly. 1) /103

---

1) Indirectly--scalogramatically the noise exposure was established with the following questions:

- How often are you disturbed by airplane or street noise?
- When you try to fall asleep or are sleeping
- When you listen to the radio or watch T.V.
- That the building vibrates
- When you have conversation or are on the telephone
- While you are resting or involved in recreation
- So much that you are startled

Answer categories:

- Very often (Score = 4)
- Quite often (Score = 3)
- Sometimes (Score = 2)
- Hardly ever, or never (Score = 1).

To obtain satisfactory reproducibility the scale categories were limited to 10 by cutting the answer categories.

Reproducibility coefficients:

Random check	Zurich:	0.90
	Geneva:	0.89
	Basel:	0.89

By dichotomizing the variables the reproducibility is raised to 0.97. To maintain a direct comparability with direct measurements the variables were only cut to a degree which maintained the same scale range. A reproducibility can be considered as satisfactory. The technique of scalogram analysis is discussed by Guttman [42]. In the following the direct as well as the indirect methods are applied and critically compared.

The investigation of optimal acoustical noise exposure measurement requires the presence of a valid and dependable subjective disturbance index. This accomplishment is attempted by validation of individual subjective disturbance indices which result from direct and indirect measurements and furthermore by the mutual validation of those.

4.2. The Choice of the Optimal Acoustical Exposure Measure for the Airport /104

The quality of a noise measure is determined by its agreement with the individual disturbance by airplane noise. Table 4.1 shows the degree of linear connections between NNI, L_{NP}, L_{eq}, L_1, $L_{0.1}$ and the individually perceived disturbance by airplane noise (direct method) in the different test areas as well as the intercorrelation between the individual noise measures.[1) 2)]

In all 3 areas . the linear context [3)] between noise exposure measures and perceived disturbance in NNI values is significantly the strongest. L_{NP}, L_{eq}, are nearly equivalent in their quality criteria.

The additional consideration of sound level scatter in L_{NP} /105 does not lead, therefore, to any improvement of the agreement of acoustical noise measures and individual disturbance. The airplane noise peak values ($L_{0.1}$) show, with the exception of the test areas in Zurich, a significantly better agreement with the percieved disturbance by airplane noise then the L_{NP}, and L_{eq}. The L_1 in comparison to the $L_{0.1}$ shows significantly worse agreement, with the exception of the test area Geneva, for the linear agreement with the directly perceived disturbance by airplane noise. This is especially valid for the area of Basel.

---

1) The air movement numbers of NNI are standardized to 16 hours if not otherwise mentioned (comparable with other investigations and with day and evening periods). The other exposure measures are referring to the time period between 6:00 am and 6:00 pm unless otherwise noted.

2) The coeficients listed in table 4.1 are Pearson's product-moment-coefficients. They require metric scales for both variables. This prerequisite is not strictly fulfilled for the disturbance index: thus a "precision error" is consciously accepted (see 4.3). For the application of metric processes for ordinal scales see Labovitz [43,44].

3) There is a significant linear connection between NNI, L_{NP}, and perceived disturbance and a significant cubic connection between L_{eq}, L_1, $L_{0.1}$ and the perceived disturbance.

C-2

Table 4.1. Product-Moment correlations between NNI, L_{NP}, L_{eq}, L_1, $L_{0.1}$ and the directly perceived by airplane noise of the survey populations Zurich-Kloten, Geneva-Cointrin, Basel-Mulhausen as well as the total population. /106

	NNI				L_{NP}				L_{eq}				L_1				$L_{0,1}$			
	ZH	GE	BS	TOT	ZH	GE	BS	TOT	ZH	GE	BS	TOT	ZH	GE	BS	TOT	ZH	GE	BS	TOT
wahrgenommene Störung durch Fluglärm *)	0.53	0.68	0.53	0.56	0.44	0.27	0.16	0.30	0.46	0.30	0.13	0.32	0.40	0.34	0.11	0.30	0.45	0.35	0.25	0.36
NNI					0.73	0.36	0.35	0.49	0.78	0.44	0.29	0.51	0.71	0.49	0.25	0.53	0.79	0.50	0.50	0.59
L_{NP}									0.97	0.94	0.93	0.95	0.73	0.90	0.93	0.90	0.91	0.90	0.82	0.89
L_{eq}													0.79	0.96	0.93	0.92	0.94	0.93	0.84	0.92
L_1																	0.91	0.97	0.84	0.92

*) = perceived disturbance by airplane noise

ZH random sample Zurich-Kloten N = 1471
GE random sample Geneva-Cointrin N = 1524
BS random sample Basel-Mulhausen N = 945
TOT random sample N = 3940

/106

The statistically significant differences between the correlation coefficients NNI/perceived disturbance of the three populations are essentially due to two causes: /107

1. By changes in the selection process of the measuring locations the validity of the acoustical data was improved in the testing areas of Geneva and Basel (see chapter 2).

2. In the middle ranges of sound the diffusion of reaction is greater than in the extreme ranges (see chapter 4.2.1.). The population under study in Basel is situated in the lower extreme as well as the middle range of acoustical stimulation by airplanes. Therefore this test area necessarily shows a lower correlation than the one for Geneva-Cointrin.

For approximately the same value ranges for the NNI the test areas of Basel and Geneva show no statistically significant differences between the correlations.

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1) Product/moment correlation between the NNI and the directly perceived disturbance for equal NNI areas in Zurich, Geneva and Basel.

	Zurich-Kloten 12 NNI 40	Geneva-Cointrin 8 NNI 40	Basel-Muehlhausen 5 NNI 40
Perceived disturbance by airpalne noise	.44	.52	.53

Based on these correlations it can assumed that the precision of acoustical measurements is not greatly affected by the runway system and by choice of air paths due to regulations of aircontrol since they are considerably more complex in zurich and Basel than in Geneva.

---

3) Footnote from previous page continued

Explained variance in the directly perceived disturbance with linear, quadratic and cubic regression equation (determination coefficients).

noise exposure measure	regression formula linear	square	cubic
NNI	0.321*	0.321	0.322
L_{eq}	0.107	0.108	0.113*
L_{NP}	0.100*	0.103	0.105
L_1	0.100	0.108	0.114*
$L_{0,1}$	0.135	0.139	0.151*

* $p < .05$
N = 984 subsample of total random sample

Based on these correlations it can be assumed that the precision of acoustical measurements is not very much influenced by the flight routes which had to be taken due to the runway systems and flight directions, since those in Zurich-Kloten as well as Basel-Mulhausen are much more complex than in Geneva-Cointrin.

In contrast to the NNI, the linear agreement between the /108

L_{NP}, L_{eq}, L_1, $L_{0.1}$, and the perceived disturbance by airplane noise is considerably less in the test areas of Geneva and Basel than in Zurich. Obviously the noise situation in these 2 areas is different from the one in the test area of Zurich (see chapter 3.6). This is also indicated by the significant inter-correlations between NNI/L_{NP}, NNI/L_{eq}, NNI/L_1, and NNI/$L_{0.1}$.

The noise pollution level and the equivalent permanent sound level as well as the L_1, are ambivalent noise exposure measurements. They measure air as well as traffic noise. The $L_{0.1}$, however, is clearly influenced by airplane noise. In the test area of Zurich, the L_{eq}, the L_{NP}, and L_1, are especially influenced by airplane noise, in the test areas of Basel and Geneva, however, to a greater degree by traffic noise. The mentioned ambivalence of L_{NP}, L_{eq}, and L_1 in respect to the noise source lead to a lower agreement with the perceived disturbance by airplane noise.

4.2.1. The Reaction Entropies Dependent on the Acoustical Exposure Measurements for Airplane Noise

The degree of agreement and unanimity with which individual stimulus situations are perceived inter-subjectively as disturbing can be seen as a further and more general sign of quality in the characterization and evaluation of acoustical noise measurements.

The reaction entropy is especially useful as a quantitative measurement for the degree of unanimity with which different individuals react to a specific stimulus situation. 1)

---

1) Entropy is an information-theoretical measurement which expresses the median degree of certainty, or uncertainty of a field of probability of events, e.g. of stimuli of reactions. The entropy of the field of probability A is defined by:

$$H(A) = -\sum_{i=1}^{n} p_i \, \mathrm{ld} \, p_i,$$

whereby p_i represents the probability of event i and A.

The differing evaluation of individual noise intervals can be interpreted as a field of reaction probability which can be characterized by its entropy, respectively its redundancy. that means, high redundancy indicates unanimity in the evaluation of airplane noise disturbances by individuals. /109

In this context individual stimulus situations are considered as being intervals of differing noise exposure measurements. Based on earlier psychological research a higher degree of unanimity in the extreme matrix areas can be anticipated since the ambiguity is greater in the middle ranges of the matrix of stimuli [45].

Fig 4.2 shows the characteristically expected course of reaction entropies asa functions of 3 noise measurements. The NNI shows especially in low and high ranges, but also systematically in the ambiguous median range, the highest redundancy values. That means that it also produces the greatest inter-individual unanimity in the evaluation of perceived disturbances by airplane noise. The capital $_{NP}$ shows distinctly lower redundancy values especially in the extreme ranges than the L_{eq}.

Continuation of footnote 1) to preceding page

To allow the comparison of the entropies of probability fields of different sizes they are standardized in the following way:

$$R(A) = 1 - \frac{H(A)}{H_{max}}$$

R(A) is called the relative redundancy of the probability field A and has a value range of $0 \leq R(A) \leq 1$;

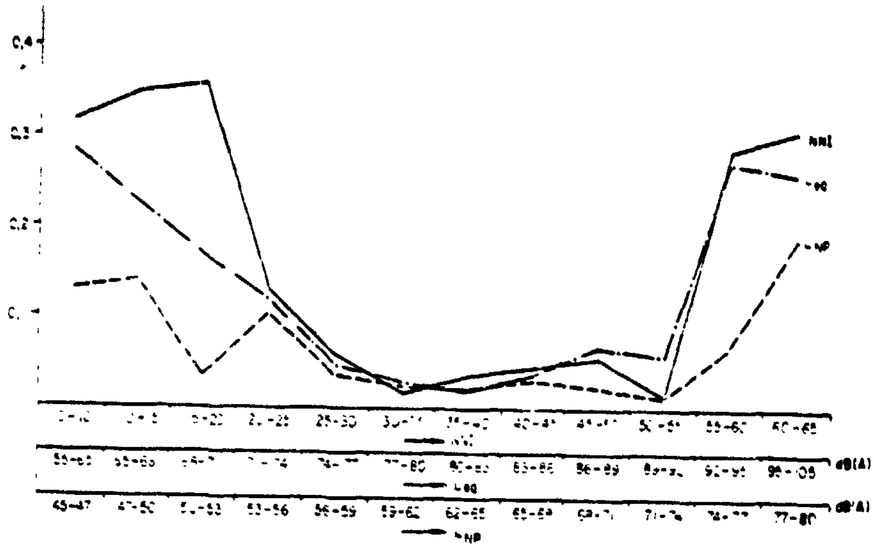
e.g. in this context the validity or unanimity in the evaluation of the disturbance is highest if the values point towards one and that it is minimal if they point towards zero. Psychophysics and information-psychology show that the evaluation capacity e.g. the assignment effort between stimulus and reaction events is, among others, a function of the entropy of the stimulus field:

$$T(S;r) = f(H(S))$$

Here T(S,R) = H(S) - H(R/S) represents the transformation or the capacity of the individual to react typically to stimulus field S by reactions of a reaction field R; H(S) the entropy, e.g. the degree of uncertainty or certainty of the stimulus field; and H(R/S) the conditional entropy or the specificity and sureness with which stimuli are reacted to. Analogous to other stimulus continua in acoustical stimuli, too, the ambiguity (H(S)) in median expression ranges is greater than in extreme ones, provided there is a homgeneous reference point.

The inclusion of reaction redundancies as an indicator of validity of the noise measurement confirms the conclusion that the NNI represents the optimal measure. Therefore, in the following, the research will essentially be limited to the NNI as independent variable for airplane noise exposure.

Figure 4.2: Reaction redundancy in the directly perceived disturbances by airplane noise dependent on NNI, L_{NP}, and L_{eq}. (Total random sample N = 3,940) /110



4.3 The Perceived Disturbance by Airplane Noise

As already noted in several other studies the range of variation of individual reaction to airplane noise is relatively large.

Table 4.3 Explained variations in the directly perceived disturbances of airplane noise (NNI) for Zurich-Kloten, Geneva-Cointrin, Basel-Mulhausen, for the total random sample.

random sample	determination coefficients (r^2)	N
Zürich-Kloten	0.2836	1471
Genf-Cointrin	0.4617	1524
Basel-Mülhausen	0.2839	944
Total	0.3136	3939

In the test population of Geneva, in which the lowest failure variant can be assumed, 46% of the variations in individually perceived disturbances can be explained with the NNI. /111

The term 46% explained variation means that the other 54% of variations can be accounted for with other factors of the acoustical stimulus situation, by intervening socio-psychological factors of stimulus reaction formation and so forth. Compared to the relationships between stimulus and reaction which are accepted in the behavioral sciences this figure of 46% of explained variation means that noise and especially airplane noise is an extremely pervasive stressor.

In comparing the correlation between the airplane noise exposure and the resulting disturbance, according the the data presented, with foreign research it has to be taken into consideration that there the agreement of airplane noise exposure and disturbance is often achieved by means of median values. This, however, is an artifical reduction of scatter and represents a decisive loss of information. A sensible comparison can only be conducted on the basis of individual values.

Table 4.4 comparison of the connection between airplane noise exposure and disturbance in foreign studies (Correlation based on individual values)

		r_{xy}	Noise exposure measure		
Swiss study (airports Basel, Zurich, Geneva		0.56	(NNI)	0.59	(NNI_{KOR*}) 1)
English study I	[16]	0.46	(NNI)		
English study II	[33]	0.43	(NNI)		
English study III	[46]	0.60	(NNI)		
French study	[18]	0.53	(R)		
American study	[47]	0.37	(CNR)		

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1) See also chapter 4.9

Figure 4.5 Arithmetical mean values of the directly perceived disturbance dependent on airplane noise exposure (NNI) for individual test areas. /112

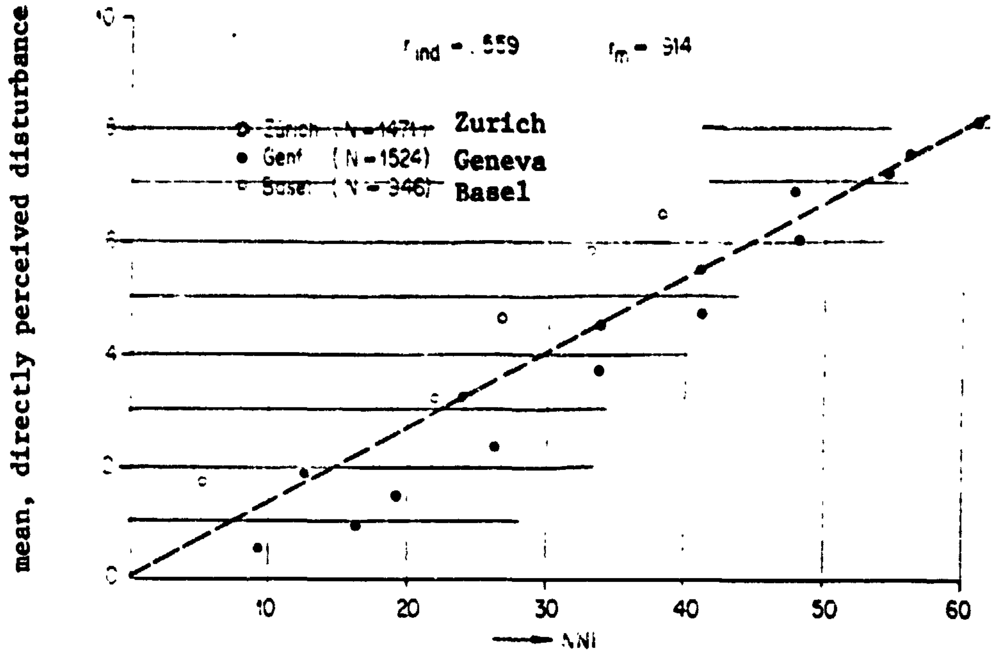


Fig 4.5 demonstrates that the arithmetic mean values of the perceived disturbance between 3 random samples shows systematic differences. The median value differentiation test leads to significantly higher median values in the lower NNI ranges for Zurich, and vice versa in the higher NNI ranges for Geneva. In the test area of Basel the median values lie systematically and significantly above those of the other two test areas.

Systematic deviations of the median values of perceived disturbances between the individual test areas can be essentially explained with nonhomogeneous acoustical noise situations (See also chapters 3.6., 4.2., 4.7., 4.8.).

In all three test areas the generally perceived disturbance per NNI interval is practically a monotonously progressing function of airplane noise. (In the test area of Zurich there are, /113 however, two deviations from the straight line). The approximately linear course of the median values shows that there are actually no noise threshold values for perceived disturbances in the middle range.

The arithmetic averaging of index values for perceived disturbance is, however, not necessarily representative for individuals. Due to the effect of scattered individual values on the median value those can be pure artifacts of grouping.

The results above are based on the use of parametric evaluation methods, that means they require interval properties of the scalometer. These results, therefore, have to be compared with the following which are nonparametric, e.g. based on evaluation processes of ordinal properties of the scalometer.

The parametric association coefficient between degree of exposure and perceived disturbance can hardly be distinguished from the non-parametric association coefficient gamma (Goodman-Kruskal). This is a good indicator that the application of parametric and nonparametric systems leads to similar results, whichis a justification for the metric interpretations of a scalometer.

Table 4.6. Parametric and nonparametric association coefficents between NNI and perceived disturbance for Zurich, Geneva, and Basel.

	Perceived Disturbance					
	rxy			Gamma		
	ZH	GE	BS	ZH	GE	BS
NNI	.53	.68	.53	.51	.66	.55

The percentage distribution of: not disturbed, little disturbed, somewhat disturbed, and very much disturbed interviewees per airplane noise zone in the different test areas is shown in table 4.7.

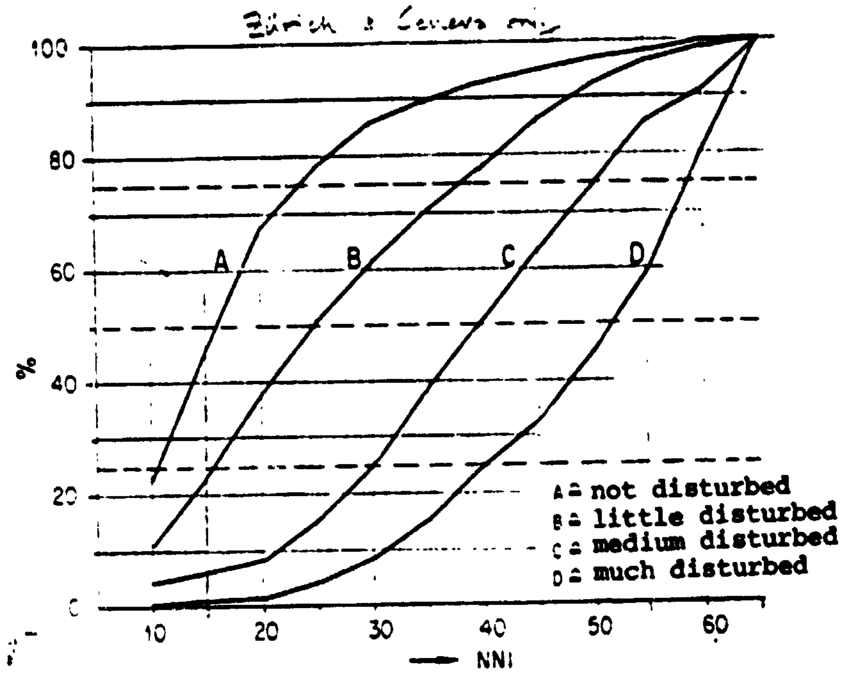
The percentage distributions of perceived disturbance per noise zone show considerable differences among the different test areas.

Table 4.7 Percentual distribution of not disturbed, little disturbed, somewhat disturbed, and strongly disturbed, interviewees per airplane noise zone in the test areas of Zurich-Kloten, Geneva-Cointrin, Basel-Mulhausen. /114

	airplane noise zone NNI	no disturb. (0)*	little disturb. (1,2,3)*	medium disturb. (4,5,6,7)*	strong disturb (8,9,10)*	No. of interv.
Zürich-Kloten	10 - 14	33.1	52.7	10.8	3.4	148=100%
	15 - 19	32.5	57.9	7.9	1.8	114=100%
	20 - 24	25.0	46.0	19.0	10.0	100=100%
	25 - 29	----	----	----	----	
	30 - 34	13.8	33.8	38.5	13.8	65=100%
	35 - 39	5.1	26.3	45.5	23.2	99=100%
	40 - 44	4.1	35.4	42.3	18.3	345=100%
	45 - 49	2.7	21.0	37.6	38.8	338=100%
	50 - 54	2.5	19.6	34.6	43.3	240=100%
	55 - 57	4.5	4.5	22.7	68.2	
Genf-Cointrin	< 10	76.1	21.7	2.2	0.0	41=100%
	10 - 14	70.2	28.7	1.1	0.0	94=100%
	15 - 19	51.9	42.6	4.7	0.8	129=100%
	20 - 24	----	----	----	----	
	25 - 29	28.3	49.0	17.9	4.8	145=100%
	30 - 34	[illegible].6	42.9	27.8	14.6	212=100%
	35 - 39	10.5	44.8	28.0	16.8	143=100%
	40 - 44	5.0	25.9	34.3	34.7	239=100%
	45 - 49	3.5	16.8	38.5	41.3	143=100%
	50 - 54	5.1	6.8	29.0	59.1	176=100%
	55 - 59	3.2	8.9	18.5	69.4	124=100%
	60 - 64	0.0	4.8	27.4	67.7	62=100%
	65 - 70	9.1	9.1	18.2	63.6	11=100%
Basel-Mühlhausen	< 10	37.4	44.5	16.5	1.6	182=100%
	10 - 14	----	----	----	----	
	15 - 19	----	----	----	----	
	20 - 24	5.9	47.1	41.2	5.9	17=100%
	25 - 29	7.6	32.3	38.9	21.2	198=100%
	30 - 34	1.7	20.1	48.8	29.4	303=100%
	35 - 39	2.9	14.3	40.6	42.2	244=100%

(* index values on the airplane noise scalometer.)

Illustration 4.8 shows sum-total distributions of the tetrarchtonalordinal classification of the scalometer values in strong; medium; not much; frequency (equal number of interviewees per noise interval). As seen in the diagram 25% of the interviewees are strongly disturbed at 40 NNI and 50% at [illegible] while for average disturbance the lower quartile lies at 30 NNI the median at 40 NNI and the upper quartile at 50 NNI. /115



4.3.1. Perceived Disturbances by Airpane Noise as Need Dependent States of Disturbance /116

In the preceding chapters the perceived disturbance by airplane noise was established with a scalometer as a direct measuring instrument. In the process the perceived disturbance was considered an individual general state of disturbance caused by airplane noise.

The needs of individuals or groups of individuals are projected onto their space where they require certain optimal conditions in their environment whose fulfilments are necessary and sufficient to satisfy these needs. That means that disturbances caused by airplane noise interfere with those need dependent optimal conditions in the environment and are directly to be considered as disturbances of the need situation. During the interviews the evaluation of those disturbances was obtained on the basis of the frequency of occurences. This indirect form of measurement of perceived disturbances can be considered as being relatively independent of the direct measurements with a scalometer because on the one hand the state of disturbance is not generalized but considered to be need specific, on the other hand the state of disturbance is not obtained directly by judging its intensity but indirectly by means of perceived frequency with which a disturbance of a certain intensity occurs. The following need dependent states of disturbance were included:

- Needs of communication

-Disturbance of conversation (Speaking)
-Disturbance in participation in public media (T.V. radio)

- Recreational needs

-Disturbance of recreation
-Disturbance of sleep

- Reflective needs

-Disturbance of activity at home

- Indirect disturbances of needs

-Being startled (Defends reaction)
-Vibration of the house as physical disturbance

Figure 4.9a Perceived frequencies (in percent of the interviewees) of disturbances in dependence of NNI.

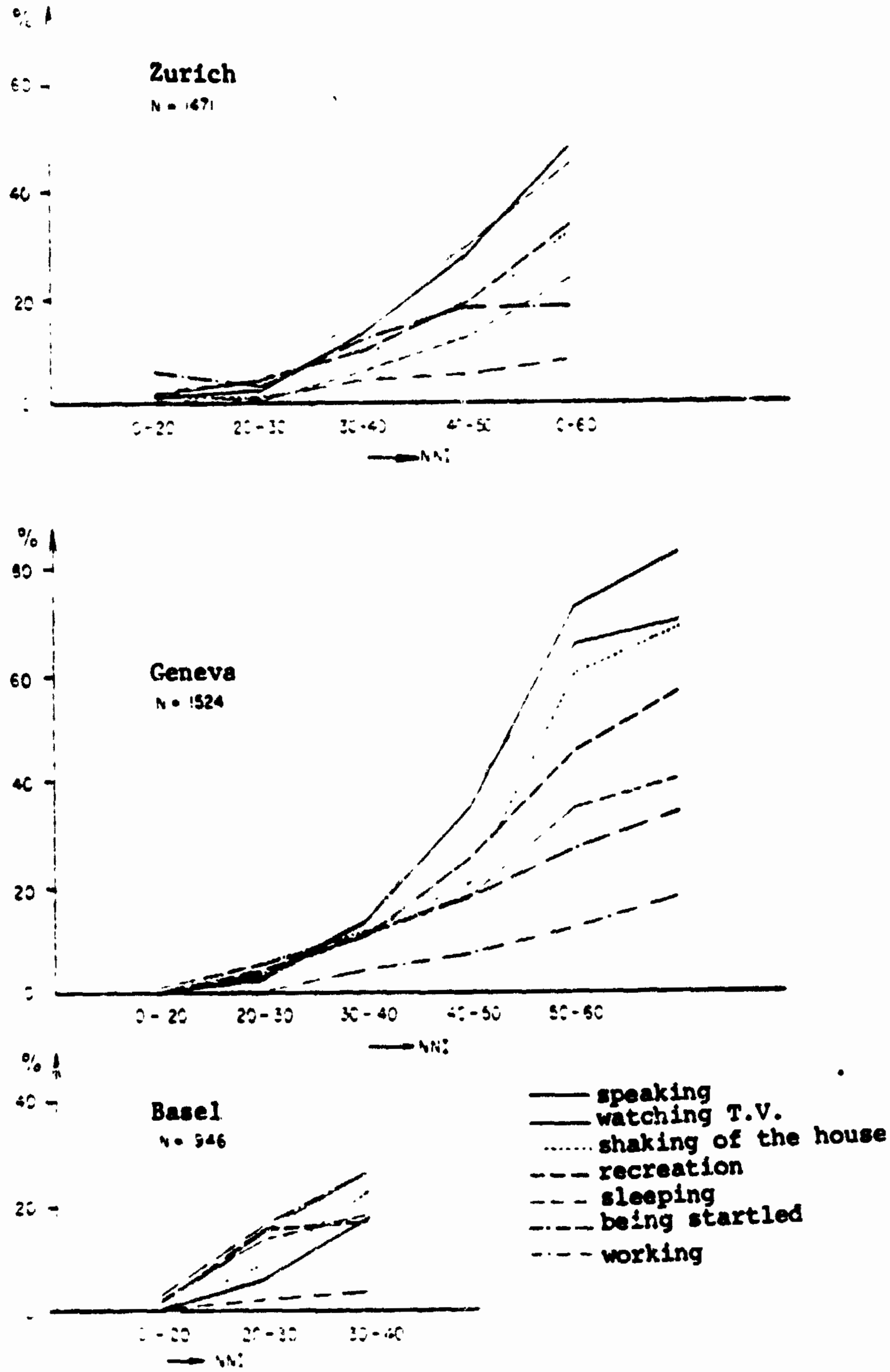
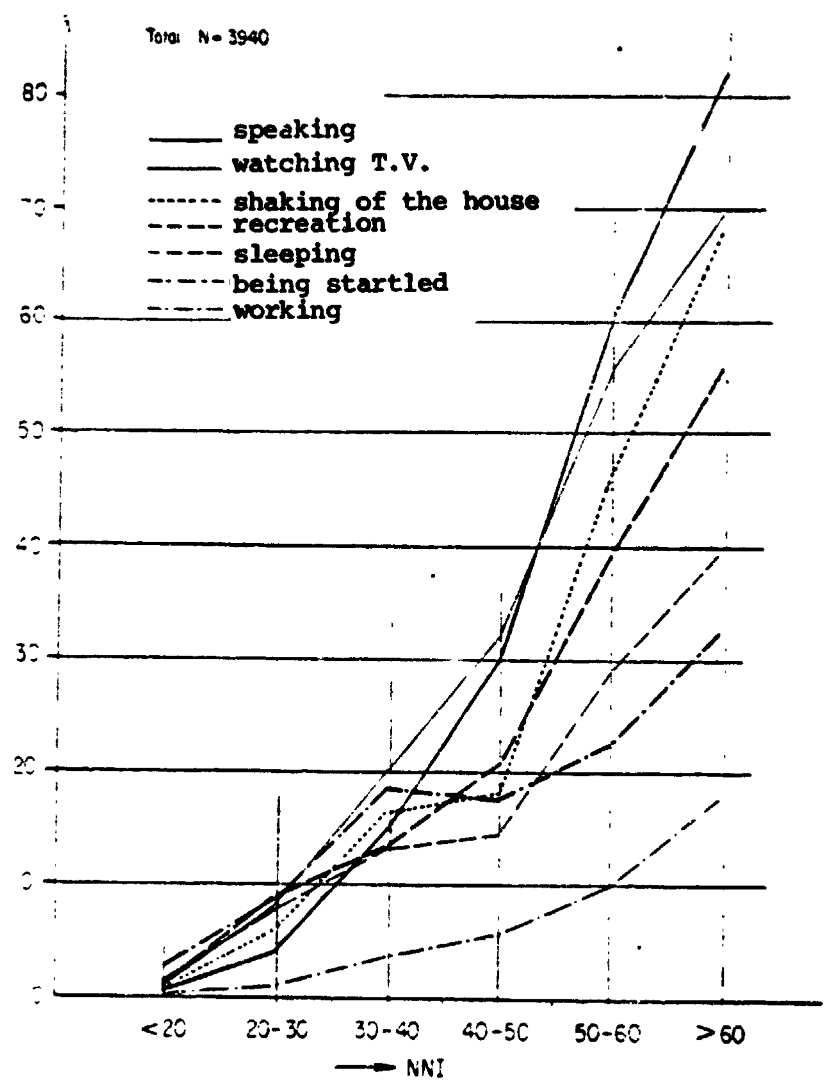


Figure 4.9b Perceived frequencies (in percent of the interviewees) of disturbances in dependence on airplane noise exposure NNI /118



It should be emphasized that the determination of the frequency of these disturbing events in the interview situation by means of self evaluation required their conscious perception. /119

This need complex is neither exhausting nor do the different needs have the same importance for all segments of the population or are even perceived consciously in all segments. These needs were chosen to permit international comparisons.

Figs. 4.9a and b show the relationship between the objective acoustic measurements of airplane noise and the perceived frequency of need dependent disturbances.

The first distinct increase in the proportions of the "very much or quite often" perception of disturbance factors happened above the threshold value of 25 NNI.

The perceived frequency of states of disturbance increases frequently in the range from 25 to 55. The range of 45 to 55 NNI shows the biggest increase. In the extreme range (over 55 NNI) the results of the random sample in Geneva show the most complete variation of NNI values; a distinct saturation of increase. The random sampling in Zurich shows an increase in the percentages of very much or quite often perceived disturbances in a more linear progression than in Geneva. However, here too the increase is steeper in the range between 45 and 55 NNI. It becomes clear that the disturbances of primary and recreational needs do not occur until the range of 45 to 55 is reached. The disturbances of secondary and communicational needs, however, are already perceived quite often in the ranges between 35 and 45 NNI. The perceived frequencies are directly dependent on the objective frequencies with which different disturbances occur. Here it becomes obvious that disturbances which interfere with communicational needs happen more often than those which disturb recreational ones because the communicational needs refer to day time and leisure time periods and thus overlap time wise more with the objective frequency of airplane events than the needs of physical recreation which usually are pursued during evening hours.

It is noteworthy that the defense or fright reaction to airplane events in the range below 25 to 30 NNI is perceived as a disturbance by most subjects. A probable explanation is the fact that in zones of lower exposure - with low flight frequency components - the subjective expectancy value of airplane events is lower than in zones of high airplane noise exposure with high flight frequency components. Defense reactions of events, however, increase with lowered subjective expectation values. Work activity at home, for instance, is ra ely perceived as being rather often or frequently disturbed because it does not represent a universal need but a population group specific one (people that are self-employed or in training).

/120

Analogous to the results of median comparisons it is shown (see chapter 4.3) that the perceived frequencies of disturbances in the random samples at Basel are also systematically higher than the ones in the 2 other random samples. This, however, should not be due to a stronger subjective reaction to airplane noise among the Basel population but is based on the weight problems of frequency components in the NNI as shown below. (See also 4.9.). This same effect is also the reason for the increasingly perceived frequencies of disturbances below 35 NNI and a satur ation or decrease in the range between 35 and 45 NNI in the complete random sampling shown in fig. 4.9b.

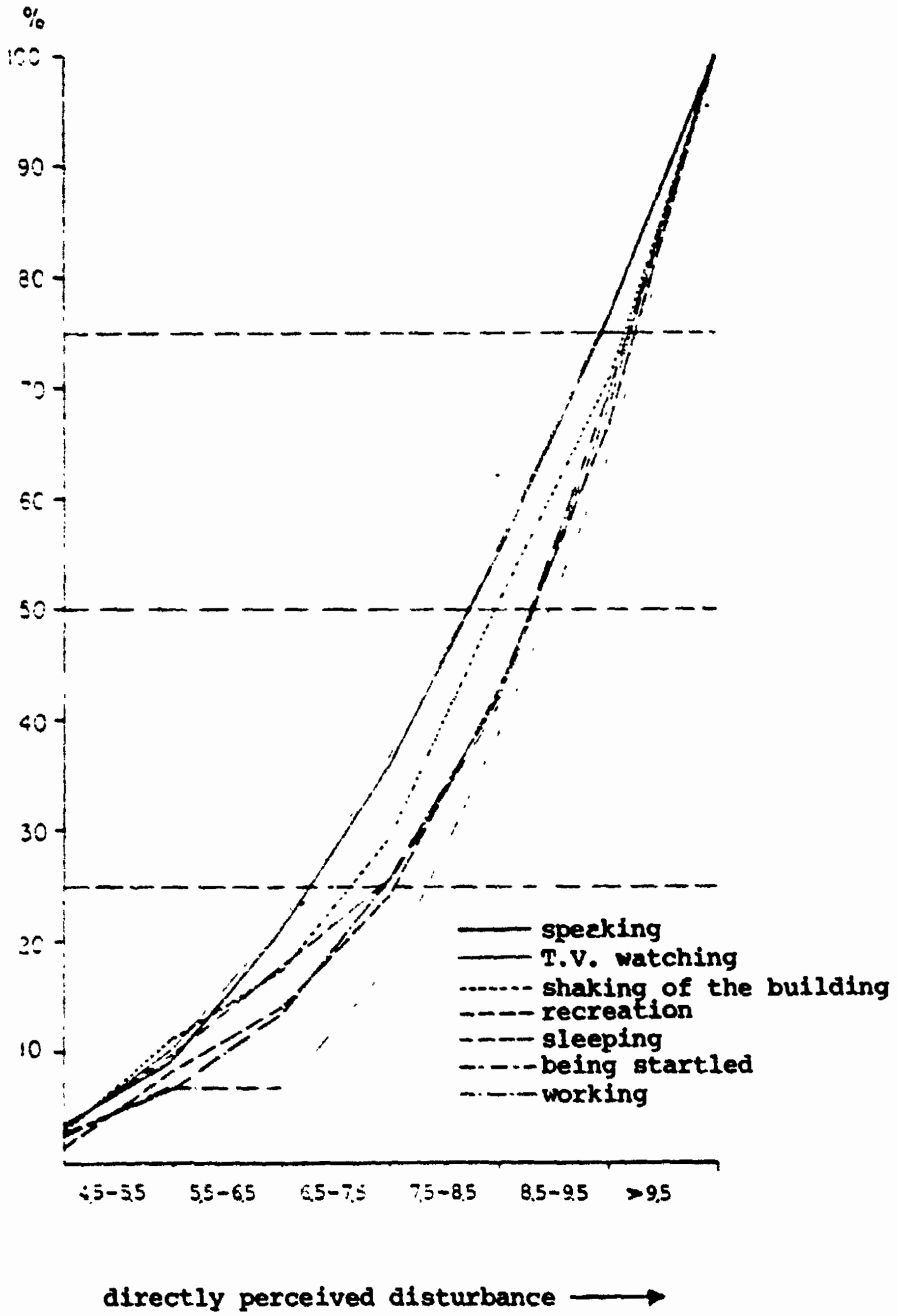
Table 4.10 shows that below 47 NNI 25% of the interviewees perceived all 7 disturbance categories very often or very frequently. Between 47 and 55 NNI already 50% of the people questioned claim quite often or very often the perception of the 7 states of disturbance. In the extreme area of airplane noise exposure above 60 NNI there are only 25% of the subjects who admit to no or only occas ional disturbances. It seems remarkable that there is little variation between the lowest and the highest quartile as well as the median for 6 of the 7 higher /121
states of disturbance. For fright reactions, however, the lower quartile but also the median, lie considerably lower which also can be traced back to the causes explained above.

Table 4.10 NNI-Values for the lower median and upper quartile of disturbances which were perceived as rather often or very often in the total random sample.

states of disturbance	NNI values of Q_{25}, Q_{50}, Q_{75}		
total random sample	Q_{25} lower	Q_{50} middle	Q_{75} upper quartile
speaking	47	55	60
T.V. and radio	45	53	59
recreation	44	54	60
sleeping	40	52	60
working	46	54	60
shaking of the house	46	55	60
being startled	36	47	57

Disturbance of the need for communication is objective and probably more frequently perceived subjectively, disturbance of recreational needs, however, is more aggravating because it

Figure 4 11. Sum-total distribution of perceived states of disturbance in dependence on directly perceived disturbance by airplane noise. (random sample of Geneva) /122



has more weight in the need hierarchy of the individual. This leads to the inference that disturbances of primary (recreational) needs with a given objectively and subjectively perceived frequency are influencing the assessment of the intensity of a directly perceived disturbance more than the disturbances of secondary (communicational) needs. This is shown distinctly in figure 4.11 which deals with the test population of Geneva. Shown are the sum-total distributions of 7 rather often and frequently perceived disturbances dependent on the directly perceived disturbance.

With the increasing priority of the disturbed needs the activation of the individual grows and is translated into an increased directly perceived disturbance.

Therefore disturbing stimuli of recreational, e.g. primary, needs create a higher directly perceived disturbance in the conscious cognition of the individual than the secondary disturbance stimuli, e.g. communicational needs. It seems remarkable that the perceived disturbance of work activities at home seems to influence the perceived disturbance the strongest. /123

Table 4.12: Index values of directly perceived disturbances for the lower quartile, median and upper quartile of the rather often and very often perceived states of disturbance for the random sample in Geneva.

States of disturbances Random Sample Geneva	Index value of directly perceived disturb. Q25 lower	 Q50 middle	 Q75 upper quartile
watching T.V.	6.7	8.2	9.5
speaking	6.8	8.3	9.5
shaking of the house	7.1	8.5	9.7
being startled	7.4	8.8	9.7
sleeping	7.4	8.8	9.7
recreation	7.6	8.8	9.8
working	7.8	8.9	9.8

Looking at the 3 quartiles in table 4.12. it becomes apparent that the weight of the respective causes of disturbance is affecting the intensity of the directly perceived disturbance in ascending sequence;

1.) Communication needs (Speaking, T.V., radio)
2.) Physical disturbance (Vibration of the building)
3.) Defense reaction (being startled) and recreational need (sleep and recreation)
4.) Need to work at home

4.3.2. Comparison of Direct and Indirect Measurements of Individual Disturbance by Airplane Noise /124

As mentioned there are 2 different methods to measure the extent of verbal reaction to noise. There is first the direct measurement in ·hich the interviewed person evaluates his own reactions on the basis of a presented reaction scheme and there is the indirect methods in which the degree of disturbance is established by the Guttman analysis of the frequency of need dependent disturbances.

In the following agreement between indirect measurements of individual disturbance and the body of acoustical data will be discussed and compared with the corresponding agreement between direc: measurement and acoustical data. Table 4.13. shows the degree of statistical agreement between acoustical measurements for airplane nσise (NNI) and the perceived individual disturbance for the indirect as well as the direct method of measurement.

Table 4.13. Pearson's product moment correlation between NNI and perceived disturbance on the basis of direct and indirect measurements for Zurich, Geneva, Basel and the total random sample test.

	perceived disturbance direct measurement				**perceived disturbance indirect measurement**			
	ZH	GE	BS	TOT	ZH	GE	BS	TOT
NNI	.53	.68	.53	.56	.46	.61	.46	.50
direct measurement					.80	.83	.72	.80

The differences between he correlation coefficient of direct and indirect measurements in the perceived disturbances are statistically significant.

Direct and indirect measures, however, are not linear, with the exception of the random sample in Basel, but show a cubic relationship to each other. Nevertheless, the increase of this explained difference due to non-linear regression calculations is small for both the direct and indirect methods of measurement. /125

Table 4.14 Explained difference in the indirectly perceived disturbance in a linear, squared and cubic regression calculations. (determination co-efficient)

random sample	**Zürich**			**Genf**			**Basel**			**Total**		
regression	lin.	quad.	kub.	lin.	quad.	kub.	lin	quad.	kub.	lin.	quad.	kub.
directly perceived disturbance	.643	.659	.671*	.672	.683	.696*	.524*	.524	.525	.637	.645	.662*
	(N=732)**			(N=762)**			(N=946)			(N=[illegible]84)**		

* p is smaller than .05

** subsample of random samples

Both methods of measurement require the conscious perception of the intensity of the disturbance respectively the frequency of the disturbance situation. The only approximate linearity between the direct and the indirect disturbance index confirms only conditionally that the increase in the directly conscious perception of disturbance in the linear relationship also leads to an increase in the indirectly conscious perception of the frequency of states of disturbance. Generally, however, the conclusion can be reached that there exists a strong trans-information relationship between the different direct and indirect disturbance indices if their evaluation requires conscious perception. The empirical determination of disturbance by noise by means of disturbance indices which do not require the conscious perception and verbal articulation requires finer instruments of measurement which are hardly realizable within the framework of an interview.

We can deduce from the significant differences of the correlation coefficients between the 2 methods of measurement and the nearly linear context that the direct measurement, despite its simpler execution, delivers a better and relatively valid disturbance index for airplane noise. The further analysis of verbal individual disturbance by airplane noise in this investigation will essentially be limited to this index.

4.4. The Choice of Optimal Acoustical Noise Exposure Measurements For Traffic Noise /126

Analogous to noise exposure measurements for airplanes here, too, the degree of agreement between individual disturbance by traffic noise and acoustical noise exposure is a criterion of validity. Since it is the goal of this investigation to look at the effects of street and airplane noise separately an

Table 4.15. **Product/Moment correlation between acoustical exposure measures and directly perceived disturbance by street noise**

Perceived disturbance by street noise	TNI	L_{NP}	L_{eq}	L_{99}	L_{90}	L_{50}	L_{10}	L_1	$L_{0,1}$	NNI
Zurich	.05	.01	.04	.05	.11	.15	.07	.03	.05	.01
Geneva	.11	.05	.08	.17	.24	.29	.25	.04	.01	-.12
Basel	.36	.36	.38	.23	.31	.43	.42	.33	.25	.05
Total	.10	.08	.12	.15	.22	.29	.2[illegible]	.08	.06	-.06
inter-correlation NNI										
Zurich	.43	.73	.78	-.09	-.03	.16	.50	.71	.79	
Geneva	-.10	.36	.44	.12	.00	-.17	-.06	.47	.50	
Basel	.25	.35	.29	-.21	-.15	-.01	.08	.47	.50	
Total	.17	.49	.51	-.05	-.07	-.09	.11	.53	.59	

add'tional criterion is established, that of the independence of traffic noise and airplane noise exposure measurements. (There is, however, a dependence on other types of noise such as noise from industry, trade etc. Since traffic and especially street traffic, aside from airplanes, is the main source of noise in most cases it seems justifiable to speak of traffic noise, and not, which would be more precise, of surrounding noise without airplane noise).

Table 4.15 shows the degree of linear connection between different acoustical noise exposure measurements and the individually perceived disturbance by traffic noise (direct measurement) in the different test areas as well as the corresponding intercorrelations. (The noise exposure measurements for traffic noise always refer to the time period between 6:00 am and 6:00 pm, unless otherwise stated).

L_{50} and L_{10} agree best with the perceived disturbance by traffic noise. At the same time they are (with the exception of the test area Zurich) relatively independent of exposure measurements for airplane noise (NNI). That means that the median surrounding noise (L_{50}) in the test areas of Basel and Geneva is not influenced by airplane noise while in the test area of Zurich a slight influence on the medium surrounding noise by airplane noise is noticeable. This is due to the usually lower level of traffic noise in this area. Despite these facts the L_{50} seems to be the best measurement of exposure to street noise in the context of this investigation.

The statistically significant difference between the correlation coefficients of perceived disturbance by traffic noise/ noise exposure measurement among the individual test areas can be traced back to two causes.

1.) The low statistical correlation between noise exposure measurements and perceived disturbance in the test areas of Zurich and Geneva led to a change of the measuring process in the test area of Basel (see chapter 2). /128

2.) The statistically significant differences in correlation coefficients of comparable areas of Zurich and Geneva can be explained with the effect of airplane noise on the median surrounding noise levels, as mentioned before. Consistently there was no differentiating exposure measure for traffic noise available in the test area of Zurich. The analysis of reaction to the traffic noise is therefore essentially limited to the test population of Basel. [1)]

In comparing the degree of agreement between noise exposure measurements, for airplane noise (NNI) and traffic noise (L_{50}) with respective perceived disturbances a generally lower agreement in the case of traffic noise is noticeable. This agrees with the already mentioned psychophysical pattern of greater reaction ambiguity in the median stimulus ranges. (Traffic noises normally does not reach the sound peaks of airplane noise).

Besides the NNI is better qualified to differentiate between the noise source "airplane" and the noise source "environment" than the weighted measurements for "traffic" noise as far as the ability to differentiate between the noise source traffic and the other environmental noise sources is concerned.

The inclusion of reaction entropies as further general criteria for the validity of exposure measures for traffic noise (fig. 4.16) suggests, similarly as in the case of acoustical measures for airplane noise, that future psycho-acoustical research should also reevaluate the relevance of the weights of acoustical parameters in the exposure measurements for traffic noise. It is obvious that the NNI achieves higher unanimity in extreme ranges in the judgement of the disturbing affect of traffic noise than the L_{50}, for instance. That means that the consideration of the difference between the basic noise (L_{90}) and the peak values (L_{10}) in the TNI proves to be the factor that produces the unanimity especially in the upper extreme range (see also chapters 4.8, 4.9, 4.12). /129

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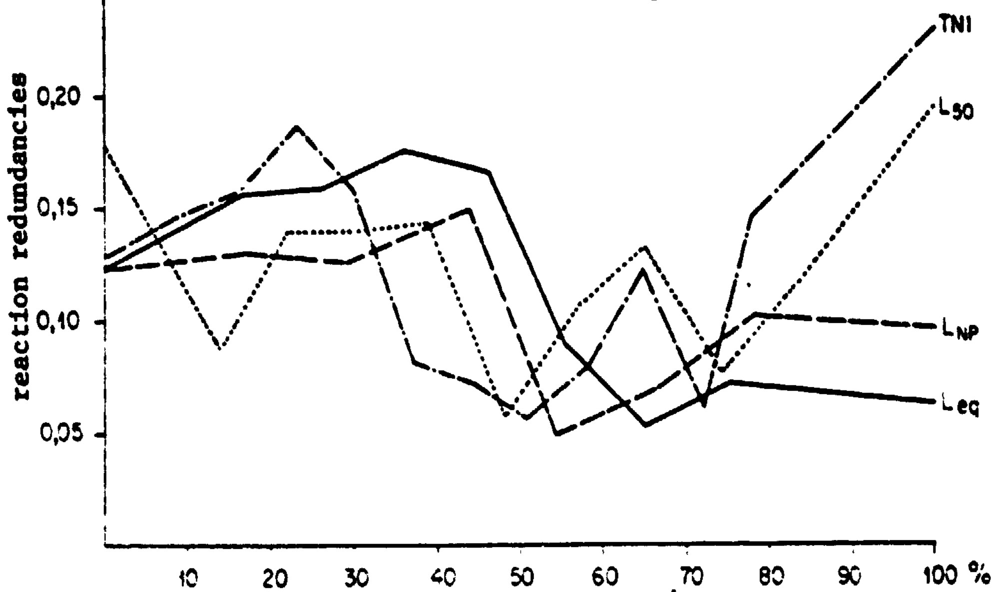
1) The determination coefficients of the relationship between the L_{50} and the perceived disturbance by street noise in linear (.167), squared (.182) and cubic (.183), regression calculations (random sample in Basel) show that, in comparison to the relationship between the NNI and the perceived disturbance by airplane noise, the linear correlation for these connections is only insignificantly less than the non-linear correlation. The additional variation on the basis of non-linear calculations is only .16 percent. Therefore the linear correlation of the statistical relationship L_{50} and the perceived disturbance by street noise is sufficient.

In summation it has to be reiterated that the median sum-total level L_{50} has been shown to be the best weight factor for traffic noise. This also agrees with French traffic noise research. [48].

Diagram 4.16 Reaction redundancies in dependence on standardized acoustical noise exposure measurements. (Random sample Basel N = 945)



For reasons of comparison these four noise curves have been standardized for minimum and maximum of their respective noise measures. Strictly speaking this permits only a qualitative comparison.

4.5. The Perceived Disturbance by Traffic Noise /130

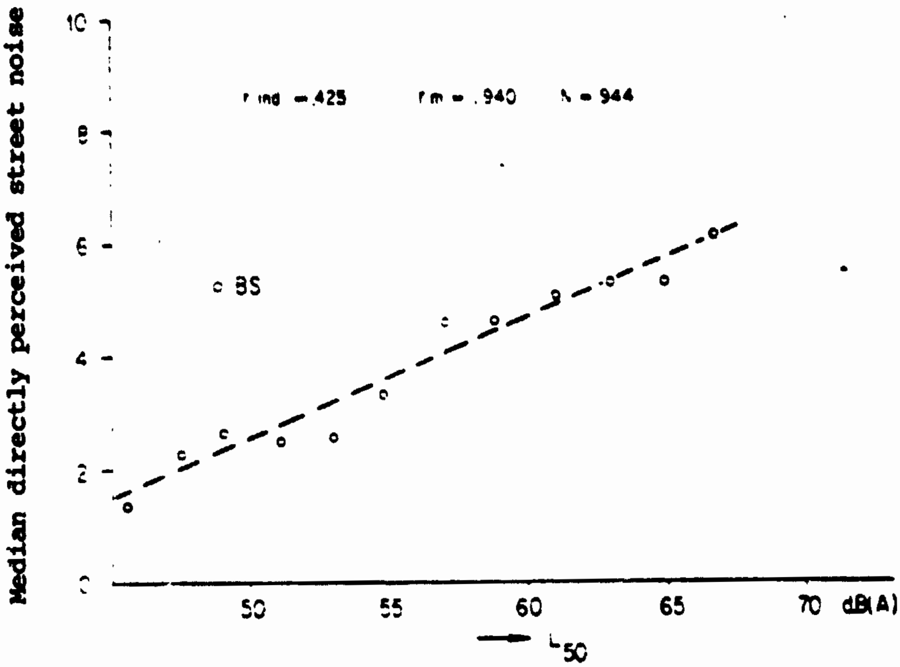
As already mentioned, the considerably lower explanatory property of the traffic noise exposure measurement L_{50} in comparison to the airplane noise exposure measurement NNI is chiefly based on two reasons: (a) the lack of differentiation between traffic noise exposure measurements and other surrounding sound sources and (b) the different physical characteristics of traffic noise exposure (L_{50}) and perceived disturbance in the test area.

Basel can be considered high when compared to foreign studies;

$r_{ind} = .43$ [1].

Fig 4.17. shows the connection between traffic noise exposure and median perceived disturbance. It shows a linear regression of the median values with an increase of the median noise exposure intensity (L_{50}) by 5 dB(A), an increase in the perceived disturbance by one unit.

Figure 4.17. Arithmetic mean of the perceived disturbance in dependence from traffic noise exposure (L_{50}) for the test area in Basel. /131



1) Furthermore, in the case of traffic noise exposure comparisons with foreign research it has to be kept in mind that there the correlations between traffic noise exposure and disturbance index are usually established by calculations based on median values or means. The comparable French study by Aubree [48] finds correlaton of individual values between noise exposure ($L_{50cor.}$) and disturbance index of r = 0.37, Griffiths and Langdon [36] finds a correlation of r = 0.29 in which case the traffic noise exposure measurement was the TNI.

The percentage distribution of not disturbed, little disturbed, medium disturbed, and strongly disturbed subjects per traffic noise zone in the test area of Basel is shown in table 4.18.

Table 4.18 Percentage distribution of not disturbed, little disturbed, medium disturbed, and strongly disturbed subjects in dependence on traffic noise exposure L_{50} (test region Basel) 1) /132

noise zones L_{50} in dB(A)	no disturb 0*	little disturb 1,2,3,*	medium disturb. 4,5,6,7,*	strong disturb. 8,9,10*	No. of inter-views
44 - 47.9	32.2	45.8	16.9	5.1	59=100%
48 - 51.9	18.8	51.2	27.6	2.4	293=100%
52 - 55.9	14.1	53.8	27.3	4.8	333=100%
56 - 59.9	6.1	26.3	55.3	12.3	114=100%
60 - 63.9	2.3	22.1	55.8	19.8	86=100%
> 64.0	5.0	13.3	58.3	23.3	60=100%

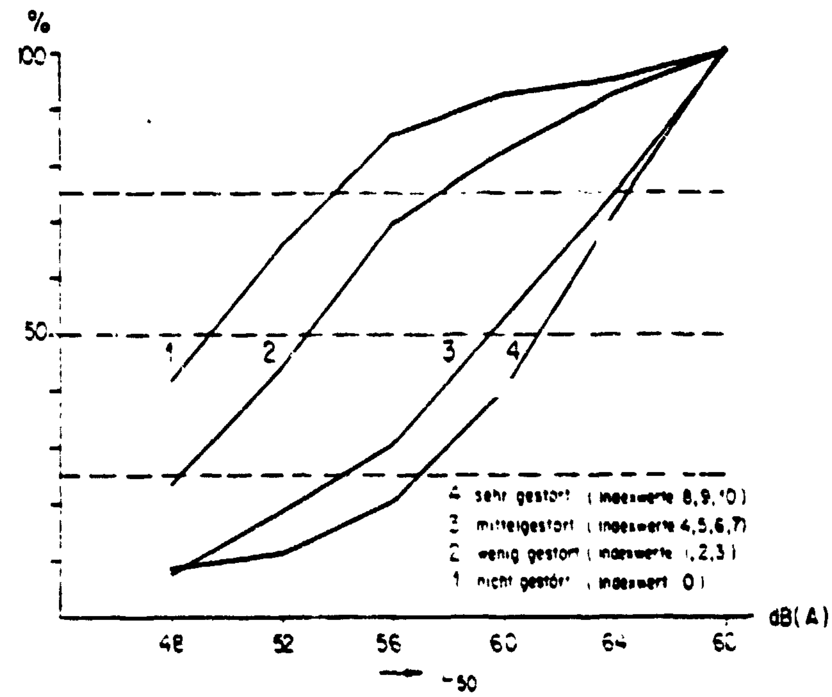
In an L_{50}-range of 56-59.9 dB(A) a strong increase of medium disturbed subject is noticeable. This fact becomes especially clear in the accumulative frequency distribution in dependence on traffic noise exposure (fig. 4.19.). Assuming an identical cell frequency there are at L_{50} = 57 dB(A) already 25% and at an L_{50} = 61 dB(A) 50% of the subjects very much disturbed.

1) It is shown here that the parametric association coefficient r_{xy} between exposure measurements and perceived disturbance is the same as the parameter free association coefficient Gamma:

	perceived disturbance by traffic noise r_{xy}	gamma
L_{50}	.43	.43

Figure 4.19 Cumulative frequency distribution of not-little-medium- strongly disturbed subjects dependent on traffic noise exposure L_{50} /133

assuming equal cell frequency
(Test area Basel)

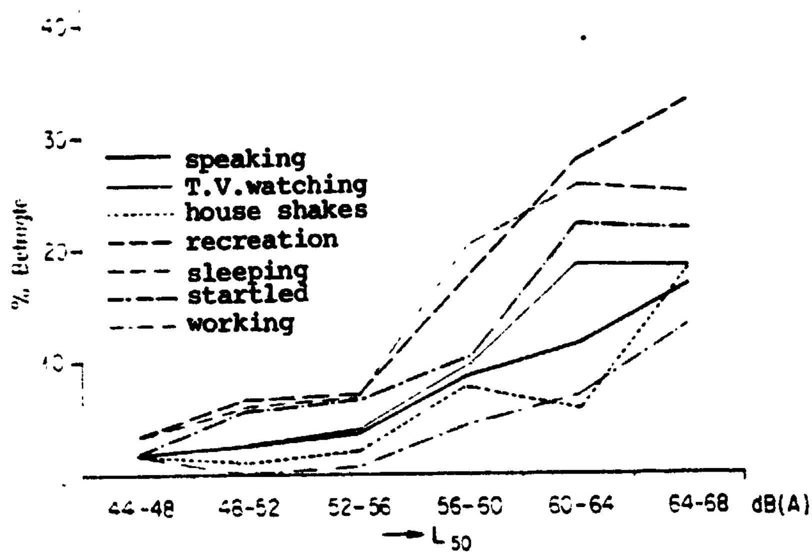


4 very disturbed (index values 8, 9, 10)
3 med. disturbed (index values 4, 5, 6, 7)
2 little disturbed (index values 1, 2, 3)
1 not disturbed (index value 0)

4.5.1. The Perceived Disturbance by Traffic Noise as Need Dependent State of Disturbance /134

Figure 4.20 shows the relationship between objective exposure measurements for traffic noise (L_{50}) and subjectively perceived frequencies of disturbance by traffic noise which are analogous to the disturbance by airplane noise shown in figure 4.9.

Figure 4.20. Perceived frequencies (often rather frequently) of disturbance in dependence on traffic noise exposure L_{50} (test area Basel N=944)



Noteworthy is the accelerated increase of perceived frequencies of disturbances in the range of L_{50} = 56 to 58dB(A).

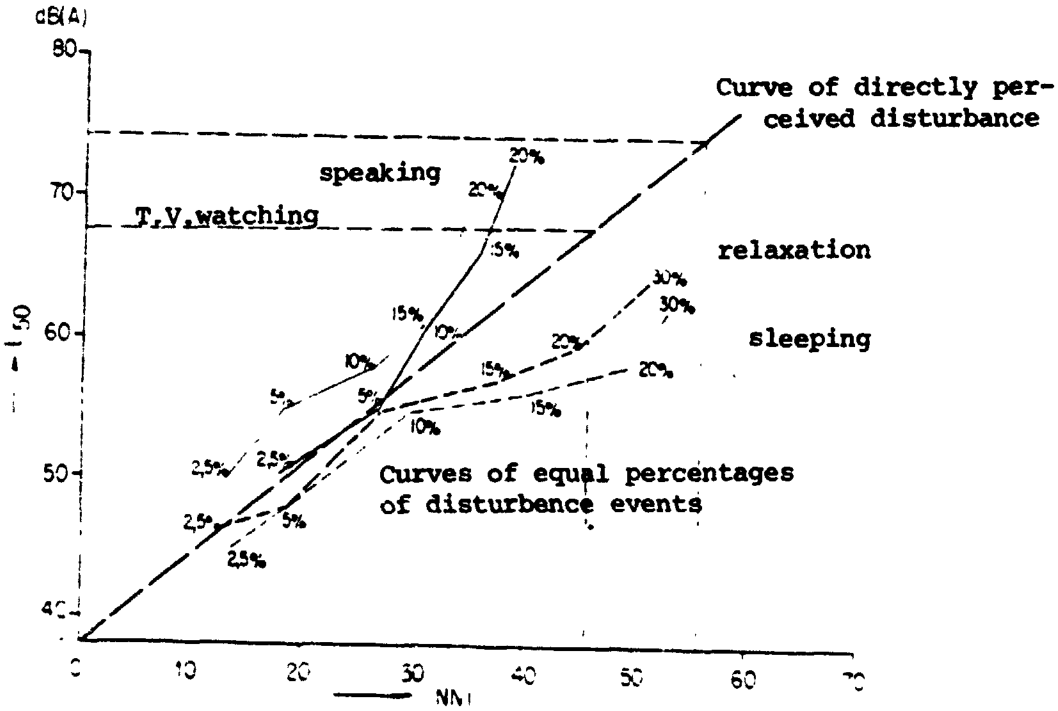
These observations coincide with those of directly perceived disturbances.

4.6. Comparison of the Effect of Airplane and Traffic Noise Exposure with the Directly Perceived Disturbance and with States of Disturbance /135

Since perceived disturbances through traffic noise are measured with an analogous process to the measurement of perceived disturbances by airplane noise the effects of both types of noise are immediately comparable.

An increase of traffic noise exposure by 10 units corresponds to the increase of airplane noise exposure by 50 units in its effect on perceived disturbance.

Figure 4.21. Comparison of the effect of flight and traffic noise on the directly perceived disturbance as well as states of disturbance. (Traffic noise exposure - test population Basel-; airplane noise exposure - total population)



The differing effects of flight and traffic noise on communicational (speaking, T.V.) and recreational needs (recreation, sleep) are of special interest. Traffic noise disturbs recreational activities to a greater degree while airplane noise affects especially communicational needs. This fact is also apparent in the inverted rank order of the needs disturbed by airplane noise and traffic noise respectively (see figure 4.11.). The divergence in the effects on different need categories of airplane and traffic noise are especially distinct in the middle noise range of 30 NNI respectively 55 dB(A). /136

The different effects are based on the fact that airplane noise is relatively intensive but falls into discreet peak events which may interrupt especially communication processes. Traffic noise, however, shows a contrary characteristic by having few peaks but greater continuity which does not collide as much with communication needs as with recreational ones.

The distinctly lower percentages of frequencies of the perceived disturbances by traffic noise in comparison with the disturbances by airplane noise have two reasons; (a) the already mentioned characteristic of airplane noise makes it more noticeable in the perception of the frequency of noise events than those of traffic noise. (b) the ability of the NNI to differentiate between the noise source airplane and other surrounding noise sources is considerably higher than the ability of the L_{50} to differenciate between the main components of street noise and the other noise sources in the environment.

4.7 The Spontaneous Reaction To Noise

The establishment of direct and indirect disturbance indices rests on the presentation of a stimulus specific reaction scale, e.g. stimulus specific questions with suggested answer categories. To check the disturbance indices for distortions which may have been caused either by form and content of the questions as well as the answer categories, it is important to discover the spontaneous reaction of the interviewees to a physical source of disturbance which is not defined more closely. In addition the relative dominance in the perception of different sources of disturbances presents an additional validity and reliability criterium for the used disturbance indices.

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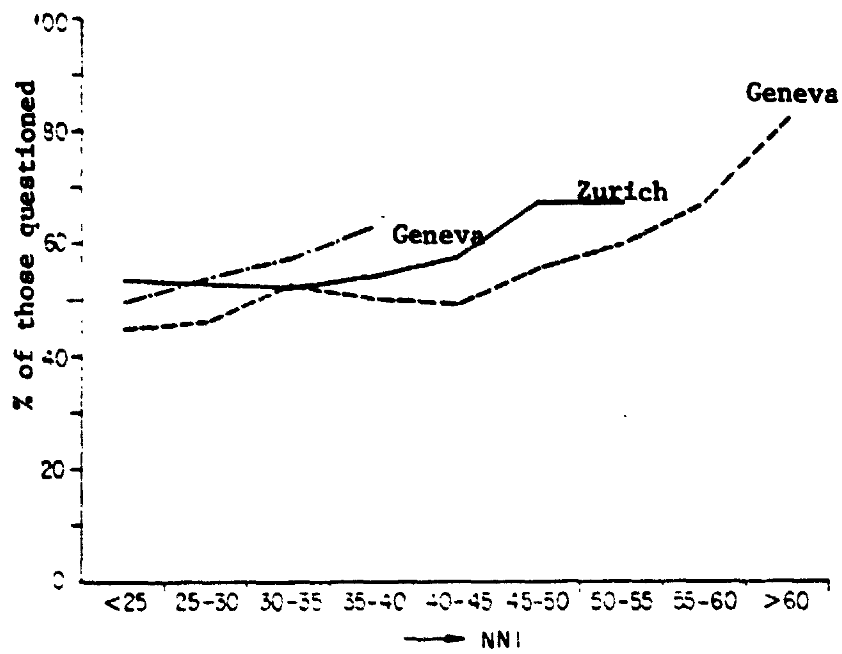
1) Operationalization; "If you think of your closer environment, is there something which you or your family dislike? Could you please tell me what that is"? The second question was asked openly the answers therefore can be considered as relatively spontaneous reactions.

Figure 4.22. Perception of a disturbance in the environment in dependance on airplane noise exposure (NNI) for the three test areas of Zurich, Geneva, and Basel (N = 3940). /137



The perception of a disturbance in the environment in all three areas is for all practical purposes a evenly ascending function of the airplane noise situation (NNI). It is noticeable that again the test population in Basel shows systematically higher percentage values than the two other test populations.

The same fact is also found in reference to the dominance of the disturbance source: airplane, as the causal factor of the perceived disturbance of the environment (See figure 4.23.). With increasing airplane exposure the relevance of the other dis- /138 turbing factors decrease. Already in the airplane noise range of 30-39 NNI the airplane predominates as source of disturbance. In the range over 50 NNI the airplane dominates as disturbance source to such a degree that all other possible disturbance factors are practically without importance. Figure 4.24. the same situation is demonstrated for traffic noise zones in the random sample in Basel. The percentage of frequency of the perception of "other noise", whose main component is traffic noise, is no linear function of the median, surrounding sounds L_{50}. This is

the result of the different dominance of other disturbance sources especially the dominance of airplane noise.

Figure 4.23 Causes of perceived disturbances of the environment in dependence of airplane noise exposure (NNI) (In percent of the interviewed of the total random sample, who perceived a disturbance of the environment).

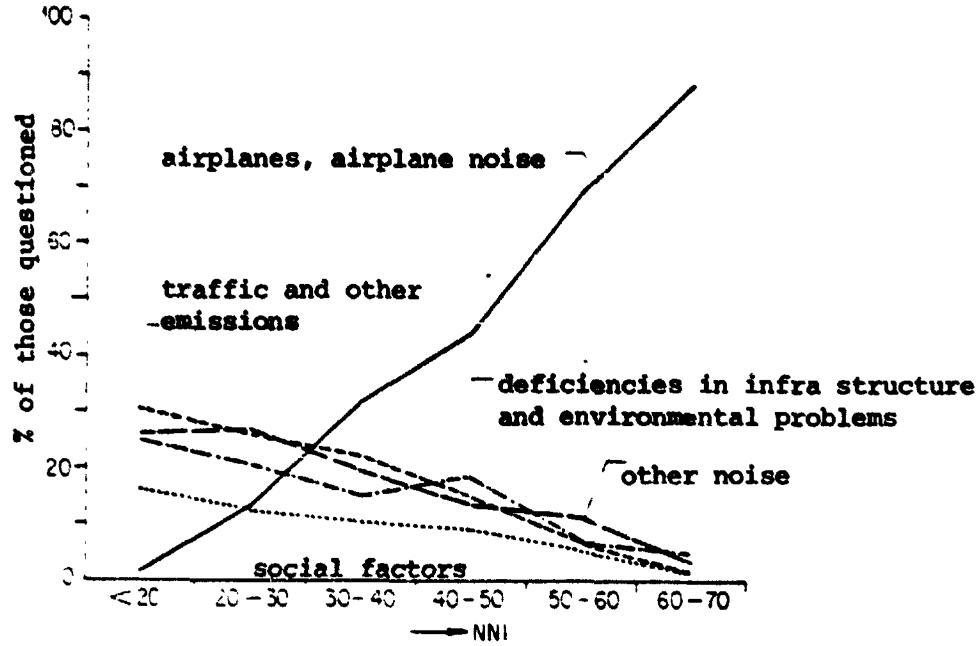


Figure 4.24 Perception of a disturbance in the environment and its causes dependent on traffic noise exposure (L_{50}) (In percent of those subjects in the Basel random sample who perceived a disturbance in their environment). /139

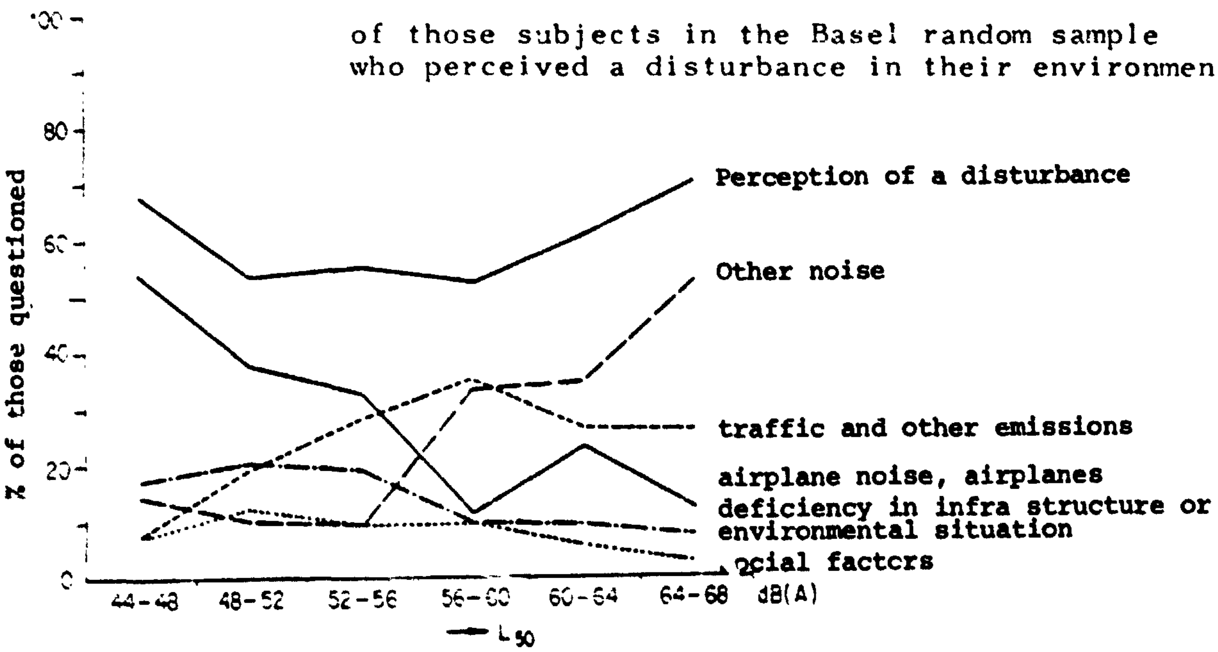
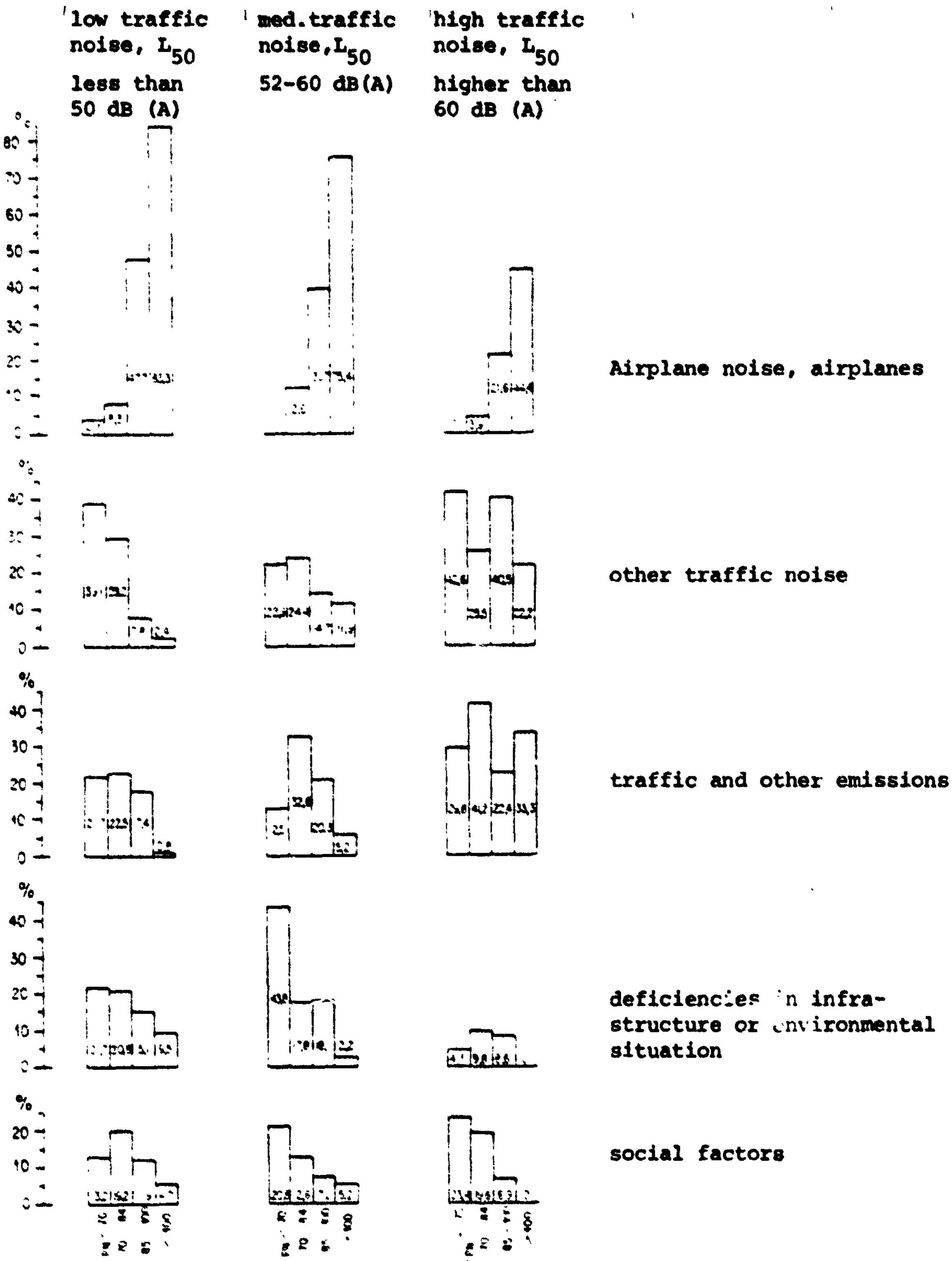


Fig 4.25 demonstrates the relative dominance of 5 sources of disturbances in dependence on airplane exposure and under control of the traffic noise exposure. This shows clearly[1)] that in areas of high airplane noise prevalance (L_{PN}) the attribution of the disturbance to their source is dependent on the level of traffic noise. This offers the conclusion that the degree of the perceived disturbance by airplane noise in those areas is influenced by the level of traffic noise.

1) To control for the possible influence of the number of airplane movements the noise exposure measure used was not the NNI which is number weighted but the L_{PN} (Perceived noise level which is a noise component of the NNI).

Figure 4.25 Relative dominance of different disturbance sources in dependence from airplane noise and street noise exposure. /140



4.8 The Perceived Disturbance by Airplane and Traffic Noise In Dependence on Acoustical Stimulus Context /141

The assumption that the evaluation of an acoustic stimulus of a sequence of stimuli may be influenced by the acoustical stimulus context can be based on mainly two reasons; (a) the stimulus context functions as a frame of reference, and (b) the adaptation of the acoustical stimulus receptor system of an individual is dependent on acoustical stimulus context. However, the empirical results of this situation are in part controversial. Espe:ially the question whether the evaluation of airplane noise should be based on its difference from the median surrounding noise level or on the basic noise, is not answered yet.

The multiple regression analysis of the present data showed that neither the median surrounding noise level nor the base line noise L_{99} of · red a significant contribution to the explanation of the variation in the perceived disturbance by airplane noise. Consequently it is possible to start from the absolute level of the disturbing sound in the evaluation of airplane noise.

Table 4.26 Shows the increase of the multiple correlation efficient in a stepwise inclusion of airplane noise (L_{PN}), background noise (L_{99}) and the median surrounding sound (L_{50}) in the regression equation. This results in a higher F value for the inclusion of L_{99} than for L_{50}.

Table 4.26 Multiple Correlation coefficients between the perceived disturbances by airplane noise and the L_{PN}, of the L_{50}, as well as the L_{99}

(Total random sample N=3940)

Multiples R	Multiples R^2	Increase of R^2	F-value for inclusion of the variables	Independent variables of the equation
0.5638	0.3178	0.3178	1834.4351	L_{PN}
0.5641	0.3182	0.0003	1.9289	L_{PN}, L_{99}
0.5641	0.3182	0.0000	0.3344	L_{PN}, L_{99}, L_{50}

In chapter 4.7, however, it was stated that the spontaneous association of a perceived disturbance of the environment with the disturbance source: airplane noise, is influenced by the level of traffic noise (L_{50}). Figure 4.27. shows /142

that, in fact, in the case of high or medium surrounding or background noises a decrease of the percentage of those subjects occurs who claim disturbance by airplane noises dependent on background sounds (L_{99}) as well as medium surrounding sounds (L_{50}).

Therefore, additional analyses of the question of influence of acoustical stimuli complexes would be necessary for the evaluation of airplane noise.

Figure 4.27a Percentage of subjects who claim very great disturbance by airplane noise (index values 8,9,10) depending on background noises (L_{99}) per L_{PN} - area.
(Total population N = 3940)

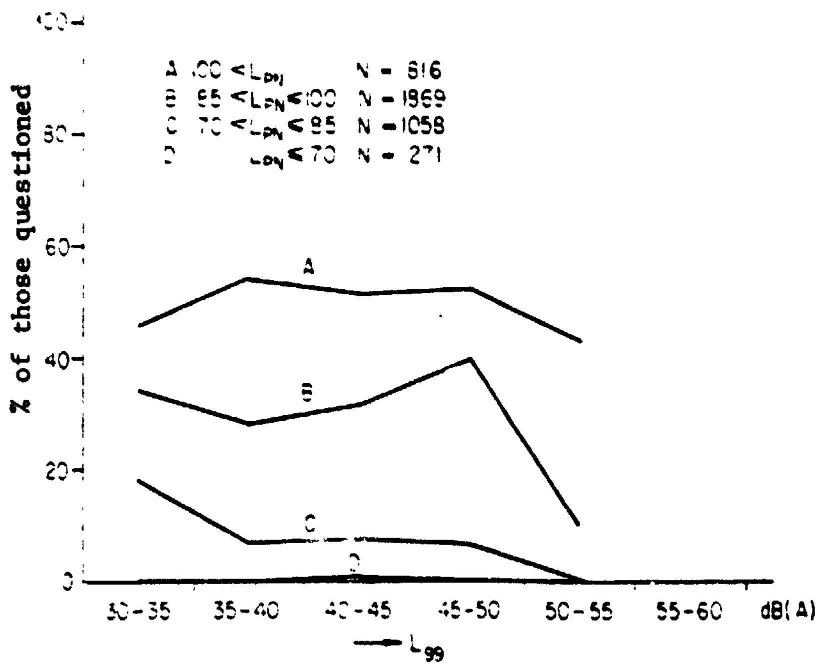
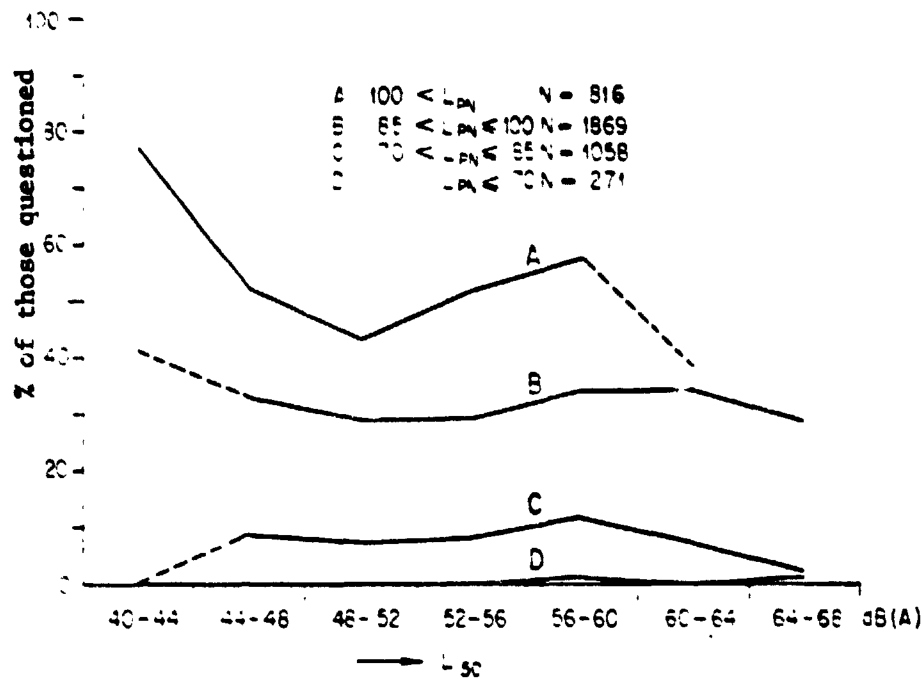


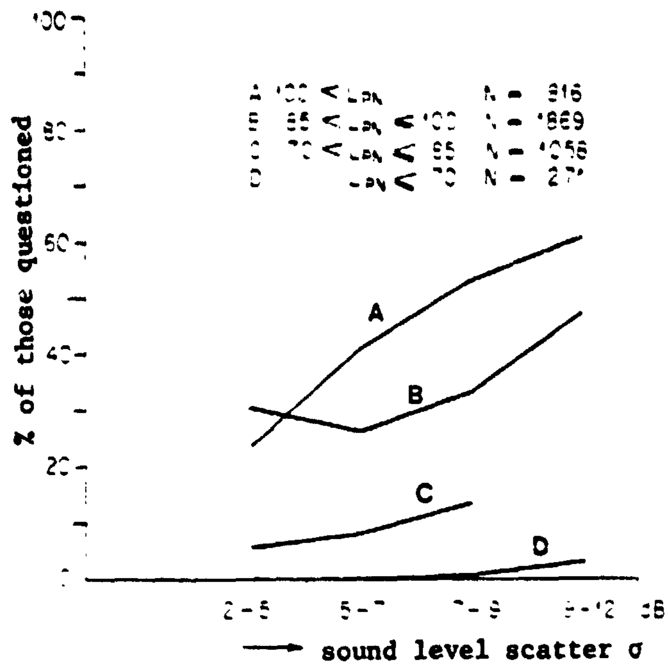
Figure 4.27b Percentage of subjects who claim very great disturbance by airplane noise (index values 8,9,10) depending on medium sound (L_{50}) per L_{PN} - area. /143

(Total population N = 3940)



Since in a situation with a constantly high L_{PN} with increasing surrounding or base line sounds a decrease in sound level fluctuation can also be expected, it is to be assumed that in higher sound level ranges of the L_{PN} the sound level fluctuation can be associated with the perceived disturbance. This is confirmed in figure 4.28.. With increasing sound level fluctuation the percentage of subjects who claim strong disturbance increases also. This relationship, however, is only in effect in L_{PN}-ranges of larger than 70.

Figure 4.28. Percentage of subjects who claim great disturbance by airplane noise dependent on sound level fluctuations. Per L_{PN} - range (Total random sample N = 3940) /144



Based on multiple regressions for the evaluation of traffic noise there is a significant influence of the base line sound (L_{99}) in contrast to airplane noise, while airplane noise (L_{PN}) does not have any influence on the perceived disturbance by traffic noise. The base line noise acts deminishing on the perceived disturbance by traffic noise.

This leads to the following multiple regression equation;

$$\text{Traffic noise exposure} = L_{50} - 0.6\ L99 - \underline{12.2}$$

It is probable that street noise peaks also influence the perceived disturbance by traffic noise. Since, however, street noise peaks can be covered up by airplane noise peaks the influence of street noise peaks on the perceived disturbance can only be researched in homogeneous noise situations with pure street noise.

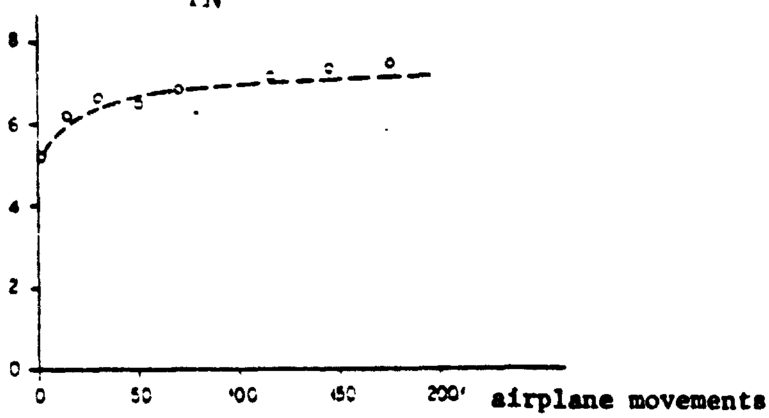
Table 4.29. Multiple correlation coefficents between perceived disturbances by traffic noise, the L_{50}, L_{99}, as well as the L_{PN} (Random sample in Basel N = 944) /145

Multiples R	Multiples R^2	Increase of R^2	F-value for inclusion of the variables	independent variables in the equation
0.4231	0.1790	0.1790	205.5750	L_{50}
0.4608	0.2124	0.0334	39.9386	L_{50}, L_{99}
0.4609	0.2124	0.0000	0.0339	L_{50}, L_{99}, L_{PN}

4.9 The Perceived Disturbance by Airplane and Street Noise In Dependence on Flight Movement Frequency or Street Traffic Density

The subjective intensity impression of a certain present acoustical stimulus is not only dependent on the objective stimulus intensity but also on the frequency of its occurrence.

Figure 4.30. Medium perceived disturbance in dependence on airplane movement frequency, independently of L_{PN} 1)



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1) To make it possible to show graphically the influence of the flight frequency independent from the L_{PN} the influence of the varying L_{PN} on the perceived disturbance of airplane noise was eliminated by extrapolation of its median value (Regression LPN perceived disturbance).

The English noise index NNI gives the logarithmic airplane movement frequency with 15 [16], the French noise index gives it with 10 [18], the American noise index CNR likewise with 10 [17]. In the second English investigation around Heathrow Airport [33] we find values between 4 and 12. /146

Based on the data of the 3 Swiss airports we obtained the following regression formula;

$$\text{Airplane Noise Exposure} = L_{PN} + 6.6 \times \log N \quad 69$$

As the regression formula shows, the weight (k = 15) of the logarithmic airplane movement frequency (logN) in the NNI is too high for the data presented. It results only in a weight of 6.6.

The daily number of airplane movements averaged over 360 days is based on the information obtained by Traffic Control, especially in the area of the control groups (NNI larger than 30), so that no longer all flight movements lead to a noticeable influence on the noise level. The numbers given by traffic control for those areas are therefore in some cases up to 50% too high. As a further correction the number of movements was corrected for the number of effectively observed airplane movements (L_{PN}* and log N* consider this correction). Based on this correction the data were obtained by the following regression equation:

$$\text{Airplane Noise Exposure} = L_{PN}^* + 8 \times \log N - 69$$

---

1) Continued from previous page

Figure 4.30. was constructed under the following condition:

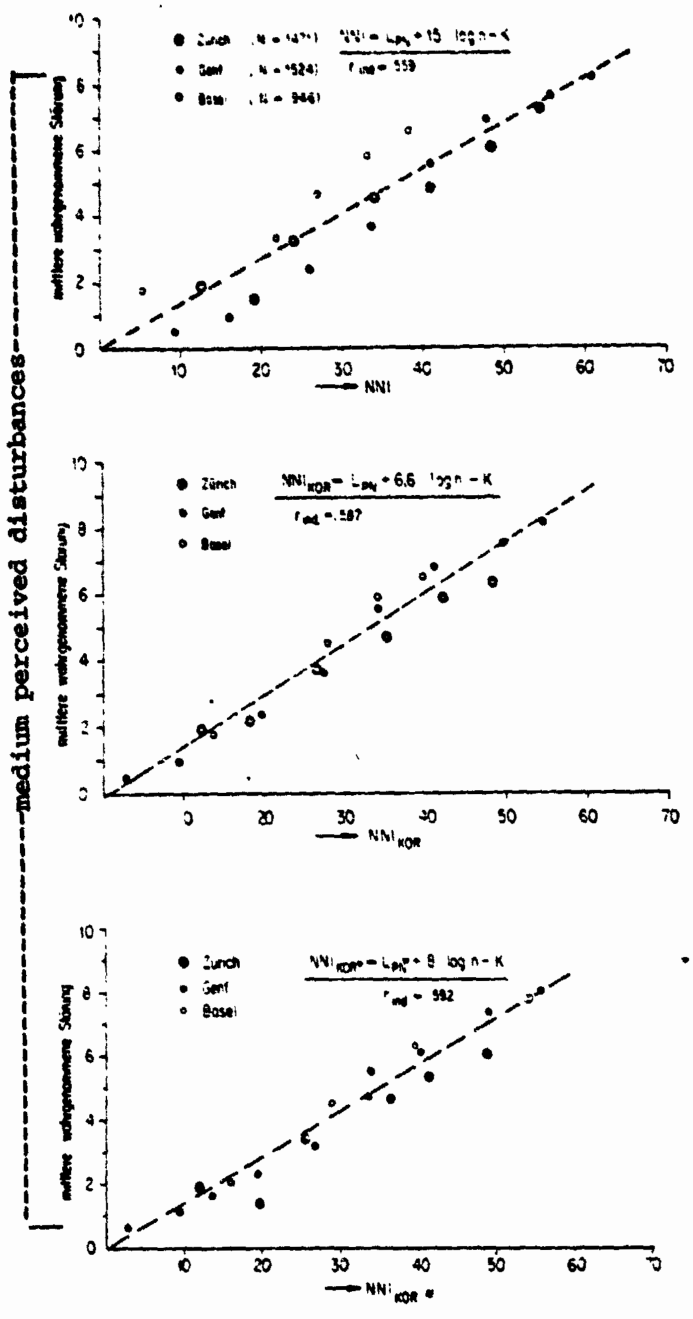
N	=	3940
$L_{PNind.}$	=	const. = L_{PN}
Perc. dist.	=	Perc. dist. + L_{PN}
L_{PN}	=	$L_{PNind.}$
	=	Regr. Coeff.

Tab. 4.31. Influence of different regression tables on the connection between noise exposure and perceived disturbance ($N = 3940$) /147

Statement	r	r^2	increase of r^2 compared to L_{PN}
L_{PN}	.5640	.3181	.3181
L_{PN} + 15 logN-80	.5593	.3128	-.0053
L_{PN} + 6,6 logN-69	.5674	.3450	.0269
L_{PN}* + [illegible] logN*-69	.5915	.3499	.0318

The overvaluation of the logarithmic flight movement frequency leads to a statistically significant lower relation between the noise exposure measure and the perceived disturbance. In addition, as shown in figure 4.32, this leads to an explanation of the systematic deviation of the middle disturbances as observed in chapter 4.3.. The overevaluation of the airplane movement frequency in comparison with the noise component resulted in a measured noise exposure that was too low for the test area in Basel with its low airplane frequency. However, it has to be kept in mind that the obtained results in which weighted airplane movement frequencies are limited by the type of distribution frequencies at the three airports.

Figure 4.32. Medium perceived disturbance depending on NNI, NNI_{KOR}, and $NNI_{KOR}*$



Since the airplane number in the NNI is weighted too high there is a better agreement between disturbance and noise exposure in the French index R which was calculated by /149

approximation as well as for the American CNR [1]. Although the CNR takes night flight frequencies into account this does not result in a better agreement between the CNR and the disturbance. Based on the small differences of variation between the 3 Swiss airports in their day and night flight relationships here too, final judgement in respect to the quality of exposure measurements has to wait (see also chapter 4.11).

Table 4.33. Linear agreement of noise exposure and disturbance for different airplane exposure measurements.

Airplane noise exposure measures	r_{xy}
NNI	0.559
NNI_{KOR}*	0.592
R [1]	0.581
CNR [1]	0.591

Analagous to the influence of airplane frequency the influence of traffic density on the perceived disturbance by traffic noise can be expected; [2]. /150

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1) For the method of approximate calculations of the R and CNR see also chapter 3.4.2.

2) Traffic density based on traffic counts in 1970 as well as estimates of the following classifications:

	Index	Amount of Traffic MPWE/h	log M
Main Traffic Arteries	1	1200	3.08
- heavily used connections between communities, railroads,	2	600	2.78
Through Traffic	3	300	2.48
- connecting streets in built up areas	4	140	2.15
Neighborhood Traffic	5	60	1.78
- local traffic only	6	25	1.34
Practically no traffic	7	3	0.48

Table 4.34. Multiple correlations between the directly perceived disturbance by traffic noise, L_{50}, L_{99}, as well as the logarithmic density ($\log M_{PWE/h}$) (random sample Basel N = 945)

Multiples R	R^2	Increase of R^2	F-value for inclusion of the variables	independent variables of the equation
0.4231	0.1790	0.1790	205.5750	L_{50}
0.4637	0.2150	0.0360	43.2073	L_{50}, $\log M_{PWE/h}$
0.4807	0.2313	0.0161	19.6554	L_{50}, $\log M_{PWE/h}$, L_{99}

A pure traffic noise exposure measure in zones with mixed noises (general noise sources as well as airplanes and street traffic) can be obtained on the basis of multiple regressions with the following equation;

$$\text{Traffic Noise exposure} = L_{50} + 6.4 \log M_{PWE/h} - 0.7\, L_{99} - 21.6$$

---

1) **Amount of traffic based on traffic counts from the year 1970 as well as the following estimated classifications:**

	Index	amt.of traffic $M_{PWE/h}$	log M
Main traffic arteries	1	1200	3.08
- much traveled connections between communities, railroads	2	600	2.78
Long distance traffic	3	300	2.48
- connecting streets in developed regions	4	140	2.15
Local traffic	5	60	1.78
- no through traffic	6	25	1.34
Practically no traffic	7	3	0.48

4.10 The Perceived Disburbance by Airplane Noise Depending on Starting And Landing Operations /151

Start and landing noise differs in several respects;

(1) The time of noise exposure in the case of starting operations in a constant of L_{PN} is considerable longer than for landing operations. This is the result of differing sound intensity as well as differing angles of climb for starting and landing airplanes. This also leads to differences in the distance to the source of noise despite the constant L_{PN}. The different distances between the noise exposed individual and the sound source introduce at the same time an essential psychological factor.

(2) Starting and landing operations influence the sound level spread in the noise exposed areas differently. Besides, the two flight operations lead to different sound frequency spectrums (See chapter 3.2.4.).

In this investigation the purpose is not to look at the effect of the individual factors but to consider the total effect of the role that starting maneuvers play in the total number of airplane movements on the perceived disturbance within the controlled PNL as well as the logarithmic airplane frequency.

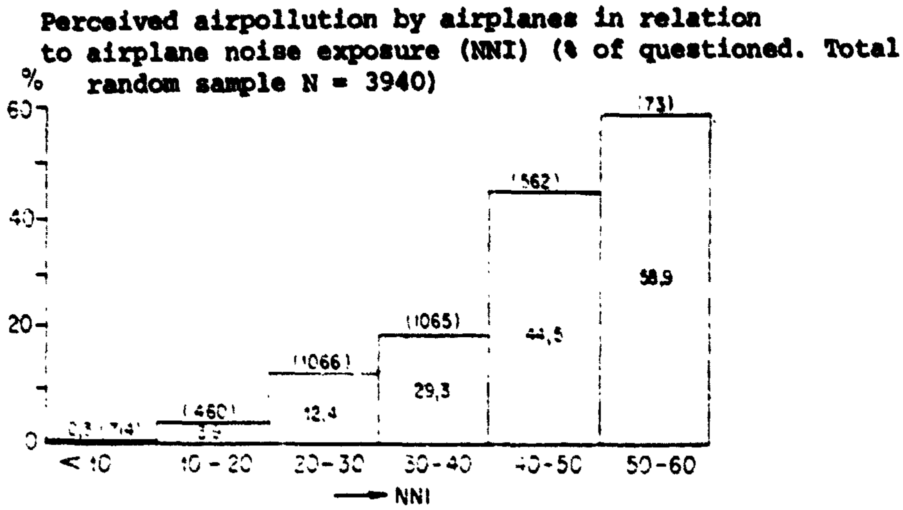
Table 4.35. Multiple correlation coefficients between directly perceived disturbances by airplane noise, L_{PN}, the logarithmic airplane movement number and the share of start movements in the total movement number.

Multiples R	R^2	Increase of R^2	F-value for inclusion of the varaibles	independent variable in the equation
0.5662	0.3206	0.3206	1857.4985	L_{PN}
0.5916	0.3500	0.0294	178.0634	L_{PN}, logN
0.5918	0.3502	0.0002	1.5140	L_{PN}, logN, take-off/landing ratio

As Table 4.35. shows, the starting and landing ratio has no effect on the perceived disturbance in a controlled L_{PN} and logN /152

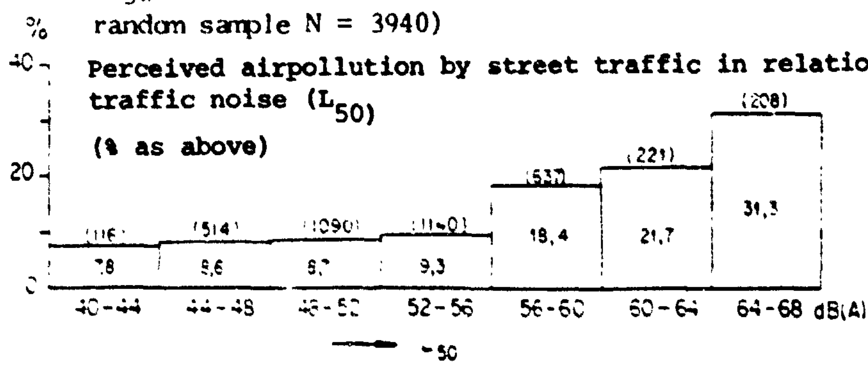
It is evident that the distance of the airplane from a measuring point coincides greatly with the measured noise exposure. Therefore an increasing annoyance by visible exhaust gas development in connection with airplane noise exposure can also be found.

Figure 4.36 Perceived air pollution by airplanes in dependence on airplane noise (NNI) (In percent of the interviewed. Total random sample N = 3940)



A similar effect can also be found in the case of traffic noise, however, it is not quite as distinct:

Figure 4.37 Perceived air pollution by street traffic conveyances in dependance of traffic noise. (L_{50}) (In percent of the questioned. Total random sample N = 3940)



4.11 The Influence of Evening And Night Noise on The Perceived Disturbance [1] /153

A great number of studies agree that night noise in comparison to day noise has a far more aggravating influence on the psycho-physical well being of individuals. This is also expressed in the greater weight it

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1) Evening is defined as the time period between 6:00 pm and 10:00 pm

Night is defined as the time period between 10:00 pm and 6:00 am receives in airplane movement numbers during the night in different exposure measures (CNR, NEF, B). Also, in chapter 3.4.1. it was discussed that in the case of the disturbance of recreative needs (sleep, relaxation) the relative stress effect of airplane noise acts more intensively on the directly perceived disturbance than in the case of the disturbance communicative needs. which sheds some light on part of the unexplained variation in the perceived disturbance by airplane noise. Here it has to be kept in mind that the disturbance, measured by the scalometer, is conceived as a general disturbance index.

Table 4.38 Multiple correlation coefficients between the directly perceived disturbance by airplane noise, L_{PN}, the logarithmic airplane movement number as well as the share of night and evening flight movements of the total airplane movement number. (Total random sample N = 3940)

Multiples R	R^2	Increase of R^2	F-value for inclusion of the variables	independent variables in the equation
0.5639	0.3180	0.3180	1833.4471	L_{PN}
0.5907	0.3489	0.0309	186.6392	L_{PN}, logN
0.5953	0.3544	0.0055	33.5286	L_{PN}, logN, evening flights
0.5955	0.3547	0.0003	1.4588	L_{PN}, logN, evening flights nightflights

The inclusion of the share of evening flight movements in the total movement number causes a small but significant increase of the multiple determination coefficients. Its increase is larger with the inclusion of the percentage of night flight movements. Partial correlation coefficients: /154

$r_{xy.uv} = 0.0539$, $r_{xy.uv} = 0.0920$

x = Percentage of night flight movements of total movement number

x = Percentage of evening flight movements of total movement

y = Perceived disturbance by airplane noise

u = L_{PN}

v = log N

Here too it has to be emphasized that the small variation of the share of night flight movements of the total movement number exerts a limiting influence on the presented results.

Table 4.39 shows that already small percentage increases in night flight numbers strongly increase the number of those interviewees who feel especially disturbed at night while the proportionate increase of evening flights in reference to the determination of the time of disturbance had comparatively little effect.

Table 3.39. Percentage of interviewees who were especially disturbed by airplane noise at night in dependence on the percentage of night flight movement (10:00 pm to 6:00 am) of the total number of airplane movements. (total random sample N = 3931)

	% of night flight movements 0-4.9 %	5-9.9 %	25-30 %
especially disturbed at night	10.8 (1487)	26.5 (2405)	35.9 (39)

$\chi^2 = 144.9$ $p < .001$ Gamma = .49

Table 4.40 Percentage of interviewees who are especially disturbed by airplane noise during the evening in dependence on the percentages of airplane movements in the evening (6:00 pm to 10:00 pm) of the total number of airplane movements. (Total random sample N = 3933) /155

	% of evening flight movements 14-19.9 %	20 - 24.9 %	25 - 30 %
especially disturbed during the evening	22.0 (2577)	38.7 (108)	28.6 (1250)

$\chi^2 = 32.0$ $p < .001$ Gamma = .17

The relation between the sleep disturbances as given by the subjects and the night flight noise exposure (NNI_{night}) is not linear [1]. As fig. 4.41 shows, based of the median values of the sleep disturbance index [2], it represents a significant increase of sleep disturbances in approximately 25 NNI_{night}.

1) Explained variation in sleep disturbance by night flight noise in linear, squared and cubic regression equations

linear	squared	cubic
0.206	0.209	.0224*
(N=985)	(N=985)	(N=985)

* Significant to the 5th percentile

2) The additive index was established by the following questions;

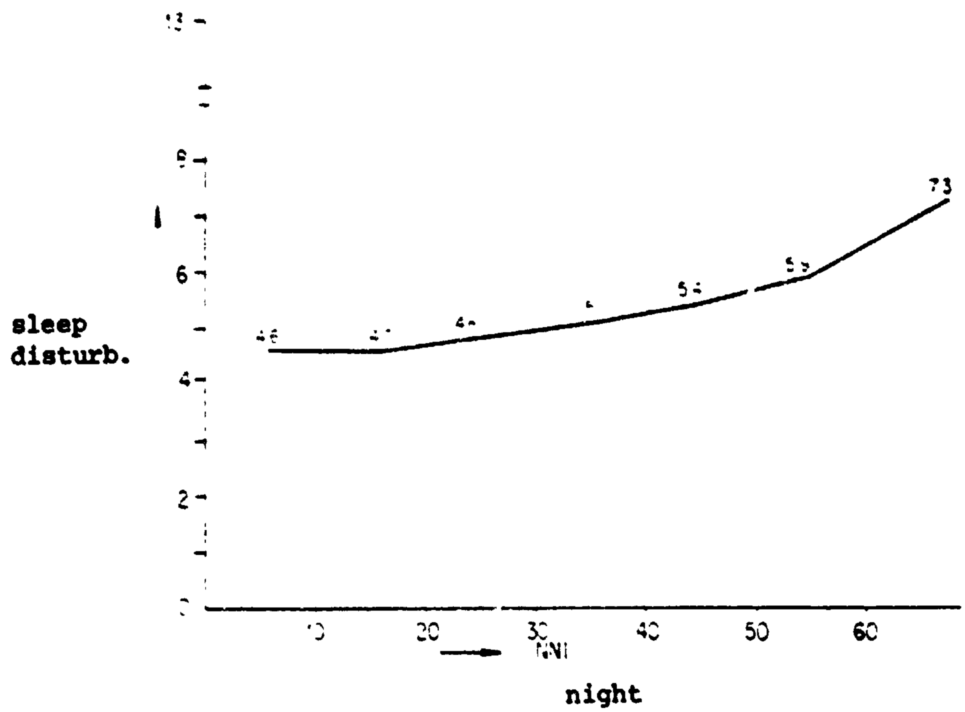
a. How often does it happen that the airplane noise disturbs you when you are sleeping or trying to fall asleep?

b. Self evaluation based on the psychosomatic inventory

- I cannot fall asleep
- I sleep fitfully and wake up often.
- I'm not rested in the morning and have difficulty getting up.

(Range 1-13)

Figure 4.41 Median sleep disturbance index values in dependence on night flight noises (NNI_{night}) (total random sample N = 3931) /156



Also in reference to street traffic noise the obtained data of evening and night noise as compared to day noise, do not explain the variance. It is remarkable that in the case of traffic noise too, the evening noise exerts a greater (yet not significant) influence on the perceived disturbance by traffic noise than the nightly noise (see table 4.42).

Table 4.42. Multiple correlation between the perceived disturbance, L_{50}, $\log M_{PWE/h}$, L_1, $L_{50(day)} - L_{50}$ (evening) as well as $L_{50(day)} - L_{50(night)}$.

(Random sample Basel N = 944) /157

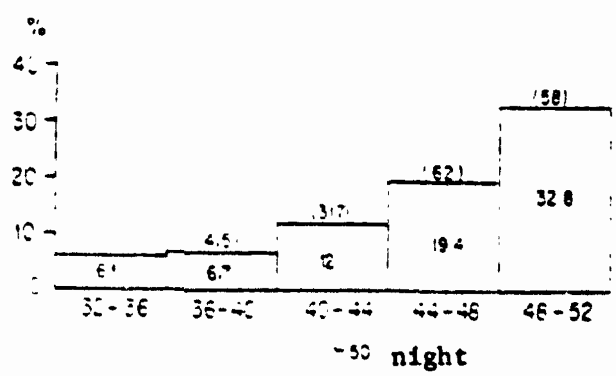
Multiples R	Multiples R^2	Increase of R^2	F-value for inclusion of the variables	independent variable in the equation
0.4231	0.1790	0.1790	205.5750	L_{50}
0.4637	0.2150	0.0360	43.2073	L_{50}, $\log M_{PWE/h}$
0.4807	0.2311	0.0161	19.6554	L_{50}, $\log M_{PWE/h}$, L_1
0.4809	0.2313	0.0003	0.3065	L_{50}, $\log M_{PWE/h}$, L_1, $L_{50(day)} - L_{50}$ (evening)
0.4809	0.2313	0.0000	0.0114	L_{50}, $\log M_{PWE/h}$, L_1, $L_{50(day)} - L_{50}$ (evening), $L_{50(day)} - L_{50}$ (night)

T percentages of the interviewed whose sleep was disturbed by traffic noise are an evenly ascending function of the night traffic noise $L_{50(night)}$.

Figure 4.43. Percentages of those interviewed whose sleep was very often or quite often disturbed by traffic noise in dependance on $L_{50(night)}$

(Random sample Basel N = 934)

(Question: "How often does it happen that traffic noise disturbes you when you sleep or try to sleep"?)



4.12. General Acoustical Exposure Measurement with Differing Dominance of Several Noise Sources /158

In the preceding chapters the noise situation was always studied in reference to a specific noise source. As a next step it has to be determined which of the objective measures of noise represent the general noise situation of an environment best so that it explains the generalized reaction of individuals [1].

It is to be expected that those noise exposure measures which are best suited to describe a generalized reaction are those which on the one hand react clearly to one dominant noise source and also are as independent as possible of different relationships of dominations in various sound sources.

Table 4.44. Connection between the categorization of living environments, as "quiet versus noisy" generalized reaction, with different noise exposure measures for the three test areas Zurich, Geneva, and Basel as well as for the total random sample.

Noise exposure measures	ZH r_{xy}	GE r_{xy}	BS r_{xy}	Total r_{xy}
L_{50}	.11	.15	.40	.17
L_1	.35	.30	.34	.34
$L_{0,1}$	.37	.28	.23	.31
L_{eq}	.38	.30	.35	.34
L_{NP}	.36	.25	.34	.32
NNI	.40	.26	.14	.34

1) The generalized reaction is statistically represented by the categorization of the immediate living environment as quiet or noisy. (Scale range -3 to +3).

It seems significant that the noise exposure measures for the dominant source of the general noise situation - in Zurich, for the NNI for airplane noise and in Basel, for the L_{50} for street traffic noise show the highest agreement with a generalized reaction. The equivalent continuous sound level (L_{eq}) proved to be the best objective measure for the generalized reaction to a general noise situation in the environment in all three areas which are characteristic for differing noise situations. Insignificantly inferior, but showing a distinct tendency, the L_1 ranged second as a qualified measure for the generalized reaction to noise situations in the environment. It is confirmed that the area of Basel was dominated by the noise source "street traffic", while the test area Geneva shows the most ambivalent noise situation. The L_{eq} and the L_1 show the greatest agreement between generalized reactions. /159

As shown, an adequate noise exposure measure consists of at least two components: (a) a sound component (b) a frequency of sound occurence component. If logarithmic flight movement frequency as well as logarithmic street density values are included as additional factors of the equivalent continuous sound level (L_{eq}) then we obtain a significantly improved connection between noise exposure and general reaction.

Table 4.45. Multiple correlations between the generalized reaction, L_{eq}, the logarithmic airplane movement number as well as the logarithmic values for traffic density. (Total random sample N = 3940) /160

multiples R	multiples R^2	increase of R^2	F-value for inclusion of variables	independent variables of the equation
0.3401	0.1157	0.1157	514.9351	L_{eq}
0.3777	0.1427	0.0270	125.8096	L_{eq}, log $N_{(flight\ movements)}$
0.4014	0.1611	0.0184	86.4280	L_{eq}, log $N_{(flight\ movements)}$ log $M_{PWE/h}$

As a general measure for general noise exposure (categorization for the living environment: quiet versus noisy) the following equation can be established on the basis of multiple regressions:

$$\text{Total noise exposure} = L_{eq} + 7.4 \log N_{flightmovem.} + 10.8 \log M_{PWE/h} - 59$$

5. THE PERCEIVED DISTURBANCE BY NOISE DEPENDENT ON INTERVENING FACTORS OF SEMANTIC AND PRAGMATIC STIMULUS INTERPRETATION /161

5.1. INTRODUCTION

From the fact that the same stimulus can cause different types and different strenghts of reaction in different individuals has to be concluded that the relationship between stimulus and reaction can only be explained by making sensible assumptions about the existence and effectiveness of specific internal factors within the system. It is therefore important to analyze and empirically scrutinize these inner states as well as their causes within the stimulus-reaction transformation process.

It is obvious that there is an arbitrary and, to a degree, pre-scientific element in the process of making a selections of variables which intervene in the stimulus. The tasks consist of selecting from a theoretically infinite number of intervening factors those which can be useful in explaining to the greatest degree the variation. In addition, the problems that present themselves in an attempt to measure inner states within the frame work of this study are partially insoluble for theoretical as well as practical reasons. Therefore the individual contribution of the explaining intervening factors cannot be determined at least quantitatively, but can only be demonstrated by means of a statistically significant connection between input and output volumes.

The inner states and their determinants which co-determine stimulus reaction transformation can be localized analytically on five different plains

5.1.1. The level of social structure factors /162

As determined by different sociological and socio-psychological studies, attitudes, behavior dispositions and actual behavior of an individual are decisively influenced by his social structural position in society. The position of an individual is a product of his development and his dependence on the social structure and the history of a given society. Empirical determinations of this position are chiefly socio-demographic such as sex, age, and marital status, as well as such social economical criteria as income, professional and education strata of society. These criteria of the position of an individual exert influence individually and in combination on his inner states, also on form and content of somantic and pragmatic stimulus processing. This influence is exerted not only passively but actively too. By his own attitudes and actions, triggered by his inner states, the individual influences not only his own position but also the particular social structure of society.

5.1.2. Level of factors of context

The individual members of a society are placed in a certain social context on the one hand and a physical context on the other. Type and properties of the social and physical contexts are correlates of the social structure of the individuals within it.

Generally the quality of the physical context in our society, especially the exposure to physical influences and stressors, is dependent on social economic states and therefore distributed unevenly. The same is true for the social context dimension: the quality of the social environment for reproductive, recreational and creative activities, as, for instance, professional and leisure time activities, is class specific.

It can be demonstrated that, for instance, one-family homes do not only offer better physical living qualities such as isolation, size and so forth, but that their possession also correlates greatly with the social stratification and thus offers their owners better social conditions, especially in respect to individual and family self-realization. 1) /163

The separation between physical and social context is also analytical: in reality the physical context dimension always has social effects and importance and, vice-versa, the social one also has always material importance in the physical context dimension.

Likewise physical and social context qualities on the levels of settlement, domicile and community correlate with the social economical level and class situation of their inhabitants.

In the physical context dimension, freedom from emissions, climatic conditions, geographical location, density of settlement and the quality of the physical infra-structure; in the social context dimension, homogeneity of social composition and class membership as well as the quality of the social and institutional infra-structure represent the most important components.

Ecological deterioration of social strata occurs quicker where stressors initially reduce the quality of the physical context. This causes members of the economically privileged group to leave the area. As a consequence the social prestige of the context is lowered, this means that a physical stressor has at the same time social effects and is able to influence the consciousness and the action of individuals exposed to it. The effect of the principle of strata-selective disintigration as a consequence and as an accelerating cause of physically or socially reduced context qualities has been demonstrated in ecological and sociological studies [50,51,52]. /164

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1) Morris proves that the inhabitants of one-family homes, an apparently strictly physical context condition, are more central sociometrically and better integrated in their social fields of context than inhabitants of multi-family dwellings. [49].

The noise an individual is exposed to is therefore only a physical factor of this context dimension. On the level of the domicile further physical context factors are especially to be included: the number of inhabitants per home, the sound insulation and the type of house. On the level of the environment further physical stressors like air and water quality, traffic and so forth, as well as the quality of the physical infrastructure have to be included.

Problem specific context factors on the level of a primary group - e.g. internal activities in context of the family - are especially determined by the family situation and the life cycle. These fixate a temporally and spatially more or less limited field of objective deprivation possibilities of noise and other stress situations. The subjective perception of the temporal fixation and strain by activities and other reproductive roles determine the degree of free, e.g. unattached valences.

As dominant social context factor on the level of secondary groups - e.g. activities and contacts outside of the family - residential integration has to be included.

Studies in connection with relocation projects and slum rehabilitation have shown that the social context bears more weight in the value scale of individuals and groups than the physical context, however, only as long as the latter did not threaten any primary assets. [53,54,55,56]

5.1.3. Level of Social-Psychological factors /165

Socio-structural and contextural factors are external determinant values of inner states, e.g. of the type and the content of semantic and pragmatic stimulus processing. This determination is dynamic and therefore the inner states too are subject to change. In the learning process these inner states, as a dynamic constantly changing image, are adjusted to the changing positions the individual holds in society. The momentary socio-structural or contextural position is therefore not absolute but has is affective as a determinant of inner states in relation to the historical development. Thereby it is important that socio-structural changes lead to the respective changes of inner states only after a certain time lag. [57].

Socio-psychological factors, like attitudes towards technique, modern versus traditional, retrospective versus prospective orientation, projective importance and others, which are associated with flight events are dimensions of inner states within the phenomenal frame of reference which are relevant to this particular research. They determine both form and content of the semantic interpretation of a stimulus or noise source. They also play a role in their pragmatic evaluation of stressors. It has to be kept in mind that the intervening factors have to be related to the socio-structural position of individuals in the society; and certainly not only in respect to static but also to dynamic aspects. In the empirical analysis, however, the latter is possible only to a very limited degree.

5.1.4. Level of Personality Factors

The personality factors represent a further category of inner states which affect form and content of the semantic and especially the pragmatic stimulus interpretation. They differ from the states of phenomenal reference systems chiefly by their: /166
stability because they are in part biologically genetically determined, therefore inert to influences of socio-structural and contextural factors. This stability is relative in two respects: (a) personality specific inner states by themselves are products of the history of development. Biological genetic and social cultural components are not to be considered as separate but alternating influences of this history of development; (b) the manifestations of personality specific states are not only affected by socio-structural and contextural factors but also by the other categories of inner states.

Included in the dimensions of these personality specific inner states which are relevant to the study, are the intro-extro version and the anxiety level of the noise source. Different studies show significant relations between intro and extrovert personality dispositions and the perception and processing of acute stimuli as well as the reactions to them. [58]

Likewise, the anxiety level of the noise source is an important influential factor for the perception and interpretation of the acoustical stimuli which it emits. The object specific anxiety level is dependent on the general level of apprehension of an individual and partially also by the degree of his introversion. However, the inclusion of personality factors within a survey are very limited. An adequate determination of these requires the employ of psychological experiments, projective tests and so forth. Therefore, the present study has to remain limited to a rough evaluation of these two dimensions.

5.1.5. Level of Interest and Need Factors /167

The inner states which chiefly influence the pragmatic stimulus interpretation are defined by the interest and need requirements of collectives and individuals in the context of the stimulus source.

In this context it is important to differentiate between the objective advantage/cost relationship of social classes, strata and groups and the way they perceive the use/cost relationship. In our society the objective advantage/cost relationship in reference to the sound is class and strata specific: the carriers of the objective noise source are the members of high socio-economic groups, the carriers of the objective cost in form of exposure to noise, however, are the lower classes.

If this objective advantage cost imbalance is seen as an antagonism of interests between societal groups and classes there are effects on the pragmatic but also, retroactively, on the semantic coding of the noise source and its meaning. The latter, for instance, means that this (interest-antagonistic) interpretation of one's own noise exposure as positive projective interpretation of the noise source can be tranformed into a negative or indifferent one. This can lead to an increase in the disturbance perception of noise.

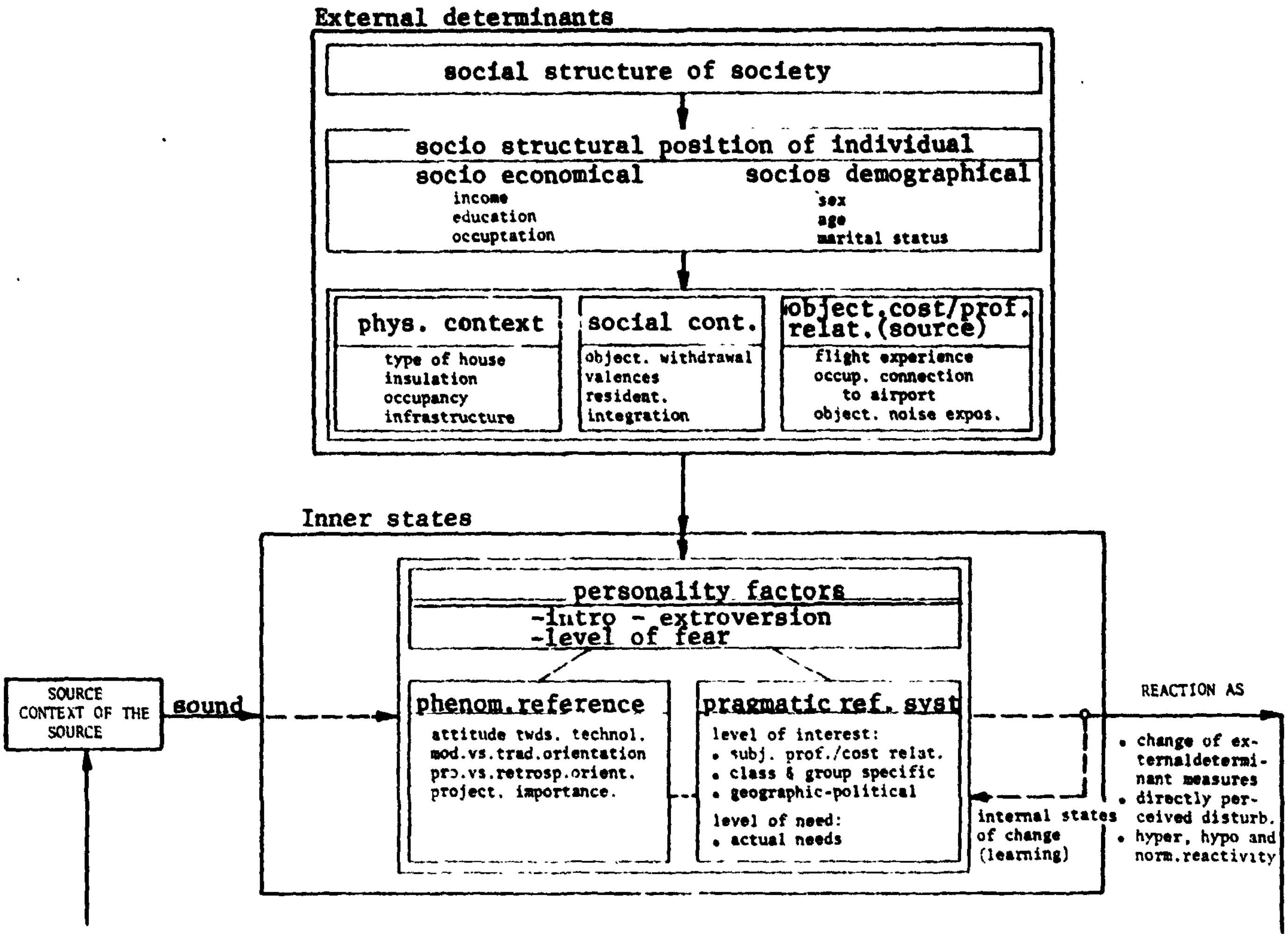
Operationally the objective profit/cost dimension is determined by the frequency of the flight experience or the professional involvement with the airport. The perception of those who profit from and those who are disadvantaged by the source of noise servesas indicator for the subjective side of this profit/cost relationship.

Likewise this profit/cost relationship can be related to the geographical/political regions. If the perceived cost as- /168
pects dominate the profit aspects in relation to a specific region in which the specific individual resides and with which he identifies himself then his interpretation of the noise source and the degree of disturbance can be additionally influenced. Indicator for this aspect is the perception of those who profit the most and of those who pay the highest price within a geographical-political region.

The profit, or the cost, which are charged to a stimulus or a stimulus source are also dependent on the actual individual situation of need. This, however, changes depending on the situation and the time, for instance within the course of a day so that these situational and temporal variations of actual individual need are practically impossible to determine empirically. Since the purpose of this investigation is the evaluation of noise exposure in a generalized situation over a longer period of time, this variability of the actual needs can be neglected: however, it has to be kept in mind that this evaluation of noise exposure can have an influence during the interview. It is important to assume temporal and situational conditions in respect to certain needs such as silence at night as well as sleep and recreational requirements during the leisure hours.

Figure 5.1. represents the five levels of intervening factors in schematic form. It has to be noted that these factors are not independent of each other on the same level as well as on different levels but that they represent a very complex interdependent system of relationships. This interdependence represents one of the basic problems of human sciences in general and limits the possibility of strictly causal statements. Furthermore, it has to be emphasized that the area of validity of the effect of the mentioned intervening factors is limited. This was already discussed in reference to reaction entropies (see 4.2.1.). This is easily demonstrated in the sample of noise exposure which exceeds the pain threshold. The unanimous judgement that such a noise is unbearable is then independent from intervening variables such as age, social integration, professional involvement, and so forth.

Figure 5.1. The five interdependent levels of intervening factors in the explanation of stimulus-reaction transformation. /169

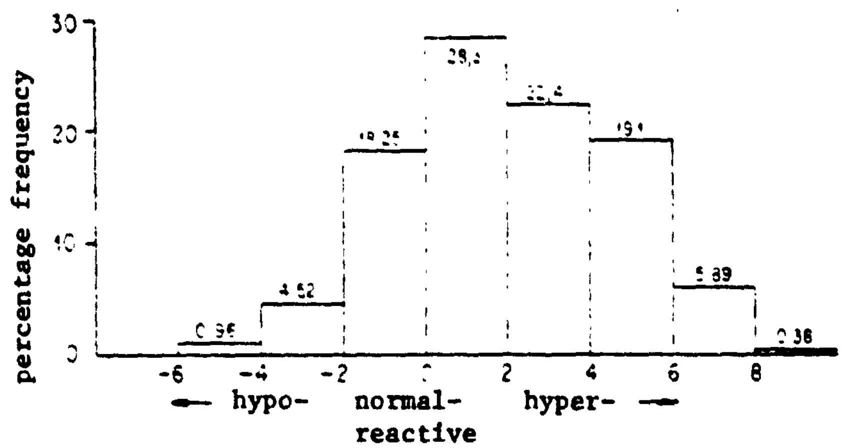


5.2. EMPIRICAL FINDINGS /170

5.2.1. The Reactivity Index

The construction of a reactivity index which reduces the two empirical dimensions of perceived disturbance and objective noise exposure to one dimension serves to simplify empirical analysis. Reactivity is defined as the orthogonal distance of the individual disturbance index to the regression straight line which is the result of the perceived disturbance in function of the noise exposure. Possible interaction effects, however, have to be ignored.

Figure 5.2. Histogram of Reactivity



mean = 1.9499; standard deviation = 2.631; max.= 10; min.= -7.28

The index values of the individual reactivity are approximately normal in their distribution (see fig. 5.2.). In respect to this distribution norm reactive, hypo-reactive and hyper-reactive individuals can be differentiated. It has to be emphasized that each determination of a norm standard represents an arbitrary act. Here, however, the determination is not normatively based but is the result of the empirical distribution. Therefore, the problems discussed in the preceding chapter can be simplified to the following question: Which of the intervening factors of the five different levels show statistically significant differences for normal, hypo and hyper-reactive individuals? /171

5.2.2. The Influence of Sociostructural Factors on the Individual Reactivity

5.2.2.1. Socio Demographic Factors

Table 5.3. Reactivity in dependence on the sex status

sex	mean	standard deviation	N	F-value 1)	P-value 1)	est ω^2 2)
male	2.109	2.65	1809	12.165	<.001	0.003
female	1.815	2.61	2130			

The comparison of the median reactivity by sex results /172
in significantly higher values for men. This indicates that generally men are more reactive than women, e.g. their perceived disturbance is larger than the one of women in controlled noise exposure. The explanatory validity of the sex status, however, is quite small. Only about 0.3% (ω^2) of variability are explainable by sex (see table 5.3.). The sex specifically different reactivity could be the result of a generally higher stress exposure of the male, especially on his work location. In addition, the noise exposure coincides almost exclusively with the regeneration and recreation time of the male population segment.

Reference should also be made to a possible biological component, namely the generally higher adaptability of the female to stress. [3] Finally sex specific socialization should be included as an explanatory factor, which educates the female to

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1) F-Values were obtained by simple variance analysis with the Bartlett-test of equality of variances.

2) $$\text{Estimated } \omega^2 = \frac{\text{SS between} - \text{df (MS within)}}{\text{SS total} + \text{MS within}}$$

SS = Sum of squares
df = Number of free degrees
MS = Mean square
See also W.L. Hayes [59]

3) Takahashi found that male newborn who were exposed to a high degree of noise during their time of fetal development were of significantly smaller stature while female newborn did not show any difference in comparison to a controlled population. This result was confirmed in rat experiments. (see [61])

a higher degree to permissive toleration of a stress situation than the male [66].

Table 5.4. Reactivity depending on absence from home at different times of day. /173

absence during specific times of day	mean reactivity	N*	standard deviation
morning	1.963	244	2.59
afternoon	2.381	247	2.37
morning and afternoon noon (at home dur.lunch)	2.203	801	2.53
all day	1.777	720	2.75
evenings	1.613	104	2.78
at night	(0.958	22	3.21)
variable	1.804	904	2.63
usually at home	1.892	1021	2.65

* Total N exceeds 3940 since multiple answers are possible

Those population segments which are not at home in the evening show the least degree of disturbance (N for those which are absent at night is too small). However, this segment of the population consists chiefly of young, mobile age groups which makes a comparison impossible.

Similar in their social demographic organization are those segments of the population which are absent during the morning and the afternoon but at home during the noon hour, on the one hand, and those segments of the population which are also absent from home during the noon hour. The median reactivity of these two comparison groups does not show a significant difference ($t = 3.132$, p smaller than .001). The exposure to airplane noise during the recreation and the regeneration time during the noon hour obviously increases the perceived disturbance.

Table 5.5. Reactivity in dependance to age /174

age group	mean reactivity	N	standard deviation	F-val.	P-val.	est ω^2
18-30 years	1.640	813	2.55			
31-40 years	1.949	1010	2.61			
41-50 years	2.062	738	2.55	4.046	<.01	0.003
51-60 years	2.009	582	2.64			
61 and over	2.102	791	2.77			

Table 5.6. Reactivity depending on length of residence in one community

Variance-analytical studies of differing individual activity in dependence on age shows statistically significant relations (see table 5.5) but here too only a small part of the phenomena can be explained with age. The T-test of equality of median values shows that only the youngest age group is significantly different from all other age groups.

The juvenile age segment of the 18 to 30 year olds shows a tendency toward hypo-reactivity. This partly is traceable to the loose residential ties of the age group. Besides, projective interpretations of the noise source "airplane", for instance as participant, are definitely localized in the age group.

As before in other studies a significant relationship be- /175
tween the length of residence and the reactivity can be found (see table 5.6.). With increasing duration of residence in the same community the tendency to hyper-reactivity increases. The validity of this intervening factor is considerably greater than the one of age. Important is also the questions of the mutual dependance or independence of both effects:

<u>Table 5.7.</u> Reactivity in dependence on age status and length of residence.

Table 5.7 shows that age as a directly intervening factor is eliminated if short length of residence is controlled in the study. Only in the case of length of residence of over 2 years there is a difference between the youngest age group and all other age groups with the same length of residence. This group reacts, however, significantly more hyper-reactive than the same age group with shorter length of residence. In other words the relationship between age and perceived disturbance proves to be largely a pseudo-correlation if the length of residence is controlled.

A longer time of residence tends to lead a greater social integration in the community, e.g. to an expressive field of interaction with similar physical environmental conditions and that increases simultaneously time the probability of a communicative effect. 1) The problem of becoming accustomed to noise is likewise connected with age and length of residence: is a readjustment of the stored phenomenal reference stimuli in the positive direction to be expected as a consequence of becoming used to the exposure to a noise stress factor over a longer period of time or does the repeated exposure to noise lead to an accumulative effect which causes an increase in the perception of the disturbance even though the noise exposure remains constant? The obvious association of a long duration of residence with hyper-reactivity seems to support the latter of the two theses. /176

Table 5.8. points in the same direction:

Table 5.8. Noise habituation 1) in dependance on length of residency.

can get used to noise (% of questioned	length of residence in the community			
	less than 6 months	6 months to 2 yrs.	2 to 10 years	10 and more yrs.
yes	83.9	73.6	70.5	69.6
no	16.1	26.4	29.5	30.4
	(176)	(280)	(1342)	(2058)
χ^2 = 16.9 $p < .001$ Gamma = +.08				

1) The NASA-Contractor report proves that communication in the meaning of conversation about noise etc. represents an important factor for the modal type of the individual who is complaining about noise. [62]

2) Question; "Can you get used to noise"?

It is interesting that against expectations, the adjustement to noise is practically independant from the degree of exposure to noise.

Table 5.11. Adjustment to noise in dependence on the total noise exposure /178

Can get used to noise	Total noise exposure[1]		
	< 20	20 - 39	40 - 59
yes	61.1	73.0	68.1
no	38.9	27.0	31.9
	(1362)	(1901)	(571)
$\chi^2 = 8.4$ $p < .02$ Gamma = -.02			

This fact indicated that the phenomenon of noise adjustment is associated with an individual disposition of sensitivity to react to external stimuli in which case the sensitivity or noise sensibility is relatively independent from the stimulus definition.

As mentioned several times, the residential constraint and the degree of objective possibilities of avoidance of a noise situation are an important intervening pragmatic factor in the stimu'us reaction transformation. This is reflected distinct in the significant relationship between reactivity and marital status.

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1) The construction of the measurements of total noise exposure is discussed in chapter 4.12.

With increasing duration of residence in the same community (e.g. with increasing length of exposure to noise) the proportion of those subjects decreases which are getting used to the noise. In the relationship between adjustment to noise and age (see table 5.9.) it becomes apparent again that the younges age group is deviating.

Table 5.9. Adjustment to noise depending on age

can get used to noise (in % of questioned	age groups		
	18 - 30 yrs	31-50 yrs,	51 and more
yes	79.0	67.8	69.9
no	21.0 (803)	32.2 (1700)	30.1 (1347)

$\chi^2 = 33.9$ $p < .001$ Gamma = .10

The relation between adjustment to noise and the duration of residence leads necessarily to a relation between adjustment to noise and reactivity. The estimated declared variance, however, is considerably larger than the one which is resulting from the relationship between duration of residency and reactivity.

Table 5.10 Reactivity in dependance on adjustment to noise

can get used	mean reactivity	N	standard deviation	F-value	P-val.	est
yes	1.685	2731	2.62	104.175	<.001	0.02
no	2.627	1122	2.56			

Table 5.12. <u>Reactivity depending on marital status</u>

family status	mean reactivivty	N	standard deviation	F-val.	P-val.	eta^2
married	2.032	2067	2.62	6.032	<.001	0.004
divorced	1.573	130	2.64			
widowed	1.933	307	2.63			
single	1.501	432	2.68			

The T-Test of equality of median values proves that there is a significant difference in respect to the reactivity of those questioned who are married in comparison to those who are divorced or single. Likewise, there is a difference between widowed and single persons. /179

Table 5.13. shows clearly that these relationships cannot be explained with the differing age structure of these segments of the population. The explanation that married and widowed people have a tendency to hyper-react lies more in their higher residential constraints which precludes possibilities of avoidance of a noise situation.

Table 5.13 Reactivity in dependence on age status and marital status.

family stat.	age group 18-35			age group 36-50		
	mean reactiv.	N	stand. deviat.	mean reactiv.	N	stand. deviat.
married	2.108	1121	2.54	1.973	1437	2.64
single	1.531	293	2.66	1.493	91	2.69
F-value	11.627 p<.001			2.777 n.s.		

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1) Monthly income per household

5.2.2.2. Socio Economic Factors

Table 5.14. Reactivity depending on income

income class 1)	mean reactivity	N	standard deviation	F-value	P-value
to 2000 Fr.	1.904	1686	2.64		nicht signi-fikant
2001-3500	2.049	1352	2.56	1.379	
3501 and up	2.076	453	2.65		

Neither the income (table 5.14.) nor the professional status (Table 5.15.) lead to statistica ly significant relationships with reactivity. Nevertheless, in the case of income status a clear trend towards hyper-reactivity in higher income classes becomes obvious.

Table 5.15. Reactivity depending on professional status /180

occupation	mean reactivity	N	standard deviation	F-val.	P-val.
farmers	1.880	43	2.36		
unscilled/semi skilled	1.941	343	2.62		
skilled workers	2.005	496	2.61		
skilled white coll.	1.984	615	2.75	0.484	n.s.
civil serv./middle management	1.810	408	2.57		
professions	2.167	202	2.62		
businessmen and top management	1.902	112	2.34		

Because of the positive correlation between income and education this trend coincides with the one that exists between formal education and reactivity although there too a statistically significant connection cannot be found.

Table 5.16. Reactivity dependent on formal education

type of education	mean reactivity	N	standard deviation	F-val.	P-val.
grammar school	1.925	1586	2.64	0.411	n.s.
trade school	1.937	1435	2.64		
high school	1.943	531	2.63		
college	2.112	387	2.56		

The general trend in the direction to hypo-reactivity for lower education and income strata can hardly be explained with a lower noise sensitivity of those population segments but rather with a deaggravation tendency of lower social groups when faced with stress and a generally higher willingness to suffer stress, which is caused by social conditioning. This is further supported by statistically very significant negative connections between adjustment to noise and income and education status.

Table 5.17. Adjustment to noise dependent on income status /181

can get used to noise (in % of those questioned	income per household		
	low (<Fr.2000.-)	medium (2001.- 3500.-)	high (>3500.-)
yes	74.4	67.6	66.5
no	25.6	32.4	33.5
	(1655)	(1333)	(436)
$\chi^2 = 20.7$ $p < .001$ Gamma = .14			

Table 5.18. Adjustment to noise dependent on educational status

can get used to to noise (in % of those questioned	eductation		
	grammar school	high school	college
	72.9	66.0	61.7
	27.1	34.0	38.3
	(2966)	(518)	(371)
$\chi^2 = 26.6$ $p < .001$ Gamma = .19			

5.2.3. Physical and Social Context Factors

5.2.3.1. Physical Context Factors /182

The state of physical context is first of all determined by the properties of residence. One such property is the type of house, like one-family or multi-family dwellings.

The effect of the type of house on the reactivity of its inhabitants can, however, not be proven statistically although one-family house dwellers usually have better physical and therefore better social context conditions than inhabitants of multi-family structures.

Table 5.19. Reactivity depending on house type

kind of housing	mean reactivity	N	standard deviation	F-val.	P-val.
one-family house	2.003	1235	2.61	0.595	n.s.
multi-fam.hse.	1.925	2704	2.64		

A further important physical property for the execution of social and communicative activities of its inhabitants in their primary group is the size of the dwelling or the number of people per home. The ratio between number of rooms and number of inhabitants is generally used as the objective indicator.

Table 5.20. Reactivity dependent on the population density per home /183

density of occup. 1)	mean reactivity	N	standard deviation	F.-val	P-val.
under occup.	1.926	1448	2.71	0.0775	n.s.
properly "	1.993	1309	2.59		
over "	1.961	1147	2.57		

Here too a statistically significant correlation between the objective population density per home and the reactivity to airplane noise cannot be found. However, the reactivity of the individual is additionally weighted by subjective perceptions and evaluations of objective properties of the physical context. Thus the evaluation of the size of the home proves to be a significant factor which influences the reaction of individuals to factors which influence noise.

Table 5.21. <u>Reactivity dependent on the evaluation of home size</u>

evaluation of size of home	mean reactivity	N	standard deviation	F-val	P-val	est
too small	2.185	899	2.69			
too large	1.959	142	2,62	4.551	<.05	0.0C
just right.	1.877	2896	2.61			

There is a trivial correlation between the positive evaluation of sound proofing of a home with hypo-reactive tendencies.

Table 5.22 <u>Reactivity dependent on evaluation of sound insulation</u> /184

Evaluation of sound insulation	mean reactivity	N	standard deviation	F-value	P-val.	est. ^{2}
poor	2.196	1946	2.63	34.867	<.001	0.009
good	1.698	1905	2.58			

The objective nature of the physical living conditions acts chiefly through its conscious perception and evaluation as influencing factor on the reactivity. Objective living properties as well as their subjective perception and evaluation are correlates of the social group membership. Fig. 5.23. shows how, in dependence on class specific value standards, the objective context quality and their conscious perception and evaluation can diverge.

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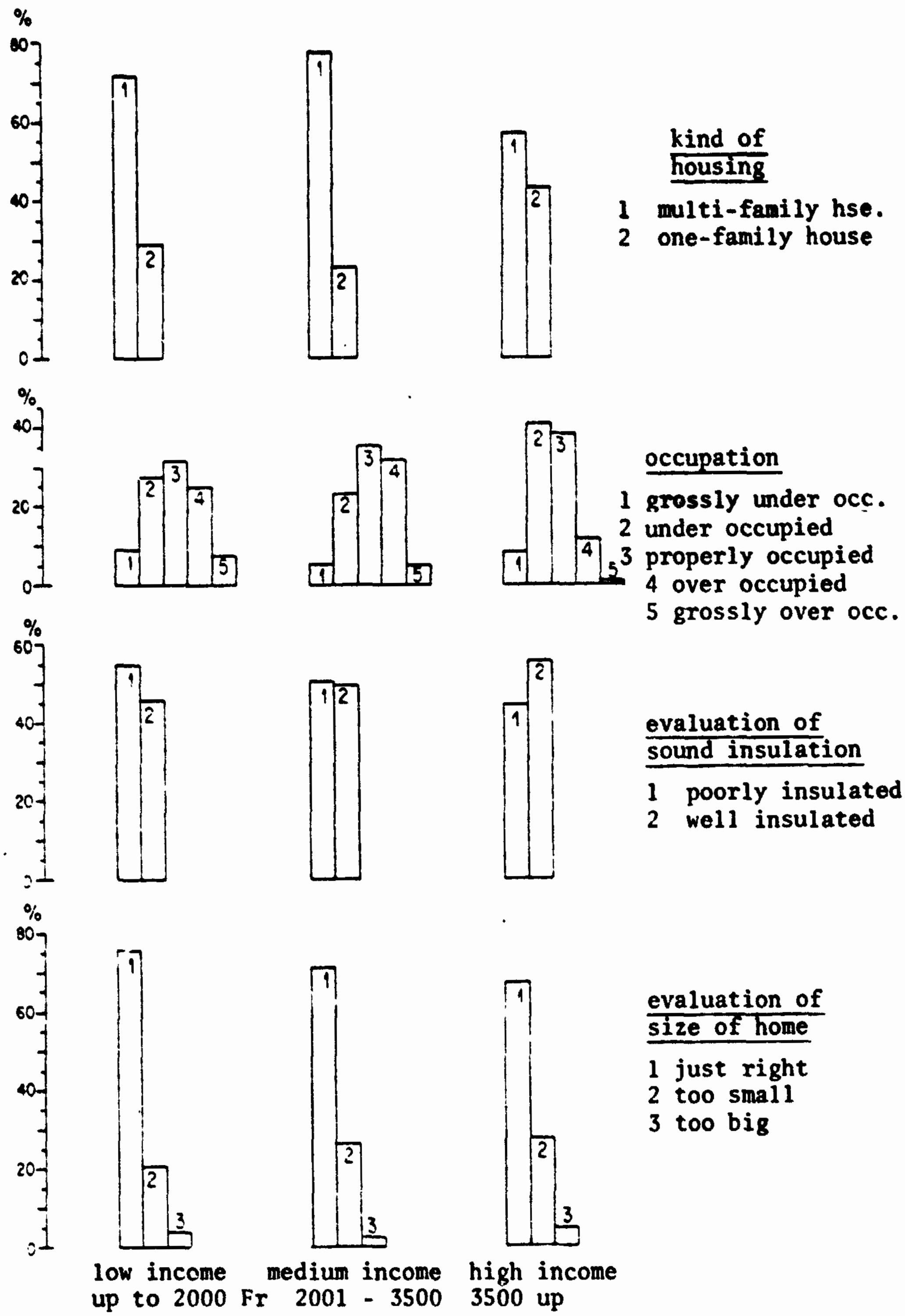
1)
- Under utilized = less than one person per room
- Properly utilized = number of persons is equal to number of rooms.
- Over utilized = more than one person per room

Between the medium and high income classes the income differentiation in relation to the properties of quality of housing is most pronounced. In a comparison between the lower and the middle class, however, the quality of housing is similar and the objective density of population per home is often even better. This is due to an ecological effect. The lower income class has a tendency to cross over into the rural segment of the random sample which lives more often in one-family homes than the middle class which lives predominantly in suburban multi-family residential zones. The three feature complexes are independent of each other. They are three dimensions which were tested by factor analysis. Decreasing mean values mean increasing positive evaluation of the properties of the environment.

Figure 5.23. Type of housing, density, evaluation of home size, and sound insulation dependent on 3 income classes (total random sample) /185

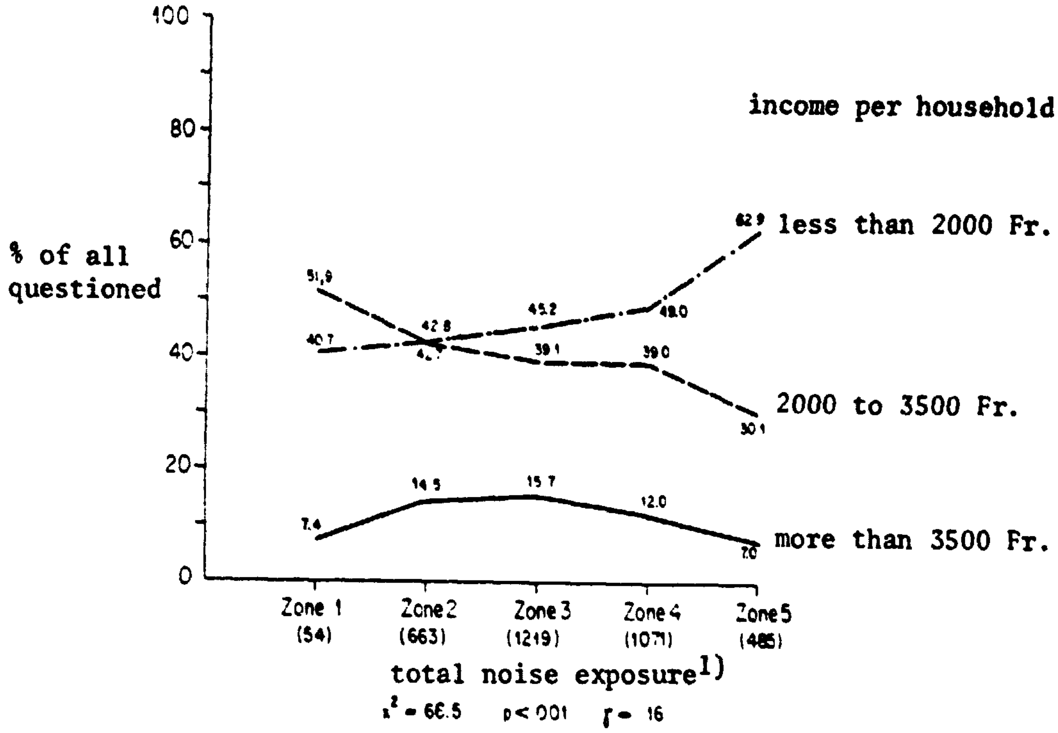


The class specific divergence between objective living conditions and their reflection on conscious perception and evaluation becomes very obvious. The upper income class appears most critical despite their prevailing residence in one family houses and consequently, their privileged space situations. This is an empirical indicator for the way in which class dependent value standards are relatively independent from objective living situations and their perception and evaluation. /186

Likewise, there is a correlation between membership in a social class and the physical environmental quality of context. This is due to the class, but most of all the income dependent possibilities to move out of regions with bad physical context quality. If the latter is subjected to objective total noise exposure it is to be expected that the social economical position, measured as income per household, decreases with increasing noise exposure.

This situation is clearly expressed in fig. 5.24. The exposure to noise results in an income selective disengagement in zones of high noise exposure. This implies at the same time an uneven distribution of social cost since with increasing deterioration of physical context quality the economically privileged groups leave the area. The class selective disengagement is not only shown in reference to income but likewise, albeit less obviously, in reference to age groups: with increasing noise exposure the proportion of the economically most productive segments of the population, the 30 to 50 year olds, is lowered. (p .01):

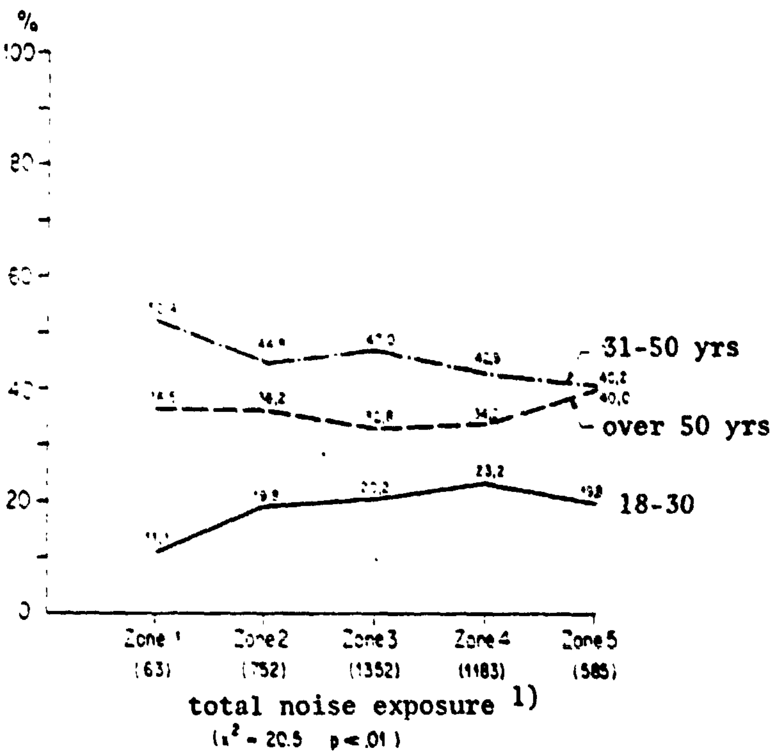
Figure 5.24 Income in dependence on total noise exposure (total random sample) /187



1) See 4.12. for the construction of the total noise exposure measurements. Zone distribution for total noise exposure:

Zone 1 = -3 to 14.9
Zone 2 = 15 to 24.9
Zone 3 = 25 to 34.9
Zone 4 = 35 to 44.9
Zone 5 = 45 to 57

Figure 5.25 Age distribution depending on total noise exposure (total random sample) /188



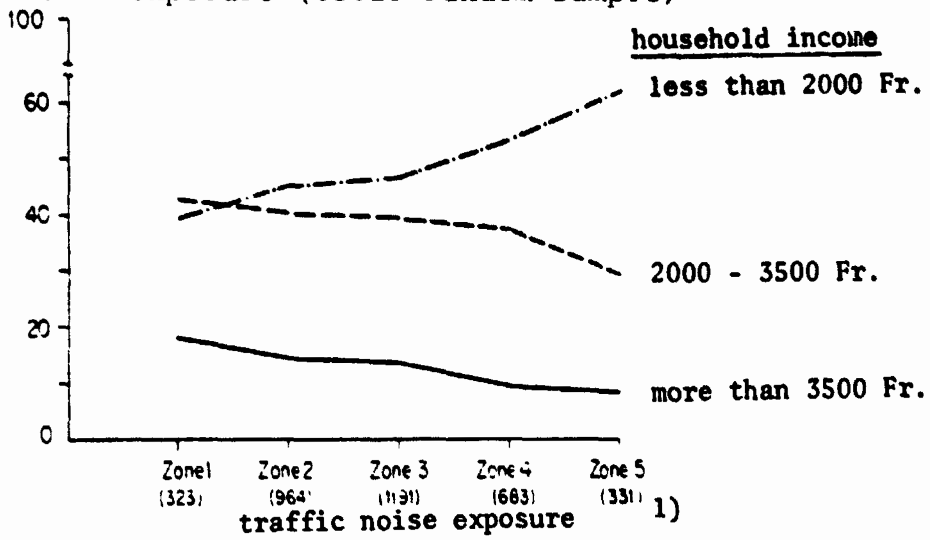
Total noise exposure [1)]

(x^2 = 20.5 p 0.1)

If the income selective disengagement process as a function of total noise exposure is specified according to traffic and airplane noise exposure a continuous income specific disengagement appears which is dependent on traffic noise exposure. Depending on airplane noise exposure the disengagement process is only found in high exposure zones (see fig. 5.26 and 5.27.). Two reasons can be given as an explanation. (a) The exposure to street and surrounding noise correlates with rent situations in multi-family dwellings. The exposure to airplane noise correlates with property situations of the home. Homeownership, however, involves greater residential fixation. Homeownership correlates inversely with the objective street traffic noise exposure while the contrary is true in the case of airplane noise exposure, especially in the extreme areas (see figure 5.28).

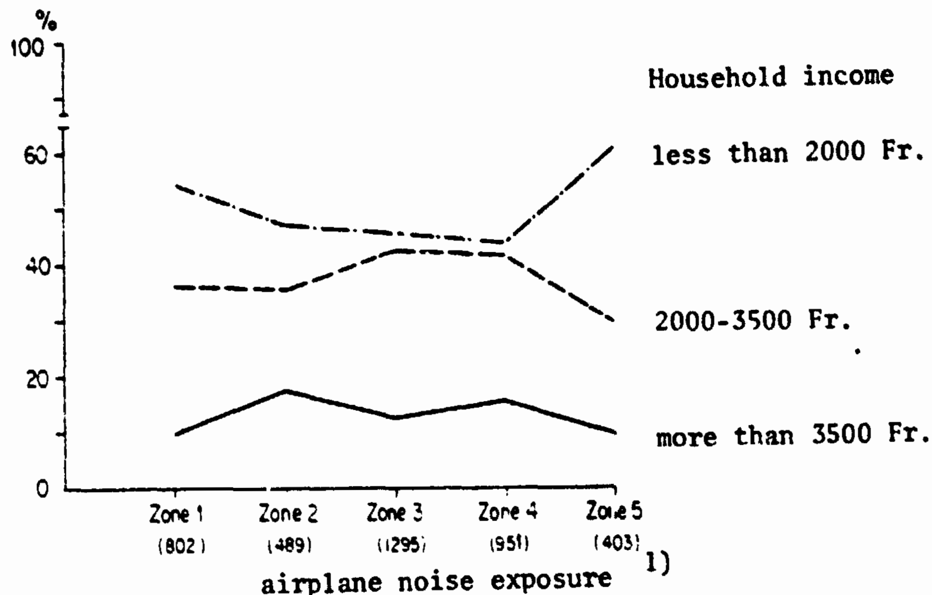
1) See footnote of fig. 5.24.

Figure 5.26. Income situations depending on traffic noise exposure (total random sample) /189



(r = .14 p = <.001)

Figure 5.27. Income situations depending on airplane noise exposure (total random sample)



(r = .02 p = <.001)

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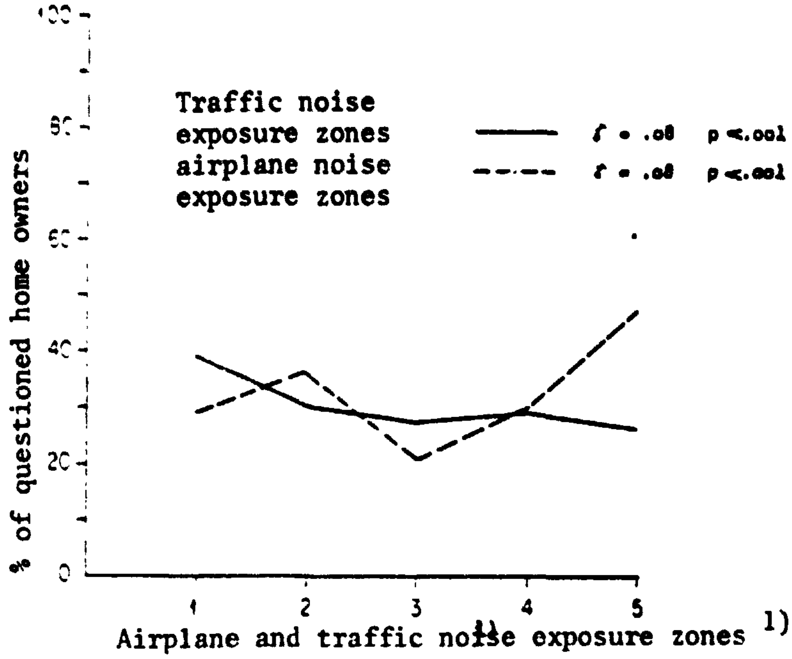
1) See footnote of figure 5.28.

Figure 5.28 Homeownership situation depending on airplane noise as well as traffic noise exposure (total random sample) /190



(b) Airplane noise exposure in comparison to street and surrounding noise is a relatively young phenomenon therefore it has not had enough time to affect class selective migration distinctly. However, for future class specific composition in airplane noise exposed communites the same clear trend can be expected as is observed now for quarters with high street noise exposure.

One correlation to the class selective disengagement is the change in the rent/income ratio. The noise exposure in lower social strata leads to a more or less forcible utilization of the relative rent advantage, however, for the price of objectively worse living and environmental qualities.

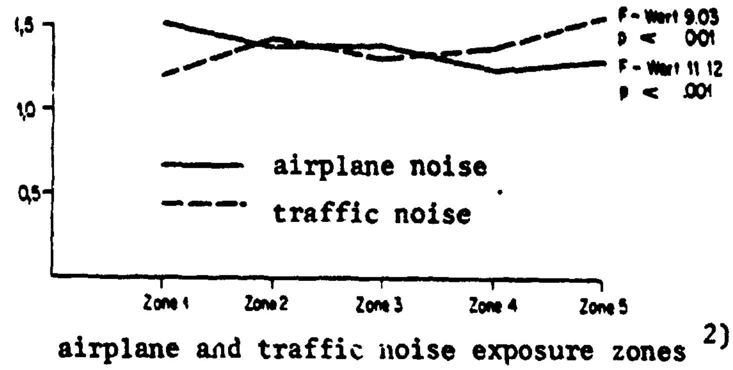
---

1) Traffic noise exposure zones / Airplane noise exposure zones (NNI_{KOR*}):

Traffic noise exposure zones		Airplane noise exposure zones	
Zone 1	1 - 9.9	Zone 1	1 - 19.9
Zone 2	10 - 14.9	Zone 2	20 - 29.9
Zone 3	15 - 19.9	Zone 3	30 - 39.9
Zone 4	20 - 24.9	Zone 4	40 - 49.9
Zone 5	25 - 34	Zone 5	50 - 67

See fig. 4.9. for the construction of noise exposure measures.

Figure 5.29. Rent/Income proportions [1] dependent on airplane noise and street noise exposure (total random sample) /191



(High quotients mean lower rent and low quotients higher rent in comparison to income).

The statistically significant reduction of the rent advantage depending on airplane noise exposure stands in contrast to a significant increase of this dependence in the case of traffic noise exposure. Increasing rent advantage in residential areas as the consequence of increased noise exposure is the economical support mechanism for class selective disengagement. The latter has already happened as a consequence of traffic noise exposure. Residential areas exposed to airplane noise, however, are in suburban areas whose more natural environment fulfills the most preferred residential requirement of urban inhabitants who are often forced by the situation of the housing market in cities to leave and thus must be absorbed by suburban areas.

---

1) Rent/Income proportion; Quotient of rent over income. Both data, however, were only determined ordinally so that this rent/income proportion can only be considered as an indicator of the real proportion.

2) See footnote to fig. 5.28.

Also in relation to the close environment of a residence /192
the differing state of the physical context of different socio-economical groups is reflected in their perception and judgment.

By means of a feature profile [1] three dimensions of the near environment, which deal with properties of physical attractiveness, noise exposure and social features, were evaluated

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1) Bipolar test with the following pairs of contrary properties:

- physical attractiveness	variable	-	monotonous
	populated	-	deserted
	familiar	-	foreign
	practical	-	inconvenient
- emission specificity	safe	-	threatening
	quiet	-	noisy
	clean	-	dirty
	nice smelling	-	bad smelling
- social properties	native	-	foreign
	helpful	-	indifferent
	generous	-	narrow minded
	entertaining	-	boring
	friendly	-	rejecting
	wealthy	-	poor

Classification value: +2, +3, +1, 0 -1, -2, -3.
For technical reasons these classifications have been converted into values from 1-7. The values given in table 5.30. and 5.32. are the averages of the added, converted classification values for the three dimensions of the property profiles. (see also questions 23 in appendix 2). The three property complexes are independent of each other and have been tested with factor analysis. Decreasing middle values indicate an increase in positive evaluation of the properties of the environment.

Table 5.30. Evaluation of the physical attractiveness and emission specific properties of the near environment in relation to income status and the residence in one-family or multi-family dwellings.

socio-economic characteristics	infra structure specific characterist.			emission specific characteristics		
household income	mean rankkg	N	stand. dev.	mean rankg.	N	stand. dev.
to 2000 Fr.	7.295	1667	4.38	9.267	1687	4.398
2000-3500 Fr.	7.509	1353	4.11	8.914	1353	4.613
over 3500 Fr.	7.494	453	4.04	8.305	453	4.627
F-value	1.043		n.s.	7.014		p < .001
Residence						
multi-family house	7.714	2704	4.21	9.098	2704	4.81
one-family house	6.506	1237	4.07	8.601	1237	4.96
F-value	71.101		p < .001	7.545		p < .001

The relation between income classes and the evaluation of physical attractiveness and emission specific properties of the environment manifested itself significantly in the latter. (See table 5.30.). Residing in a one-family home and the thus implied objective improvement of living quality increases, however, the perceived positive evaluation for both feature complexes distinctly.

An important feature of the home context is what it has to offer infra-structurally. Against expectations no statistically supported connection between the degree of the perceived infra-structurally lack of possibilities and the reactivity was found.

Table 5.31. Reactivity in dependence on the perceived incompleteness of the infra-structure of the community. 1)

No. of perceived infra-struct. short comings	mean reactivity	N	standard deviation
none	2.080	791	2.53
one	1.957	734	2.48
two	1.925	536	2.66
three	1.883	284	2.63
four	2.522	150	2.48
five	1.915	39	2.19
six	0.575	12	1.94
F-value	1.944		n.s.

5.2.3.2. Social Context Factors

5.2.3.1. Socio-Structural Determinants

The effects of social context factors on the reactivity is determined to a large degree by the socio-structural position and roll of the individual (See 5.2.2.).

It can also be shown for the social features of the environment how the subjective judgement of the individual of lower (as oppossed to higher income classes) is reflecting the objectively lesser social context quality.

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1) Operationalization: The following 6 properties were to be judged by their absence:

- proximity to the place of work
- proximity to the city
- good traffic possibilities
- many shopping possibilities
- good schools for the children
- recreational and entertainment possibilities

Table 5.32. The evaluation of social features of the environment 1) dependent on income status and the residence in one respectively multi-family houses.

Socio-economical characteristics income per household	social characterist.			general context quality		
	mean rankg.	N	standard deviati.	mean rankg.	N	standard deviation
up to 2000 Fr.						
up to 2000 Fr.	15.40	1687	6.4	28.97	1687	11.8
2001 - 3500 Fr.	15.32	1353	6.3	28.74	1353	11.2
over 3500 Fr.	14.66	453	6.1	27.48	453	11.0
F-Value	1.646		n.s.	2.864		p < .05
type of housing						
multi-family	15.90	2704	6.2	29.71	2704	11.2
one-family	13.75	1237	6.3	25.85	1237	11.4
F-Value	101.921		p < .001	99.728		p < .001

* Total perception of all 3 feature complexes of the environment.

Although the evaluation of the social properties of the environment becomes more positive with increasing income, the context is statistically not significant. However, the evaluation of the social features of the environment are highly significantly tied in with the type of residence. In reference to its physical context relatively privileged inhabitants of one-family houses consider their social context features much more positive than the inhabitants of multi-family dwellings. The dependence on perceived general context quality of the socio-economical indicators of income and type of residence confirms that the social stratification is not the cause of differing economical access but also influences the substantial quality of the physical and social environment.

1) See footnote page 192.

5.2.3.2.2. Residential Integration

An important intervening factor of the social context level is the residential integration of the community. The residential integration, however, does not exert an influence on the reactivity which is independent of the length of residence.

Table 5.33. Reactivity dependent on the integration and the length of residence in the community.

Degree of integration[1] into the community	Length of residense	
	less than 4 yrs.	more than 4 yrs.
four	1.135 (15)	1.988 (394)
three	1.467 (154)	1.976 (1315)
two	1.342 (113)	2.056 (910)
one	1.592 (108)	2.117 (512)
zero	1.399 (78)	1.996 (339)
F-Value	0.1897 n.s.	0.2431 n.s.

The length of residence is a source of ecological orientation, e.g. integration into the community. This orientation leads to an intensification of the communicational fields of reference. This is the reason why a collective exposure to stress factors helps to explain how an individual reactivity can be weighted by these (see 5.2.2.1.).

1) Operationalization: The number of the following activities ich are chiefly executed within the community:

- Shopping
- visit of cultural events
- visit of friends and relatives
- visit of restaurants

The integration into the community is a clear correlate to the length of residence.

Table 5.34. Integration into the community dependent on the length of residence.

Degree of integrat.[1)] into communit.	Length of residence			
	less than 1 year	2-3 yrs.	4-10 yrs.	over 10 yrs.
four	3.8	2.8	6.3	14.7
three	36.8	30.4	34.8	39.9
two	24.7	23.8	26.2	26.1
one	19.2	25.5	18.3	12.5
zero	15.4	17.5	14.3	6.8
N	(182)	(286)	(1376)	(2096)

$\chi^2 = 195.0$ $p < .001$ Gamma = -.26

1) See footnote of table 5.33.

5.2.3.2.3. Subjective role encumbrance

It is one of the central theses of this study that the evaluation of the physical as well as social stress factors is dependent on the actual individual stress and tension level. Within the frame work of an empirical study it is, however, only possible to a limited degree to differentiate between the great number of possible stress factors and isolate their effects.

One of the important stress sources within social context consists of the varying degrees of role encumbrance. Two different kinds of stresses are to be differentiated: (a) tension can result from overextention in the case of an acceptance of a number of different roles, (b) stress can also result in the case of underextention when there is a lack of roles to be assumed. On the basis of the above mentioned central thesis a curvilinear relationship between the degree of role encumbrance and reactivity is therefore postulated e.g. it is expected that over as well as under extended individuals will have a tendancy to be more hyper-reactive than people who are extended to a normal degree only.

Table 5.35. Reactivity in dependence on subjective role encumbrance. 1)

Subjective role encumbrance	median reactivity	N	standard deviation	F-value	P-value
under	2.126	634	2.64		
normal	1.912	3018	2.63	1.634	n.s.
over	1.931	276	2.62		

---

1) Empirically the degree of role encumbrance was determined by subjective estimates of the bound and free valence with the following items (Additive index):

- " I feel over extended"
- "I often have so much to do that I don't know where to find time".
- " My life sometimes appears monotonous and boring"

Based on variance analysis the thesis has to be rejected. However, if the influence of the perceived role encumbrance is differentiated by sex the hypothesis is confirmed for the male segment of the population but not for the female.

Table 5.36. Reactivity in dependence on perceived role encumbrance by sex.

Subjective role encumbrance	men			women		
	mean react.	N	std. dev.	mean react.	N	std. dev.
under	2.321	333	2.60	1.910	301	2.67
normal	1.887	1355	2.61	1.934	1663	2.64
over	2.392	113	2.65	1.661	163	2.56
	5.009	$p < .01$		1.052	n.s.	

A possible explanation of this fact is the different quality of the encumbrance especially in the case of the role underextention for both population segments. The role underextention of the women is to a considerably higher degree characterized by an actual stimulus deprivation. This leads to an increased stimulus seeking behavior whose consequence is a positive interpretation of acoustical stimuli such as airplane noise.

5.2.4. The Influence of Social Psychological Factors on the Individual Reactivity /200

The interpretation of the stimulus is not only dependent on the corresponding stimulus periphery but just as much on the interpretation of the respective stimulus source. That means concretely that the degree of the desirability or undesirability of sound is to a high degree dependent on the interpretation of the sound source "airplane". The sound emitting object "airplane" is evaluated on the basis of certain associative attitudes. Thus the positive interpretation cf the stimulus source can reduce the stress effect of the focal physical stimulus or vice versa interpretation can increase the stress eftect.

The infinite number of individual attitudes can be considered in independent attitude dimensions for the interpretation of the stimulus source airplane. In the present study three dimensions were considered as determinants:

1. the projective interpretation of the sound source,
2. the modernistic cosmopolitan attitude,
3. the prospective or retrospective time orientation.

Two limitations have to be considered - one in content and one in method: if a stress exceeds the physical limit of tolerance the attitudes to the stress source or its interpretation have very little or no influence. This is not only valid in the case of socio-psychological factors but also in most of the intervening factors of semantics stimulus interpretation. The methodic limitation consists of the types of indices used here: these (although tested for their mutual independence) consist of too few individual items to give dependable and valid scales. This lack is caused chiefly by the necessary limitation of the questionnaire.

5.2.4.1. The Projective Interpretation of the Sound Source

This dimension includes two aspects. (a) The symbolic participation in the world-wide mobility which can be connected with the visual perception of the airplane and (b) the positive identification with the professional role of the pilot. In other words: this dimension is based on the projection or association of partially supressed desires at the time of perception of an airplane.

Table 5.37. Reactivity in dependence on projective interpretation 1)

projective interpretat.	median reactivity	N	standard dev.	F-val.	P-val	est
high	1.672	1343	2.70			
normal	2.106	1596	2.56	15.253	<.001	0.0
low	2.252	778	2.57			

The simple variance analysis shows a highly significant relation between reactivity and projective interpretation (See table 5.37.). Individuals with high projective interpretation of the sound source react expectedly more hyporeactive than indiviudals with medium or lower projection.

World-wide mobility is an age-specific dominating cultural value especially in the younger population segment. This is one of the causes of the hyporeactive tendencies of the 18-20 year olds. The projective interpretation of the sound source, however, has also an age-independent effect on the reactivity, as shown in Table 5.38. and, furthermore, is a special explanatory factor for the hyperreactive tendency in older population segments.

1) Additive index of the following Likert type items:
- "When I hear an airplane I often think of interesting and far away countries".
- "Being a pilot is one of the most beautiful and exciting professions".

Table 5.38. Reactivity in dependence on projective interpretation of the noise source as well as age-status. /202

project interpretation	Age Status 18-30 years Mittl. Reakt.	N	Stand. Abw.	31-50 years Mittl. Reakt.	N	Stand. Abw.	over 50 years Mittl. Reakt.	N	Stand. Abw.
low	1.958	91	2.85	2.244	332	2.66	2.461	461	2.58
normal	1.745	380	2.48	2.027	860	2.55	2.072	602	2.68
high	1.408	265	2.54	1.938	382	2.64	1.616	144	2.93
F-val.	2.105	n.s.		1.221	n.s.		6.164	$p < .01$	

5.2.4.2. Modernistic - Cosmopolitan Attitudes

The dimension of modernistic-cosmopolitan attitudes is chiefly reflected in the positive and negative attitude towards technology as well as in a cosmopolitan, universalistic orientation. The more negative the effects of modern technology are considered the less cosmopolitan is the orientation of an individual and the greater is his tendency to hyperreact due to a negative interpretation of the noise source. 1)

1) Operationalization: Additive index of the following Likert-type items
- "The modern technique makes it possible for people to ead a happier life".
- "In the final analysis the mechanization of our world brings to people more disadvantages then advantages".
- "Before giving developmental help to other countries we should first help our own poor people".
- "The preservation of our Swiss culture is more important than increasing well-being".
- "For an important position in the community it is best to elect somebody who has been living there for a long time".
- Cities are important but the backbone of Switzerland are fortunately still her rural communities".

Table 5.39 Reactivity dependent on modernistic cosmopolitan attitudes

modernism	med. reactiv.	N	stand. deviat.	F-val.	P-val.	est ω^2
high	1.700	793	2.67			
norm.	1.983	1843	2.58	12.056	•.001	0.006
low	2.326	885	2.64			

It is apparent in table 5.39. that the hypothesis of the 1 pro mil level is confirmed.

Analogous to the dimension of projective interpretation here too the age status is influencing the modernistic cosmopolitan attitudes. In addition we find the effect of formal educational status since the latent formal goal of education contains the greater universalitity of the internalized value model. However, if both factors are controlled, an independent effect of modernistic cosmopolitan attitudes in the reactivity can be found.

Table 5.40. Reactivity depending on modernistic cosmopolitan attitudes as well as the age status.

modernism	age								
	18-30 yrs.			31-50 yrs.			more than 50 yrs.		
	med. react.	N	std. dev.	med. react.	N	std. dev.	med. react.	N	std. dev.
high	1.332	261	2.54	1.591	562	2.59	1.931	519	2.83
normal	1.812	348	2.46	2.221	738	2.54	2.142	510	2.63
low	1.851	175	2.64	2.[illegible]	368	2.59	2.518	233	2.44
F-Wert	3.309	$p < .05$		11.965	$p < .001$		3.739	$p < .05$	

Table 5.41. Reactivity depending on modernistic cosmopolitan attitudes as well as the formal educational status. /204

modernism	formal education								
	10 yr. grammar			high school			junior college +		
	med. react.	N	std. dev.	med. react.	N	std. dev.	med. react.	N	std. dev.
low	2.383	752	2.70	2.050	88	2.49	1.926	45	2.32
normal	1.928	1424	2.58	2.079	271	2.63	2.335	148	2.49
high	1.618	503	2.65	1.701	140	2.62	1.9[illegible]3	150	2.78
F-val.	13.780	$p < .001$		1.030	n.s.		0.868	n.s.	

The attitudinal dimensions of modernism and cosmopolitanism are especially obvious in lower and middle educational strata while in the higher educational strata the modernistic attitudes do not have an influence on reactivity. The age assists the influence of modernistic attitudes in every case and with these the degree of reactivity. This is especially true for the younger and older segments of the population.

5.2.4.3. Time Perspective /205

Through a generally retrospective orientation the stimulus specific points of reference are placed more in the past. This increases the tendency to hyper-reactivity. This can be demonstrated with the relationship between retrospective comparison of the disturbance with the reactivity. Individuals which feel more disturbed now than a year ago are by comparison more hyper-reactive than those which feel that they are disturbed less.

Table 5.42. Reactivity dependent on retrospective comparisons

in comparison to previous year	median reactivity	N	standard deviation	F-val.	F-val.	est ω
more	2.759	1172	2.58	79.200	<.001	0.039
equally	1.671	2346	2.57			
less disturbed	1.441	353	2.41			

That also means that those segments of the population which look for the cause of this increase of disturbance in themselves (e.g. reacting intropunitively) are also extremely hyperreactive (see table 5.43. and table 5.34.). However, this relationship is statistically not significant.

Table 5.43. Reactivity dependent on interpretation of the increase in disturbance.

Table 5.44. Interpretation of disturbance increase (in % of those subjects who feel more disturbed) /206

own reactivity increased	8.5
more noise	80.5
both factors	9.8
don't know	1.3
	(178)

The retrospective causation of the judgment of the degree of disturbance of noise is juxtaposed with the prospective expectations of the amount of future noise emissions. The anticipation of this amount influences the reactivity.

Table 5.45. Reactivity dependent on the expectation of future noise emission.

anticipating that noise will:	mean react.	N	standard deviation	F-value	P-value	est ω^2
increase	2.06	2993	2.60			
stay the same	1.113	464	2.56	28.270	<.001	0.014
decrease	2.186	384	2.65			

It is to be expected that in anticipation of increased noise emissions a tendency to hyperreactivity follows. Interestingly enough the same is the case in prognosis of decreasing noise emission. In this population segment a reaction potential has obviously accumulated due to the disturbing action of past noise exposure, whose resolution is anticipated, which leads to an expectation of the decrease of noise emissions.

The retrospective causation of the judgment can be considered as the part of a superseding dimension of time orientation of an individual under the influence of the degree of disturbance by noise as well as the prospective expectation of future noise emissions. Therefore it can be expected that individuals who are generally retrospectively oriented show a greater tendency to hyperreaction than prospective oriented people or those who are indifferent to time orientation.

Table 5.46. Reactivity in dependence on time perspective 1) /207

time perspect.	median react.	N	stad. dev.	F-val.	P val.	est ω^2
prospective	1.898	735	2.65			
indeifferent	1.808	1570	2.59	8.135	<.001	0.004
retrospective	2.190	1412	2.63			

As shown in table 5.46., the hypothesis of the one pro mil level is confirmed.

5.2.5. The Influence of Personality Factors on Individual Reactivity

It was already mentioned in the introduction that an adequate evaluation of personality factors in a study, which is based on interviews, is extremely limited. If, nevertheless, (a) the extroversion and (b) the individual anxiety or apprehension had to be included as personality factors it was done, because earlier studies proved their relevance. [63,64,65]

Thus the factor of extroversion is [illegible] ble for interviews in a suitable short form. [66] The [illegible] of individual anxiety was limited to the establishment [illegible] t specific fear level.

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1) The retro or prospective orientation [illegible] determined operationally only by the following alternative questions:

A Present and past are freqently full of bad luck, only the future counts.

B The future will not be much better or worse than the present and the past.

C The present and the future are unsafe and unsure, therefore, one should observe trusted traditions and habits.

This operationalization is certainly insufficient. In context with the previously reported results, however, a certain reliability can be assumed.

5.2.5.1. Extroversion

According to Eysenck [58] there is a close relationship between the personality dimension of extroversion and cortical inhibition. Introversion is characterized by cortical excitation. Therefore extroverts (according to Eysenck) demand more external stimulation then introverts to maintain an optimal level of external stimulation. It therefore is obvious that a relationship between noise sensitivity and extroversion can be postulated.. Frith [63] proves the existence of such a relationship (see also Philipp [64] and Davies [65]).

Table 5.47. Reactivity on extroversion 1)

extro-version	mean reactivity	N	standard deviation	F-value	P-value
high	1.882	1007	2.68		
medium	2.029	998	2.54	0.702	n.s.
low	1.918	1312	2.63		

In the rough operational form which was used this thesis was not confirmed (see table 5.47.). The limitations, mentioned at the opening of this paragraph, should, however, be emphasized once more. Only with the aid of a reliable introversion scale a dependable statement could be made about the explanatory contribution of these variables.

1) Intro-extroversion was operationally defined by the following 4 items of the 6 item short form of the introversions scale of Eysenck:
- Do you think of yourself as a lively or a quiet person?
- Do you usually start when you make a new acquaintance?
- Do you make plans or do you prefer to act?
- Would you be very unhappy if you would have to forgo frequent social contact with friends and acquaintances?

5.2.5.2. Objects Specific Anxiety Level

Anxiety is the perception of endogenous or exogenous factual or anticipated danger. Generally anxiety is differentiated from fear. Fear is related to a specific object while the cause of anxiety is not localized. Anxiety is transformed into fear by localization and dramatization of danger threatening causes. Anxiety is often transferred to surrogate causes whose function it is to bind the free floating anxiety cognitively on symptoms and causes. Therefore object specific fear besides being the perception and anticipation of real danger, can represent a form of coping with anxiety. (For psycho-analytical and socio-psychological aspects of anxiety see especially Klein [67] and Weinberg [68]).

The object specific fear of airplane disasters can partially be considered as such a form of dealing with anxiety. Therefore the inner level of anxiety which is expressed as fear of the object "airplane" is an important internal factor which influences stimulus interpretation. That the fear level of airplane disasters has an effect on the verbalized perceived disturbance is especially clear in Borsky [17] and in the NASA-Report [62].

Table 5.48 Reactivity in dependence on the level of fear 1)

level of fear	mean reactivity	N	standard deviation	F-val.	P-val	est ω^2
low	1.362	903	2.58			
med.	1.975	1584	2.48	89.548	<.001	0.044
high	2.872	1335	2.66			

1) Operationalization: Additive index of the three following Likert-type items:

- Flying is dangerous
- I have a bad feeling when an airplane flies low above my head
- If an airplane flies above me I never have the fear it could fall down.

The present study shows also a highly significant relationship between reactivity and the object specific level of fear. 4,4% of the variation are explained by this factor (see table 5.48). /210

Sex specific cultural value models lead to the expectation that the level of fear in dependence on sex is strongly differentiated. In fact, the female population segment shows a significantly higher level of fear than the male population segment.

Table 5.49. Level of fear in dependence on sex

level of fear	sex	
	male	female
low	43.0	28.6
medium	41.8	40.8
high	15.2 (1772)	30.6 (2341)
$x^2 = 159.9$ $p < .001$ Gamma = .31		

If the mean reactivity is considered dependent on the level of fear as well as sex there is no difference in the reaction between female and male segments of the population in the case of a low level of fear. Once medium and especially high levels of fear are reached, statistically significant differences become obvious: the male population is highly hyperreactive in the case of high levels of fear. This fact can be explained with the culturally caused deaggravation in the male population segments, e.g. the tendency of males to hide their anxiety and their fear. If they are included their actual level of fear is higher than the one of females with the same measured level of fear.

Table 5.50. Reactivity dependent on fear levels as well as sex /211

level	age					
	male			female		
	mean react.	N	std. dev.	mean react.	N	std. dev.
low	1.387	693	2.54	1.336	662	2.72
med	2.067	749	2.47	1.892	835	2.49
high	3.271	318	2.52	2.608	585	2.59
F.-val.	60.644 $p < .001$			37.302 $p < .001$		

C-3

Not only with sex but also with the age status is there a proven connection with the level of fear. This too can be explained as a culturally rooted age specific role expectation and value model.

Table 5.51. Level of fear and dependency on age status

level of fear	age		
	18-30 yrs.	31-50 yrs.	51 yrs. and up
low	42.4	36.2	29.7
medium	40.7	41.8	40.9
high	16.9	21.9	29.4
	(800)	(1704)	(1338)

$x^2 = 60.8$ $p < .001$ Gamma = .17

If the mean reactivity is considered in relation to the level of fear and age, age seems to act strongly additive to the reactivity in the case of medium and high levels of fear. At low levels of fear, age does not show any influence.

Table 5.52. Reactivity dependent on the level of fear and the age status /212

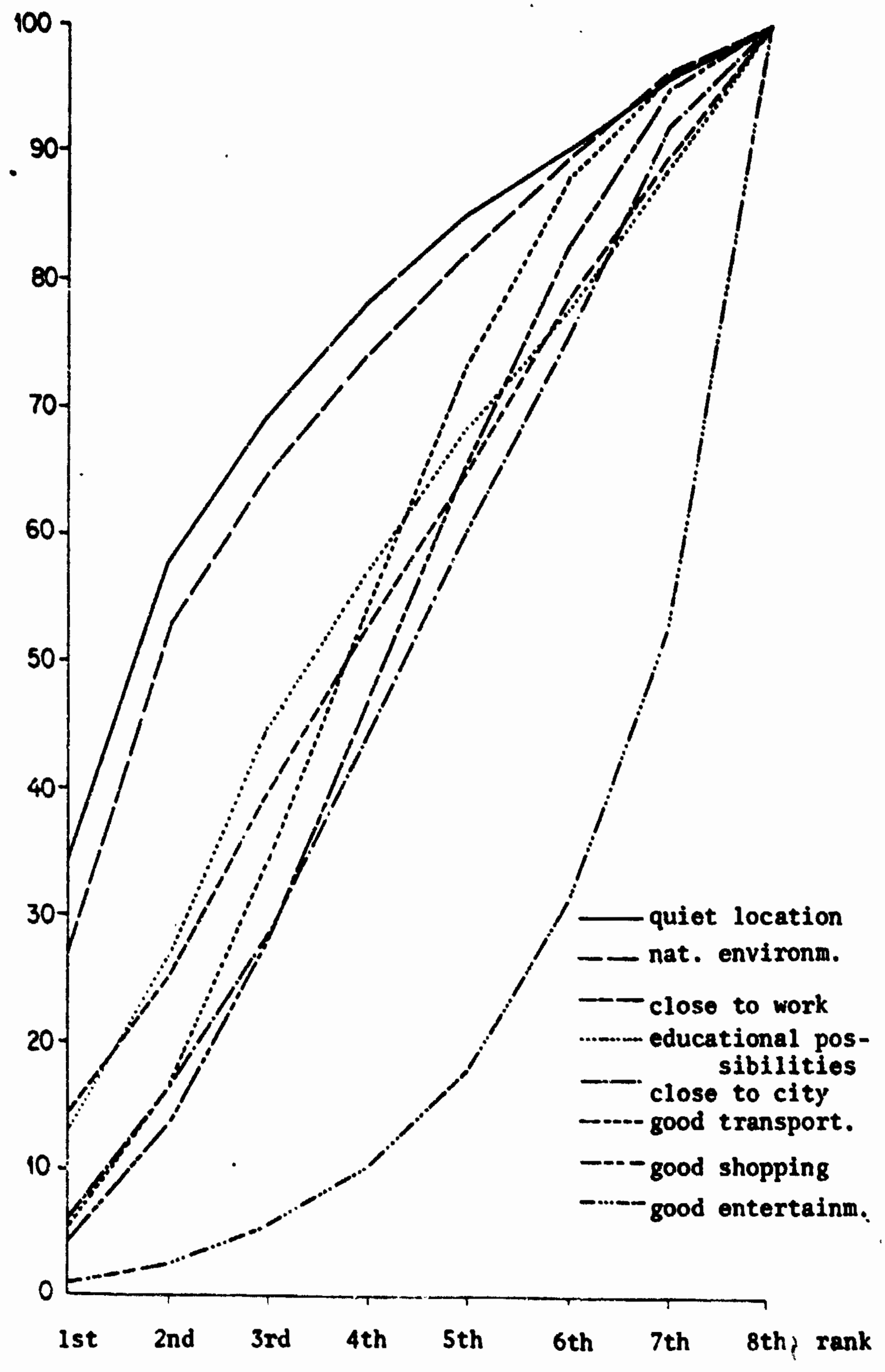
level of fear	age								
	18-30 yrs.			31-50 yrs.			51 and over		
	mean react.	N	std. dev.	mean react	N	std. dev.	mean react.	N	std. dev
low	1.313	339	2.66	1.445	616	2.60	1.269	397	2.74
medium	1.699	326	2.39	2.045	714	2.48	2.049	544	2.56
high	2.349	135	2.47	2.854	374	2.55	2.998	394	2.63
F-val.	8.249	$p < .001$		35.887	$p < .001$		43.050	$p < .001$	

5.2.6. The Influence of Interest and Need Factors on the Individual Reactivity

5.2.6.1. The Relative Priority of the Nominal Value of Rest

The weight of the disturbance by undesirable stimuli depends on the priority of the needs in the order of preferences of other needs in an individual.

Figure 5.53. Sum frequency of 8 nominal values of the environment dependent on their priority (Total random sample) /213



An important need in context with noise exposure is the need for a quiet residence. The relative priority of this need in relation to the priority of other needs within the environment 1) is demonstrated in the priority profile in fig. 5.53.

A comparison of the curves shows a trichotomy of grouping in the ranking of the 8 nominal values relating to the environment: /214

- Quiet location in natural environment is the need with the highest priority. The living situation in airplane noise exposed suburban zones is fulfilling the need for a natural environment, but it negates at the same time the fullfillment of the need for a quiet location. This contradiction goes also for the fullfillment of the need for optimal proximity of work, however, this latter belongs in the second group of subjective priorities. Social-psychological research shows that contradictory needs of a higher priority presents sources of conflict if they cannot be fulfilled simultaneously.

- In a group of nominal values of medium priority proximity to work and the quality of schools dominate. Needs of lesser weight in this group are proximity to the city, the quality of the traffic system and shopping possibilities.

- The request for infrastructural institutions for cultural entertainment and leisure time activities has the lowest relative priority.

Research of suburban residential areas in respect to the needs show generally the dominance of the idea to live close to nature and the conflicting relationship of other needs, especially the location of work and, in this case the exposure to airplane noise. This order of priorities shows the typical value orientation of the broad middle class in suburban residential area.

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1) Prerequisite for the manipulation of these eight needs is a qualitative comparability. Therefore they were chosen as exclusively environment related needs.

The following eight needs were presented to the interviewee for the purpose of ranking:

- proximity to work
- proximity to the city
- good traffic possibilities
- many shopping possibilities
- good schools
- leisure and entertainment possibilities
- location in natural environment
- quiet location

The relative priority of the nominal value "quietness" in comparison to other comparable nominal values acts as a weighting factor in the consciously perceived disturbance, e.g. as added condition for hyperreactivity. This is confirmed in a significant way: The higher priority of peace and quiet leads also to an increased hyper-reactivity towards noise.

Table 5.54. Reactivity dependent on the priority of the nominal value "quiet" /215

priority of desire for quiet	mean reactivity	N	standard deviation	F-val.	P-val.
RANKS: 1	2.089	1339	2.59		
2	1.893	905	2.60		
3	2.048	448	2.64		
4	1.640	334	2.65	2.934	<.01
5	1.663	262	2.54		
6	1.794	203	2.75		
7	1.592	174	2.44		
8	2.369	170	2.81		

This relationship is not linear but shows a very complex course. In the case of the highest and lowest priority of the need for quiet hyperreactivity is most pronounced. By interpreting these results it has to be taken into consideration that the priority pattern of the nominal values is a consequence of learning and adaptation processes to objective conditions of the environment. That means, that the relative subjective priority of the nominal value "quiet" is, for instance, influenced by the objective stimulus "exposure". Theoretically one has to differentiate between dissonance-evoking and dissonance reducing effects. In the former the objective exposure to noise leads to an increased priorities of the disturbed need for quiet and therefore to a higher conscious dissonance. The dissonance reductive effect, however, leads to a reduced priority of the disturbed need and therefore to a lowered conscious dissonance.

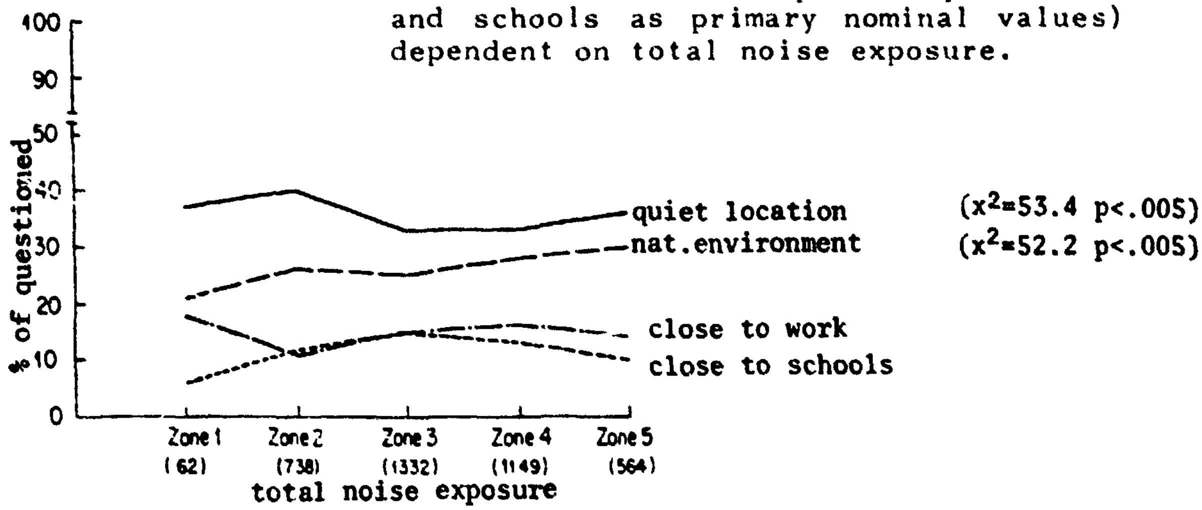
Hyperreactivity is not the result of an increased priority of the nominal value "quiet" in the conscious of the individual but can by means of dissonance reducing processes, also lead to their replacement into lower ranks of priority or to a complete repression from the conscious mind. This dissonance reducing process is one of the ways of coping /216
with the conflicts between needs of a higher priority, e.g. between the need for quiet on the one hand and the desire

for living in a natural environment in areas that are exposed to airplane noise on the other hand.

Socio-pschological research often proves the consequence of these effects which ultimately cancel each other out. However, as in the present case, the difficulty lies in the determination of the empirical threshold values of the stimulus situation and the personality factors which discriminate between the triggering of the one or the other effect. As seen in fig. 5.55. the relative priority of the nominal value "quiet" in comparison to the one of the other nominal values is clearly influenced depending on the various zones of airplane exposure.

In fact, the decreasing priority of the nominal value "quiet" at the increasing priority of the one for "living in a more natural environment" indicates, the effect of dissonance reductive mechanisms with increasing objective noise exposure.

Figure 5.55. Relative priorities (percentage of those questioned, who rank quiet location, natural environment, proximity to work and schools as primary nominal values) dependent on total noise exposure.



5.2.6.2. The Direct Benefit Aspect of the Noise Source /217

The benefit aspect of airplane traffic influences the reactivity of individuals.

The first operational determination of the direct benefit of the noise source is represented by the mobility of the individual, the flight experience.

Table 5.56 Reactivity dependent on the flight experience.

flight-experience	mean reactivity	N	standard deviation	F-value	P-value
with	1.937	2644	2.65	0.1128	n.s.
withou	1.978	1294	2.50		

Flight experience has only then a significant and subtractive effect on hyperreactivity if it occurs more than ten times.

Table 5.57. Reactivity dependent on the frequency of flight experiences.

frequency of flight experience	mean reactivity	N	standard deviation	F-val.	P-val.	est ω^2
1 to 2 x	2.063	1021	2.54	4.889	<.01	0.003
3 to 10 x	2.005	922	2.62			
over 10 x	1.669	692	2 81			

The frequency of flight experiences, e.g. the direct profit of the noise source is, however, dependent on the socio-economical situation (research shows that other forms of geographical mobility in our society are also unevenly distributed).

Table 5.58. Freqency of flight experience dependent on income. /218

frequency of flight experience	income per household		
	up to 2000 Fr.	2001 to 3500 Fr.	over 3501 Fr.
1 to 2 times	51.4	36.6	15.7
3 to 10 times	32.4	39.5	27.9
over 10 times	16.1	23.9	56.5
	(957)	(1015)	(402)

$\chi^2 = 286.2$ $p < .001$ Gamma = .41

It is also important to note that the subtractive effect of frequency of experienced flight events on the hyperreactivity for the three income classes is different.

Table 5.59. Reactivity dependent on frequency of flight experiences and income status.

frequency of flight exper.	Household Income								
	to 2000. Franc			2001 to 3500 Fr.			over 3500 Fr.		
	Mean react.	N	Std. dev.	Mean react.	N	Std. dev.	Mean react.	N	Std. dev.
1 - 2 times	1.948	459	2.50	2.281	354	2.57	2.259	92	2.65
3 - 10 times	2.155	337	2.67	2.150	368	2.60	1.534	114	2.61
over 10 times	1.614	241	2.85	1.474	231	2.80	1.902	157	2.62
F-value	2.894	n.s.		7.079	p < .001		1.952	n.s.	

Frequency of flight experience beyond the threshold value of ten lead in the lower, but chiefly in the medium income classes to a decrease in hyperreactivity, which is not true for high income classes. This status specific effect of the frequency of airplane experiences is also manifest in a significantly higher hyperreactivity in the upper, in comparison to medium and lower income classes, in the comparison collection with more than ten flight experiences.

From these results it can be concluded that the effects of projective interpretation of experienced flight events on reactivity are varying according to social class. In the lower social classes the experience of flight events is more associated with interpretations which lower the hyperreactivity. /219

In the low income class, flight experiences lead, with mostly higher projective interpretations, to decreasing hyperreactivity which is not true for the upper class. Here the increase in frequency of flight experiences is relatively independent from projective interpretations and has no subtractive effect on hyperreactivity (see table 5.60.). This result shows also that the saturation with the experience of certain events with the of the experience of certain events also makes their interpretation routine. They become common place and customary. This association is dependent on the social class of the individual which determines his objective access to the instrument of mobility "airplane". This produces the tendency of a curvilinear effect of the frequency of flight experiences on the hyperreactivity in the higher income groups which is indicative of the mentioned routinization of the projective interpretation of the experiences of flight events.

Table 5.60. Reactivity of the lower and upper income classes dependent on the frequency of flight experiences and the projective interpretation of flight experiences. 1)

Frequency of flight experience	INCOME											
	low (income less than 2500 Fr.)						high (income over 2500 Fr.)					
	projective interpretation						projective interpretation					
	low			high			low			high		
	mean react.	N	stand. dev.	mean react.	N	stand. dev.	mean react.	N	stand. dev.	mean react.	N	stand. dev.
1 to 2 times	2.041	350	2.58	2.076	227	2.50	2.331	108	2.44	2.179	100	2.53
2 to 10 tim.	2.134	196	2.58	2.136	216	2.64	1.959	110	2.66	1.975	168	2.54
over 10 tim.	1.222	85	2.82	0.789	116	2.60	2.127	80	2.71	2.075	238	2.82
F-Value	3.984 $p < .05$			12.02 $p < .001$			0.561 n.s.			0.186 n.s.		

Table 5.61. shows that the projective importance of flight events has a tendency to decrease as the frequency of flight experiences increases. /220

Table 5.61. Projective interpretation of flight events in dependence of frequency of flight experience.

frequency of flights	Projective interpretation		
	low	med.	high
1 - 2 times	38.0	38.7	40.2
2 - 10 times	32.9	34.9	35.6
more than 10 times	29.1	26.3	24.2
	(516)	(1059)	(935)
$\chi^2 = 4.2$ n.s.			

1) See footnote of table 5.37.

The second operational determination of the direct profit of the noise source "airplane" are the professional ties an individual or a member of his primary reference group such as a family member, a relative or an acquaintance, has to the airport.

Table 5.62. Reactivity dependent on professional ties to the noise source.

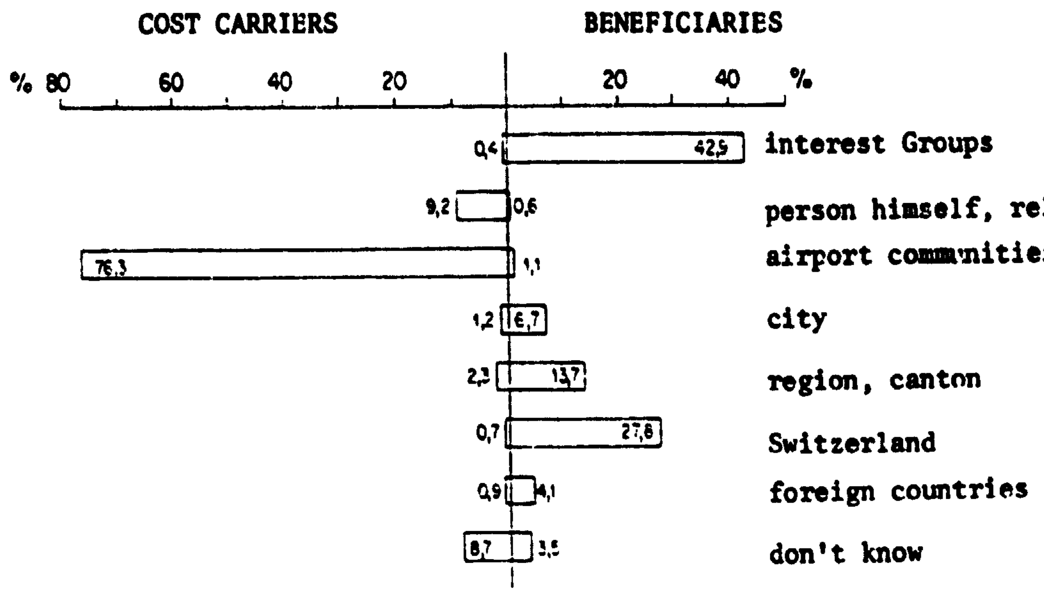
Occupation ties to airport	mean reactivit	N	standard deviation	F-val.	P-val.	est ω^2
with	1.621	1163	2.68	24.954	<.001	0.006
without	2.080	2757	2.60			

As is to be expected, professional ties prove to be a strong factor in the lowering of hyperreactivity in pragmatic stimulus interpretation.

5.2.6.3. The Perceived Social Cost/Profit Aspect of the Noise Source /221

Besides the individual profit, the noise source can also be seen in relation to its societal profit. The perception of profit and the cost of the noise source and their distribution among segments of society is, as shown in several studies, a dominantly intervening factor of pragmatic stimulus orientation. As seen in fig. 5.63., economical interest groups are chiefly seen as the recipients of the profit properties of the noise source, the airport communities, the own person and one's family members are perceived as the carriers of the social cost. Exposure to noise emissions in form of airplane noise exposure can be considered as a category of social costs.

Figure 5.63. Perception of profit and cost distribution in respect to the noise source "airplane" 1)



In the perception of the distribution on the geographical systems levels Switzerland is dominating and -- in descending sequence -- the canton the city and, finally, foreign countries are considered the beneficiaries of air traffic. /222

This subjective perception of the profit/cost carriers of airplane traffic is influenced by several factors. The direct exposure to airplane noise of those questioned is also the reason for the increased inclusion of the own person and his relatives into the primary groups of the cost carriers.

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1) Operationalization: "Whom do you consider as the greatest beneficiary of airports"? "And who is at a disadvantage"?

Interest Groups
Myself and my relatives
Airport communities
City
Canton/Region
Switzerland
Foreign Countries

Table 5.64. Perception of cost carriers of airplane traffic dependent on airplane noise exposure.

cost carrier	Airplane noise exposure (NNI_{KOR*})		
	<20	20 - 39	40 - 59
person himself or relatives	3.2	9.9	14.7
airport communities	89.7	82.8	80.9
interest groups	0.7	0.4	0.6
cities	2.1	1.5	0.7
canton	2.5	3.2	1.7
Switzerland	0.7	1.1	0.5
foreign countries	1.2	1.1	1.0
	(757)	(1611)	(1327)

$x^2 = 840 \quad p < .001$

With increasing airplane noise exposure the tendency to perceive business interests, Switzerland, but also the airport community as beneficiaries, increases.

Table 5.65. Perception of beneficiaries of airplane traffic dependent on airplane noise exposure.

beneficiaries	Airplane noise exposure (NNI_{KOR*})		
	< 20	20 - 39	40 - 59
self or family members	1.8	0.4	0.5
airport communities	1.2	0.7	2.0
interest groups	40.7	45.1	43.4
city	6.2	7.6	6.6
canton	14.4	15.1	13.1
Switzerland	30.4	26.4	31.2
foreign countries	5.2	4.8	3.2
	(769)	(1714)	(1316)

$x^2 = 46.2 \quad p < .001$

The perception of beneficiaries is, however, less influenced by the objective exposure to airplane noise then the one of the cost carrier.

It is also noticeable that the length of residence is a significant factor of influence in the perceived profit/cost distribution. Length of residence leads to higher communal integration, especially in the areas of communication, identification and common interest. It polarizes the perception of interest groups and Switzerland as beneficiaries and airport communities as cost carriers.

Table 5.66. Perception of the most important profit/cost carriers of air traffic in dependence on length of residence. /224

	Length of residence			
	1 yr.or less	1 - 2 yrs.	3 - 10 yrs.	10 yr.up
beneficiary				
interest grps.	37.4	36.1	40.7	47.2
Switzerland	43.0	36.8	31.6	24.8
others	19.6	27.1	27.7	28.0
	(179)	(280)	(1325)	(2006)
$\chi^2 = 64.2$ $p < .001$				
cost carriers				
airport comm.	80.7	85.1	83.6	83.6
person himself	9.[illegible]	7.6	10.7	10.1
others	9.4	7.3	6.7	6.3
	(161)	(275)	(1253)	(1907)
$\chi^2 = 29.4$ $p < .05$				

Table 5.67 Reactivity dependent on perceived profit/cost distribution

beneficiary	cost carrier	
	self or family	airport communities
interest groups	3.578 (170)	2.283 (1302)
airport communities	2.091 ([illegible])	1.382 (49)
city	1.917 (29)	1.838 (192)
canton	3.709 (54)	1.873 (417)
Switzerland	3.268 (73)	1.433 ([illegible])
foreign countries	2.454 (20)	1.956 (120)
F-value	3.298 $p < .05$	11.909 $p < .001$

People who consider themselves or members of primary reference groups as a cost carrying subject, interest groups, the canton, Switzerland or foreign countries, however, as beneficiaries are significantly more hyperreactive (see table 5.67). If airport communities or the city are perceived as beneficiaries it has a significant subtractive effect on hyperreactivity since in these contexts individuals are usually professionally and in respect to free time, e.g. by personal interest, associated. /225

If the communal level is considered the cost carrier, some economical interest groups, however, the beneficiary, we find likewise a significant reinforcing effect on hyperreactivity. This reinforcing effect is then reduced, when the perception of the benefiting segment can be transfered to the immediate reference level, e.g. the city, the canton or Switzerland. It is interesting to note that the perception of Switzerland as a benefiting segment is leading to a less significant hyperreactivity than if foreign countries are perceived as beneficiaries. This is an intervertion of the cosmopolitical, respectively local political orientation.

6. REACTION TO STRESS FACTORS IN THE ENVIRONMENT

6.1. Introduction /226

In previous chapters the analysis was limited to the disturbing effect of sound and its physical parameters as well as the intervening influence of somatic and pragmatic factors which partially explained the inter-individual variability of the disturbing effect of sound. To limit the sociopsychological effects of the stressor to the consciously perceived disturbance represented a restriction which led to a theoretical and practical misinterpretation problem of noise exposure since the measured perceived disturbance represented only an indicator of a reaction potential to react to a stress factor. Such a reaction potential is probably a necessary, however, not sufficient condition to the triggering of a certain behavior.

It is the goal of the present chapter to fit the concrete problem of noise exposure into a general frame of reference which explains varying reactions of individuals to stress factors of the environment with the effect of different discriminating factors. That means, that individuals are not only considered as stimulus interpreting but also as active stress reactive systems. Thereby the behavior modi of individuals in response to stress factors are determined by societal characters of stimulus interpretation and the associated behavior decisions. Three main problems have to be answered:

- what are the different behavior modi towards the stress factors,
- what are the intervening socio-cultural and psychological factors which determine the triggering of a specific mode of behavior toward the stress factor,
- which are the optimal, e.g. socially desirable, respectively socially undesirable modi of behavior towards the stress factor?

6.˙1. Physical Stimulus Fields and Stress Factors /227

Individuals and collectives perceived their environment as a complex field of physical stimuli where the social environment too is perceived by physical carrier signals. Depending on activity and watchfulness an individual associates the specific sector of a given stimulus field with subjective images. This association is independent of an individual's available memory content. That means that a subject image is determined by the acquired repertory of individual experiences which are associated with a given stimulus field. These images are complexes of stimulus interpretation which were acquired by acts of communications or on one's own. The association of image (stimulus interpretation) with the archetype (given stimulus configuration) should, however, not only be understood in a passive mechanistic way but rather as an active creative process.

Two essential dimensions of the memory contents (images) were differentiated, the semantic and the pragmatic dimension. The semantic dimension is determined by phenomenal reference systems , the pragmatic by needs and interests. Through this independence of pragmatic stimulus interpretations from need situations it is possible to differentiate between positive and negative, e.g. depending on the situation desirable and undesirable stimuli. Thereby it is important that the degree of desirability or undesirability of the stimulus or a stimulus configuration always is in relation to the reference dimensions which are determined by the need situation. Generally, the concept of stress factor can be considered as an undesirable stimulus or an undesirable event. 1) Therefore noise can be defined as an undesirable sound. In addition a distinction has to be made between purely physical factors and those physical stress factors which have a social meaning. Based on the exposure of in- /228 dividuals to differing physical and social stress factors there originate individual states of activation or tension with qualitatively different weighted and quantitative differing intensity. Thereby the exposure to physical stress factors is disturbing differentially especially according to symptoms of economical class (see 5.2.3.).

6.1.2. Practical Behavior and Substitution Reactions

One way in which an individual can react to a stress factor is by active practical actions in a form affecting the environment, which changes the stimulus field, e.g. the relatioship of negative and positive stimuli.

1) The medical sociological literature differentiates between two concepts of stress factors: (a) the general undesirability of events (stimuli) where a conscious negative interpretation of events is postulated, (b) an abrupt life change independently of its degree of desirability. If the supposition of a conscious event interpretation is given up the "life change concept" of the concept "stress factor" can be explained by the undesirability. Therefore the stress factor can generally be considered as a disturbance factor in the inner or exterior environment which creates a state of tension and thus a reaction potential. See [69,70]

Practical behavior is consciousness enhancing because it initiates differentiated and conscious interpretations of the stimulus field and its economical and societal condition factors and at the same time the cognitive stimulation of a practical change possibility. It is a learning process.

The other reply possibility to stress factors is a practice substituting behavior which is impractical and thereby anti reality and consciousness impeding. Such behavior suppresses the active influence on the stimulus field. Instead the stimulus field or even the self image is reinterpreted. In contrast to active and conscious actions this behavior occurs internally e.g. chiefly in the preconscious of the subconscious. However, it is leading the external consequences which can be proven indirectly with empirical methods.

The difference between practical and consciousness enhancing actions and of practice substituting and consciousness impeding reactions is the social goal concept that an optimal adaptation to stress factors always is consisting of practice related conscious actions.

6.1.3. Practical Behavioral Replies to Stress Factors /229

Practical reactions to stress factors are measures which actively remove the stress factor completely or partially from the stimulus field concretely, e.g. by actions on the immediate environment.

On an individual basis this may represent a more or less efficent and successful way of coping with stress exposure, the access to it is, however, to a very great degree determined by the socio-economical means of the concerned individual. This is especially true for the resolution of stress exposure by means of change of residence.

But society related solutions can only be based on actions which address themselves to the problem of the socially unequal distribution of the cost/profit relationship of the stress exposure, e.g. those actions which attempt to change the social and political conditions of stress exposure themselves. These are individual and collective forms of political articulation of interests and their practical execution. Methods and success chances of such actions have to be simulated before they are undertaken [71]. Negative results of such a simulation can lead to the recognition that practical actions towards the stimulus field which would lead to medically or socially undesirable results or substituted by other actions by reinterpretation of the stimulus field or the self-image.

6.1.4. Reinterpretation of the Stimulus Field as Reaction to Stress Factors /230

The pragmatic interpretation of a stimulus as positive, negative or indifferent does not happen in isolation but in relationship to the interpretation of the other stimuli of a stimulus field.

This interaction can be experienced as a transfer of importance among stimuli: The pragmatic meaning of a negative stimulus can be transfered to positive or indifferent stimuli of the stimulus field and vice versa. The negative judgment of a certain context catagory is generalized on other context units. Of course, this process can also occur in the opposite direction. Such generalizations are of course also effective in the case of semantic stimulus interpretation. For instance is the codification of impressions of one stimulus always relative to the impressions of other stimuli. Between the act of stimulus interpretation there also acts a transfer system between pragmatic and semantic meanings.

It is a transfer system with feedback, that means that transfered pragmatic meanings can also have a feedback effect on changed semantic meanings and vice versa.

Tne daily experiences and interpretations of the environment are shaped by such transfers since transfer of meanings in the interpretation of the environment is information reducing and thereby functional for the practical behavior. If transfer and feedback effects lead to wrong practices or to practice substi utions in the process of stimulus they act as prejudice or suppression mechanisms or as scapegoats. Such wrong forms of cognition are not limited to transfers of the meanings of physical stress factors on other physical stimuli but they also have to be taken into account in respect to the transfer on social stimuli. Since the physical stress factor also acts additionally /231
as a social stress factor, for instance in family situations, the response to it is therefore wrong. Since the social sector of a stimulus field is generally more relevant then the physical - this again as a consequence of the social natu. of the individual -transfer effects of stress factors on social stimuli represent an aggravating reduction of social quality of life too.

6.1.5. Reinterpretation of the Self Image as Reaction to Stress Factors

Transfer of meanings between stimuli represent extra punitive reinterpretations, e.g. they are directed towards the stimulus field of the environment. But the stimulus fields of the environment are not the only objects of importance. Individuals can consider themselves too as objects of importance. The result of this transaction is the self concept which an individual acquired about himself. This self concept is the product of manifold relations which he experienced actively and passively in the course of his life history within his social and physical environment.

Exposure to stress factors which directly or indirectly change the self concept of an individual are intropunitive reinterpretations, e.g. they are directed towards the self. The most important component of this self concept is the subjective interpretation of one's own competence and ego strength with which to succeed against the environment as well as the physiological and psychological state of health. This subjective interpretation of one's own competence and state of health are distinguished by a relative autonomy from their objective impression. Deviations in the subjective interpretation of the objective impression of symptoms, for instance in the form of subjective aggrevation of symptoms which are objectively not at all or only poorly defined, represent effective illness phenomena (mental health) in sociological or medical-sociological respect the latter are /232
capable of accelerating the respective semantic definitions. This leads to psychosomatic states. In every case, however, they lower the self concepts of individuals and thereby their competence to act consciously and practically within their environment. Impaired mental health can appear as a direct or indirect effect of the exposure to stress factors especially if conscious actions, which could change the stimulus field or the conditions, are not available.

The chain of events between a stress exposure and effects on mental health is, however, only then direct when the stress exposure exceeds a certain tolerance threshold for a longer period of time. Less extreme exposures to stress factors lead only indirectly along intervening effects of additional components of the self concept for instance ego strength and in socio-cultural factors to effects on mental health.

Here we are confronted with the problem of standards of normality. The world health organization defines health not only as the absence of disease but also as a state of complete physical mental and social well being. This definition, however, is to abstract because they do not concretely define the concepts of completeness or not even the standards of normality. In contrast to the epidemiology of semantic illness there are only a few practical criteria available in the area of psychological illness and especially mental health, which make it possible to define a standard which is applicable for the population as a whole. Therefore in the following it is only possible to make statements to the mental health of individuals which are based on average values obtained from statistical results of the interviews.

6.1.6. Discriminating Factors Among Differing Behavior Patterns /233

The results of semantic and pragmatic stimulus interpretations determine the reaction potential, however, not the shape and the conditions that triggers the reactions. These discriminating factors between differing kinds of reactions are on the one hand localized on the sociostructural and sociocultural level and on the other hand on the personality level. The former includes chiefly aspects of resources and experiences:

- Economical material resources
- Immaterial resources
- The repertory of actions against the environment based on experiences of success or failure. This determines the degree of subjective powerlessness to carry out actions which are adequate to the stimulus
- Ideological orientation models

The personality level includes:

- The self image of one's own competence to influence the environment
- The level of anxiety

6.2. EMPIRICAL FINDINGS

6.2.1. External Adaptive Reactions

In the introduction external reactions were defined as conscious efforts with the goal to reduce or eliminate exposure to stress factors or the effect of stress. These external actions can occur on 4 levels:

1.) Actions of individuals on the own person:
   - Use of ear protection device
   - Consumption of hypnotica, analgetica and tranquilizers.

2.) Actions on the physical environment: /234
   - Sound proofing of the home
   - Closing of windows and shades.

3.) Withdrawal from the field of stress exposure by mobility
   - Avoidance of the home
   - Avoidance of open areas around the home.

4.) Actions on the social and political environment:
   - Individual and collective protest actions.

The concrete external means of adaptation of these four levels can be categorized according to the following criteria:

1.) Area of effect:
  - The effects of a form of adaptation: can be related to socio-medical, environmental hygienic as well as social micro and macro-areas. However, these areas cannot be considered in isolation but represent states of interdependence.

2.) Efficiency:
  - Forms of adaptations can be efficient or inefficient in relation to their goal orientation, namely minimization or elimination of exposure to stress factors.

3.) Feasibility or acessibility:
  - The choice of a form of adaptation can depend on material or non-material resources which are unequally distributed in society.

4.) Extent of effect:
  - Forms of adaptation can disturb aspirations of a higher order. This introduces the criterium of varying severity for differing forms of adaptation.

5.) Forms of articulations:
  - Forms of adaptation can be articulated individually or collectively.

Actions on the own person, for instance by consumption of hypnotica lead to immediate negative socio-medical consequences. Negative effects of manipulation of the physical living environment impair, more or less aggravatingly, the /235
environmental hygienic situation of the individual. Indirectly decreasing socio-medical or environmental hygienic nominal values can also lead to negative effects in social, micro and macro areas. The efficiency of both levels of adaptation are limited to the individual levels and their feasibility is determined by socio-economical and socio-demographical class-characteristics. The adaptation technique to withdraw from the field of stress exposure by mobility acts more or less aggravating on social micro or macro-areas. For instance, the moving away from noise zones is a class specific measure, because of the situation in the housing market. It therefore can cause a disengagement process. Other withdrawal possibilities such as increased avoidance of the home are determired by sex and family roles. Like the actions on the own person or the physical environment, the means of withdrawal by mobility are limited individual solutions for stress exposure.

In contrast to these three adaptation levels the effects on the social and political environment are more pervasive and therefore efficient because by their choice the exposure to stress factors is attempted to be resolved on the societal collective level. This qualitative difference means that this adaptation attempts the elimination of social cost not only on the basis of individual but of collective gain. Here it is essential that the choice of political adaptation is not only dependent on socio-structural factors but also on intentional as well as psychological factors. Thus, the recognition of the societal cause of stress exposure, the experience of powerlessness and the ego strength, to be capable to influence the environment successfully, are intervening conditions which assure that a general activation for political measures is also converted into a personal dispositon and into effective behavior.

6.2.1.1. Actions On the Own Person /236

Fig. 6.1. shows that the essential frequency distribution of both subjects who, because of exposure to airplane noise (NNI_{KOR*}), use ear protection devices, consume sleep or tranquilizing medications or have discussed with a doctor the medical results of airplane noise exposure 1). The consultation of a physician is a indirect measurement how severe an individual considers the medical effects of airplane noise exposure.

In the socio-medical field the most aggravating means of adaptation against airplane noise exposure is the consumption of sleeping or tranquilizing medications. Here it has to be assumed that the socio-demographical attributes of sex and age function as main discriminators for this adaptation device. The female population of the random sample mentioned, even if statistically not significant, shows systematically more frequent use of hypnotica or tranquilizers as a reaction against airplane noise than the male population of the random sample (see fig. 6.2.).

1) Since in Switzerland the zone planning around airports is based on the classical NNI, the fig. 6.1*, fig. 6.5*, 6.6*, 6.9*, 6.14* which are contained in appendix 3, are based on the NNI values.

Figure 6.1. Actions on the own person dependent on the degree of airplane exposure. (NNI_{KOR}*) /237

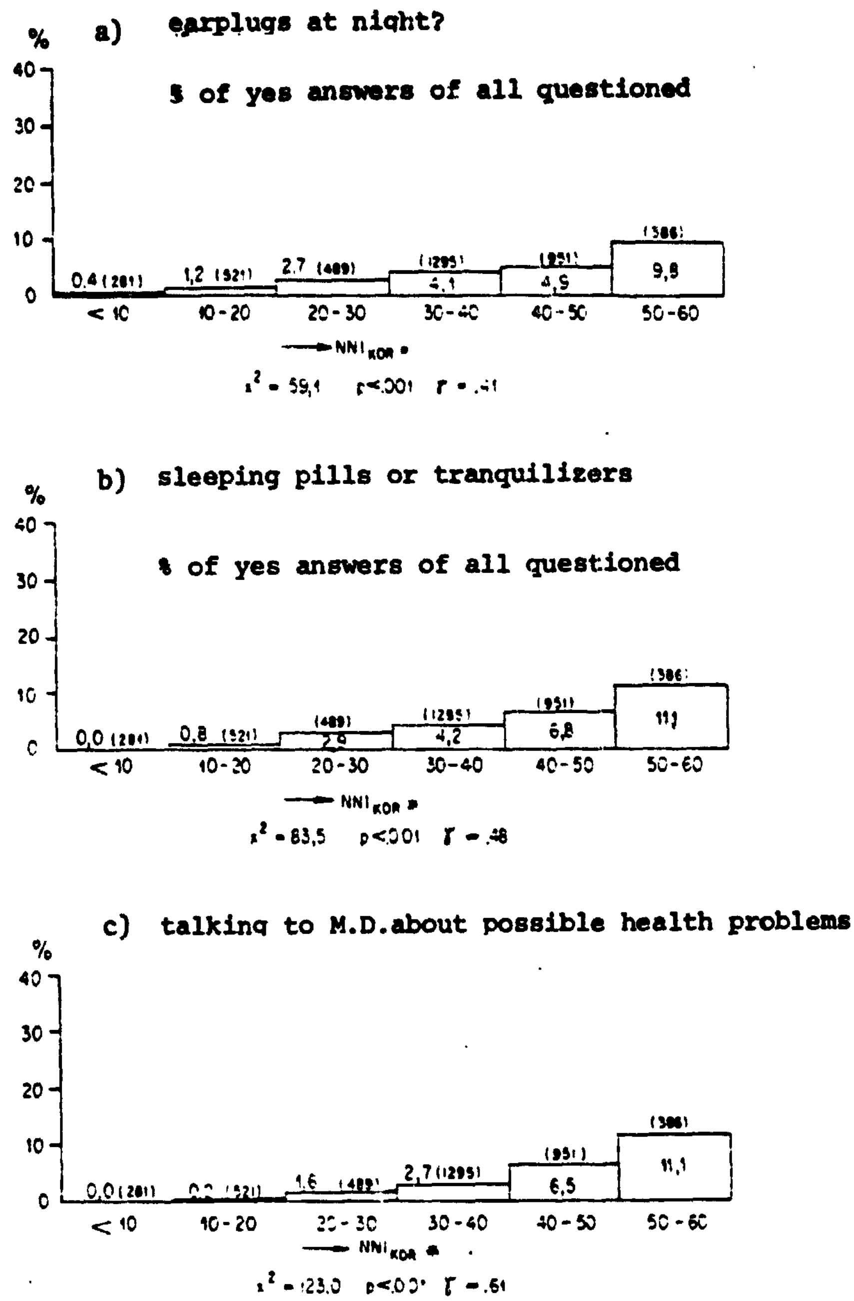
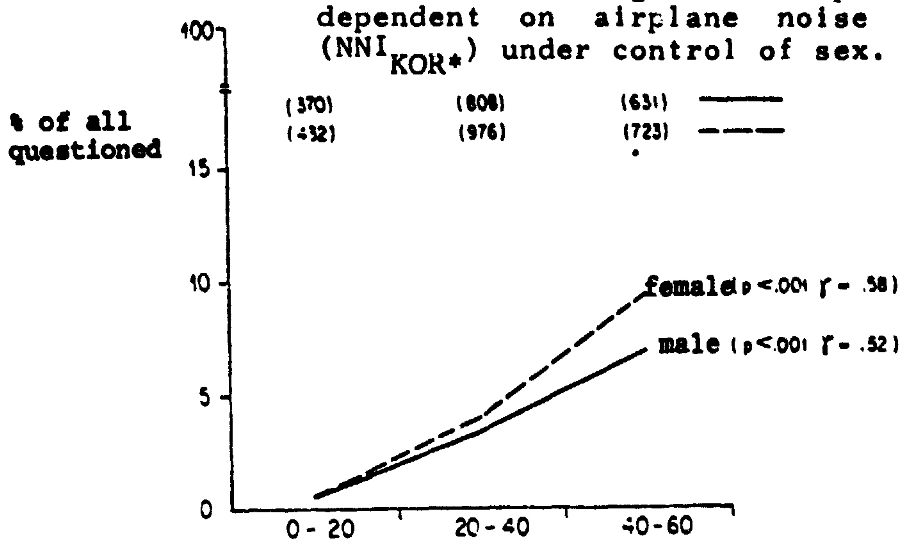
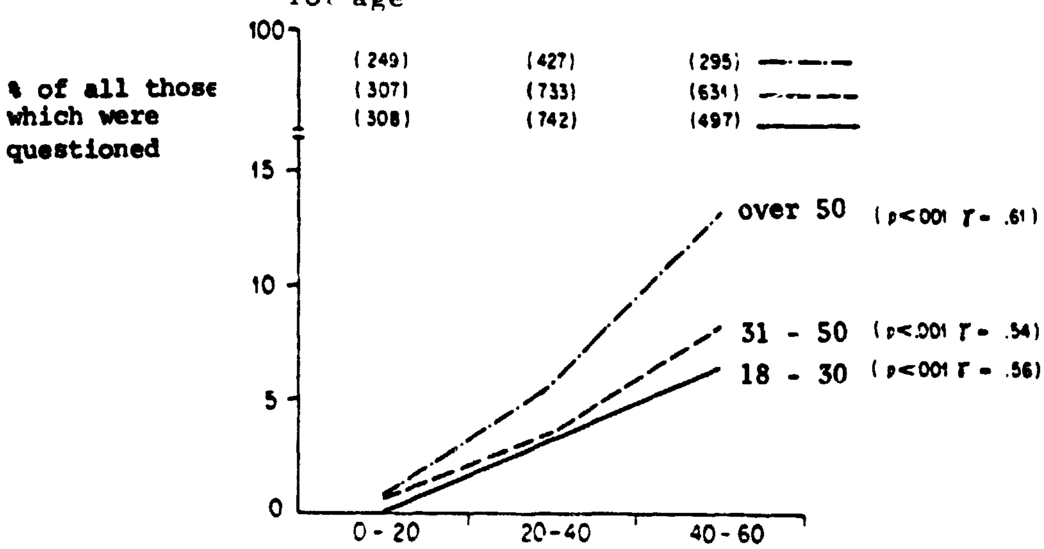


Figure 6.2. Consumption of hypnotics and tranquilizers as a measure against airplane noise dependent on airplane noise exposure (NNI_{KOR*}) under control of sex. /238



Susceptibility to disturbance of sleep goes with increasing age. Based on physiological fact the younger age groups use sleeping or tranquilizing tablets because of airplane noise exposure less often than older ones. With older, especially the oldest segments, however, the reported frequency of the consumption of sleeping or tranquilizing medications against the disturbance by airplane noise increases as the exposure to airplane noise increases. In the zone of maximum airplane noise exposure the frequency in use of these medication against airplane noise is considerably higher for the oldest segment than the medium or younger segment of the random sample (See fig. 6.3.).

Figure 6.3. Consumption of hypnotics and tranquilizers as remedies against airplane noise depedent on airplane noise exposure (NNI_{KOR*}) controlled for age /239



Two types of consumption of tablets were determined by measurement. (a) Stimulus specific (see formula of question in fig. 6.1.) and (b) without referring to the stimulus "airplane noise". Stimulus specific questions about the consumption of tablets can contain aggravation effect e.g. the stimulus "airplane noise" can be evoked so that the subject gives exposure to noise as a reason for use of hypnotics or tranquilizers without really using it factually as a means of adaptation. In the second measurement of the consumption of tablets such an aggravation effect is excluded to the greatest degree. Fig. 6.4. confirms that the consumption of hypnotics increases also in the questions which do not contain the aggravation causing stimulus with increasing airplane and traffic noise as well as the corresponding increasing total noise exposure.

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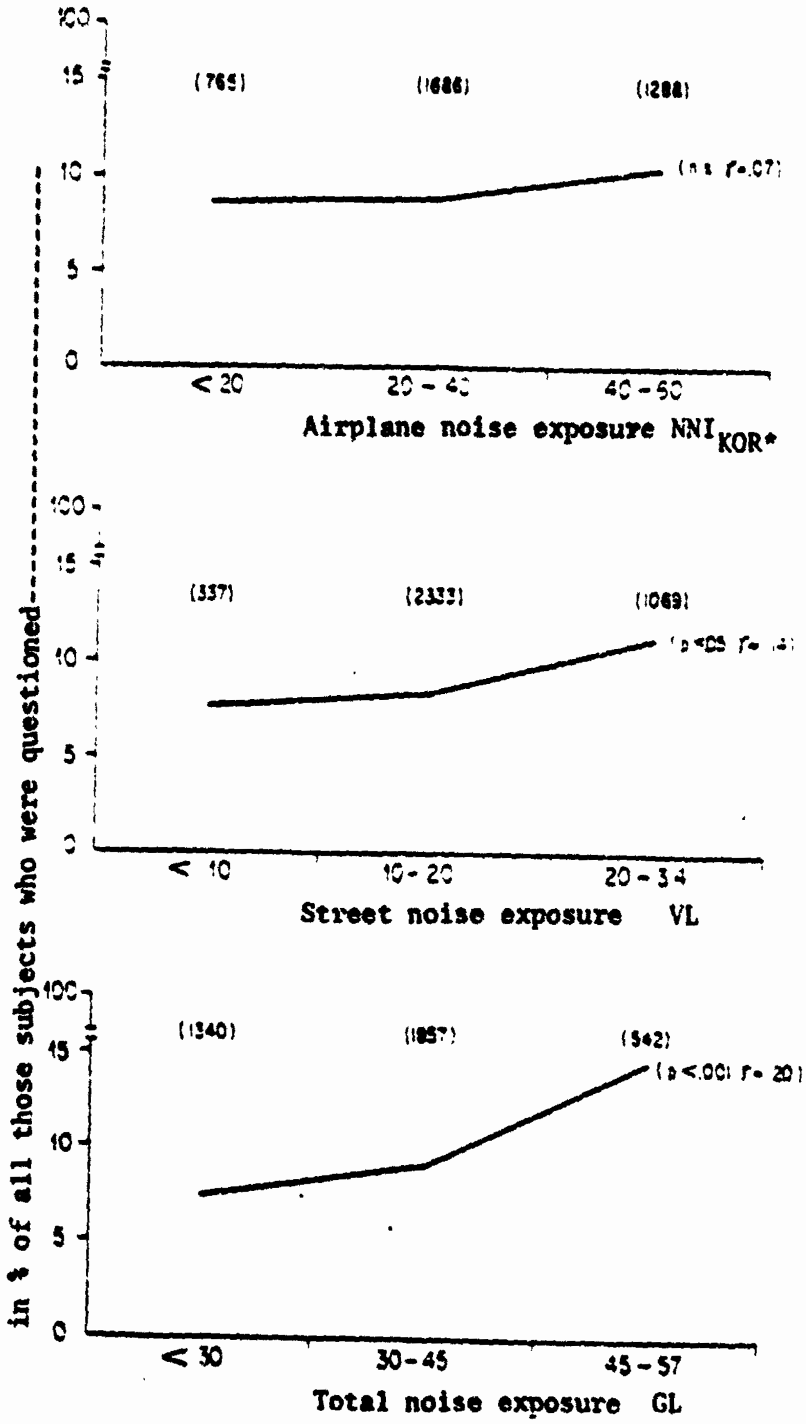
1) The question which did notelicit the mentioning of the stimulus was asked anonymously in supplemental medical questionnaires which were filled out by the subjects themselves.

Figure 6.4. Consumption of hypnotics in reply to the question without stimulus aggravating effects dependent on airplane, street as well as total noise exposure (in percent of those questioned, which take hynotics more than twice a week. /240



From the medical-sociological view point aggravation phenomena are to be considered as the tendency of individuals to overemphasize in a self-evaluation the medically undesirable reactions, for instance consumption of tablets because of exposure to a stress factor. Self perception of illness symptoms or undesirable reactions to stress occur dependent on socio-structural class differences as well as personality dispositions. /241

Aggravation tendencies show a difference, albeit not significant, between female and male parts of the population;

2.2% of the male subjects report on the one hand consumption of hypnotics or tranquilizers in reaction to the disturbance by airplane noise but report otherwise only little or no use of such medications in the stimulus independent question (N=1576). In comparable female subjects, however, 3.2% give this inconsistent response (N=1816). These findings agree with the different role concepts of both sexes which shows socially the conditioned higher permissivness towards medically undesirable states of reaction in the female sex, in other words, less resistance against aggravation, then is true for the male sex (see 5.2.2.1.).

In the adaptation of individuals to undesirable inner states or stresses, accommodation can prove to be disfunctional, aggravation, however, functional. It can be assumed that the aggravation tendency grows also with increasing age since the objective threshold of tolerance of resistance against undesirable inner or external disturbances is lowered in a later age.

In fact, there is a significant difference in the aggravation tendency as a function of age. The 18-30 year olds show only 1.8% of inconsistent cases between the two types of measurements of consumption of tablets. Both older population segments show 3.1% (31-50 year olds) and 3.6% (over 50 year olds).

Theoretically it can be expected that the level of fear of the source of stress, as special momentum of general anxiety disposition, increases the probability to react to stress with hypnotics and tranquilizers. Also in the establishment of consumption of tablets without the aggravation factor it has been shown that those subjects with a high level of fear of the stress source "airplane" in the extreme zones of exposure (40-59 NNI_{KOR*}) 15.5% reacted with this /242

means of adaptation (N=490). The comparable group with a lower level of fear reacted significantly lower, namely with 8% to this means of adaptation (N=941).

The level of fear is not only a discriminating factor of the probability in the choice of drugs as a means of adaptation against airplane noise but it also influences significantly the aggravation tendency which evolved on an operational level from the difference between the two types of measurements of consumption of tablets. Only 1.7% of those questioned with the lower level of fear (N=1200) show such aggravation tendencies while in the group with the high level of fear 4% of those questioned (N=1194) show aggravation tendencies.

6.2.1.2. Effects on the Physical Environment

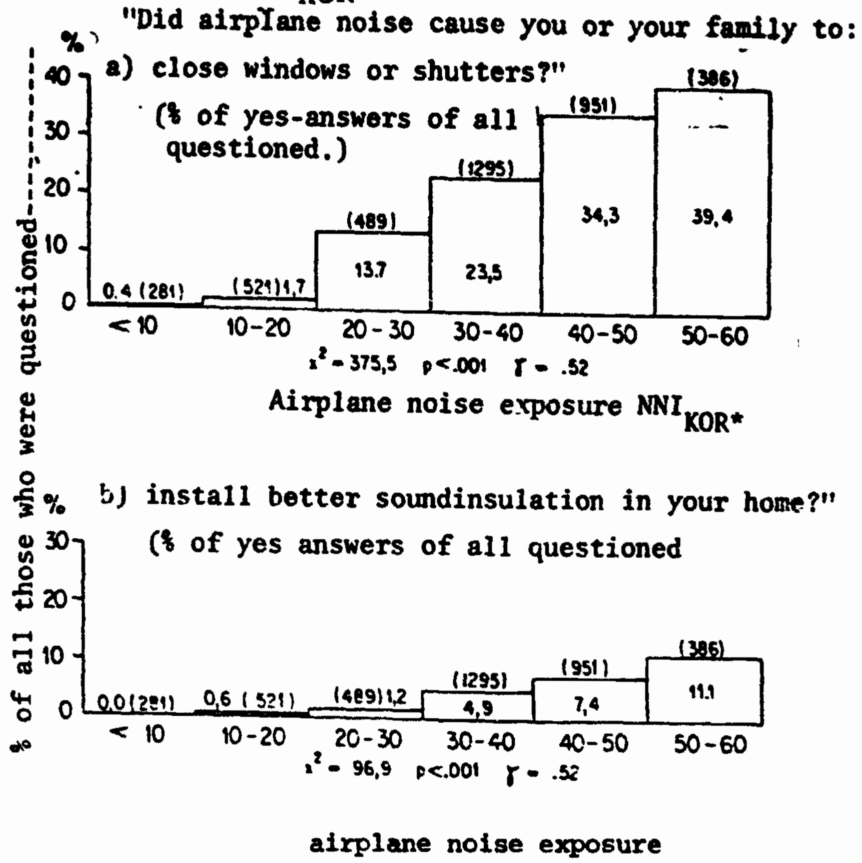
Fig. '.5. shows the significant and continuous increase of the percentages of those questioned who tried to reduce their exposure to airplane noise by manipulating their homes. Already in the third exposition zone the choice of the method of closing the windows or shades suddenly increased. The choice of this method or the use of additional sound proofing devices has probably no immediate social medical consequences, but it affects the environmental hygienic circumstances of individuals more or less aggravatingly.

For direct manipulation of the house by means of better sound insulation and class specific availability, the pro- /243
portion of those which improve the insulation of their home, is comparatively low.

It is obvious that the possession of the apartment or house usually includes instrumental economical resources to be able to protect the house from undesirable sound with additional sound proofing devices. It is statistically significant that in the extreme zones of airplane exposure 12.5% of those questioned who own a house or apartment (N=586), however, only 6.2% of renters have already taken measures of additional sound proofing investment as a method to reduce airplane noise exposure (N=906).

Avoidance of the immediate surrounding of the home because of noise leads to an essential loss of the phycial context quality of the living environment. If noise expsoure leads to the effect tha 20% of those questioned in the highest noise zone are reporting that they stay less outdoor than they would like to do then that environment (see fig. 6.68.).

Figure 6.5. Influence on the physical environment dependent on airplane noise exposure (NNI_{KOR*})



6.2.1.3. Withdrawal From the Field of Stress by Mobility /244

In the measurements three forms of withdrawal from the stress field were differentiated:

- Withdrawal by avoidance of the immediate surroundings of the home
- Withdrawal by avoidance of the home (being less at home)
- withdrawal by moving out of the noise regions

a) Withdrawal by avoidance of the immediate surrounding of the home.

Avoidance of the immediate surrounding of the home because of noise leads to an essential loss of the physical context quality of the living environment. If noise exposure leads to the effect that 20% of those questioned in the highest noise zones are reporting that they stay less outdoors then they would like to then that indicates a decisive usage limitation of the complete living environment (see figure 6.6a.).

b) Withdrawal by avoidance of the home

Increased avoidance of the residence as a way to cope with airplane noise exposure can have relatively aggravatingly negative effects within the social micro-area of an individual, for instance within his family. As for the other two coping mechanisms the second highest exposition zone shows a sudden increase of those subjects who react to airplane noise by an increased avoidance of their home (see figure 6.6.b).

It can be assumed that this form of adaptation is chosen less frequently by segments of the population who have stronger residential ties such as women, children, married and older people because it is for them difficult to realize.

In fact this adaptation alternative is chosen by the male segment (see figure 6.7.) systematically, but not significantly more often, than by the female population.

c) Withdrawal by moving out of the noise region /246

The choice of the method to eliminate the exposure to the stress by moving away from the area can have aggravating effects within the social macro-area because the differing distribution of socio-economical resources for this adaptation device can cause social disengagement (see chapter 5.3.1.). The intentions to move away, which were voiced during the interviews do, however, not represent real action because the mere intention to move away does not imply the realization of this plan since teh chances for its execution are lower in the income groups, e.g. the intention to move away is no dependable indicator for the real factor of moving away but rather an indirect indicator for the degree of disturbance.

Figure 6.6. Withdrawal from the field of stress by mobility dependent on airplane noise exposure (NNI_{KOR*}) /245

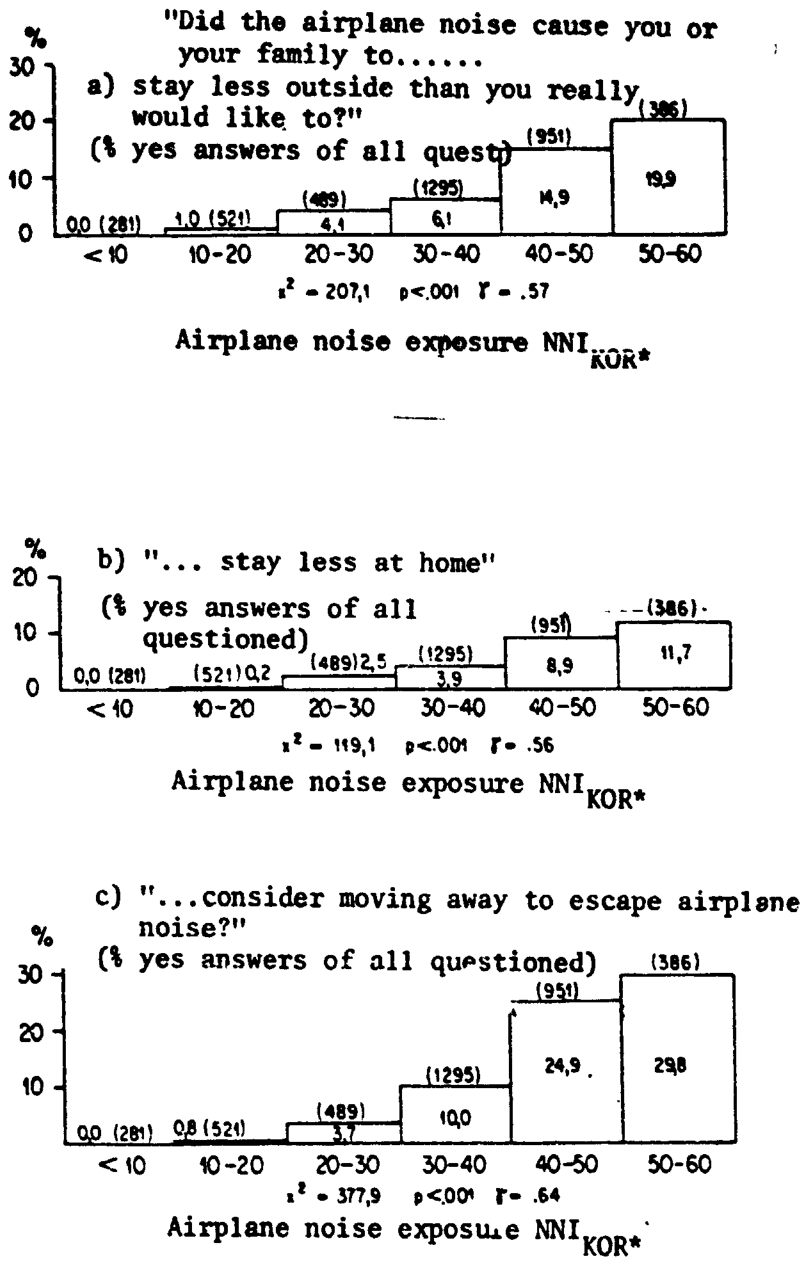
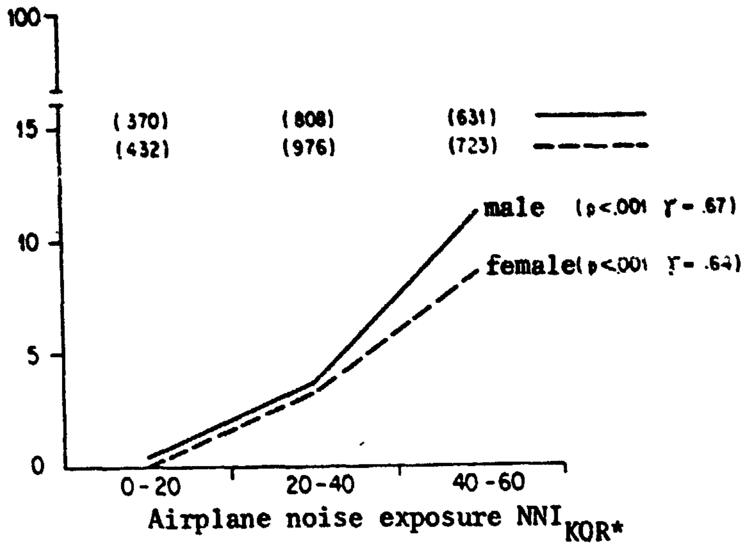


Figure 6.7 Withdrawal by avoidance of the home as a measure against airplane noise dependent on airplane exposure (NNI_{KOR*}) by controlling for sex. /246

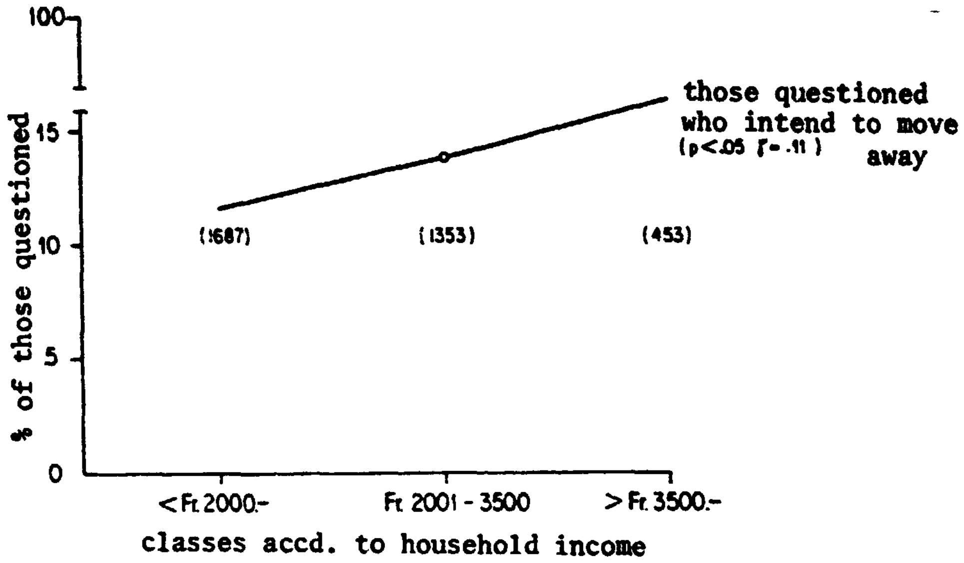


As seen in fig. 6.6.c, the percentage of those questioned, who mentioned tne intention of moving away because of airplane noise shows a sudden increase in the second highest airplane noise zone. In the zone of highest airplane noise exposure 30% of the people questioned mentioned intentions to move away because of the airplane noise. /247

It can be assumed that the cognitive discrepency between the intentions to move and the perceived socio-economical impossibility to find a new residence in the low social strata is resolved by cognitively suppressing the possibility of withdrawal from the noise zone by moving or that it loses on importance. Therefore it can be expected that the intention of moving away as a reaction to airplane noise is less often observed in lower social strata than in the higher one.

Fig. 6.8. confirms this situation significantly.

Figure 6.8. Intentions to move as a behavior disposition towards the exposure to airplane noise dependent on income.

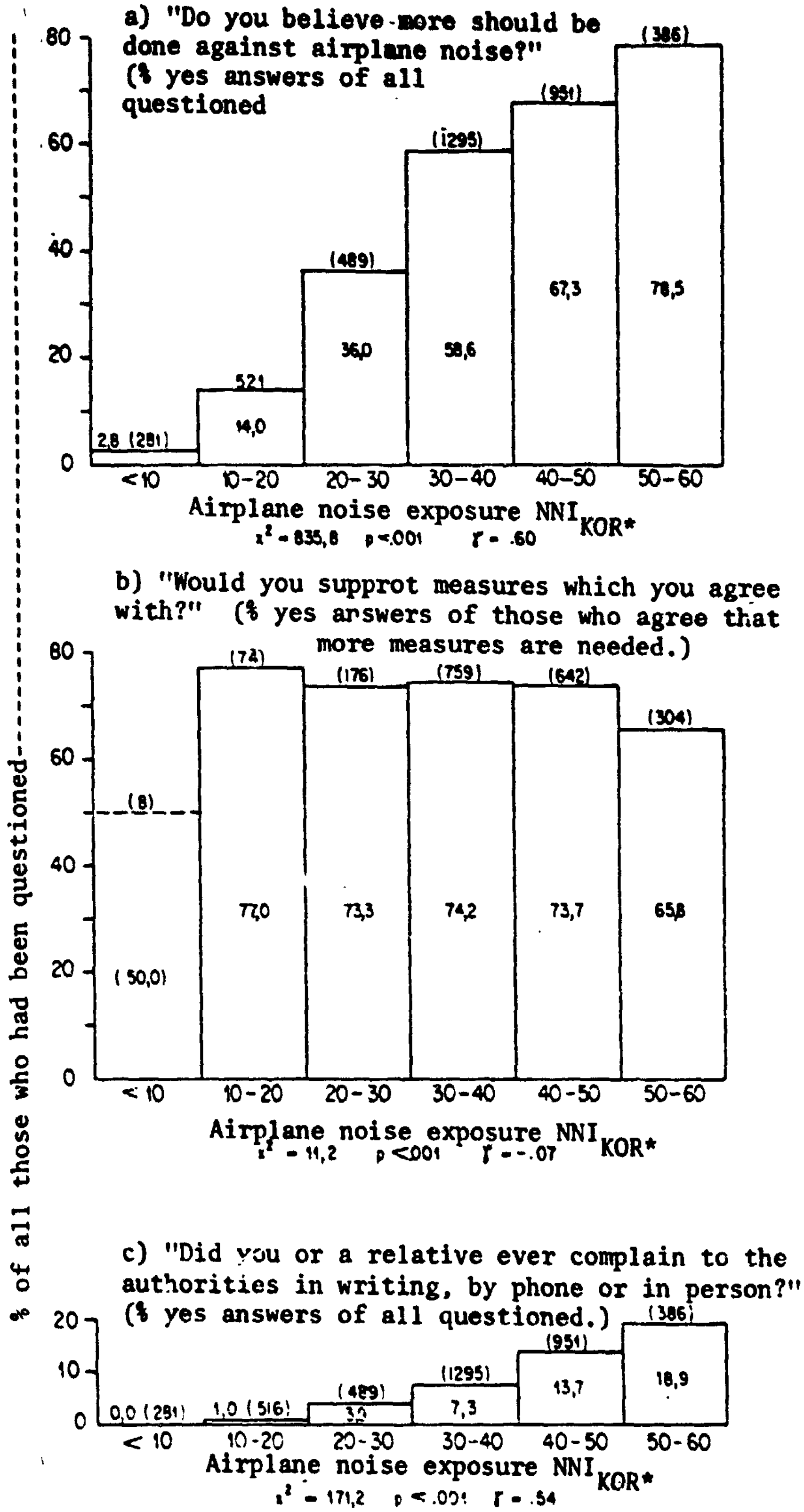


6.2.1.4. Effects on the Social or Political Environment /248

Actions directed toward the social or politcal environment have the goal to change the physical environment on a short term or long term basis such that the exposure to the stress factor is minimized. This type of action implies always some type of interaction with other individuals. Such action can be on two levels, as for instance in the case of an individual who contacts the bureaucracy or on several levels, as in the case of a collective protest. The articulation of political means against the exposure to stress differs qualitatively from the other external adaptation measures because it is not directed towards individual short term but towards collective long term adaptations of environmental situations.

Fig 6.9. shows the relationships of the three forms of articulation for the six exposure zones. On the level of measurement they appear as attitudes for increased actions against airplane noise, as personal disposition to support political measures against airplane noise and as personal action of the individual in the form of complaints to the airport administration or protests to a newspaper. With the growing exposure to airplane noise the frequency of positive attitudes toward increased measures against airplane noise increases continuously and significantly. In contrast to these general attitudes concrete actions in the forms of complaints and protests are much rarer. However, they increase also continuously and significantly with increasing airplane noise and exposure.

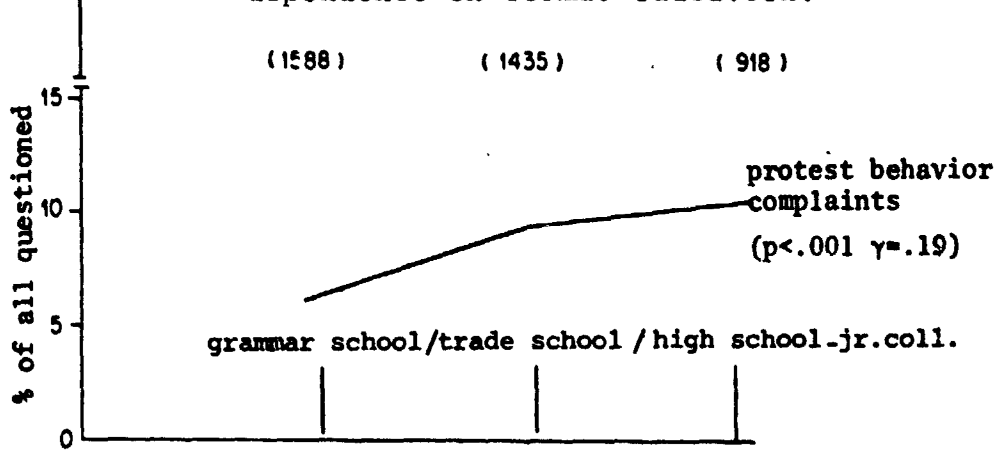
Figure 6.9. Ways of political articulation dependent on airplane noise exposure (NNI_{KOR*}) /249



This illuminates the fact that there is a more or less distinct divergence between attitudes towards actions and actual actions of individual. The realization of a concrete protest action is relatively difficult because it is independent of cognitive and verbal abilities which are to a great degree determined by the formal status of education.

Fig 6.10 indicated how the tendency to react to airplane /250
noise exposure by means of complaints or protest actions correlates significantly with the formal educational status.

Figure 6.10. Complaints to the airport administration or complaints in newspapers as actions against airplane noise exposure in dependence on formal education.



The fact that the personal disposition towards political measures against airplane noise is significantly lower in zones of maximal airplane noise exposure than in those of low noise levels is, indeed, not trivial. This relationship disagrees with the significant and consistent connection between objective airplane noise exposure and the positive attitude toward measures against airplane noise.

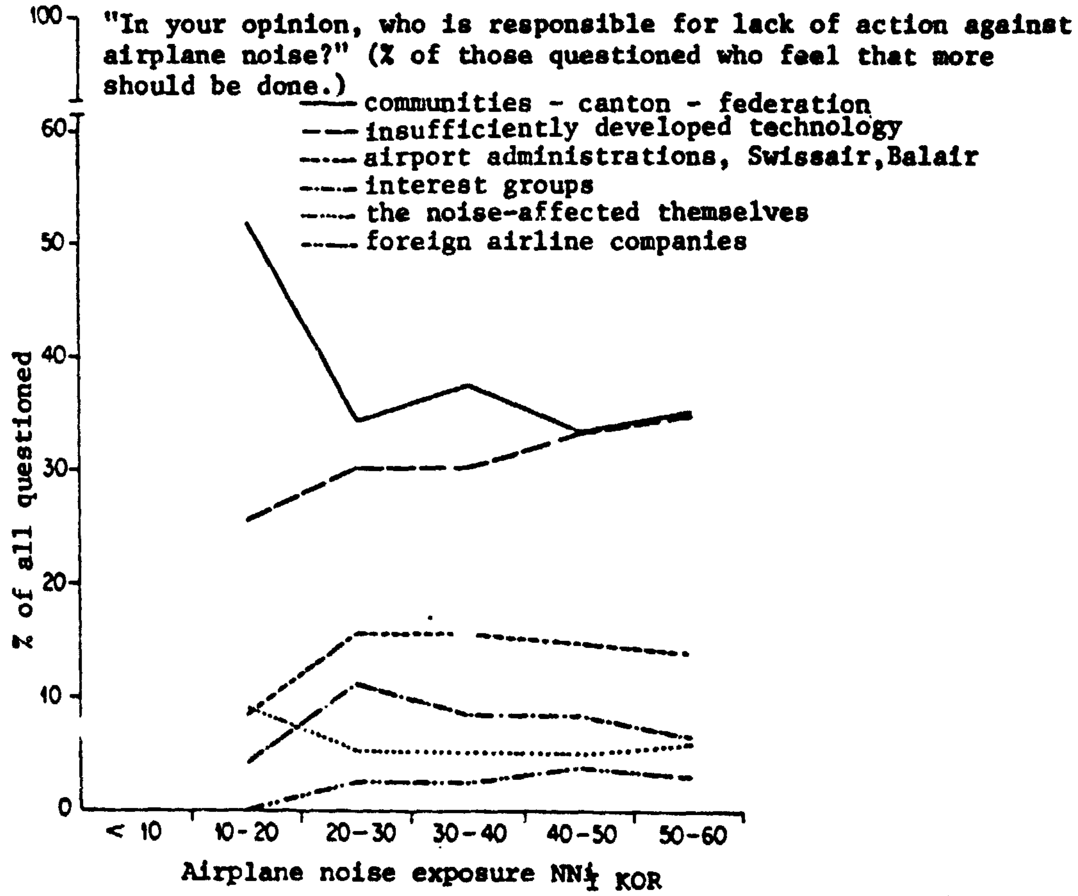
This contradictory relationship can be first explained /251
by the recognition of those cause factors which are perceived as responsible but not enough is done against airplane noise. These causes can be localized by individuals in different areas: (a) The societal political area of interest groups, airline companies, bureaucracy, and (b) in the technological area, namely insufficiently developed techniques. The form of articulation (individual versus collective) as well as the personal disposition for certain external actions are independent of the cognitive localization of these fields. However, other factors intervene also such as material resources, the accumulative experiences of former success or failure of external actions and the subjective self evaluation of the capability to influence the environment.

Fig. 6.11. shows what the subjects of the study perceive as the causes responsible for insufficient measures against airplane noise. Named are the following in increasing sequence of central freqency:

- foreign airline companies
- those affected by noise themselves
- the interest groups of economy and real estate interests
- the airport administration, Swiss air, Balair
- insufficiently developed technique
- the communities, cantons, or federal administrations.

While the frequencies of the first four groups are relatively independent of airplane noise exposure the perception of federal authorities and the insufficiently developed technique as responsible causes show an interesting trend: with increasing airplane noise exposure insufficiently developed technique is considered the cause increasingly while the frequency of the citing of federal authorities decreases. That means that, with increasing airplane noise exposure, the causes are not so much sought in societal political /252 but increasingly in technological areas and vice versa, with decreasing noise exposure they are blamed more on societal political and less on technological reasons.

Figure 6.11. Perceived causes of insufficient measures against airplane noise in dependence on airplane noise exposure (NNI_{KOR}*)



It can be assumed that the cognitive localization of the cause of the technological areas blocks the personal activation of the individual for political action against airplane noise and that, vica versa, the perception of the cause in the social areas increases this activation. Table 6.12. confirms this supposition: the personal disposition towards actions against airplane noise shows only then a significantly inverse association to the objective exposition to airplane noise if the course for insufficient measures are socialized in the non social technological areas. Likewise this cognitive pattern is acting negatively on the probability to react with personal actions in the form of complaints or letters to the newspapers to airplane noise. /253

The discriminating effect of these conscious factors on personal dispostion to its political action against airplane noise is significant in the maximal zones of airplane noise exposure at the 1% level.

Table 6.12. Personal disposition towards ways and concrete measures against airplane noise of those questions, which consider insufficiently developed technology respectively social factors as cause of insufficient measures against airplane noise in dependence on airplane noise exposure (NNI_{KOR*})

Individual and political articulation in % of those inconvenienced Ss who feel that more should be done against airplane noise		Perceived reasons for insufficient measures taken against airplane noise					
		Lack of sufficient technology			Social factors administrations, airline companies, noise sufferers, interest groups.		
		NNI_{KOR*}			NNI_{KOR*}		
		<20	20-39	40-59	<20	20-39	40-59
Personal inclination towards political means against airplane noise	yes	77.8	75.1	65.0	75.9	75.4	77.4
	no	22.2	15.6	24.8	17.2	15.9	15.1
	perhaps	0.0	9.3	10.3	6.9.	8.7	6.9
		(18)	(269)	(311)	(58)	(618)	(598)
		x^2=10.0	$p < .05$	Gamma= .20	x^2=1.6	n.s.	Gamma= -.05
Personal action against airplane noise: complaints to airport administration or newspaper	yes	0.0	10.3	19.0	8.5	13.0	23.4
	no	100.0	89.7	81.0	91.5	87.0	76.6
		(18)	(273)	(316)	(59)	(621)	(607)
		x^2=12.1	$p < .005$	Gamma= -.38	x^2=26.1	$p < .001$	Gamma= -.35

Since cognitive localization of cause complexes for insufficient measures against airplane noise in the technological area increases with increasing objective exposure to airplane noise, the inversely significant relationship between airplane noise exposure and personal disposition of these individuals towards political measures is explained (fig. 6.9.b) /254

The negative experience to achieve a reduction of airplane noise exposure by means of political articulation in the societal political area acts as a further consciousness factor. That means that it is believed that the social conditions which cause the exposure to stress by airplane noise are considered as not accessible to political manipulation. The discriminating effect of this specific form of perceived powerlessness in stress/adaptation relations is also shown empirically:

Table 6.13. Personal disposition for ways and actions against airplane noise dependent on the perceived powerlessness to eliminate airplane noise exposure by political means. Zone of maximal airplane noise exposure.

Individual and political articulation	Perceived powerlessness to eliminate airplane noise exposure with political means		
	low 40-59 NNI_{KOR^*}	medium 40-59 NNI_{KOR^*}	high 40-59 NNI_{KOR^*}
Personal disposition towards political means against airplane noise (% of Nn who think not enough is done against airplane noise	81.[illegible] (223)	70.3 (462)	71.0 (214)
Personal action against airplane noise, complaints to airport administrations or protests to newspapers (% of disturbed Nn)	30.8 (227)	18.9 (466)	20.1 (219)

The percentages of those subject who are personally disposed toward political actions against airplane noise or who already undertook actions in the form of complaints and protests against airplane noise, are in areas of maximum [1] noise exposure with a low degree of perceived powerlessness significantly higher than by medium and high development of this attitude. /255

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1) The perceived powerlessness to use political means successfully against the stress exposure to airplane noise was operationalized as an additive index of the scale values of the following two attitudes:

- "A small minority has to acquiesce to airplane noise. It simply cannot be prevented".
- "Economical interests are so strong that nothing can be done against airplane noise"?

Both attitudes showed up as elements of this dimension in cluster analysis.

6.2.2. Internal Adaptive Reactions /256

External and internal reactions are interrelated, e.g. the differentiation of internal and external reactions does not mean that internal reactions can not have an external effect and vice versa that external reactions can not have an internal effect. Measurements of internal reactions can, however, in survey analysis only be done by observation of their external effects.

Internal adaptions in comparison to external are rather unconscious, respectively preconscious to adaptations to environmental situations. Two levels of internal adaptation can be differentiated:

- the semantic level and
- the psychological level.

Based on the interrelationship between both levels a third one has to be included

- the psychosomatic level.

It is clear that the somatic level of adaptation can not be a subject of this study.

6.2.2.1. The Psychological Level of Adaptation

From the great number of theoretically imaginable effects of a psychological level of adaptation - for instance effects on the psychological or mental development of children - only a limited area of affects on the level of cognative perceptions of the physical and social environment will be researched. Cognitive changes happen by transfer of the evaluation of a central stimulus on the stimulus context, e.g. the transfer of negative judgments of environmental sounds on other properties of the environment and thus, their generalization.

6.2.2.1.1. The Influence of Exposure to Stress on the Perception of the Home Situation /257

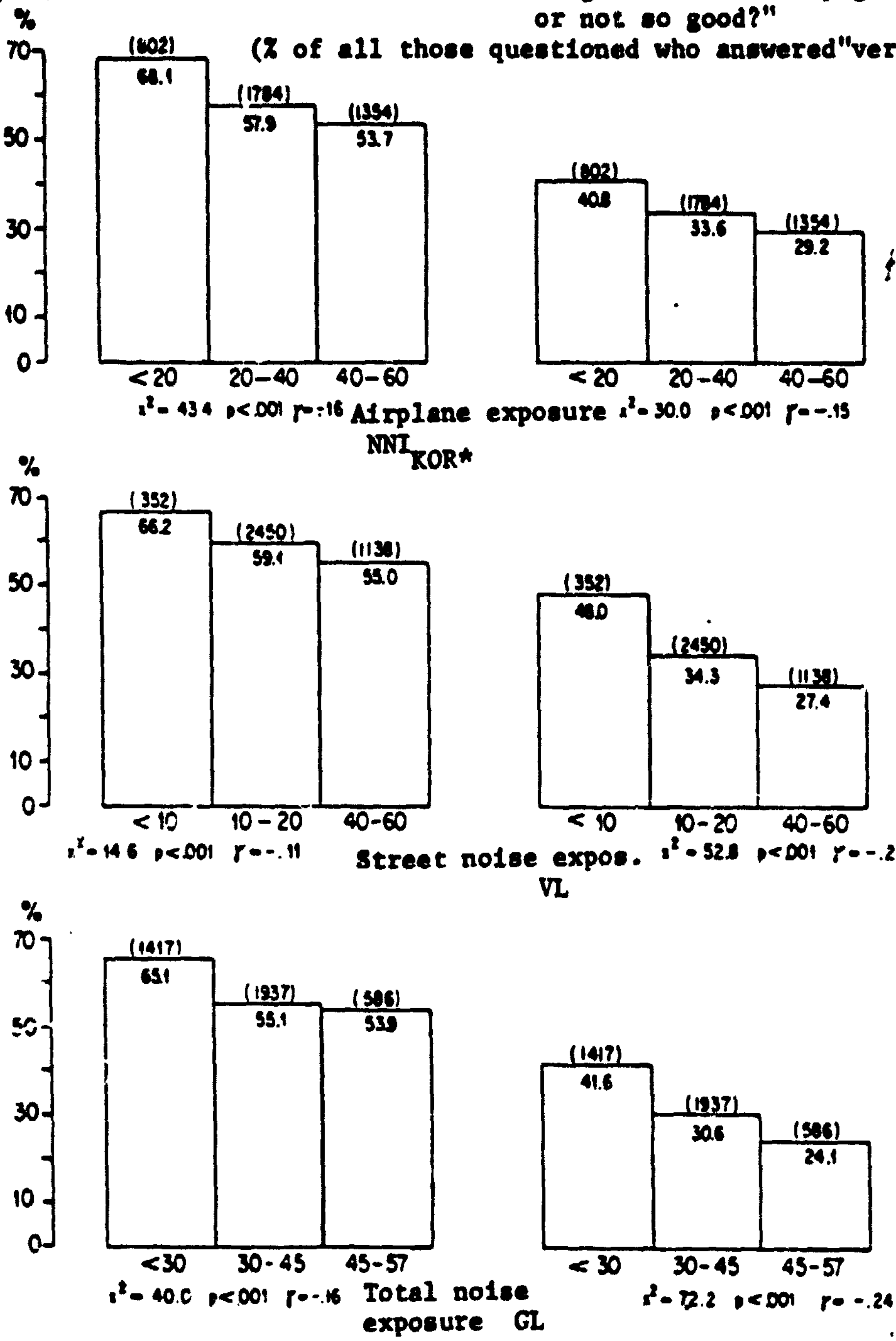
The cognitively perceived satisfaction with the placement of residence is a general indicator for the direction and intensity of direct and transferred evaluations of properties of the environment. Therefore it can be assumed that the exposure to noise directly influences the general level of satisfaction with one's place of residence. The relationship between cognitively perceived satisfaction with the place of residence and the objective air, street traffic and total noise exposure proves to be empirically highly significant (see figure 6.11.).

Figure 6.14. Satisfactory living arrangements and perceived evaluations by others dependent on airplane noise street traffic as well as total noise exposure. /258

Satisfaction with living conditions:
"Thinking of your home - do you like it very much, quite well, not too much, not at all?"

Evaluation by others:
"If you have visitors from other areas, do they consider your neighborhood as very good, good or not so good?"

(% of all those questioned who answered "very good".)



How individuals evaluate the properties of their environments is decisively influenced by the cognitive perception of these properties by other members of the significant group of reference (the significant others). In his own evaluation of the prestige value of his place of residence the individual will usually orient himself to a great degree on the judgement of the "significant others". The perception of the other's evaluation by the individual can also be seen as an indirect measurement of his own satisfaction with his place of residence. If this other evaluation, which has been perceived by the individual, is related to reference persons who do not live in the same vicinity, this can become an indirect measure which can validate the direct measure of satisfaction with the place of residence. If the relationship between objective exposure to noise and the individually perceived other evaluation of his own living environment, is evaluated, it will also be shown that the effect of the objective noise exposure is highly significant on the perceived other's evaluation [72].

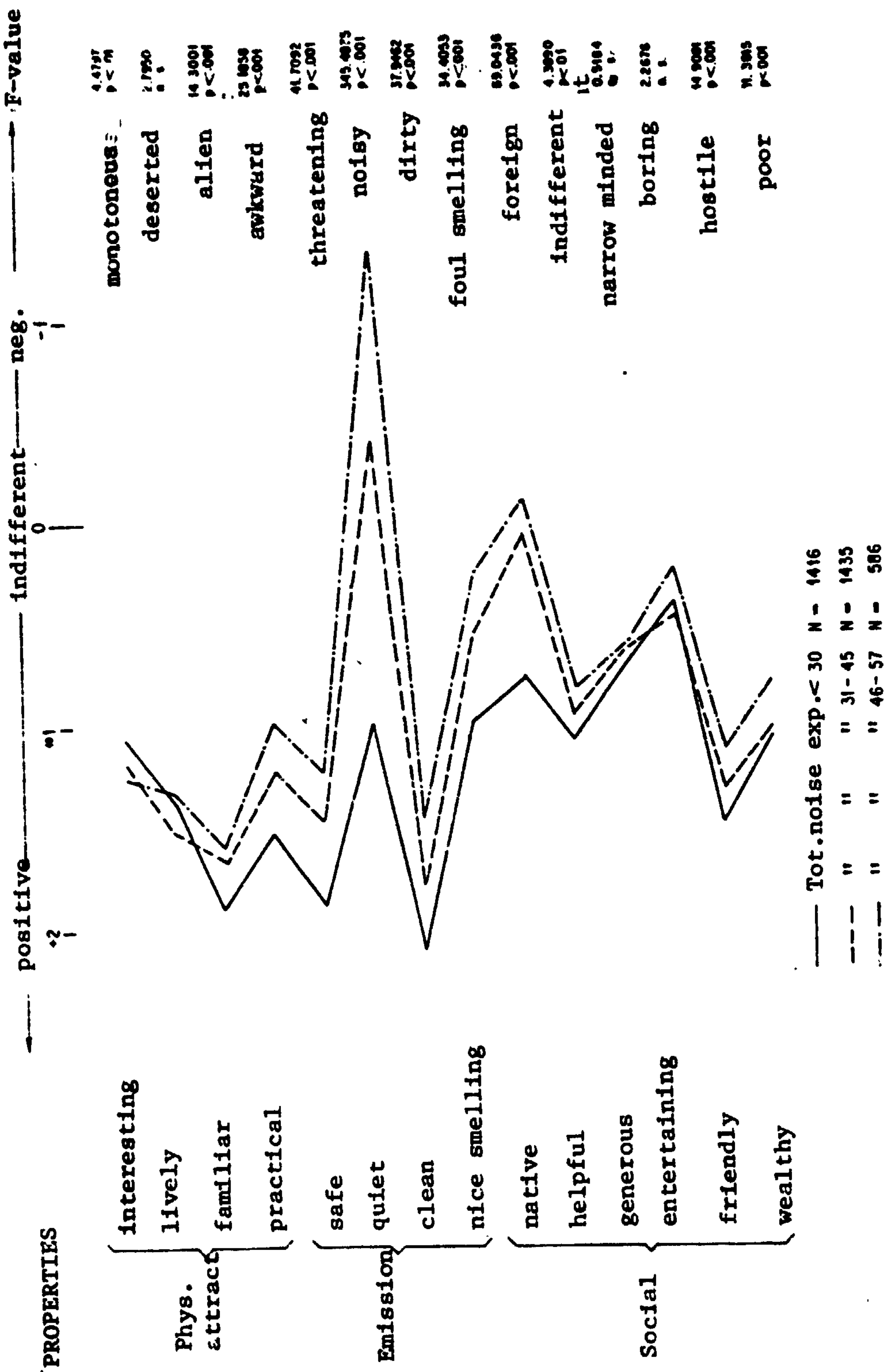
6.2.2.1.2. Exposure to Stress and Generalization Effects on the Perception of Physical Social Stimulus Fields /259

It is theoretically postulated that the generalization of the negative meanings of a specific stimulus in relation to the stimulus context, for instance of a physical stress factor, is directly dependent on the effect of similarity between the specific stimulus and the stimulus context.

It follows that the generalization of negative meanings of acoustical stimuli are more pervasive in their effect on the other physical stimulus complexes than the generalization of the social stimulus fields of the environment. Studies have confirmed that the social environmental dimensions dominate those of the physical dimensions in the cognitive evaluation and in the behavior of individuals [53]. One prerequisite, however, is that no physical stress factors occur whose definitions touch extreme physical nominal values.

Fig. 6.15. shows by means of the course of the semantics profile of three comparison collectives that the evaluation of the physical, but also of the social stimulus field co-vary systematically and significantly with the values of the total noise exposure in the case of 11 of the 14 pairs of attributes (see 5.2.3.1.). The negative evaluation of the stimulus fields of the environment which increases with greater total noise exposure can be partially explained with a co-variation of the noise exposure of objectively worse general context qualities and their perception. However, at the same time it can also be the consequence of the generalization of negatively evalued acoustical stimulus meanings on the cognition of the stimulus context.

Figure 6.15. Middle ranking values of bipolar attributes of the environment in dependence on total noise exposure.



Expectedly, the rank valuation of the environment in all four emission properties are shifting significantly towards the negative pole with increasing total noise exposure. Likewise are the rank valuations of two of the four attractiveness properties significantly more negative. In reference to the attractivity property "diversified versus boring". The /261 rank valuation tendency runs inversely to the total noise exposure. This mirrors the fact that the total noise exposure is higher in densely populated and function diversified residential areas than for instance in function homogenous apartment developments. The effect of the generalization mechanism is clearly evidenced by the fact that in the middle rank values too four of the six determined social attribute pairs of the environment also move in the direction of the negative pole with increasing total noise exposure. This confirms that acoustical stress exposure not only leads to negative displacements of the conotation of physical environmental properties but also to negative connotations of certain social environmental properties.

Perceived negative context quality results in the lowering of the attractivness of the corresponding living environment which, based on the home market leads to the fact that higher zones of noise emission show an over proportional sector of the social lower class. In border line cases this mechanism can actually lead to " noise slums".

In Switzerland the immigration labor force represent the new lower class. Studies show that the lower class of the native population which at the same time is the ecological context area for this new lower class often reacts with neofeudal segregation idiologies and based on that with prejudice [73]. This objective fact is significantly subjected in subjective judgments about the degree of wealth and the access of foreign influence in the closer living environment. Therefore in the maximum total noise exposure zone the comparison collective ranks the surrounding area as poorer than less noise exposed collectives. At the same time the collective judges the two higher noise exposure zones in their surrounding more frequently as populated by too many foreigners than the two comparison collectives in the lower exposure zones.

6.2.2 1.3. Physical stress factors as Aggravation Objects of Negative Experiences in Areas of Social Interaction /262

Transfer effects can also be expected in the reverse direction, e.g. the cognitive perception of a environmental sound is influenced by those of other properties of the physical and social environments.

The physical, but in importance especially the social environment of an individual, is an objective source of conflicts and contradictions. These social sources of conflict cause conscious or unconscious dissonances which can be transfered on the cognitive perception and evaluation of other stimuli or objects of the environment.

The effect of this transfer mechanism is quantitative because it aggravates the negative meaning of a physical stimulus due to dissonances that were experienced in other, for instance social fields of experience.

The cognitive interpretation of stimulus fields also contains the causal tie between stimuli, stimulus effects and their objective causes in the physical or social environment. Cognitive miscoding of a cause effect relationship effect between stimuli, stimulus effect and stimulus cause can be considered as the qualitative aggravation effect, e.g. the adequate causal relationship between experienced dissonances and their causation factors in the social environment is, so to speak, recoded so that stimuli or stimulus sources of the physical environment are considered as causal factors.

One of the main sources of possible conflicts lies in the primary fields of interaction of individuals namely the family. The other is in the area of professional activities and interactions. It can be expected that dissonances in both areas first of all influence the evaluations of sounds additionally in a quantitative aggravation effect and secondly in a qualitative aggravation effect, or even can be traced back to the noise as cause, e.g. the noise takes on the function of a scapegoat for other more important dissonances and conflicts of individuals.

Empirically it is attempted to prove the existence of /263
the scapegoat mechanism by means of the relation between private and professional worries as well as the tendency to consider noise as the cause of all problems.

It is confirmed significantly that with increasing experience of dissonances in private or professional fields of interaction the cognitive aggravation of noise increases as cause factor of dissonances.

Table 6.16 Scapegoat functions of noise dependent on negative experiences in professional or private area. (Percent of all interviewed) 1)

noise is the cause of all worries	Private or job worries		
	low	med.	big
aggravation °			
1	54.8	41.3	39.8
2	18.7	25.1	18.8
3	11.6	15.6	18.3
4	8.8	11.5	14.8
5	6.2	6.4	8.3
	(1543)	(1710)	(515)

$x^2 = 87.3$, $p < .001$, Gamma = +.17

6.2.2.2. The Psycho-somatic Level of Adaptation /264

The interdependence between psychological and somatic factors leads to the appearance of the psycho-somatic ones. Empirically both concepts are not unequivocally separable. Therefore, contrary to customs, the concept of mental health also includes the psychological level. From the interrelation between psychological and somatic levels followsthat there is no simple cause and effect relationship between exposure to stress factors and mental health.

A physical stress factor becomes then a potential trigger as a psychogenic cofactor of organic distrubances if a psychological predisposition is present. Therefore, are in the following those effects of a noise stress factor.

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1) The following question was used to determine noise as aggravaticn: Here you have the thermometer again: (Interviewer hands out card number 17) with which you can measure how strongly the noise is a cause of your worries and difficulties. Number 10 means that the noise is the cause of almost all of your problems and number 0 means that noise is not involved at all. Please tell me what your situation is. The original scale values (0-10) were divided into 5 original categories of aggravation in ascending sequence.

As operational measurement of perceived dissonances in social fields of experience an additional index of two items was used in the supplementary medical questionnaire:

- "I have professional worries"
- "I have personal problems with myself and my family".

on the psychological levels of interest, which manifest themselves in somatic symptoms as well as in their psychological correlates.

Measurements of these symptoms was achieved by means of subjective self grading of the interviewees with a special questionnaire that consists of 33 psychological and somatic symptoms, which was filled out by the subjects anonymously. 1) 4 of the 33 items belong to other levels of adaptation and were excluded from further analysis 2). It is evident, that a subjective self-evaluation implies conscious mediation. That means on the one hand that only a limited section of the reference net between psychological and somatic factors could be considered. Included were, on the other hand, socio-cultural factors by cognitive mediation, which intervene in the relationship between stress factor and adaptation, which, for instance, leads to sex and class specific dissimularities and aggravation tendencies.

One primary problem in the constructions of scales and /265 indices is the mono-dimensionality, the e.g. the degree to which a specific symptom is to be counted towards basic dimensions. To test the internal consistency of the inventory obtained, a factor analysis was done which was based on the values of the main components. The main component method extracts the maximal common variance in reference to the first factor. For further factors the maximal variance is extracted again, however, based on residual correlation matrixes 3). If a basic dimension is existing consistently high charges of the first factor have to result 2). The choice of the main component equation was taken under the assumption that all of the 29 items can be coordinated to a common basic dimension which can be considered a general indicator of mental health.

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1) The symptoms which were included in the questionnaire came for the most part from the mental health scale of Leo Srole et al. [74]. For the validation of the Srole scale with a clinical control group see J.G. Manis et al.[15]

2) The 4 items which were not included deal with the consumption of analgesics, hypnotics, tranquilizers and alcohol. For the respective behavior patterns see chapter 6.2.1.1. of this report.

3) Uberla [75]

4) Varimax-rotation. Number of rotations = 13. Number of extracted factors on the basis of self-evaluation is 1.

Table 6.17. Factor charges for the first unrotated factor as well as for the factor rotation of mental health indicators. /266

	unrotierter Hauptfaktor	rotierte Faktoren I	II	III	IV	V	VI
1. I have no appetite	38	14	11	-37*	21	-14	23
2. I feel fatigued and listless	62	17	22	-14	24	-13	60*
3. I have hear. palpitations or a stabbing pain in my chest	49	07	31	-22	20	11	52*
4. I quickly feel exhausted	64	13	29	-07	21	-18	66*
5. I am fearful and insecure	61	37	02	-04	03	-21	60*
6. I feel bloated or feel pressure in my stomach	47	14	12	-77*	09	-16	16
7. I suffer from heartburn and belching	36	07	18	-79*	04	-06	06
8. I am constipated	38	06	05	-23	07	-71*	09
9. I have no energy	59	37	0[illegible]	-12	14	-27	40*
10. I am angered by trifels	55	48*	01	-12	00	-05	41
11. I am worried	67	55*	07	-07	10	-11	45*
12. I suffer from rheumatism	35	02	75*	-00	10	-05	18
13. I can not concentrate	58	44*	09	-09	11	-12	37
14. I suffer from feelings of anxiety	71	57*	05	-14	17	-07	45
15. I suffer from lack of libido	44	27	08	-08	13	-40*	13
16. I suffer from sleep disturbances and wake up often	55	12	18	-08	80*	-06	20
17. I can not fall asleep	53	13	14	-07	84*	-10	12
18. I am not rested in the morning	60	36	03	-17	50*	-16	21
19. I have bad dreams or nightmares	55	27	18	-07	38*	-30	18
20. I have private and family problems	50	50*	10	-02	13	-27	08
21. I feel cold, shiver, have cold hands and feet	49	23	22	-0[illegible]	11	-59*	14
22. I feel depressed and sad	75	63*	12	-03	18	-28	34
23. I am tense	66	56*	08	-25	19	-08	25
24. I suffer from neck and shoulder pains	51	19	73*	-11	15	-12	12
25. I am restless and can not sit on the same chair for a long time	44	53*	27	-22	18	26	-04
26. I have back and lower back pain	53	65*	01	-03	12	-15	06
27. My life appears monotonous and boring	51	23	67*	-14	08	-17	10
28. My moods change without reason	57	63*	19	-04	02	-08	15
29. Everything is repugnant to me	58	71*	05	-07	08	-11	07
Share of total variance in %		15.3	7.4	6.0	7.6	5.9	9.7

** Items which define the factor

Table 6.17. reproduces the first column of the unrotated charges of the first factor whereby consistently high charges can be observed so that it is really possible to talk of a common baseline dimension. (26 symptoms show higher charges than .40).

Mental health is considered to be a complex of factors. Therefore, specific elements of the structure, e.g. subdimensions of mental health can be crystalized out by rotation of individual factors. The rotation minimizes the overlap of one item or symptom into various factors (subdimensions). The corresponding rotated factor charges are likewise reproduced in table 6.17.

The first of the extracted factors includes only psycho- /267
logical symptoms of insufficient ability to concentrate as well as hypochondriacal, depressive disorders. These symptoms are indicators of a reduced threshold for the processing of external and internal stimuli which results in an increase sensitivity toward stimuli of the surroundings. Generally it can be considered a factor of neurasthenic disposition.

The second factor lies in the contrast on the somatic level. Psychogenic factors rarely contribute to rheumatic illnesses as well as back and lower back pain. However, it should be mentioned that psychogenic factors are believed to strongly contribute to rheumatoid arthritis. [76]. The third of the symptoms which rank high on this factor are neck and shoulder pains. Especially neck pains can be considered symptom of the headache syndrome which can include psychogenic contributions. The first two symptoms of this factor were established with the inventory of psychological and somatic symptoms with the thesis that the physical stress factor "noise" does not have any influence on organic symptoms. Therefore the second factor is, albeit with reservations in respect to ambivalent neck and shoulder pain symptoms, to be considered a control factor for aggravation phenomena.

The third factor lies likewise on the somatic level and includes the symptoms of gastric disturbances. These often result as the consequence of a psychogenic lability of the vegetative hemeostasis.

The fourth factor, too, can be clearly added to a subdimension of the mental health status, namely as sleep disturbance factor (see also the discussion in section 4 of this report).

High charges of the fifth factor cover the symptoms of intestinal, libidinal disturbances as well as tendencies to feel cold. All three symptoms are parts of a highly sex specific syndrome of psychosomatic disturbances. Especially in this factor tendencies to dissimilarities of the male population segment should be effective. /268

The sixth factor includes chiefly symptoms of chronical tiredness. In addition, symptoms of cardiovascular disturbances as well as their frequent companion, anxiety, rate especially high. Chronic tiredness combined with cardiac arrhythmia are often symptoms of an organic or also psychogenic hypotonia.

As mentioned, negatively interpreted sound as stress factor can actually not be considered as an etiological factor of the worsening of a mental health state but as trigger of psychosomatic adaptations in the case of a corresponding psychological condition.

The connection between psychological predispositions which are socially as well as genetically caused and the stress factor as well as their effects on the state of mental health can therefore not be seen as mono-causative but as multi-conditional.

Table 6.18. Median scores of the mental health status 1) as well as their subdimensions in dependence on total noise exposure. /269

Total Noise Expos.	General Mental Health	Neurasth. Disposit.	Control Factor	Gastric Disturb.	Sleep Disturb.	Sex Specific Factor	Chronic Fatigue
≤ 20 (N=1059)	2.958	1.606	1.339	1.163	1.346	1.221	1.323
21 -39 (N=1534)	3.228	1.686	1.354	1.152	1.461	1.231	1.374
40 -59 (N=414)	3.897	1.917	1.454	1.171	1.564	1.307	1.532
F-Wert	14.081 $p < .001$	8.723 $p < .001$	4.714 $p < .001$	0.296 n.s.	13.104 $p < .001$	5.130 $p < .01$	12.014 $p < .01$

As seen in table 6.18. a highly significant statistical connection can be found between the general and mental health status as well as its subdimensions, with the exception of gastric disturbances.

1) Additive index of the symptoms frequency report in Table 6.17.
Low scores = higher mental health status
High scores = lower mental health status

Meanwhile socio-cultural units do not only intervene in the process of cognition but they are also directly contributing factors in the state of mental health. Several epidemiological studies show that especially the socio-economical status influences the mental health status 1). Lower socio-economical classes have, because of their low material and nonmaterial resources, also a decreased accessiblitily to efficient adaptative behavior strategies to stress which increases the probability to react to stress situation with dysfunctional (mis -) /270
adaptation. To a degree this fact is also true for the female segment of the population where societal role expectations limit the repertory of behavioral reactions. However, these sex specific role expectations can also lead to the mentioned aggravation or deaggravation results.

Table 6.19. confirms the connection between socio-economical levels 2) and mental health states also in populations of the random sample on which this study is based. The situations is intensified by the fact that lower social levels have more of a tendency towards deaggravation then higher social classes 3).

Table 6.19. Median scores of mental health states as well as their subdimensions in dependence on income.

Household Income	General Mental Health	Neurasthen. Disposit.	Control Factor	Gastric Problem gen	Sleep Disturb.	Sex Spec Factor	Chronic Fatigue
low (N=1422)	3.753	1.857	1.449	1.192	1.523	1.271	1.504
med. (N=1277)	2.832	1.565	1.307	1.127	1.362	1.212	1.287
high. (N=424)	2.746	1.519	1.267	1.163	1.333	1.206	1.275
	31.618 p< .001	18.378 p< .001	17.359 p< .001	6.6248 p< .001	15.281 p< .001	4.6083 p< .01	28.651 p< .001

Household income low = < Fr. 2'000.--
medium = Fr. 2'001.-- bis Fr. 3'500.--
high > Fr. 3'500.--

1) See especially the studies of Srole [74], Dunham [77], and **Hollingshead** [78].

2) As a raw group indicator serves income per household. Professional status and educational background as further relevant group indicators show a high correlation with income.

3) See Hollingshead [78].

The connection between sex and mental health is equally clearly confirmed (see table 6.20.). Within the interpretation of the extracted factors the sex specific factor consistently shows the greatest differences between the female and male population. It should be emphasized again that the sex specific differences can be explained (a) by socio-culterally determined differing accessibilities to external adaptation forms and thereby to higher probabilities of internal adaptation for the female population: (b) by the likewise socio-culturally determined deaggravation or dissimulation tendencies of the male, respectively aggravation tendencies of the female population. The latter however, is contradicted by the fact that the female population reports significantly less disturbance on the level of the evaluation of the disturbing effect of noise. /271

Table 6.20. Median scores of mental health status as well as its subdimensions in dependence of sex.

Sex	General Mental Health	Neurasth. Disposit.	Control Factor	Gastric Disturb.	Sleep Disturb.	Sex Specific Factor	Chronic Fatigue
male (N=1669)	2.563	1.521	1.265	1.150	1.310	1.097	1.252
female (N=1804)	3.849	1.848	1.453	1.168	1.550	1.370	1.496
F-val.	134.189 p<.001	48.323 p<.001	58.708 p<.001	1.307 n.s.	69.218 p<.001	248.73 p<.001	79.4 p<.001

Age is a further socio-demographic factor which directly influences the state of mental health. This is, on the one hand, based on biological conditions, on the other hand age is above all a social factor not a biological one. Here are especially the status inconcistencies and ambiguities important which are connected with the aging process 1). /272

Table 6.20a proved the connection between age status and status of mental health. It is interesting to note that the neurasthenic disposition, e.g. chiefly the psychological health, is age independent.

Table 6.20a. Median scores of mental health status as well as its subdimensions in dependence of age.

age	General Mental Health	Neurasthen. Disposit.	Control Factor	Gastric Problem	Sleep Disturb.	Sex Spec Factor	Chronic Fatigue
18 - 30 yrs (N=722)	2.835	1.657	1.203	1.122	1.344	1.247	1.274
31 - 50 y (N=1574)	3.031	1.669	1.300	1.158	1.391	1.230	1.324
51 y. up (N=1029)	3.827	1.750	1.576	1.189	1.568	1.246	1.537
F-val.	25.526 p<.001	0.9485 n.s.	74.341 p<.001	4.745 p<.01	19.3948 p<.001	0.202 n.s.	31.045 p<.001

1) In this context it is impossible to give a causality of social and socio-pychological determinations of the mental health status. These are interesting here only as far as they influence the empirical findings in regards to the connection between noise exposure and state of mental health as given in Table 6.18.

Since, as shown in section 5.2.3.1., the objective exposure to stress factors leads to an income and age selective disengagement processs in zones of high noise exposure the study had to control for age and income status in the effect of noise on mental health (sex status is distributed randomly over the three total noise exposure zones). /273

Table 6.21. Median scores, adjusted for the covariance of income and age, of status of mental health as well as its subdimensions in dependence on total noise exposure.

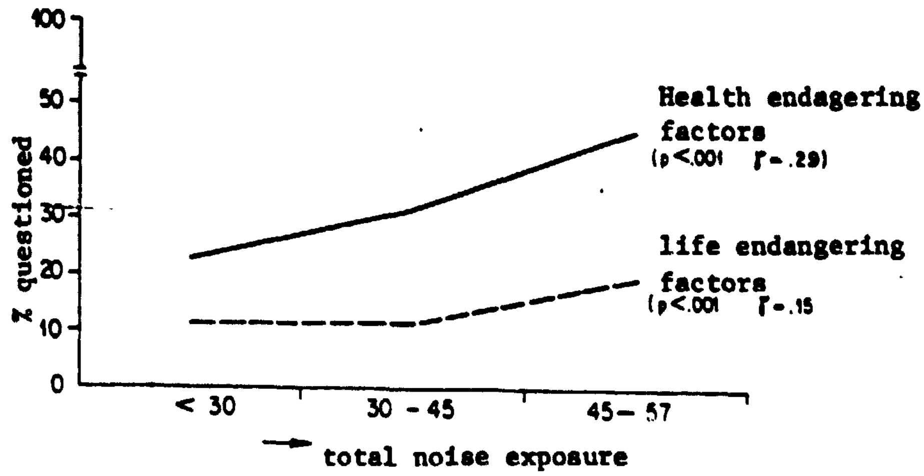
Total Noise Expos	General Mental Health	Neurasthen Disposit.	Gastric Disturb.	Control Factor	Sleep Disturb	Sex Specific Factor	Chronic Fatigue
<30 (N=1059)	3.094	1.617	1.309	1.208	1.374	1.211	1.386
31 - 45 (N=1534)	3.264	1.705	1.280	1.153	1.476	1.241	1.395
46 - 57 (N=414)	3.613	1.930	1.301	1.113	1.519	1.309	1.475
F-val.	1.150 n.s	2.506 n.s	0.034 n.s	1.1811 n.s	1.644 n.s	1.838 n.s	1.056 n.s

Table 6.21. gives the median scores, adjusted for the covariants of income and age, for the three total noise exposure zones 1). Although, with the exception of the control factors and the gastric disturbances, the trend of an increasing impairment of mental health in areas with increasing noise exposure is retained, the differences of the adjusted median scores are statistically not significant e.g. the connection between noise and mental health which is appearing in table 6.18. is essentially the result of a class selective disengagement in zones of high noise exposure. However, it should be mentioned, that the class specific deaggravation and dissimulation tendencies, which a survey can hardly control for, should only reinforce the above mentioned trend. To clear up this problem, however, further epidemiological studies would be necessary. /274

Fig. 6.22. proves that on other levels of the results of the subjective evaluation increasing total noise exposures threatens not only health but even life.

1) For covariance analysis see G.U. Snedecor et al. [79]

Figure 6.22. Percentage of those questioned who perceive health and life endangering factors in their living environment in dependence on total noise exposure. 1). (Total random sample N=3923)



6.2.3. The Relationship between External and Internal Reactions /275

Every adaptive behavior presupposes a target value. It is clear that the target value of the adaptation to a noise stress factor is to minimize the effect of this disturbance factor on the adapting system. The means of this regulation process are conscious actions on the one hand and pre- or subconscious reactions on the other. Conscious acting, however, always stands in relation to the social environment. Therefore it is inadequate to consider the individual adaptation to a physical stress factor as an isolated control process which is only relative to the individual level, e.g. the individual control system can only be considered as part of a comprehensive system: society. Not only are the exposure conditions to stress factors determined by society but also the material and non material resources as well as the cognitive factors which determine actions. This is the reason why adaptation to stress factors leads to more or less pervasive changes in the societal relationships of the micro or macro areas which are more or less desirable for certain segments of society and therefore represent potential sources of conflict.

1) Percentage of yes answers to the following questions:
- "If you think of your immediate surroundings, is there something that could influence the health of yourself of your family negatively"?
- "Is there possibly something which even could endanger the life you or your family"?

Because of this reality context of individual behavior a criterium for the evaluation of stress-factor adapting behavior patterns is simultaneously given, namely their far reaching and long term efficiency in the minimizing of the stress. Dominating goal value of such adaptation forms is a social principal of profits which is opposing the collectively experienced stress factor exposure by mobilization of political means. In contrast to the far reaching and long term effects of such adaptation forms are those, whose range of effectiveness is limited to the single individual. Dominating goal value of these adaptation methods is the maximizing of individual profit.

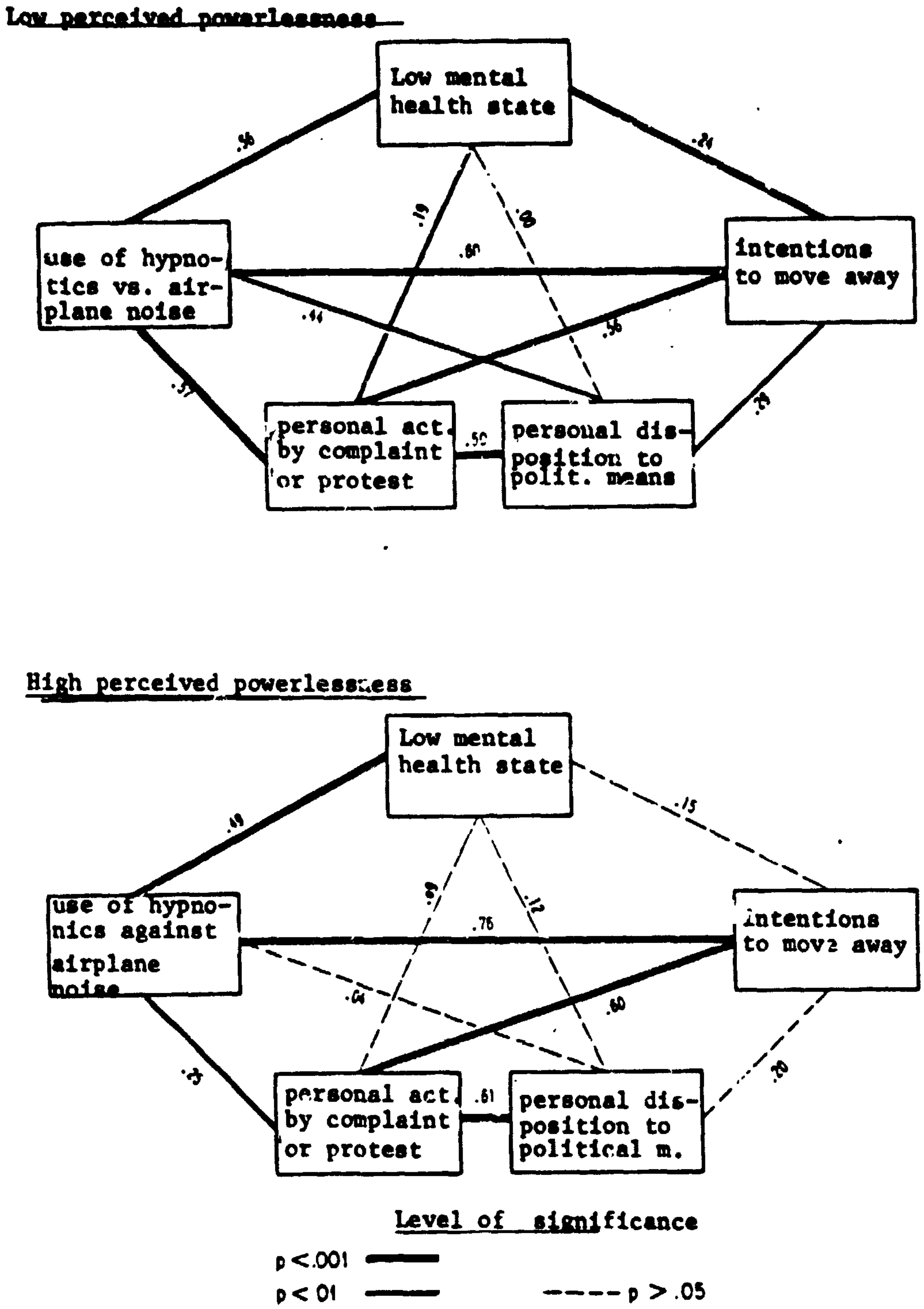
In comparison to the effect on the social and political environment in the case of these behavior patterns the area of cognitive reference is limited to individual aspects of stress exposure and the reaction to it. /276

Both of these external behavior catagories are associated with a third catagory which differs only by degree not by quality: Inner adaptations. These are not only inefficient and limited in there effectiveness but they also can damage nominal values of highest priority. This is especially true of intropunitive psychosomatic reactions.

The range of effectiveness of an adaption form coincides with the level of cognitive relationship for the individually controlled process of minimizing the disturbing factor. The more far reaching and long term the efficiency of an adaption form is the more include the cognitive references also social and political aspects of stress exposure. In the case of an internal adaptation such relationships are freqently missing completely. The inversion of the tension caused by external stress factors occurs mostly subconsciously. It has to be kept in mind, the less behavior patterns are sufficient for the criterium of far reaching and long term effectiveness the more limited is the cognitive relation of the individual control process and the less desirable are these to be considered. This makes it possible to divide behavior patterns into desirable and undesirable ones.

The resource aspect is closely tied to the degree of efficiency and awareness of adaptations, because material and non material resources determine the availability of efficient adaptation methods. This situation leads to the tendency to exclusion among types of behavior of differing efficiency and awareness degree, however, this exclusion relationship is not symmetrical, e.g. it is to be assumed that the change-over to a less efficient mode of action becomes more irreversible the higher the inversion level is found to be. The highest inversion step is intropunitive reaction which appears on the psychosomatic level.

Figure 6.23. **Pattern of interdependence of five adaptation forms towards airplane noise with high or low perceived powerlessness against the political system. (Those questioned were disturbed by airplane noise.)**



The differing objective access to efficient modes of behavior is dependent on differentially distributed resources. This is reflected in the awareness of the individual and is accumulated as a degree of perceived powerlessness. This powerlessness, e.g. the experience of ones inability to efficiently influence the environment by political means, represents one of the essential experience factors which under other factors, as for instance the personality disposition are able to trigger or accelerate the inversion mechanism. /277

In correlation with the inversion mechanism the conflict is shifted from the socio-political level to the lower level of the environment, namely that of the social micro area or the individual himself. 1) Therefore it can be expected,

- that with increasing definition of the perceived powerlessness the exclusivity relationship between efficient and inefficient behavior can be observed increasingly because the triggering of the inversion mechanism by this experience factor is accellerated and at th^ same time becomes more irreversible with increasing inversion levels.

Fig. 6.23. shows that the perceived powerlessness against the political system 2) functions as discrimination and /279

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1) Lack of conflict for instance on the political level in a society does not simply mean the absence of conflict per se but can be an indicator for the shifting or the inversion of conflict potentials to group, individual, or intra individual levels.

2) The following two attitude items proved to be relatively independent elements of dimensicns of generally perceived powerlessness against the political system in the cluster analysis. Therefore they were included as only elements in the additive index, despite there limited number:

- "Switzerland too is actually ruled by a few powerful people and the average citizen can not change much .
- It doesn't make much sense to address the authorities because they are hardly interested in the problems of the average citizens".

exclusion 1) relationship between efficient and inefficient reactions.

With a low degree of perceived powerlessness against political institutions the only relatively exclusive relationship is between the most efficient reaction, the readiness for political articulation and the most inefficient reaction, the reduced state of mental health. The other behavior choices form a cluster of positively interacting relationships, e.g. they are in a mutual inclusion.

With a high degree of perceived powerlessness, by comparison, the most inefficient reaction is a lowered state of mental health, which is only inclusively interrelated with its effects on the person - consumption of hypnotics. Between the polarized adaptations, according to the mentioned efficiency criteria, the intra individual psychosomatic reaction on the one side and the political reaction on the other, control the rest of the external behavior modi.

The individual complaint or protest behavior is inclusively interrelated with the readiness for collective political articulation, with the disengagement position from the stress field action method: consumption of hypnotics. There is a relatively exclusive relationship between the intention to withdraw from the stress field and the intra individual psychosomatic reaction as well as the readiness for political articulation. Contrarily the manipulation of the own person, consumption of hypnotics is only exclusively interrelated with the political articulation readiness. /280

Despite the limitations of the methods of measurement and evaluation it can be deduced that the theoretically postulated ranking of more inefficient adaptations, like psychosomatic reactions, individual external modes of behavior, such as consumption of hypnotics, intentions to withdraw from the field of stress and in more efficient adaptations, such as complaints or protest behaviors and collective political articulation readiness are also empirically supported. That means that the sequence of the mentioned behavior modi represents steps of inversion, dependent on the perceived powerlessness against the political system and other factors to react to stress causing activations.

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1) The interrelation between the five adaptation forms are as well within the same cluster as among several clusters only qualitatively comparable. Criterium for exclusive interrelated adaptations is the significance above the 5% level in the X^2 Test. The criterium for gradually differing inclusively interrelated adaptation is the significance level of p smaller than .05, p smaller than .01 and p smaller and .001 in the X^2 Test. Likewise the gamma coefficients of the relationship based on different frequencies and distributions is only conditionally comparable.

The study shows that the objective relationship of individuals and collectives towards the political system is a correlation of their social class. Lower social classes show negative experiences in the interaction relationship with political institutions and this is reflected subjectively as a general or specific form of inability to achieve interests or goals by political means 1). This objectively conditioned political alienation which is stored in the awareness of powerlessness can transfer class differential inversion /281
tendencies, e.g. lower social classes tend to regress from the political environment because of their higher perceived powerlessness and therefore transfer the adaptation into less effective individual or intra-individual areas.

Table 6.24. confirms that the factor of experienced and accumulated powerlessness against the political system is more strongly interrelated with the intra-individual psychosomatic reaction then it is the case in higher income strata.

Table 6.24. Mental state of health depending on the perceived powerlessness against the political system for 2 income classes (in percent of those questioned).

State of mental health	low income		high income	
	perceived powerlessness against the political system		perceived powerlessness against the political system	
	low	high	low	high
low	34.3	45.9	22.0	30.8
medium	27.0	24.9	32.2	33.4
high	41.7	29.2	45.8	35.8
	(725)	(527)	(114)	(452)
	$x^2=30.6$	$p<$ [illegible] $\gamma=.25$	$x^2=17.6$	$p<.001$ $\gamma=.12$

1) The perceived powerlessness against the political system is negatively associated to a highly significant

degree with the level of income (X^2 = 65.9 p less than .001 Gamma = .26 N = 3227) as well as with the educational

level X^2 = 61.8 p less than .001 Gamma = .31 N=3591

Even if the results are controlled for powerlessness against the political system a significantly higher number of those questioned who belonged to lower income strata show lower scores in the field of mental health. Independent of the experience factor of powerlessness the class differentially distributed resources, for instance income, education, work conditions, also have an effect as inversion factors, e.g. not only in the extent of stress exposure but also in the objective and subjective possibility to react efficiently, are distributed class differentially. /282

IV SUMMARY AND FINAL CONCLUSIONS /283

IV Summary and Final Conclusions

worked out by the Study Group for Socio-Psychological Airplane Noise Research on the basis of the scientific final report and the experiences of the group (I) of experts of airplane noise exposure in the areas of the airport Basel-Mulhausen, Geneva-Cointrin, and Zurich-Kloten on July 31, 1969.

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1 Study Plan and Methods /285

In the areas surrounding the three civil airports Zurich, Basel and Geneva the extent of airplane noise emission and its effect on the population was studied during 1971/72. In the area of Basel studies of traffic noise emissions and their effect were studied simultaneously.

The whole project was conducted according to the following Plan:

- Noise curves for 30, 40, and 50 NNI*) established for the three airports and presented in the form of "noise maps". The calculations were based on information obtained from the airport administration concerning flight movements of commercial air traffic during five days in summer in 1969. The average noise peaks of the individual airplane types were taken from a technical report of Bolt, Beranck, and Newman, Inc. (81)

- The Selection of the households to be surveyed was done according to a random sample process for each established noise zone around the three airports.

  For each noise zone we got the following results:

Less than 30 NNI	1213
30 to 39 NNI	1094
40 to 49 NNI	1143
50 NNI and more	654
Total	4104

After the conclusion of the survey the following number of questionnares per airplane zone could finally be evaluated: /286

Zurich	1471
Geneva	1524
Basel	944
Total evaluated questionnaires	3939

The group with less than 30 NNI served as a control group: It was selected from communities outside of the airplane regions. These communities were comparable to those in the airplane regions in respect to job structure, number of inhabitants, tax yield, population increase and distance to metropolitan areas.

The socio-economical characteristics of those questioned: sex, age, family status education, income, profession, number of children, length of residence and state of homeownership (showed comparable conditions for the three airports and for each of the noise zones.

*) NNI = Noise and Number Index = Measurement of noise exposure which is based on the numerical value of the average noise peaks as well as the number of airplane movements in a certain time period.

- The noise was measured in each airport area at 87-142 measurement locations. The choice of points of measurement was such that the measured noise was representative for groups that averaged from 5 (Basel) to 14 households (Zurich).

  Traffic noise which was surveyed equally was only representative enough for a study of street noise situations in Basel. The traffic noise for the region of Basel was measured at 182 locations.

- The noise measurements were executed continually during 24 hours and during a whole week. Frequently these measurements were supplemented by short time measurements of 20 minutes each.

  The values obtained for airplane noise peaks and the median freqency of airplane movements were the basis for the calculations of yearly averages of NNI values for daytime. (6:00am to 10:00 pm) and for nighttime (10:00pm to 6:00am). Unless stated otherwise the daytime -NNI values always refer to the period between 6:00 am and 10:00 pm. /287

  The following noise exposure measures were determined from the registered sound level frequency distributions

  Some Frequency Level L_{99}, L_{50}, L_1 and $L_{0,1}$

  Equivalent Continuous Sound L_{eq}

  Noise Pollution Level L_{NP}

  Traffic Noise Index TNI

- One Questionnaire was developed , which was based on a number of sociological hypotheses and did agree extensively with a questionnaire that was recommended by the O.E.C.D.

  Two pretests were conducted chiefly to establish the useability of the French and Italian translations.

  In a written announcement the selected subjects of the survey were alerted. The test was explained as concerning environmental problems. References to noise questions were therefore avoided.

  The interviewers considered the majority of those interviewed as having a "lively interest" and as being "completely honest"

- The execution of the interviews was turned over to a private market testing institute. The interviews occured in Zurich and Geneva in May 1971 and in Basel in June 1972.

2 Results of Noise Measurements /288

The comparison between the previously calculated noise zones with the actually measured noise emissions showed characteristic deviations: Near airports the measured noise values were partially lower than those calculated. With increasing distance from the airport, however, higher values than those originally calculated were often noted. The consequence was that the calculated curves agreed well with the measured noise curves near the runways. The measured noise zones, however, are wider at a certain distance from the runways.

The following reasons are chiefly responsible for these deviations: firstly, the muffling affect of airplane noise due to proximity to the ground near runways is more effective than expected secondly, deviations of actual flight paths from the prescribed routes are greater with increasing distance from the runways.

The noise zones established by noise measurements are contained in chapter 3 in the form of noise maps for each of the three airports in fig. 3.30.-31.-32.

Mention is made of special results in the region Basel: Here noise exposure only reached values of 40 NNI. This was caused by the low number of flights as well as the special location of the airport which is in considerable distance to the city of Basel on French territory. Around the airports of Geneva and Zurich airplane noise reached values of more than 60 NNI respectively 50-60 NNI in residential areas.

3 Disturbance by airplane and traffic noise /289

The disturbance discussed in this chapter is one that is considered "perceived disturbance" in the form of self-evaluation which was obtained by a direct question. The subjects were asked to evaluate the degree of disturbance on a thermometer scale from 0-10, depending on their subjective impression. The indicators 0 respectively 10, were labeled: "no disturbance at all" respectively "unbearable disturbance".

Further explanations as to the meaning of the in between steps on the scale was omitted to avoid influences during the translation. For purposes of comparison with other results the in between steps were later grouped and labeled:

Step 1	No disturbance
Step 1 to 3	Little disturbance
Step 4 to 7	Medium disturbance
Step 8 to 10	Strong disturbance

31 Disturbance by airplane noise

In a rough approximation it can be stated that the airplane noise around the three airports caused the following average degrees of disturbance:

Below 35 NNI*	little noise exposure
34-45 NNI	Medium noise exposure
Above 45 NNI	Extensive noise exposure

These, however, are only roughly estimated average values. There were in fact many people in this zone of medium noise exposure (34-35 NNI) who considered this noise emission as a strong disturbance and, vice versa, also such who considered the effect of the same amount of noise as a minor disturbance. /290

In the test areas of Zurich and Geneva the distribution of the subjects with a strong disturbance (as summation value) was as follows: 25% were below 43 NNI, 50% perceived a strong disturbance at 45 NNI, in Zurich respectively 51 NNI in Geneva.

That means that airplane noise around 43 NNI represents a critical area above which the frequency of "strong disturbance" steeply increases.

More details are given in the scientific concluding report in chapter 4 in fig. 4.5. and 4.8..

32 Disturbances by street traffic noise

Only in Basel was it possible to study the extent of disturbance by traffic noise. Previous analyses of noise values have shown that the sum frequency level of L_{50}* was hardly influenced by airplane noise and nearly exclusively dependent on street traffic. dB(A) showed the greatest relationship with self-evaluated disturbances ($r_{ind.}$ = 0.43). Consequently this measure was used for the characterization of traffic noise.

Table 1 combines the information about medium and strong disturbances by traffic noise in the area of Basel.

*) If not otherwise mentioned the noise exposures refer always to the times between 6:00 am and 10:00 pm

Table 1 /291

Percentage of those interviewed in the area of Basel who reported medium or strong disturbance by traffic noise. Number of interviewed per noise zone = 100%.

Noise Zone = 100%

noise zone L_{50} (0600 - 2200) dB(A)	N	medium disturbance % steps 4 - 7	strong disturbance % steps 8-10
44 - 47,9	59	16,9	5,1
48 - 51,9	293	27,6	2,4
52 - 55,9	333	27,3	4,8
56 - 59,9	114	55,3	12,3
60 - 63,9	86	55,8	19,8
over 64	60	58,3	23,3

Table 1

Disturbance by traffic noise increased in a range around L_{50} = 56 dB (A) clearly. In the range of 60 - 64- dB (A) approximately 20% of those interviewed felt strongly disturbed.

By considering the average values of disturbances the following relationships become clear:

Below L_{50} = 55 dB(A) little disturbance

L_{50} = 55 to 70 dB(A) medium disturbance

Also in the case of traffic noise the individual results showed a considerable scatter. For instance the noise range L_{50} = 52 to 55.9 dB(A) showed the following rank order:

No disturbance	14.1 %	/292
Little disturbance	53.8 %	
Medium disturbance	27.3 %	
Strong disturbance	4.8 %	

The range of L_{50} = 60 to 63.9 dB(A), which nowadays is frequently considered the critical borderline for traffic noise during the day showed the following distribution:

No disturbance	2.3 %
Little disturbance	22.1 %
Medium disturbance	55.8 %
Strong disturbance	19.8 %

Further details about disturbances by traffic noise can be seen in fig. 4.17. and in chapters 4.4. and 4.5. of the scientific final report.

4 Suitability of noise exposure measures

41 Noise exposure measures and disturbances

A noise exposure measure is the more suitable the better it agrees with the effects on man or, to put i. another way, the closer the relationship between noise measure and effect. The agreement is usually judged by calculating a correlation coefficient*.

Table 2 shows the calculated correlation coefficients between the self-evaluated disturbance and the four different noise exposure measures.

Table 2 /293

Correlation coefficient r, which indicates the relationship between the individual values of disturbance and four noise exposure measures. N = number of individuals values.

Noise Exposure Measurements	airport area		
	Zurich 1471	Geneva 1524	Basel 944
Noise and Number Index (NNI)	0,53	0,68	0,53
Noise Pollution Level (L_{NP})	0,44	0,27	0,16
Equivalent contin.sound level (L_{eq})	0,46	0,30	0,13
Sum-frequency level ($L_{0,1}$)	0,45	0,35	0,25

The values in the table show that the NNI represents the best correlation between individual values of self-evaluated disturbance. (the differences between NNI and the other three measures are significant). Of the four tested measures of airplane noise the NNI represents the most appropriate measure.

Considerably higher correlations were calculated by replacing the individual values with averages of groups in similar noise zones. For these correlation coefficients, we obtained between NNI and average disturbance the value

$$r_m = 0.914$$

* In case of a complete agreement between two measures the correlation coefficient has the value 1.0. Values of 0.8 and 0.9 are considered as a very good correlation.

Table 2 also shows that the agreement between airplane noise and disturbance in the three airport areas was different. This was especially true with the measures L_{eq} and L_{NP} which evaluated airplane noise as well as traffic noise. There are good reasons to assume that the traffic noise which is different in the three airport areas had a strong influence on the evaluation of the disturbance by airplane noise. /294

42 Weighting of the Number of Over-Flights in the NNI Formula

As fig. 4.5. in the scientific final report shows the average values of the self-evaluated disturbances were higher in the region of Basel in every noise zone than in the other 2 airport areas. Or, in other words: with equal evaluation of disturbance in Basel a NNI value was approximately 5 to 10 units lower than in the other 2 areas.

Since political or social reasons for this deviation in the region of Basel could not be found the problem of their weighting of the number of over-flights in the formula of the NNI exposure measure came up again. In fact, the number of over-flights in the area of Basel was considerably less than in the other 2 areas. This situation led to a multiple regression analysis which shows that the values of Basel fit well into those of Zurich and Geneva if less weight is given to airplane movements. As fig. 4.32. the final report shows, the application of a correspondingly corrected NNI formula* showed a closer relationship and a better agreement with the average values of the self-evaluated disturbance in all three airport areas. This finding agrees well with the French study (82) and with the second survey in the surrounding areas of the airport of Heathrow near London (83). In both surveys /295 a reduced weighting of airplane movements resulted in a better correlation with the disturbance.

The corrected NNI formula is not intended to presage the future. Rather, it is our opinion that further similar studies are necessary to optimize the weighting of the airplane movement for the NNI formula and to hopefully arrive at an internationally acceptable measure.

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*) $NNI = L_{PN} + 15 \log N - 80$

$NNI_{cor} = L_{PN} + 6.6 \log N - 69$

L_{PN} = Medium peak noise in PNdB

N = Number of flight events during the time under consideration.

5 Effects of Flight and Traffic Noise on Leisure Time Activities

51 Effects of Airplane Noise

It was attempted with appropriate questions to survey those disturbing effects which are determinants of the leisure time in a residential area. The analysis of the answers showed that the following statements increased significantly with increasing airplane noise exposure:

- Disturbance of conversation
- Disturbance during T.V. watching and radio listening
- Disturbance by vibration of the house
- Disturbance during recreation
- Disturbance during sleep
- Distubances by being startled
- Distubances during work.

Although the frequencies of the answers deviated from each other in the three airport areas they allowed the following conclusions:

- The strongest increase of disturbances occured above 45 NNI. /296

- Approximately 25% of those questioned mentioned already below 40 NNI "Very often" or "Quite often" disturbances of conversations and in the participation in television and radio.

- Approximately 25% reported "very frequent" or "quite frequent" disturbances of sleep or recreation in a range between 45 and 50 NNI.

- Although the functions of communication (conversation, T.V., radio) were clearly mentioned most often the reports of disturbances of sleep and recreation had a greater importance. This becomes obvious if these reports of self-evaluated disturbances are juxtaposed on the scalometer: those subjects who reported disturbances of sleep and recreation generally showed a higher degree of disturbance in the self-evaluation process then those who mentioned the disturbance of communicative functions (conversation, T.V., radio).

For further details see the fig. 4.98. and 4.11. in the scientific final report.

52 Effects of Street Traffic Noise

The analysis of 944 answers from the area of Basel made it obvious that the report of disturbel leisure time activity increased significantly with the increase of the exposure to street noise (expressed in the sum freqency level L_{50}).

A noticeable increase in reports of disturbed activities occured above the range of L_{50} = 52 to 56 dB(A). "Very often" or "quite often" disturbances of sleep and recreation were reported by more than 25% of those questioned in the noise range of L_{50} = 60 to 64 dB(A) of more that 25% of those questioned were mentioned. /297

6 Spontaneous Reaction to Airplane and Street Noise

At the beginning of the interview, before noise questions were asked, an open question was asked to explore the obvious disadvantages and disturbances in the environment of a home. These answers can be considered as relatively spontaneous reactions.

Far more than half of those questioned agreed to the questions about disturbances in the environment. If asked for the causes of the disturbances the following were mentioned most often: Airplane noise or airplanes, traffic noise or traffic, traffic and other emissions, deficiencies in the infrastructure and environmental arrangement of social factors. The analysis of those results made it clear that the percentage of the spontaneous mentioning of "airplane noise or airplanes" increased with increasing airplane noise. In an analogous way the spontaneous mentioning of "traffic noise or traffic" increased also with increasing traffic noise. In table 3 parts of these results are shown.

Table 3

Spontaneous Reports in Geneva and Basel about Causes and Disturbances in the Environment in Dependence on Noise Exposure /298

N = 100% = Number of those questioned who reported a disturbance in the environment.

Noise zone NNI	N	airplane noise Geneva %	noise zone L_{50} dB(A)	N	street traffic noise Basel %
<30	118	1,1	44 - 48	40	14,6
30 - 34	112	19,6	49 - 52	157	10,2
35 - 39	72	18,1	53 - 56	184	9,8
40 - 44	119	49 6	57 - 60	60	33,3
45 - 49	80	52,6	61 - 64	52	34,6
50 - 54	106	72,6	65 - 72	42	52,4
55 - 59	83	79,0			
>60	60	88,3			

A further analysis of spontaneous reports of the causes of disturbances the following connection between airplane noise and traffic noise is obvious: with equal airplane noise exposure the freqency of the report "airplane noise" decreased with increasing traffic noise. It can be concluded that the surrounding noise influenced the disturbing effect of airplane noise: the more quiet the surrounding was the more disturbing was the airplane noise and vice versa. For more details see fig. 4.25. in the scientific final report.

7 Noise, Behavior, Well-Being, and Satisfaction with Living Quarters /299

71 Effects on the Well-Being

A number of questions concern themselves with forms of behavior and habits. If the answers were compared with the corresponding noise exposures the results were interesting. With increasing airplane noise exposure the following increased significantly:

- Use of ear protection
- Consumption of sleep or tranquilizing medications
- Frequency of medical consultation
- Consideration of moving away
- Staying away from home
- Less time spent outside
- Closing of windows
- Actions to improve sound insulation

From the medical point of view the dependence on sleep and tranquilizing medications because of airplane noise is especially important. The percentage of reports is distributed as follows:

Lower or no airplane noise (less than 35 NNI)	2.3 %
Medium airplane noise (35-44 NNI)	3.7 %
High airplane noise (45 NNI and more)	9.3 %

This effect of airplane noise on the consumption of sleeping and tranquilizing medications has to be considered as a serious threat to health.

The disturbing effect of airplane noise on the night rest was also obvious from other answers and especially from the self-evaluation of sleep disturbances which were likewise converted into a scale.

An increase in sleep disturbances was already noticeable in values above 25 NNI (night value). /300

Further, the answers to "chiefly disturbed in the evening" or "chiefly disturbed during the night" in regions with 10% night flight traffic became considerably more frequent (43 and 41 %) then in regions with only 1% night flight traffic (23% 7%).

In regard to residential hygiene the influence of airplane noise on the closing of windows and staying outside is also important. Above 45 NNI, 30-54% of those questioned closed the windows and 15-35% mentioned that they stay less outside because of airplane noise.

Part of a desirable living arrangement is certainly the airing by opening the window and by staying outside (on the balcony, in the garden or in the immediate surroundings). A disturbance of this lifestyle has to be considered as a undesirable limitation of the hygienic values of the residence.

72 Effects on the Satisfaction of the Living Arrangement

Some questions in the beginning of the interview were refering to the satisfaction with the living arrangement. Statistical analysis showed a significant decrease in the satisfaction with increasing airplane noise as well as with increasing traffic noise.

Just as distinct as a decrease of one's own satisfaction was the evaluation by others. This was obtained by questions about the judgment of chance visitors concerning the living environment.

The thorough analysis of evaluation of the living environment /301 with a bipolar test process* showed that those questioned, who were exposed to high noise levels, had a low but still significant tendency to also evaluate other physical circumstances of their living environment (for instance smells).

In addition it was clear that high noise exposure also led to transfers of negative evaluations of social properties of the environment.

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*) In bipolar test processes the interviewed are asked to rank themselves subjectively among words of contrary meaning, for instance between noisy and quiet, foreign and familiar, dirty and clean and so forth.

73 Effect on The Readiness To React To Noise

A number of special questions lead to a significant increase in the frequency of the following answers with increasing airplane noise exposures:

- "More should be done against airplane noise"
- "They would support measures against airplane noise"
- "Have complained about airplane noise".

The following were chiefly held responsible for the lack of noise abatement: administrations of communities, cantons or federation as well as insufficiently developed technology. It was interesting to note the increase in reference to insufficient technology with a concurrent decrease of the mentioning of "bureaucracies". Sociologists interpret this result as follows: With increasing noise exposure the degree of subjectively experienced powerlessness increases which leads to an increased perception of the cause in technological areas.

8 Airplane Noise and Psychosomatic Symptoms*) /302

The present study was, among others, also concerned with the questions whether there are relationships between airplane noise exposure and the occurrence of psychosomatic illnesses. For this purpose the questionnaire contained 29 questions for psychosomatic symptoms (heart rhythm disturbances, difficulties with digestion, nervousness, diaphoresis, tiredness and attacts of weakness, etc). The material was subjected to factor analysis which showed that all 29 symptoms could be coordinated with the main factor.

The analysis of the relation of these factors to airplane noise showed that "the psychological state of health" showed no directly assured relation to ai 'ane noise exposure if the test was controlled for age and ome status.

Even though the present analysis was not exhaustive, social or other factors could, for instance, mask obvious influences), it can be said with assuredness that airplane noise does not show an essential influence on the development on psychosomatic disturbances.

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*) Psychosomatic symptoms are to be understood as disturbances of health which have their causes chiefly in psychological conflicts. Frequent symptoms are disturbances of heart rhythm and digestion, headaches, nervousness 's well as tiredness and feelings of weakness. In serious cases stomach ulcers, asthma, or skin eruptions can develop.

This will not be very suprising to the physician since individual psychological conflicts are an essential cause of psychosomatic disturbances. /303

9 Analysis of Noise Sensitivity

Based on the self evaluated disturbance and the airplane noise exposure the distribution of the noise sensitivity of the whole sample group of 3939 subjects was constructed. This distribution permitted a grouping in hypo-reactive (little noise sensitive), normal reactive and hyper-reactive (excessively noise sensitive) people. In the next step it was tested which interviewees were represented in the group of hyper-reactive persons disproportionately often. Let us summarize some of the results here.

The following people were represented most frequently among the less noise sensitive (hyporeactive) persons.

- Women
- Young subjects (18-30 years)
- Persons with a short duration of residence
- Single and divorced people (greater possibility to withdraw)?
- Persons who consider their apartment well sound-insulated.
- Persons who have a positive association with airplanes and air traffic.
- Persons with a great amount of flight experience (more than 10 times).
- Persons with a professional connection to the airport.

- Among the excessively noise sensitive (hyper-reactive) subjects: The following interviewees were represented in these proportions: /304

- People with a negative attitude towards technology or those with less cosmopolitan thoughts.
- Persons who claimed to be more disturbed today than a year ago (power of explanation).
- Persons who are very much afraid of airplane disasters (power of explanation 4%).
- Persons who believe that they have to pay the cost while the Canton, Switzerland, or foreign countries profit from air traffic.

It must be kept in mind that, with two exceptions, all influences mentioned had only a slight effect. In every case they represented less than a 1% changability of noise sensitivity. The two exceptions were "fear of disasters" and the statement "Noise has increased during the last year". These reached 4% of the changeability in sensitivity to noise.

It is interesting, that the <u>following factors did not show any significant influences on noise sensitivity:</u> /305
income, professions, education, single or multi-family dwellings, objective population density and, among the personality traits: the extent of extroversion.

10 Adjustment to Airplane Noise

Daily experience shows that man can get used to certain noises under specific conditions. The question seems justified whether it is possible to get used to airplane noise.

Research shows that people with excessive noise sensitivity were more frequently represented in the group of subjects with a long time of residence. (The factor of "length of residence" was effective independently from the factor "age" and considerably more effective than the latter). This leads to the conclusion that the number of excessively noise-sensitive people increases with the increase of length of residence. This explains the assumption that people can get used to airplane noise in time.

During the interview the subjects had to report whether they can get used to airplane noise. Approximately 2/3 agreed and 1/3 disagreed. While the extent or airplane noise exposure did not influence the distribution of these answers, length of residence showed the following influence:

- After length of residence of less than 6 months 16% of the subjects disagreed with the possibility of getting used to airplane noise.
- With the length of residence of 10 years and more 30% disagreed with the same possibility.

Those results confirm the conclusion already mentioned above that sensitivity to airplane noise increases with the duration noise of exposure.

11 Noise and Living Conditions /306

It is known that unfavorable environmental conditions lead to lowering of rents and to a social disengagement "combined with an increase of the low social classes" and an extreme cases to the development of slums. In the present study the question was tested whether the observed noise conditions show effects of this type.

Especially in the case of traffic noise an increase of noise exposure among the subjects was accompanied by a decrease in income and a strong decrease in home ownership.

Table 4 shows that there was also a smaller percentage of income used for rent with an increasing exposure to airplane noise.

Table 4

Relationship of Rent to Income quiet and Noisy Areas
Quotient: Income/rent based on ranking. High quotients mean relatively low rents, low quotients mean relatively high rents.
N = Number of those questioned.

airplane noise in NNI	N	Quotient	traffic noise L_{50} in dB(A)	N	Quotient
< 15	284	1,5	40 - 47	306	1,4
15 - 29	445	1,5	48 - 55	1457	1,3
30 - 44	1116	1,4	56 - 63	572	1,4
45 - 59	629	1,3	64 - 72	154	1,6

The same effects were not recognizable in the case of airplane noise. It has to be assumed that airplane noise expositions did only increase to today's extent in the last 10 years and therefore has so far not lead to a disengagement of inhabitants. Besides, airplane noise areas are suburban regions which provide a location in a natural environment and thereby provide, at least presently, an incentive to urban dwellers who leave the city. /307

12 Comparison Between Airplane Noise and Traffice Noise

121 Self Ranked Disturbances

It should be mentioned right away that the two exposure measures NNI and L_{50} cannot be compared in physical respects.

Therefore it is necessary to conduct comparisons based on the effect on people.

Table 5 is a juxtaposition of equal scale values of self-evaluated disturbances with corresponding values for traffic noise and airplane noise. This makes it obvious that both noise measure scales do not run parallel in respect to the disturbance.

Table 5

Self Ranked Disturbances of Street Noise and Airplane Noise

selfevaluated rank values	L_{50} in dB(A)	NNI
2	47	14
5	62	38
8	77	60

122 Effects on Leisure Time Activities /308

In comparison to the disturbance of leisure time activities there is a distinct difference in areas of higher noise exposure: in the case of airplane noise reports of disturbances of communication (conversation, T.V., radio) predominate. In the case of traffic noise, however, reports of disturbances of sleep and recreation are clearly always the first among disturbed activities. This may be due impart to the fact of nocturnal noise emissions that are of differing strengths but partially also to the different character of the two noise sources. The passing of an airplane is of considerably longer duration than the passing of a car. Therefore the understanding of sentences in a conversation is considerably more affected by airplane noise even with equally loud noise peaks.

123 Evaluation of the Evironment

Comparison of spontaneous information about the causes of disturbances through the environment was interesting.

The statement "airplane noise is the cause of the disturbance" increased steeply and nearly in a straight line with the NNI values. In a similar way the statement "traffic noise is the cause of the disturbence" increased in relation to L_{50} values.

We can clearly state that approximately 50% of those interviewed gave causes for disturbances through the environment as follows

- at 45-49 NNI airplane noise
- at L_{50} equals 65-72 dB(A) the traffic noise.

All these considerations indicate that a comparison between the effects of airplane noise with those of traffic noise are difficult. Relatively enlightening is the comparison of the two noise scales if self-ranked disturbances are used as a common denominator. Here it shows that with increasing noise /309 levels the difference between NNI and L_{50} decreases considerably.

13 Comparisons With Foreign Test Results

Comparisons with similar studies in other countries are interesting but they are not possible without limitations since all of the conditions are never strictly comparable. Nevertheless, some of our results should be compared with those from foreign sources.

The degree of disturbance by airplane noise in foreign studies was established by the addition of reports over disturbed activites (Conversation, sleep, T.V., and so forth). For this purpose an index value of disturbances was calculated with a special process based on Guttman. To make a comparison possible we calculated index values for the disturbance of Geneva and Zurich with the same process. Fig. 1 and Table 6 compare our index values with those of foreign studies.

Figure 1 Average value of disturbance (Guttman Process) in France (82), England (86), Holland (84), and Switzerland. All foreign values are taken from compilation by Alexandre (85). /310

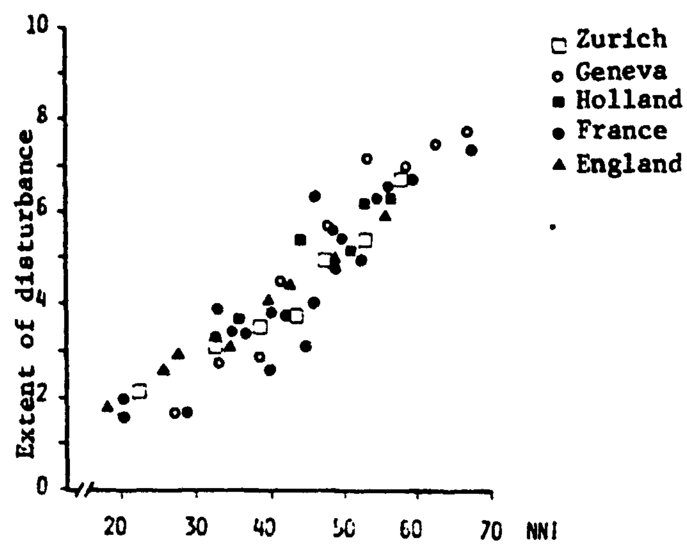

Table 6
Average Values of Disturbances for Varying Zones of Airplane Noise. 10 equals maximum disturbance 0 equals no disturbance.

Airplane Noise rng. NNI	France (Orly, Bourget, Lyon, Marseille)	Holland (Schiphol)	England (Heathrow 1963)		
31 - 40	2,5 - 3,8	3,6 - 3,9	3,0 - 4,0	3,3	2,8
41 - 50	3,0 - 6,2	5,3	4,4 - 5,0	4,3	4,9
51 - 60	5,0 - 6,7	5,1 - 6,3	5,9	5,3	7,0

Generally the disturbance by airplane noise test zones shows a certain agreement. Especially the increase of disturbance dependent on NNI values is almost the same in all test results. /311

Direct questions about disturbed leisure time activities were asked in the English, French, and Swiss studies in a comparable way. Table 7 compiles the percentage of reports of disturbed activites *) in a noise zone from 47-52 NNI respectively a corresponding index value of R-84 to R-85.

Table 7

Disturbed Leisure Time Activities In the French, English and Swiss study on Airplane Noise. The percentages are based on the number of answers "occasionally to very often disturbed".

Type of Disturbance	Persons with disturbed leisure activities		
	France at 84-89 R % %	England at 47-52 NNI % %	Switzerland at 47-52 NNI % %
being startled	29	59	51
sleep	20	47	45
waking up at night	37	64	45
quiet and recreation	50	44	57
radio and T.V.	75	76	68
vibrations	69	75	60
conversation	61	73	71

*) All answers between "occasionally to very frequently disturbed" were considered.

Disturbances of communicative functions (conversation, television, and radio) as well as information of vibration and disturbances of rest and recreation agree in the three compared studies quite well. In first approximation it can be said that in each of the three studies in a noise range of 50 NNI approximately 50-70% of the exposed population felt disturbed in conversation. /312

Certain deviations are found in the questions concerning sleep disturbance. We assume that differing conditions in night air traffic are responsible for those deviations.

14 Threshold Values For Airplane Noise

In the enclosed expert report on airplane noise exposure of July 31, 1969 the authors (Prof. K. Battig, Dr. A. Gilgen, Dipl.-Ing. J.R. Hediger and Prof. A. Lauber) also recommended provisory threshold values. Those recommendations were established on the basis of foreign surveys. They were supposed to have temporary character until the Swiss results of the effects of airplane noise would create a new basis for the evaluation of these questions. In this chapter the threshold values which were then suggested will be critically analyzed in the light of the present study. Only conditions for residential areas were taken into consideration since airplane noise studies gave very few indications for their usefulness in other areas.

141 Recommended Threshold Values of 1969 /313

The mentioned group of experts came to the conclusion that two situations have to be kept separate in the establishment of separate threshold values:

- The Situation in Already Developed Residential Areas. Here it is important to determine the limit of excessive disturbance. The criterion is the threshold at which a majority of the population shows a considerable effect on their well being.

- The Situation for as yet Undeveloped Areas. Here the threshold values have to be established for regional planning around airports. Decisive are those thresholds below which little or medium noise exposure with hardly provable or only limited noise exposure could be guaranteed. For further details see the report of July 31, 1969 pages 11-25.

Tables 8 and 9 show these temporary recommendations of July 31, 1969 again.

Table 8 /314

Threshold values of excessive disturbance by airplane noise. temporary recommendations of July 31, 1969. NNI-Values between 6:00 am and 10:00 pm 5 NNI have to be deducted for buildings with little sound proofing. For buildings with increased sound proofing 5-10 NNI have to be added depending on the extent.

Apartments	50
Schools	40
Office buildings	50
Industrial and trade buildings	55
Hospitals	35
Ware houses and buildings ith temporary tenants	60
Agricultural and military use	60 and up

142 Effects at Airplane Noise Within the Range of Recommended Scheduled Values of 1969. /316

In the following it should be tested, first of all, which degree of disturbance by airplane noise could be expected in Switzerland if the threshold value of excessive disturbance of 50 NNI for homes and the standard threshold value for regional planning of 35 NNI for exclusive residential areas is achieved. For this purpose table 10 shows the two values of 50 and 35 NNI and the most important statements which are suitable to indicate the degree of disturbance. Two values are usually given which are based on the airports of Zurich and Geneva. The values of Basel were excluded from this discussion because of the special situation of this airport.

Table 9 /315

Threshold Values for Regional Planning Around Airports. Temporary Recommendations of July 31, 1969. NNI Values between 6 and 10 PM

Utilization and Zones	NNI-Values
Industrial buildings with special sound protection measures and airconditioning in office sections. -- Ware houses. -- Militray and agricultural use.	more than 50
Office buildings with special sound protection. -- Industrial buildings and trade shops.	41 to 50
Mixed zone (Businesses, workshops and apartments). -- Schools with special sound insulation.	36 to 40
Residential zones, schools and hospitals with special sound insulation.	25 to 35
Hospital and sanitarium zone without special sound insulction	less than 25

Table 10 /317

Extent of the Effects of Airplane Noise in Geneva at Levels of 50 NNI and 35 NNI.

Kind of Effects	Percent of thos questioned	
	at 34-36 NNI	at 49-51 NNI
"much disturbe", scale 1 - 10	12,3	43,2
conversation disturbed	9,0	46,5
recreation disturbed	9,4	31,8
sleep disturbed	8,2	24,1
Spontaneous: airplane noise is cause of disturbance	7,8	36,2
earplugs used	4,1	5.0
sleeping pills taken	6,6	8,5
consider moving away	5,7	30,3
closing of windows	16,0	38,5

Airplane noise exposure in the range of 50 NNI causes a high degree of disturbance to people living near Swiss airports. In this connection it should be remembered that an especially steep increase was seen in the increase of disturbed leisure time activities and the ranking of "strong disturbance" in the range of 45 NNI. This range can therefore be considered as the critical threshold. The suggestion of the experts of July 31, 1969 to limit airplane noise exposure to 50 NNI as the highest tolerable limit for homes is definitly to high.

In the range of threshold values of 35 NNI, which was suggested as upper limit for the planning of residential areas in presently undeveloped zones, a certain amount of disturbance could already be noted. However, it was a definite minority which reported disturbances, so that it can be expected that disturbances in zones below NNI should be minimal. /318

143 Noise Zones Resulting from the Swiss Study

Disturbances in noise zones between 35 and 50 NNI are difficult to evaluate. To do justice to this middle range the effects in important noise zones are presented in table 11.

Table 11

Extent Of Effects of Airplane Noise in Zurich and Geneva in three Noise Zones of 10 NNI each.

Type of effect	% of questioned Ss		
	25 - 34 NNI	35 - 44 NNI	45 - 54 NNI
Very much disturbed, scale range 8 - 10	11,1	23,4	44,4
Medium disturbance, scale range 4 - 7	26,1	37,9	35,2
Little disturbance, scale range 1 - 3	43,6	33,2	17,2
No disturbance, scale value 0	19,2	5,6	3,2
Conversation disturbed	8,8	20,1	47,2
Recreation disturbed	9,2	15,0	31,0
Sleep disturbed	8,5	11,4	22,1
Spontaneous: airplane noise is reason for distubance	8,1	17,7	37,0
Use of ear plugs	3,3	3,8	4,7
Use of sleeping pills	3,[illegible]	3,5	7,7
Consider moving away	5,5	11,7	27,5
Closing of windows	15,6	23,4	37,1

The three NNI zones differ distinctly in relation to the effects of airplane noise. They agree well with zones A,B,and C which the expert group established in their report from July 31, 1969 (Page 12). We therefore can complement these zones with our values and formulate the following description:

ZONE A /320

Zone with low airplane noise exposure. Upper limit lies at 34 NNI. Approximately 10% of the population rank airplane noise exposure as strong disturbance. Approximately 73% report little or no disturbance. Zone A is an area with little disturbance.

ZONE B

Zone with medium airplane noise exposure which lies between 35 and 44 NNI noise exposure . Approximately 23% of the population rank airplane noise effect as "strong disturbance". 39% of those questioned report little or no disturbance. Zone B therefore is an area with medium disturbance.

ZONE C

Zone with strong airplane noise exposure which lies in an area of 45 or more NNI. 50% or more of the population rank the effects of airplane noise as "strong disturbance". Zone C is an area of strong disturbance.

It should again be remembered that a group of experts in their report suggested limitations between the three zones as follows:

- Zone A: Less than 25 to 30 NNI
- Zone B: Between 30 and 50 NNI
- Zone C: 50 and More NNI.

The indicators and the evaluation of airplane noise exposure of the three zones A,B, and C was essentially adopted as given by the expert group (page 12 in the expert report of July 31, 1969). However, the reported NNI values which defined the three zones deviate from those which the experts had estimated, based on foreign reports. The reasons are as follows:

- The upper limit of Zone A (low airplane noise exposure) is raised from 25 to 34 NNI because in this extended zone the disturbances are low and only a minority of about 10% of the population are affected. /321

- The demarkation between Zones B and C (medium respectively strong airplane noise exposure) is lowered from 50 to 45 NNI because "strong exposure" as well as some other criteria increase steeply especially in this range. The results indicate that the range between 45 and 50 NNI represent the critical threshold.

Those two "border adjustments" are the result of the Swiss survey evaluation.

The three zones rate airplane noise based on its effects on people. It does not necessarily represent threshold values which were mandated by the law makers.

144 Basis for Measures Against Airplane Noise.

The study group for socio-psychological airplane noise research has been assigned on the basis of their test results to create foundations for new legislation in respect to original planning and air traffic. It is the opinion of the study group that the results established with this study, especially the above mentioned zoning and the statements in table 11 concerning the extents of the effects of airplane noise in Geneva and Zurich represent a usable basis for the necessary measures.

Table 12 shows the connection between airplane noise exposure and quality of life. These evaluations refer to areas which are already developed. Airplane noise exposure represents, especially in Zone C, a limitation of quality of life which has to be taken seriously and which should be reduced by suitable measures. The study group wants to emphasize that stronger criteria should be applied to areas that are not zoned yet and which are presently not developed: In these areas which fall within the noise Zone C no residential areas should be included. /322

Table 12

Noise Zones and Noise Exposure: Evaluation of the quality of life

Zone	noise range NNI	airpl.noise exposure	evaluation of living quality
A	to 34	low	little affected
B	35 to 44	medium	affected
C	45 and above	strong	strongly affected

The establishment of threshold values is a political decision which, in addition to the effects of airplane noise on people, has also to take economical technical and planning factors into consideration. The study group is not able to competently evaluate the latter factors. It therefore is limited to the report of basic findings which were established by the results of the Swiss study.

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APPENDIX 2

/12

STUDY GROUP FOR
ENVIRONMENTAL RESEARCH
UNIVERSITY ZURICH/ETH

Instructions for the Interviewer

1. Purpose of the Research

Information about the background and purpose of this inquiry are solely for the use of the Interviewer. By no means are they to be passed on to the interviewed subjects.

The study in which you are involved is part of a larger research project into the socio-psychological effects of noise and specially of airplane noise on the population. The study has been authorized by the federal government and is conducted by a work study group of the University of Zurich and the ETH. The execution of the inquiry was awarded to the IMR.

Since it is our goal to obtain spontaneous and undistorted answers about the degree of disturbance and the effect of noise it is important that the interviewees are not to be informed of the actual purpose of the survey. A person who is aware of the purpose of the questioning from the very beginning has the tendency to exaggerate his answers, especially if he is actual disturbed by noise.

2. Who will be Questioned?

A) General

Each individual household was chosen by a random sampling process within various noise zones which had been established by acoustic engineers. The interviewer is in the possession of a list of the selected households which he has to interview. Now it is the task of the interviewer to choose the target person within this household, again, on a random basis. Only if the interviewer uses the following, scientifically proven process for the selection of the target person is the guarantee given that the totality of the interviewed persons resembles a reduced but true sample of the total population living in the noise zone. /13

Therefore it is absolutely essential that the target persons are chosen on the basis of the prescribed process

B) The Process for the Selection of the Target Persons within the Household.

Relationship to the head of household	Sex	Age	Persons	Check
Head of household	m		1	
Son	m		2	
Mother of wife	f		3	
Wife	f		4	

Table D

Number of persons over 18 years.	Choose Person
1	1
2	2
3	2
4	3
5	4
6 or more	4

All persons over 18 years have to be entered in this diagram. The number of persons over 18 years is to be listed in the following order: Oldest male, second oldest male, and so forth, oldest female, second oldest female, and so forth. The person to be interviewed is selected on the basis of selection TABLE D. Within the selection table D the translation is: The interviewer is listing every person over 18 years within a household. In the first column give the relation to the head of household, in the second column the sex and in the third column if necessary the age. In the fourth column the persons are numbered in such a way that male and female persons are listed according to their age in decreasing order. (See above). To obtain these numbers it is only necessary to give the age if there are two (2) adults of the same sex to be found in a household who do not stand in a parent/child relationship. (This will only happen in a small number of households). In case of an answer; "I, my wife, her mother, and our grown son", the persons can immediately be numbered without giving their age. (See above; 1.4.3.2.). Then the interviewer consults the selection table D which tells him which person is to be interviewed. The name of this person is to be written on the cover page of the questionaire. For each chosen person a new questionaire has to be used since the selection tables are not the same for all interviews. /14

Initially this selection process may seem complicated, however after one or two contact it can be easily handled.

3. <u>How to Conduct the Interview?</u>

If there is a telephone in the household to be interviewed the first contact is by telephone, otherwise it will be done directly. To simplify the establishment of contact with the target person an introductory letter has been sent to each of the chosen addresses (the letter can be found at the end of these instructions). Refer to this letter, ask the contact person briefly about the other people who live in the household as instructed in the previous chapter. During the introduction avoid by all means the mention of the word "Noise". It is best to use approximately the following text;

"I an a member of the study group for [illegible]mental research of the University of Zurich. I [illegible]orized to question someone in your household [illegible]out [illegible]s opinions on certain environmental factors at [illegible]e of residence, as we had mentioned in the lett[illegible] [illegible] you please tell me how many people are over [illegible]age 18"? (Depending on the answer the age [illegible]hese persons has to be obtained to determine the target person). "According to my random key it is ..... whom I would like to question. When does this person have time for the interview"?

Usually this text is sufficient to obtain the appointment for an interview with the target person or, in the case of direct contact, to start the interview. /15

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STUDY GROUP FOR
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Dear Madam or Sir;

Our study group has been authorized by the federal government to research the environmental situation in several communities of Switzerland. This will also include household interviews.

Your household is one of the 4,200 which have been selected for this process by a random method. One person which is living in your household will be selected by one of our interviewers who will contact you within the next few days. This will again happen by means of a random selection process. Since the group of selected persons is to represent a small but true sample of the total population over 1° years of age in your community it is important that really all chosen persons can be interviewed to prevent a distorted representation of the population of your community.

Since our interviews will be evaluated statistically the participants will remain completely anonymous. This means that nobody will be able to subsequently determine which person gave certain answers. Just like in a public election, all of your statements will be treated absolutely confidentially.

We deeply appreciate all help you can give to our interviewer during the interogation and we thank you for the time you make available for the interview.

Again, we like to thank you for your help during our research and remain

Sincerely

Study group for
Environmental Research
University Zuerich/ ETH

Prof. Dr. Med. E. Grandjean

Margin Count of Questionaires for the test areas of Zürich-Kloten, Genf Cointrin and Basel-Mulhausen* /17

Question 0

Sex of the Interviewee?

	ZH	GE	BS	
Male	46.0	47.8	42.7	%
Female	54.0	52.2	57.3	%
	1471	1524	946	Abs.

Question 1

If you think of your residence, do you like it very much, quite good, not so much, not at all?

Very much	50.3	66.3	58.9	%
Quite good	39.5	27.1	36.0	%
Not so much	7.3	4.7	3.3	%
Not at all	2.9	1.9	1.7	%
I don't know, no answer	0.0	0.1	0.1	%
	1471	1524	946	Abs

Question 2

How long have you already lived in this community?

Less than one year	6.9	2.9	3.8	%
Between 1 and 2 years	8.2	7.2	5.8	%
2--10 Years	38.9	34.8	28.9	%
10 or more years	46.0	55.1	61.5	%

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* The percentages refer to the number of those interviewed who actually have been asked the particular question during the interview.

C-4

Question 3

Do you like this community today better or worse than some time ago?

Better	29.1	20.6	22.3	%
Same	49.0	57.7	55.5	%
Less	20.3	20.6	17.8	%
I never liked it	0.7	0.5	0.1	%
I don't know	0.9	0.7	4.3	%
	1383	1479	910	Abs

Question 4

How long have you already lived in this residence?

Less than 6 months	4.3	2.1	1.9	%
6 months to 2 years	16.4	12.5	12.4	%
2 years to 10 years	47.1	40.6	39.6	%
10 years or more	32.2	44.7	46.1	%
	1471	1522	945	Abs.

Question 5

Here is a number of different activities. Please tell which of those you conduct away from your place of residence most of the time or always?

Shopping	34.7	62.1	26.4	%
Visit cultural events like, cinema, concert, sports	56.6	45.8	49.2	%
Visiting friends and acquaintences	59.3	53.3	49.7	%
Visit cafes, restaurants	34.6	24.0	33.4	
None of the above	9.0	5.9	19.9	
(More than one answer)	2857	2911	1689	Abs

Question 6

Thinking of your close environment, is there something that you or your family dislike to a certain degree?

Yes	60.2	53.8	56.7 %
No	39.4	45.9	41.6 %
Don't Know	0.3	0.3	1.7 %
	1469	1524	946 Abs

Question 7

Is there something disturbing to you or your family so that you can no longer enjoy life to the fullest?

Yes	20.2	26.2	17.7 %
No	79.7	73.4	81.4 %
Don't Know	0.1	0.4	1.0 %
	1467	1524	946 Abs.

Question 7 A

What does disturb you?

	ZH	GE	BS	
Airplane noise	45.6	45.6	35.8	%
Airplanes	2.0	4.8	4.8	%
Street traffic noise	18.5	17.0	24.2	%
Street and train traffic	6.4	8.1	6.1	%
Neighbors	11.7	8.9	15.2	%
Climate (foehn, fog, little sun)	1.3	1.0	0.6	%
Airpollution, exhaust emiss.	5.4	2.5	5.5	%
Industrial emissions	2.0	4.3	1.8	%
Other	7.0	7.8	6.1	%
	298	395	166	

Question 8

On these cards are several properties listed which are important for location and living quarters. Please sort the cards in such a way, that the property most important to you is on top with the remainder in descending order of importance.

Proximity to the place of employment

Rank:				
1	15.6	11.8	10.4	%
2	12.2	8.3	9.6	%
3	14.5	11.8	12.7	%
4	13.3	9.9	12.9	%
5	11.6	9.7	11.7	%
6	12.6	11.5	12.8	%
7	9.7	10.5	10.0	%
8	6.2	12.1	8.4	%
Dont know	4.1	14.3	14.2	%
	1471	1524	946	

Proximity to the city	ZH	GE	BS	/21
Rank				
1.	5.0	5.6	7.0 %	
2.	8.5	9.6	11.3 %	
3.	11.8	11.8	11.3 %	
4.	12.4	15.4	16.9 %	
5.	14.5	15.0	16.7 %	
6.	16.0	13.7	12.8 %	
7.	19.6	13.0	13.7 %	
8.	9.5	7.5	3.2 %	
I Don't Know	2.6	8.3	7.1 %	
	1471	1524	946 Abs.	

Good traffic location

1.	5.4	5.7	3.8 %
2.	10.7	10.8	9.0 %
3.	13.6	19.2	17.8 %
4.	19.3	19.6	18.7 %
5.	19.4	17.3	18.4 %
6.	16.8	10.5	14.4 %
7.	9.3	6.2	7.2 %
8.	3.5	4.1	3.3 %
I don't know	2.0	6.6	7.5 %
	1471	1523	946 Abs.

Many shopping opportunities

1.	4.1	3.3	5.1 %
2.	7.7	10.4	8.1 %
3.	12.1	16.7	13.6 %
4.	14.7	21.3	16.3 %
5.	18.2	16.8	17.2 %
6.	19.5	13.1	17.0 %
7.	15.8	8.9	11.3 %
8.	5.2	3.8	4.3 %
I don't know	2.6	5.7	7.0 %
	1471	1524	946 Abs

Good schools for the children: /22

Rank	ZH	GE	BS	
1.	15.9	6.2	12.6	%
2.	14.4	9.2	10.8	%
3.	18.8	15.0	15.3	%
4.	12.5	9.8	10.3	%
5.	10.5	10.3	9.3	%
6.	7.1	10.7	6.7	%
7.	7.3	11.2	10.3	%
8.	8.9	10.6	8.6	%
I don't know	4.6	17.1	16.3	%
	1471	1524	946	Abs

Entertainment and cultural possibilities like movies, concerts, restaurants etc.

1.	0.7	0.5	0.5	%
2.	1.2	2.0	1.3	%
3.	2.0	4.4	1.0	%
4.	3.3	6.1	2.0	%
5.	5.5	8.8	5.4	%
6.	9.7	14.4	10.1	%
7.	19.7	20.3	16.5	%
8.	52.1	28.7	42.1	%
I don't know	5.6	15.0	21.1	%
	1471	1524	946	Abs.

Natural surrounding:

1.	21.1	32.3	24.6	%
2.	24.7	21.4	30.2	%
3.	15.2	7.6	13.2	%
4.	12.0	6.0	10.3	%
5.	9.0	7.4	6.7	%
6.	7.5	7.7	5.7	%
7.	7.0	7.4	4.1	%
8.	2.7	6.0	1.4	%
I don't know	0.8	4.2	3.8	%
	1471	1524	946	Abs

Quiet location:

/23

Rank	ZH	GE	BS
1.	32.0	35.0	35.4 %
2.	20.4	26.4	21.6 %
3.	11.4	10.2	13.2 %
4.	11.1	6.4	8.8 %
5.	8.2	5.8	5.6 %
6.	6.1	5.0	4.1 %
7.	5.4	3.7	4.0 %
8.	4.4	5.1	3.1 %
I don't know	1.2	2.4	4.2 %
	1471	1524	946 Abs

Question 9

Now look at the cards again and tell me whether each of these properties is available or not at your present place of residence.

Proximity to place of work

Present	76.9	56.6	61.3 %
Not Present	19.6	28.7	25.2 %
I don't know	3.5	14.8	13.5 %
	1471	1524	946 Abs

Proximity to the city

Present	87.2	81.4	93.4 %
Not Present	12.2	16.7	5.4 %
I dont know, no answer	0.7	2.0	1.2 %
	1471	1524	945 Abs.

Good traffic location

Present	68.9	75.1	90.1 %
Not Present	30.3	23.4	8.5 %
I don't know, no answer	0.7	1.6	1.5 %
	1471	1524	946 Abs

Many shopping opportunities: /24

	ZH	GE	BS
Present	53.3	71.3	75.8 %
Not present	46.0	27.2	22.6 %
I don't know, no answer	0.7	1.5	1.6 %
	1471	1524	946 Abs.

Good schools for the children:

	ZH	GE	BS
Present	79.1	73.4	79.1 %
Not present	13.3	16.1	7.2 %
I don't know, no answer	7.5	10.5	13.7 %
	1471	1524	946 Abs.

Entertainment and cultural possibilities such as movies, concerts, restaurants, and so forth

	ZH	GE	BS
Present	32.7	39.1	35.3 %
Not present	64.0	54.1	52.9 %
I don't know, no answer	3.3	6.8	11.7 %
	1471	1524	945 Abs

Natural surroundings:

	ZH	GE	BS
Present	85.0	62.7	83.2 %
Not present	14.8	35.7	15.8 %
I don't know, no answer	0.2	1.6	1.1 %
	1471	1524	945 Abs

Quiet location:

	ZH	GE	BS
Present	47.1	57.9	65.2 %
Not present	52.3	40.7	32.9 %
I don't know, no answer	0.6	1.4	1.9 %
	1471	1524	946 Abs.

Question 10

Does the interviewee live:

	ZH	GE	BS	
In apartment	72.7	55.1	72.8	%
A rented one family house,	2.0	6.2	1.8	%
Subletting,	1.1	0.6	0.8	%
In a condominium,	1.3	3.2	0.6	%
In own one - or multi-family house	22.8	34.9	23.9	%
	1471	1524	946	Abs.

Question 11

How much is your rent, including utilities?

Less than 150 francs	1.8	9.7	3.8	%
151 to 250	10.4	22.0	15.3	%
251 to 350	20.3	27.4	24.5	%
351 to 450	31.7	16.3	19.7	%
451 to 550	18.9	9.0	15.5	%
551 to 650	10.3	5.8	11.2	%
651 to 750	4.1	3.9	5.5	%
751 to 850	1.2	1.3	2.0	%
851 and more	1.4	4.6	2.3	%
No answer	----	----	----	
	1086	898	685	Abs

Question 12

How many rooms (excluding kitchen, bath, toilet) does your apartment have?

	ZH	GE	BS
1 to 1 1/2	2.0	3.6	2.0 %
2 to 2 1/2	6.9	14.8	10.8 %
3 to 3 1/2	36.1	23.8	47.4 %
4 to 4 1/2	31.9	23.7	20.9 %
5 to 5 1/2	12.0	14.6	9.9 %
6 to 6 1/2	5.5	8.4	5.1 %
7 to 7 1/2	2.6	4.8	2.1 %
8 and more	1.9	6.2	1.7 %
No number	----	0.3	----
	1454	1515	941 Abs.

Question 13

How do you feel about the size of your apartment?

To small	18.9	21.5	21.6 %
To big	2.7	4.5	2.3 %
Just right	54.3	74.0	76.0 %
I don't know, no answer	0.0	0.1	0.1 %
	1471	1524	946 Abs

Question 14

How well is the sound insulation in your residence?

	ZH	GE	BS	
Poor sound insulation	50.8	45.2	54.0	%
Good sound insulation	48.4	51.8	42.8	%
I don't know, no answer	0.8	3.0	3.2	%
	1471	1524	946	Abs.

Question 15

At what times are you usually at home on work days?

(Multiple answers)				
Mornings	5.9	6.4	6.4	%
Afternoons	6.0	5.6	7.7	%
All day, during noon hour	18.8	22.6	19.0	%
All day, but not during Noon hour	23.2	14.2	17.1	%
Evenings	2.6	2.0	3.8	%
Nights	0.4	0.5	0.7	%
Usually at home	24.3	27.6	25.7	%
Always different	24.3	22.7	21.4	%
No answer	0.0	0.6	0.0	%
	1554	1557	965	Abs

Question 16

If you have visitors from a different area how do they find your living situation?

	ZH	GE	BS	
Very good	28.6	36.4	36.9	%
Good	54.5	50.0	53.2	%
Not so good	14.3	10.4	6.1	%
I don't know	2.6	3.2	3.8	%
	1471	1524	946	Abs.

Question 17

Assuming you live in Winterthur and would have to move for professional or other reasons, which of the following places would you least likely select if the choice is up to you?

Bulach	3.9	%	Lancy	3.7	%
Regensberg	3.9	%	Geneve-Champel	5.1	%
Hori	40.9	%	Geneve-Jonction	44.3	%
City of Zurich	28.3	%	Meyrin	24.6	%
Kloten	13.7	%	Nyon	5.2	%
Regensdorf	5.0	%	Cologny	5.2	%
Zollikon	2.0	%	Chene-Bourg	4.0	%
I don't know	2.2	%	I don't know	2.2	%
	1471	Abs		1524	Abs.

(This question was not asked in Basel)

Question 18

Is this because of one of the following reasons?

	ZH	GE	
Hectic Life, Nervous People	9.9	6.9	%
Too much airplane noise	51.2	25.0	%
I just don't like that place	8.0	23.6	%
Too much traffic, to much exhaust	15.8	22.6	%
High rents	2.4	3.8	%
I don't like the people that much	1.3	2.9	%
The place is boring	5.3	4.8	%
I don't like the area or climate	1.9	4.3	%
Another reason	4.2	6.1	%
I don't know, no answer	0.0	0.0	%
	1435	1393	Abs

(This question was not asked in Basel)

Question 19

Which of the schools did you visit last?

	ZH	GE	BS	
Grammar School	15.8	25.6	11.4	%
Secondary/County/Real/School (American equivalent: 10 grade school)	18.1	21.7	27.8	%
Vocational high school	42.6	31.8	34.2	%
High school/junior college	16.5	9.4	15.2	%
Four year college or university	7.1	11.5	11.3	%
	1471	1524	946	Abs

Question 20

What is your marital status?

	ZH	GE	BS	
Married	82.2	75.9	74.6	%
Divorced	2.7	3.3	4.1	%
Widowed	4.6	9.8	9.5	%
Single	10.4	11.0	11.6	%
No answer	0.1	0.0	0.1	%
	1470	1524	946	Abs.

Question 21

Do you have children?

Yes	81.7	81.3	78.4	%
No	18.3	18.7	21.6	%
	1331	1361	843	Abs

Question 22

How many are below 18 years of age?

None	25.5	44.2	38.1	%
1	25.8	24.6	23.6	%
2	31.3	21.8	25.6	%
3	13.0	7.8	8.9	%
4 and more	4.5	1.5	3.8	%
	1088	1108	661	Abs

Question 23

/31

We have here a number of terms which could be used to describe a residetial environment. Please indicate which of the two attributes describes your immediate environment. Please do not skip any lines and check only one box in each line. Here is an example with the attribute pair "Inviting-Inhospitable" (the interviewer shows a card to his subject). If you feel that your surrounding is very inviting then check the left side of your card. If you consider your closer surrounding very unhospitable then check off the far right. If you feel that the truth is somewhere in between check off the box that you feel is closest.

	ZH	GE	BS	
Exciting-monotonous				
1	15.9	29.0	16.2	%
2	25.4	34.2	29.3	%
3	19.0	17.1	18.8	%
4	20.3	11.7	19.9	%
5	9.4	3.6	8.5	%
6	5.6	2.9	5.3	%
7	4.3	1.4	2.1	%
	1470	1524	946	Abs
Lively-deserted				
1	25.0	29.9	21.9	%
2	33.3	27.8	35.3	%
3	22.3	15.8	24.1	%
4	13.0	9.9	14.3	%
5	1.8	6.2	1.4	%
6	1.8	6.2	1.4	%
7	0.8	4.7	0.4	%
	1471	1524	946	Abs

	ZH	GE	BS	
Familar-foreign				/32
1	41.5	34.0	46.6	%
2	25.4	32.3	29.8	%
3	13.9	14.6	11.0	%
4	7.8	8.6	7.7	%
5	5.1	4.2	2.1	%
6	3.9	4.1	1.4	%
7	2.4	2.2	1.4	%
	1470	1524	946	Abs
Practical-awkward				
1	29.7	19.6	41.3	%
2	25.6	26.1	32.6	%
3	14.2	20.0	13.6	%
4	13.3	17.5	6.7	%
5	6.7	7.2	2.5	%
6	6.1	6.0	2.1	%
7	4.4	3.5	1.2	%
	1471	1524	946	Abs
Safe-threatening				
1	34.8	41.7	42.3	%
2	24.6	25.9	29.1	%
3	13.0	9.5	11.5	%
4	13.7	10.0	8.5	%
5	5.3	4.5	4.2	%
6	5.0	5.1	3.2	%
7	3.5	3.3	1.3	%
	1470	1524	946	Abs

	ZH	GE	BS	
Quiet-noisy				
1	15.2	12.8	22.8	%
2	16.0	16.1	23.5	%
3	9.2	10.2	13.5	%
4	9.0	9.4	8.8	%
5	10.5	9.8	9.8	%
6	16.3	17.1	10.8	%
7	23.8	24.4	10.8	%
	1469	1524	946	Abs
Clean-dirty				
1	45.2	48.7	46.6	%
2	27.6	27.0	28.4	%
3	8.8	8.1	10.8	%
4	7.4	6.8	6.9	%
5	4.2	4.2	3.2	%
6	4.1	2.8	3.1	%
7	2.7	2.4	1.1	%
	1469	1524	946	Abs
Pleasant-Foul Smelling				
1	19.5	18.9	22.9	%
2	20.3	18.1	20.9	%
3	12.2	11.5	13.7	%
4	21.8	26.6	18.4	%
5	13.0	9.9	11.6	%
6	8.2	8.5	8.6	%
7	5.1	6.4	3.8	%
	1471	1524	946	Abs

	ZH	GE	BS	
Native-alien				
1	14.4	13.8	26.2	%
2	17.7	15.2	22.8	%
3	11.4	8.1	12.9	%
4	20.7	26.6	16.5	%
5	13.3	8.1	8.2	%
6	13.3	11.8	7.5	%
7	9.3	16.3	5.8	%
	1470	1524	946	Abs
Helpful-indifferent				
1	23.4	20.4	24.4	%
2	27.3	25.9	24.8	%
3	13.2	13.6	16.3	%
4	19.5	17.5	18.2	%
5	6.8	7.0	6.6	%
6	5.7	7.7	5.7	%
7	3.9	7.9	4.0	%
	1469	1524	946	Abs
Generous-narrowminded				
1	12.4	11.6	14.3	%
2	23.7	19.9	21.1	%
3	17.4	17.6	15.9	%
4	27.0	40.8	27.7	%
5	8.1	4.3	9.0	%
6	7.2	3.2	7.6	%
7	4.3	2.6	4.4	%
	1471	1524	946	Abs

	ZH	GE	BS	
Entertaining-boring				
1	6.8	7.5	9.8	%
2	18.4	17.7	18.0	%
3	20.8	20.3	17.7	%
4	27.6	40.0	32.8	%
5	11.5	6.4	9.2	%
6	8.4	4.9	8.7	%
7	6.4	3.3	3.9	%
	1469	1524	946	Abs
Friendly-hostile				
1	27.6	18.0	29.4	%
2	34.8	30.1	35.1	%
3	17.8	19.4	15.3	%
4	13.1	16.8	11.7	%
5	2.8	5.2	3.6	%
6	2.0	5.8	2.9	%
7	1.8	4.7	2.0	%
	1468	1524	946	Abs
Wealthy-poor				
1	9.0	11.4	10.0	%
2	29.0	31.5	22.6	%
3	24.0	20.3	23.6	%
4	33.5	29.5	36.8	%
5	2.4	4.4	4.0	%
6	1.7	2.3	2.2	%
7	0.5	0.7	0.7	%
	1471	1524	946	Abs

Question 24

Which outside noises do you hear most often in your residence?

	ZH	GE	BS	
Traffic noises (trucks, cars, auto horns, street cars, train)	48.3	43.0	52.7	%
Industrial noises, (trade, factories, building sites)	3.3	5.0	5.1	%
Airplane sounds	58.9	57.7	57.7	%
From neighbors (Directly and Indirectly)	11.6	14.9	7.7	%
Sounds of nature	1.7	3.5	1.5	%
Other Sounds	2.7	4.7	3.5	%
I don't know, no answer	0.7	4.9	1.6	%
(Multiple answers)	1870	2035	1228	Abs

Question 25

Do you notice air and water pollution in your closer surroundings?

Yes	55.9	51.4	41.7	%
No	43.6	47.7	57.1	%
I don't know	0.5	0.9	1.2	%
	1471	1524	945	Abs

Question 26

What's the cause of this pollution?

	ZH	GE	BS	
Air traffic	40.5	43.6	20.9	%
Street and train traffic	17.7	30.5	26.1	%
Industry (trade, factory building)	31.5	19.8	39.8	%
Households	21.5	10.5	14.4	%
Other	8.4	11.3	12.0	%
I don't know	2.3	1.0	2.4	%
(Multiple answers)	1001	915	455	Abs

Question 27

How much are you bothered by this pollution?

	ZH	GE	BS	
Very much	10.9	22.4	9.1	%
Somewhat	37.1	39.9	43.9	%
A little	31.3	26.7	26.3	%
Not at all	20.4	10.7	19.7	%
I don't Know	0.2	0.4	1.0	%
	822	787	396	Abs

Question 28

Are you working?

Yes	59.4	55.1	56.1	%
No	40.6	44.9	43.9	%
	1471	1524	946	Abs

Question 29

Do you work in your neighborhood or outside of it?

	ZH	GE	BS	
Neighborhood	42.0	41.0	37.9	%
Outside	55.4	59.0	59.4	%
Both	2.6	0.0	2.6	%
	874	839	530	Abs

Question 30

What kind of work are you presently doing?

Farmer	2.7	2.2	0.4	%
Unskilled worker, semi-skilled worker, office worker	16.6	14.9	14.5	%
Skilled blue collar	22.3	22.8	21.7	%
Skilled white collar	24.4	26.8	34.5	%
Managerial, Official, Technician, tradesman	20.4	18.3	15.3	%
Professional, artist	7.2	9.6	11.3	%
Businessman, director	6.4	5.4	2.3	%
	857	832	530	Abs

Question 31

Please state the amount of the combined gross-earnings of yourself and your spouse.

A. Under $500.00	3.1	5.1	2.7	%
B. 501.00 to 1,000.00	4.9	10.1	8.7	%
C. 1,001.00 to 1,500.00	9.9	14.4	10.5	%
D. 1,501.00 to 2,000.00	24.1	16.7	16.5	%
E. 2,001.00 to 2,500.00	18.7	13.2	18.1	%
D. 2,501.00 to 3,000.00	13.2	9.1	11.9	%
E. 3,001.00 to 3,500.00	7.5	4.8	8.0	%
F. 3,501.00 to 4,000.00	5.4	3.1	4.9	%

	ZH	GE	BS	
$4,001.00 and more	6.5	7.9	6.9	%
No income	3.1	2.8	2.2	%
Don't know	1.0	3.1	1.8	%
No answer	2.5	9.7	7.8	%
	1471	1524	946	Abs

Question 32

Do you have a car?

Yes	67.6	72.7	57.3	%
No	32.4	27.3	42.7	%
	1471	1523	946	Abs

Question 33

Which age group do you belong to? Please tell me the letter.

18 to 25 years	11.4	6.2	7.0	%
26 to 30 years	15.3	10.0	11.4	%
31 to 35 years	15.9	10.6	13.1	%
36 to 40 years	12.6	11.2	14.3	%
41 to 45 years	11.4	9.6	10.6	%
46 to 50 years	7.4	9.2	7.8	%
51 to 55 years	6.9	8.2	7.2	%
56 to 60 years	6.1	8.4	7.5	%
61 to 65 years	4.9	7.7	7.2	%
66 to 70 years	3.5	6.4	5.8	%
70 years and more	4.6	12.3	8.1	%
No answer	0.1	0.3	0.0	%
	1471	1524	946	Abs

Question 34

Are you a Swiss citizen?

	ZH	GE	BS	
Yes	93.9	82.7	92.9	%
No	6.1	17.3	7.1	%
	1471	1524	946	Abs

Question 35

What is your nationality?

	ZH	GE	BS	
Italian	4.2	33.7	14.7	%
Spanish	0.0	6.1	0.0	%
German	21.6	5.3	51.5	%
Austrian	11.3	3.4	4.4	%
French	0.0	30.7	11.8	%
Czhecoslovakian	0.0	0.4	4.4	%
Hungarian	1.9	0.0	1.5	%
Europe	3.3	14.0	7.4	%
Outside of Europe	0.0	6.4	4.4	%
No Information	0.0	0.0	0.0	%
	90	264	68	Abs

Question 36

With which of the following three opinions could you agree easiest? Just mention the letter:

	ZH	GE	BS	
Past and present are too often full of misfortune. Only the future is important.	16.5	23.3	14.7	%
The future will not be much better or worse than the present and the past.	43.2	34.9	42.8	%
Present and future are uncertain, therefore one should observe proven traditions and habits more.	36.2	34.3	37.6	%
I do not know, no answer	4.1	7.6	4.9	%
	1471	1523	946	Abs

Question 37

If you again think of your closer surroundings, is there something that could endanger the health of yourself or your family?

	ZH	GE	BS	
Yes	33.0	29.5	17.7	%
No	66.7	70.2	71.6	%
I don't Know	0.3	0.3	0.7	%
	1471	1524	946	Abs

Question 37A

Could you please tell me what that is?

	ZH	GE	BS	
Airplane noise	31.2	45.8	18.7	%
Airplanes	3.4	4.7	1.9	%
Traffic noise	8.6	13.1	18.7	%
Street and train traffic	4.8	5.1	6.9	%
Climate (foehn, fog, little sun)	4.5	2.0	3.4	%
Air pollution, exhaust fumes	25.5	16.2	36.3	%
Industrial emissions	2.3	3.3	6.5	%
Other	4.7	9.6	6.5	%
Don't Know	0.0	0.2	1.1	%
	485	450	262	

Question 38

Is there possibly even something that could endanger you or your families life?

Yes	13.5	9.6	15.5	%
No	85.9	89.8	83.7	%
I don't know	0.6	0.5	0.7	%
	1471	1524	946	Abs

Question 38A

What is it?

Airplane noise	3.3	22.4	4.1	%
Airplanes	14.4	22.4	7.5	%
Traffice noise	2.6	3.4	7.5	%
Street and train traffic	36.3	21.1	51.7	%

	ZH	GE	BS	
Climate (foehn, fog, little sun)	0.4	0.7	2.7	%
Air pollution, exhaust fumes	10.4	15.0	15.6	%
Industrial emissions	0.7	2.7	4.8	%
Other	5.2	10.9	4.8	%
I don't know	0.0	1.4	1.4	%
	198	147	147	Abs

Question 39

I will read to you a number of opinion of varying problems. Please tell me each time your own feeling.

Modern technic enables eople to have a happier life:

Completely correct	25.1	10.1	22.7	%
Somewhat correct	46.1	40.0	44.8	%
Not quite wrong	23.8	36.8	25.5	%
completely wrong	4.3	11.1	4.1	%
I don't know	4.3	11.1	4.4	%
No answer	0.7	2.0	2.5	%
	1471	1524	946	Abs

Before giving developmental assistance abroad, we should help the poor people in our own country first.

Completely correct	60.5	47.4	52.3	%
Quite correct	24.1	30.4	29.7	%
Not quite wrong	11.6	14.9	13.5	%
Completely wrong	3.1	5.1	3.0	%
I don't know, no answer	0.6	2.2	1.5	%
	1471	1524	946	Abs

	ZH	GE	BS	
It doesn't make much sense to become involved with the bureaucracy because it shows hardly any interest in the problems of the average citizen:				
Compelety correct	19.4	17.5	18.2	%
Quite correct	27.3	27.6	27.6	%
Not quite wrong	36.8	36.5	37.7	%
Completely wrong	13.3	11.4	11.2	%
I don't know, no answer	3.1	7.0	5.3	%
	1471	1524	946	Abs
Most people fall in one of two categories, honest or dishonest:				
Completely Correct	30.7	19.7	30.2	%
Quite Correct	26.6	28.5	23.9	%
Not quite wrong	23.7	28.7	25.4	%
Completely Wrong	18.1	18.8	17.3	%
I don't know, no answer	1.0	4.3	3.2	%
	1471	1524	946	Abs
The preservation of Swiss ways is more important than increasing wealth.				
Completely correct	31.8	20.7	33.5	%
Quite correct	33.8	28.7	33.1	%
Not quite wrong	20.9	23.0	18.1	%
Completely wrong	9.0	14.4	7.4	%
I don't know, no answer	4.6	13.3	7.9	%
	1471	1524	946	Abs

	ZH	GE	BS	
In the final analysis the mechanization of our world creates more disadvantages than advantages for people:				
Completely correct	16.5	12.3	19.8	%
Quite correct	31.7	31.7	31.8	%
Not quite wrong	36.6	39.0	33.2	%
Completely wrong	12.2	12.3	10.8	%
I don't know, no answer	2.9	4.7	4.4	%
	1471	1524	946	Abs

	ZH	GE	BS	
One can see right away if one can trust another person or not:				
Completely correct	20.1	16.4	17.4	%
Quite correct	23.6	26.7	23.3	%
Not quite wrong	33.4	36.7	37.4	%
Completely wrong	22.2	17.3	20.6	%
I don't know, no answer	0.7	2.9	1.3	%
	1471	1524	946	Abs

	ZH	GE	BS	
Even Switzerland is practically governed by a few powerful people and the average citizen can not do much about it.				
Completely correct	27.1	22.4	25.6	%
Quite correct	30.9	33.3	32.8	%
Not quite wrong	26.9	25.5	27.1	%
Completely wrong	12.9	9.7	9.3	%
I don't know, no answer	2.2	9.0	4.2	%
	1471	1524	946	Abs

For an important position in the community someone should be chosen who has lived there for a long time.

Completely correct	29.5	39.0	31.7	%
Quite correct	27.3	33.9	30.2	%
Not quite wrong	29.8	17.5	22.8	%
Completely wrong	12.8	4.4	11.4	%
I don't know, no answer	0.6	5.1	3.8	%
	1471	1524	946	Abs

/46

If one studies the world situation thoroughly, one can increase one's influence on politics:

Completely correct	22.6	19.0	20.7	%
Quite correct	41.1	41.9	33.3	%
Not quite wrong	21.2	20.1	24.9	%
Completely wrong	8.0	7.8	9.7	%
I don't know, no answer	7.1	11.1	11.3	%
	1471	1524	946	Abs

Cities are important but the backbone of Switzerland is fortunately still its many rural communities:

Completely correct	35.6	24.6	35.3	%
Quite correct	34.9	37.8	32.3	%
Not quite wrong	20.2	18.3	21.2	%
Completely wrong	6.2	6.0	5.6	%
I don't know, no answer	3.1	13.3	5.5	%
	1471	1524	946	Abs

Usually there is only one correct way to do something:

Completely correct	26.4	29.6	25.6	%
Quite correct	20.9	33.5	21.2	%
Not quite wrong	31.0	23.4	30.4	%
Completely wrong	20.5	9.0	19.5	%
I don't know, no answer	1.2	4.5	3.3	%
	1471	1524	946	Abs

Question 40

Which of these three opinions do you tend to agree with the most?

	ZH	GE	BS	
In our country a young man can reach any position if he has enough education and tries hard.	30.5	42.7	27.4	%
In our country too there are societal barriers or obstacles which make all efforts useless unless one has the necessary connections.	29.1	23.4	35.6	%
That there always will be people that will go further than others is based on the fact that not all people are equally intelligent and efficient.	38.7	29.6	34.4	%
I don't know, no answer	1.7	4.3	2.6	%
	1471	1524	946	Abs

Question 41

Do you consider yourself a rather lively or rather quiet person?

	ZH	GE	BS	
Lively	41.3	51.9	40.1	%
Quiet	57.6	46.1	58.0	%
I don't know	1.1	2.0	1.9	%
	1471	1524	946	Abs

Question 42

Do you usually break the ice when you make new friends?

	ZH	GE	BS	
Yes	42.6	40.4	40.8	%
No	49.6	50.5	48.5	%
I don't know	7.8	9.2	10.7	%
	1471	1524	946	Abs

Question 43

Do you prefer to plan or do you prefer to act?

Prefer to act	65.0	67.5	65.00	%
Prefer to plan	30.7	25.8	28.2	%
I don't know	4.4	6.7	6.8	%
	1471	1524	946	Abs

Question 44

Would you be very unhappy if you would have to make do without frequent social contact with friends and acquaintances?

Yes	51.2	57.2	50.0	%
No	47.2	40.2	47.3	%
Don't know	1.6	2.6	2.7	%
	1471	1524	946	Abs

Question 45

Let's assume that this would be a thermometer with which it is possible to measure how much street traffic noise disturbs you at home. The number ten (10) means that you find street traffic noise unbearable, the number zero (0) that it doesn't disturb you at all. Please tell me the number that applies to you.

	ZH	GE	BS	
0	20.9	31.0	14.1	%
1	11.6	7.9	13.5	%
2	13.1	10.6	18.8	%
3	16.9	11.6	11.4	%
4	8.5	6.4	10.5	%
5	10.8	11.5	12.7	%
6	5.0	6.0	6.0	%
7	5.8	4.6	5.5	%
8	4.4	4.6	3.6	%
9	1.5	3.9	2.6	%
10	1.6	3.9	2.6	%
	1471	1524	946	Abs

Question 45A

How often does it happen that street traffic noise startles you?

Very often	4.7	7.9	3.6	%
Quite often	20.2	17.1	13.0	%
Sometimes	44.0	30.5	49.1	%
Hardly ever, never	31.2	44.6	34.3	%
	555	597	507	Abs

- that it keeps you from falling asleep or it disturbs you while you sleep? /50

	ZH	GE	BS	
Very often	6.1	10.6	6.7	%
Quite often	18.7	16.9	13.6	%
Sometimes	29.9	28.0	29.6	%
Hardly ever, never	44.9	44.6	50.0	%
	553	597	506	Abs

- that it disturbs you when you listen to the radio or watch T.V.?

Very often	5.8	12.3	3.0	%
Quite often	13.9	13.3	8.7	%
Sometimes	22.7	16.6	22.1	%
Hardly ever, never	57.7	57.8	66.3	%
	555	595	507	Abs

- that the house vibrates?

Very often	2.0	7.0	1.8	%
Quite often	4.3	11.7	5.3	%
Sometimes	19.5	14.1	18.3	%
Hardly ever, never	74.1	67.2	74.6	%
	554	597	507	Abs

- that it interferes with your conversations, or when you phone somebody?

Very often	6.8	9.0	2.0	%
Quite often	10.6	13.1	7.9	%
Sometimes	23.4	19.4	22.9	%
Hardly ever, never	59.1	58.5	67.3	%
	555	597	507	Abs

That is distracts you from your work? /51

	ZH	GE	BS	
Very often	1.6	2.3	0.8	%
Quite often	3.1	5.2	3.6	%
Sometimes	16.0	11.6	16.2	%
Hardly ever, never	78.7	80.9	79.4	%
	552	597	505	Abs

- that it interferes with your relaxation or recreation?

Very often	8.5	14.1	6.5	%
Quite often	20.0	18.9	15.2	%
Sometimes	35.9	28.8	33.9	%
Hardly ever, never	35.7	38.2	44.4	%
	555	597	507	Abs

Question 45B

Now use the same thermometer to assess the noise from your neighbors and how much this disturbs you, again from zero (0) to ten (10).

0	42.4	55.8	38.2	%
1	15.4	10.9	19.6	%
2	13.7	9.1	15.9	%
3	9.7	6.8	7.2	%
4	5.0	4.6	4.3	%
5	5.6	4.6	6.8	%
6	3.1	2.2	3.6	%
7	2.2	1.8	1.6	%
8	1.7	2.4	1.6	%
9	0.4	0.9	0.3	%
10	0.7	1.1	1.0	%
	1471	1524	946	Abs

Question 45C

And how about noise from factories, from building locations and other business noises, how strongly do they disturb you?

	ZH	GE	BS	
0	70.6	78.6	59.9	%
1	8.8	3.9	13.0	%
2	6.0	4.7	6.7	%
3	3.5	2.4	4.9	%
4	2.6	2.4	3.7	%
5	2.7	2.6	4.9	%
6	1.5	1.2	2.2	%
7	1.0	1.2	1.5	%
8	1.7	1.3	1.5	%
9	0.8	0.4	1.0	%
10	0.9	1.2	0.8	%
	1471	1524	945	Abs

Question 45D

Now let's apply the thermometer to airplane noise:

C	10.5	18.8	10.2	%
1	7.3	7.7	8.1	%
2	9.2	9.3	11.6	%
3	16.0	11.3	6.6	%
4	5.5	4.3	7.0	%
5	12.6	7.9	13.4	%
6	7.0	4.9	8.5	%
7	7.2	6.8	9.4	%
8	11.6	8.9	12.4	%
9	5.4	3.1	4.3	%
10	7.6	17.1	8.5	%
	1471	1524	945	Abs

Question 45E

How often does it happen that the airplane noise startles you?

	ZH	GE	BS	
Very often	7.3	10.3	5.9	%
Quite often	17.1	16.7	21.3	%
Sometimes	41.8	24.8	47.7	%
Hardly ever, never	33.8	48.2	25.1	%
	837	807	662	Abs

- that it keeps you from falling asleep or disturbs you while sleeping?

Very often	6.9	13.9	4.4	%
Quite often	11.9	17.5	14.8	%
Sometimes	34.4	29.1	42.4	%
Hardly ever, never	46.7	39.5	38.4	%
	837	807	662	Abs

- that it interferes when you listen to the radio or watch T.V.?

Very Often	16.7	32.1	8.2	%
Quite Often	25.2	22.8	18.1	%
Sometimes	36.6	21.1	33.5	%
Hardly ever, never	21.5	24.0	33.5	%
	837	807	662	Abs

- that is vibrates the house?

Very often	7.2	24.5	5.4	%
Quite often	19.0	19.6	16.0	%
Sometimes	42.8	24.7	44.7	%
Hardly ever, never	30.9	31.2	33.8	%
	836	807	662	Abs

- that it disturbs you in conversations or when telephoning? /54

	ZH	GE	BS	
Very often	14.8	33.1	4.4	%
Quite often	25.8	23.9	11.9	%
Sometimes	41.1	21.1	43.1	%
Hardly ever, never	18.3	21.9	40.6	%
	837	807	662	Abs

- that it distracts you from your work?

Very often	1.9	4.7	1.1	%
Quite often	5.7	6.7	2.3	%
Sometimes	17.7	11.8	20.4	%
Hardly ever, never	74.6	76.8	76.2	%
	836	807	661	Abs

- that it interferes with your relaxation and recreation?

Very often	10.4	18.8	5.3	%
Quite often	18.4	20.6	13.6	%
Sometimes	40.0	29.6	39.6	%
Hardly ever, never	31.2	31.0	41.5	%
	837	807	661	Abs

Question 46

Did the airplane noise cause you or your family to use ear plugs or other hearing protectors at night?

Yes	6.2	8.8	5.4	%
No	93.5	90.8	94.6	%
No answer	0.2	0.4	0.0	%
	837	807	662	Abs

- that you use sleeping medication or tranquilizer? /55

	ZH	GE	BS	
Yes	6.5	11.9	5.3	%
No	93.5	87.5	94.6	%
No answer	0.0	0.6	0.2	%
	837	807	662	Abs

- that you do not stay outdoors as much as you would like to?

Yes	14.9	20.9	5.7	%
No	84.9	78.1	93.7	%
No answer	0.1	1.0	0.6	%
	837	807	662	Abs

- that you stay home less?

Yes	9.9	11.0	3.6	%
No	89.7	87.2	95.3	%
No answer	0.4	1.7	1.1	%
	837	806	654	Abs

- that you close windows and blinds, or do not open them at all?

Yes	34.5	52.9	23.6	%
No	65.1	46.6	76.0	%
No answer	0.2	0.5	0.5	%
	836	807	662	Abs

- that you haa noise insulation installed in your residence?

Yes	6.0	14.3	4.1	%
No	93.7	84.5	95.5	%
No answer	0.4	1.2	0.5	%
	837	806	661	Abs

- that you discussed possible health damage with the doctor? /56

	ZH	GE	BS	
Yes	8.1	8.9	2.6	%
No	91.8	90.2	97.3	%
No answer	0.1	0.9	0.1	%
	837	897	661	Abs

Question 47

At what time during day or night does airplane noise bother you most?

In early morning (6:00 to 8:00 am)	7.6	5.9	6.6	%
During forenoon (8:00 to 12:00)	7.4	4.0	3.3	%
During noon (12:00 am to 2:00 pm)	39.1	25.9	7.9	%
In the afternoon (2:00 to 6:00 pm)	16.5	22.1	9.2	%
In the evening (6:00 to 10:00 pm)	39.9	43.5	42.9	%
At night (10:00 pm to 6:00 am)	23.4	38.8	46.3	%
Always the same	9.6	8.7	10.6	%
I don't know	1.4	3.7	4.5	%
	1214	1226	865	Abs

Question 48

- on which week days?

	ZH	GE	BS	
On weekends	28.8	31.2	28.9	%
On other days	8.1	7.4	4.2	%
Always the same	58.3	53.7	53.3	%
I don't know	4.8	7.7	13.6	%
	837	807	662	Abs

Question 49

During which season does airplane noise bother you the most?

Spring	4.8	1.6	2.6	%
Summer	51.4	52.5	58.5	%
Fall	2.3	0.9	3.2	%
Winter	6.2	1.9	3.2	%
Always the same	32.9	39.5	29.9	%
I don't know	2.5	3.6	4.4	%
	837	807	662	Abs

Question 50

Do you sometimes contemplate moving away to escape the airplane noise?

Yes	27.6	26.9	9.4	%
No	72.2	72.5	90.3	%
I don't know	0.2	0.6	0.3	%
	837	807	662	Abs

Question 51

Do you believe that more should be done against airplane noise?

	ZH	GE	BS	
Yes	81.6	93.4	81.0	%
No	17.4	5.1	16.3	%
I don't know	1.0	1.5	2.6	%
	837	807	662	Abs

Question 52

In your opinion who or what is chiefly responsible for the fact that not much is done against airplane noise?

	ZH	GE	BS	
The airport administration, Swissair	15.9	11.8	16.8	%
Local, district, or federal legislatures	31.3	34.3	39.9	
Interests group like real estate speculators, and real estate owners	10.1	6.6	7.3	%
Noise victims	5.4	2.0	8.2	%
Insufficiently developed technology	31.2	37.7	20.9	%
Foreign airlines	3.6	3.7	2.2	%
I don't know, no answer	2.5	3.8	4.7	%
	636	755	536	Abs

Question 53

Here are a number of concrete actions with which people who are noise victims could successfully defend their interests. Which measure do you consider the best?

	ZH	GE	BS	
Write to a newspaper	2.9	0.9	1.9	%
Complain to Swissair	4.8	1.6	4.9	%
Telephone a federal agency	2.3	1.2	2.8	%
Join an action group	18.8	22.0	6.5	%
Participate in a demonstration	1.7	11.9	0.4	%
Sign a petition		35.8	13.1	%
Start an initative against airplane noise	48.1	16.4	57.8	%

Put government bodies under pressure with unusual measures?	9.0	10.2	7.5	%
I don't know	5.1	0.0	5.2	%
	686	755	536	Abs

Question 54

Which one do you consider the worst?

	ZH	GE	BS	
Write a newspaper	18.5	22.0	14.9	%
Complain to Swissair	24.5	26.5	21.5	%
Telephone a federal agency	15.6	22.5	16.4	%
Join an action group	0.9	2.1	1.5	%
Participate in a demonstration	19.0	2.8	17.0	%
Sign a petition	0.3	0.9	0.6	%
Start an initiative against airplane noise	0.9	17.9	0.4	%
Put government bodies under pressure with unusual measures	18.5	5.3	19.4	%
I don't know	1.9	0.0	8.4	%
	686	755	536	Abs

Question 55

Would you yourself support the measure which you consider good?

Yes	77.4	64.0	78.4	%
No	13.1	24.2	12.3	%
Perhaps	7.3	9.5	7.8	%
I don't know	2.2	2.3	1.5	%
	686	755	536	Abs

Question 56

Did you or one of your relatives ever complain personally to a government agency or newspaper in writing by telephone or in person?

	ZH	GE	BS	
Yes	12.0	24.9	10.4	%
No	87.6	74.2	89.2	%
No answer	0.4	0.9	0.4	%
	686	755	536	Abs

Question 57

How many airplanes, do you think, pass near your house everyday?

0-25	39.7	21.4	71.6	%
26-50	21.1	25.2	16.6	%
51-75	10.0	14.0	1.2	%
76-100	6.8	11.4	0.6	%
101-150	7.0	7.3	0.2	%
151-200	3.8	4.3	0.0	%
201-250	2.7	2.0	0.0	%
251-300	2.0	1.5	0.2	%
301-350	0.5	0.5	0.0	%
351-400	0.0	0.2	0.0	%
401 or more	0.6	0.2	0.0	%
I don't know	5.6	11.9	9.7	%
	837	807	602	Abs

Question 58

What is your estimate of the distance at which these airplanes usually pass your house?

Under 150 M	9.7	15.2	12.8	%
151-250 M	14.7	12.6	15.8	%
251-400 M	17.2	18.8	19.8	%

	ZH	GE	BS	
401-600 M	14.7	18.4	19.6	%
601-800 M	9.4	10.3	8.2	%
801-1200 M	16.7	13.2	11.5	%
1201-1600 M	6.0	4.0	3.5	%
1601-2000M	4.5	4.0	2.7	%
More than 2001 M	6.9	3.5	6.0	%
I don't know	0.0	0.0	0.0	%
	795	741	546	Abs

Question 59

Adding together all those noises do you believe that your neighbors feel less, just as much or more disturbed than you do?

Less	5.9	12.5	4.5	%
As much	72.3	74.5	73.8	%
More	17.3	4.3	15.0	%
I don't know	4.6	8.7	6.7	%
	1471	1524	946	Abs

Question 60

Are you now more, equally or less disturbed by noise than you were one year ago?

More	31.0	30.9	25.9	%
Equally	56.5	60.5	62.8	%
Less	11.4	6.4	9.4	%
I don't know	1.2	2.2	1.9	%
	1471	1524	946	Abs

/62

Question 61

Is this so because you have become more sensitive to noise or because the noise level has increased?

	ZH	GE	BS	
More sensitive	4.8	15.4	2.0	%
More noise	83.6	75.7	83.8	%
Both	10.3	7.6	13.0	%
I don't know	1.3	1.3	1.2	%
	457	474	247	Abs

Question 62

Do you think that in ten years there will be more, equal or less noise?

More	76.8	71.3	82.5	%
Equal	12.0	12.1	11.0	%
Less	10.2	12.6	4.3	%
I don't know	1.0	4.1	2.2	%
	1471	1524	946	Abs

Question 63

Can you get used to the noise?

Yes	73.5	65.8	68.5	%
No	24.9	31.6	29.1	%
I don't know	1.6	2.6	2.4	%
	1471	1524	946	Abs

Question 64

Here is that thermometer again with which you can measure how much the noise is responsible for your worries and difficulties. Number ten means that the noise is practically the cause of all your problems, and the number zero means the noise is not involved at all. Please tell me how you feel about that?

0	46.4	45.6	47.9	%
1	12.0	8.0	11.3	%
2	11.9	9.5	12.1	%
3	8.6	8.6	8.2	%
4	6.3	5.9	4.5	%
5	7.2	8.7	7.0	%
6	2.2	3.9	2.6	%
7	1.6	3.1	2.3	%
8	1.4	2.8	1.4	%
9	0.3	1.1	0.3	%
10	1.2	2.8	1.1	%
No answer	0.6	0.0	1.1	%
	1471	1524	746	Abs

Question 65

I will read some opinions to you about air traffic and the profession of a pilot. Please tell me how correct or how wrong you find those opinions.

Being an airplane pilot is one of the most beautiful and most exciting jobs of all.

Completely correct	31.9	24.7	30.1	%
Quite correct	40.1	40.7	39.7	%
Not quite wrong	20.8	23.4	20.5	%
Completely wrong	4.8	5.2	5.0	%
I don't know, no answer	2.4	6.0	4.7	%
	1471	1524	946	Abs

I often have a bad feeling if an airplane flies low above me: /64

	ZH	GE	BS	
Completely correct	18.7	5.6	21.0	%
Quite correct	23.5	12.6	31.0	%
Not quite wrong	24.2	25.2	26.1	%
Completely wrong	33.2	55.2	20.8	%
I don't know, no answer	0.4	1.4	1.1	%
	1471	1524	946	Abs

Sure, airplane noise is a problems for many people but it is possible to escape it if it becomes too disturbing:

Completely correct	22.2	10.0	9.9	%
Quite correct	24.7	21.8	19.5	%
Not quite wrong	31.4	39.6	38.1	%
Completely wrong	21.0	26.2	30.3	%
I don't know, no answer	0.7	2.5	2.2	%
	1471	1524	946	Abs

When an airplane flies above me I sometimes am afraid it could fall down:

Completely correct	8.4	4.9	11.1	%
Quite correct	14.1	9.4	18.9	%
Not quite wrong	20.7	19.7	24.8	%
Completely wrong	56.4	65.0	44.2	%
I don't know, no answer	0.3	1.0	1.0	%
	1471	1524	946	Abs

There are such powerful economic interests that it is impossible to do anything against airplane noise:

Completely correct	22.6	14.8	16.2	%
Quite correct	27.2	29.3	31.0	%
Not quite wrong	34.3	34.2	33.4	%

	ZH	GE	BS	
Completely wrong	13.5	15.5	14.5	%
I don't know, no answer	2.3	6.2	5.0	%
	1471	1524	046	Abs

It is unavoidable that a small minority will have to accept airplane noise:

	ZH	GE	BS	
Completely correct	49.5	25.7	35.3	%
Quite correct	35.3	43.8	40.4	%
Not quite wrong	10.0	15.8	16.3	%
Completely wrong	4.1	11.5	6.3	%
I don't know, no answer	1.1	3.1	1.7	%
	1471	1524	946	Abs

When I hear an airplane I often think of interesting and far-away places:

	ZH	GE	BS	
Completely correct	39.6	33.5	35.4	%
Quite correct	25.2	30.1	29.1	%
Not quite wrong	17.3	17.7	16.7	%
Completely wrong	16.9	16.3	17.1	%
I don't know, no answer	0.9	2.4	1.7	%
	1471	1524	946	Abs

Compared to a bus driver pilots are overpaid :

	ZH	GE	BS	
Completely correct	8.6	6.8	5.9	%
Quite correct	17.7	13.5	10.4	%
Not quite wrong	30.9	33.7	32.6	%
Completely wrong	35.6	27.3	32.6	%
I don't know, no answer	7.2	18.8	18.6	%
	1471	1524	946	Abs

/66

Flying is dangerous:

	ZH	GE	BS	
Completely correct	8.6	9.4	14.3	%
Quite correct	12.4	18.0	19.8	%
Not quite wrong	31.3	33.2	36.3	%
Completely wrong	47.2	38.1	28.2	%
I don't know, no answer	0.5	1.4	1.5	%
	1471	1524	946	Abs

If the people who notice airplane noise most would be compensated they would accept it.

	ZH	GE	BS	
Completely correct	8.1	5.8	5.0	%
Quite correct	17.2	14.8	14.1	%
Not quite wrong	35.2	28.4	35.6	%
Completely wrong	37.3	45.0	40.1	%
I don't know, no answer	2.2	6.0	5.3	%
	1471	1524	946	Abs

Question 66

To whom do airports bring the greatest advantages

	ZH	GE	BS	
Interest groups in the economy, businessmen, industrialists	38.3	42.3	47.7	%
Myself, my family, friends and acquaintences	0.5	1.0	0.5	%
The communities near airports	2.2	0.5	0.6	%
The cities of Zurich, Geneva, Basel	2.0	10.0	8.8	%
The cantons of Zurich, Geneva, Basel	6.8	16.4	20.0	%
All of Switzerland	47.3	16.9	15.4	%
The foreign nations	1.5	7.7	2.6	%
I don't know, no answer	1.4	5.2	4.3	%
	1471	1524	946	Abs

Question 66 A

And to whom chiefly is it disadvantageous?

	ZH	GE	BS	
Interest groups of the Economy (businessmen, industrialists)	0.3	0.4	0.8	%
Myself, my relatives, friends and acquaintances	8.6	8.3	11.7	%
The community bordering on the airport	79.1	79.1	67.3	%
The cities of Zurich/Geneva /Basel	0.5	0.7	3.3	%
The cantons of Zurich/Geneva /Basel	1.5	1.6	4.8	%
Foreign countries	1.2	0.9	0.8	%
I don't know, no answer	8.1	8.5	10.1	%
	1471	1524	946	Abs

Question 67

Did you ever fly?

Yes	68.7	67.8	63.4	%
No	31.3	32.2	36.6	%
No answer	0.0	0.1	0.0	%
	1471	1524	946	Abs

Question 68

How often?

One to two times	38.7	35.3	44.3	%
Three to ten times	36.3	33.2	35.2	%
More than ten times	24.8	30.9	20.5	%
I don't know, no answer	0.2	0.7	0.0	%
	1011	1034	600	Abs

Question 69

Do you or one of your close relative or friends work in a company that is connected with the airport of Kloten?

	ZH	GE	BS	
Yes	43.1	25.7	14.6	%
No	56.7	73.6	84.9	%
I don't know, no answer	0.2	0.7	0.4	%
	1471	1524	945	Abs

Question 70

Do any of the following statements apply to you?

I often have so much to do that I don't know where to find the time

Yes	46.2	46.3	52.5	%
No	3.4	45.3	41.9	%
I don't know, no answer	0.5	8.5	5.6	%
	1471	1524	946	Abs

"It would be fun to trap a lier in his own lies".

Yes	59.4	36.1	40.9	%
No	37.9	61.9	58.1	%
I don't know, no answer	2.7	2.0	1.0	%
	1471	1524	946	Abs

"In a discussion I often lose the argument"?

Yes	35.9	21.2	28.6	%
No	58.7	67.9	62.2	%
I don't know, no answer	5.4	10.9	9.2	%
	1471	1524	946	Abs

"If someone talks stupidly about something I am well informed about I correct him?

	ZH	GE	BS	
Yes	73.6	86.9	69.1	%
No	23.7	11.0	26.1	%
I don't know, no answer	2.7	2.2	4.8	%
	1471	1524	946	Abs

"I can be friendly to people whose actions I consider to be wrong"?

Yes	64.0	60.5	66.8	%
No	33.2	35.5	29.1	%
I don't know, no answer	2.8	4.0	4.1	%
	1471	1524	946	Abs

"My ways to do things are often misunderstood by other people"?

Yes	22.8	33.7	20.5	%
No	71.3	59.8	70.0	%
I don't know, no answer	5.9	6.4	9.5	%
	1471	1524	946	Abs

Question 70 A

Reaction of people interviewed to the judgement of the interviewer

Lively, Interested	64.4	71.9	73.1	%
Indifferent	24.9	17.5	15.6	%
Reserved	9.4	8.7	8.9	%
Negative	1.3	1.9	2.4	%
	1471	1524	945	Abs

Question 70B

Assessment of the honesty of the answers by the interviewer?

	ZH	GE	BS	
Honest	60.6	86.7	71.9	%
Generally honest	36.4	12.3	25.6	%
Questionable	3.1	1.0	2.5	%
	1471	1524	945	Abs

Question 71

In conclusion I have a number of personal questions which are interesting to physicians. To assure anonymity also from me as the interviewer these questions have been printed on a special sheet. You may fill out the answers and put the sheet in the envelope. Please check whether the statements apply to you often, sometimes, rarely, or never. Please do not omit any of the lines.

I have no appetite

Never	32.4	44.0	38.5	%
Seldom	39.0	33.4	35.3	%
Sometimes	22.4	17.3	19.1	%
Often	6.3	5.3	7.1	%
	1458	1490	916	Abs

I feel fatigued and listless

Never	7.1	9.6	12.0	%
Seldom	34.2	23.2	35.9	%
Occassionally	46.7	48.8	39.3	%
Often	12.1	18.4	12.8	%
	1461	1483	920	Abs

I have heart palpitations or a stabbing pain in the heart area. /71

	ZH	GE	BS	
Rarely	46.8	50.6	49.9	%
Never	27.1	22.0	23.5	%
Sometimes	19.8	19.6	20.7	%
Often	5.8	7.9	5.9	%
	1452	1476	912	Abs

I quickly feel exhausted

Never	23.1	20.9	25.1	%
Seldom	44.9	35.6	41.4	%
Sometimes	23.2	29.1	25.4	%
Often	8.5	14.4	8.0	%
	1453	1481	912	Abs

I am fearful and insecure

Never	37.9	34.3	42.2	%
Seldom	38.6	32.9	36.6	%
Sometimes	17.6	23.9	17.3	%
Often	5.0	9.0	3.9	%
	1446	1474	909	Abs

I feel bloated or have pressure in my stomach

Never	39.2	55.1	44.2	%
Rarely	34.6	22.8	31.6	%
Sometimes	20.5	16.8	18.4	%
Often	5.6	5.3	5.8	%
	1456	1462	914	Abs

I suffer from heartburn and belching /72

	ZH	GE	BS	
Never	54.9	54.2	60.2	%
Seldom	26.2	22.3	23.8	%
Sometimes	13.9	16.6	12.0	%
Often	4.6	6.9	4.0	%
	1453	1473	919	Abs

I am constipated

Never	44.8	52.5	48.5	%
Seldom	28.4	22.7	28.2	%
Often	15.2	12.7	12.4	%
Sometimes	11.2	12.1	10.9	%
	1452	1477	919	Abs

I have no energy

Never	32.4	50.1	38.5	%
Seldom	45.2	35.4	44.1	%
Sometimes	18.9	11.7	14.7	%
Often	2.5	2.8	2.7	%
	1444	1454	910	Abs

I am angered by trifles

Never	14.7	32.3	18.7	%
Seldom	42.4	30.2	39.8	%
Sometimes	32.6	28.3	33.9	%
Often	9.8	9.2	7.6	%
	1450	1479	921	Abs

I am worried

	ZH	GE	BS	
Never	17.8	27.7	20.1	%
Seldom	40.7	29.4	41.4	%
Sometimes	30.2	27.4	28.9	%
Often	10.7	15.5	9.6	%
	1450	1482	914	Abs

I suffer from rheumatism

Never	64.5	50.3	65.6	%
Seldom	14.9	14.5	13.3	%
Sometimes	12.3	17.6	13.4	%
Often	7.8	17.6	7.6	%
	1451	1481	916	Abs

I can not concentrate

Never	18.1	28.5	23.0	%
Seldom	46.6	34.2	45.1	%
Sometimes	29.8	29.8	27.9	%
Often	4.8	7.5	3.9	%
	1447	1464	913	Abs

I suffer from feelings of anxiety

Never	24.3	30.1	29.4	%
Seldom	42.0	34.3	38.8	%
Sometimes	26.5	28.7	26.3	%
Often	6.3	6.9	5.6	%
	1447	1475	913	Abs

I suffer from a lack of libido

Never	43.7	59.3	50.5	%
Seldom	32.9	23.9	29.5	%
Sometimes	15.9	13.2	14.8	%
Often	3.6	3.6	5.1	%
	1402	1383	836	Abs

I suffer from sleep disturbances and wake up frequently

Never	28.2	30.0	32.2	%
Seldom	36.1	28.5	33.5	%
Sometimes	22.0	24.2	20.4	%
Often	13.8	17.3	14.0	%
	1459	1487	917	Abs

I cannot fall asleep

Never	30.7	35.9	35.3	%
Seldom	37.8	27.3	34.8	%
Sometimes	21.9	22.4	19.8	%
Often	8.8	14.4	10.1	%
	1447	1484	914	Abs

I am not rested in the morning and have difficulty getting up

Never	20.2	27.5	25.9	
Seldom	35.7	31.6	35.0	%
Sometimes	28.8	25.7	26.2	%
Often	15.0	15.1	12.8	%
	1453	1482	929	Abs

I have bad dreams or nightmares

	ZH	GE	BS	
Never	46.2	41.9	49.5	%
Seldom	36.8	35.2	35.8	%
Sometimes	12.8	16.4	11.4	%
Often	3.8	6.5	3.3	%
	1453	1478	915	Abs

I worry about my job

	ZH	GE	BS	
Never	46.0	46.1	54.9	%
Seldom	31.6	23.7	32.2	%
Sometimes	18.7	23.2	11.3	%
Often	2.6	7.1	1.7	%
	1441	1457	904	Abs

I have problems with my relatives

	ZH	GE	BS	
Never	26.1	29.4	32.5	%
Seldom	42.5	32.1	39.0	%
Sometimes	24.6	29.5	22.3	%
Often	6.3	9.1	6.3	%
	1450	1477	912	Abs

I feel cold, shiver, have cold feet and hands

	ZH	GE	BS	
Never	43.8	50.9	47.8	%
Seldom	29.1	22.7	26.3	%
Sometimes	16.9	16.8	15.6	%
Often	9.0	9.7	10.4	%
	1441	1474	917	Abs

I feel depressed and sad

	ZH	GE	BS	
Never	31.6	41.7	36.6	%
Seldom	44.2	34.6	40.1	%
Sometimes	19.8	19.3	19.2	%
Often	3.8	4.4	4.0	%
	1450	1475	917	Abs

I am tense

	ZH	GE	BS	
Never	18.6	41.3	25.1	%
Seldom	39.4	31.4	37.0	%
Somtimes	33.1	21.7	30.2	%
Often	8.1	5.5	7.7	%
	1446	1449	906	Abs

I suffer from neck or shoulder pains

	ZH	GE	BS	
Never	50.7	47.3	51.7	%
Seldom	23.0	19.7	20.3	%
Sometimes	18.3	19.7	19.4	%
Often	7.5	13.2	8.7	%
	1451	1480	913	Abs

I am restless and cannot sit on the same chair for a long time

	ZH	GE	BS	
Never	27.5	38.7	34.8	%
Seldom	35.5	27.6	33.7	%
Sometimes	23.7	21.6	21.9	%
Often	12.7	12.1	9.7	%
	1450	1475	915	Abs

	ZH	GE	BS	
I have back and lower back pain				/77
Never	28.9	31.4	31.3	%
Seldom	25.9	22.9	23.7	%
Sometimes	27.2	27.2	29.2	%
Often	17.8	18.6	15.8	%
	1456	1476	919	Abs
I suffer from groundless mood changes				
Never	35.7	41.0	40.9	%
Seldom	40.7	34.8	39.9	%
Sometimes	18.4	18.8	15.4	%
Often	4.3	5.4	3.7	%
	1446	1465	914	Abs
I find everything repugnant				
Never	49.2	59.9	53.7	%
Seldom	35.4	25.1	32.7	%
Sometimes	13.4	12.0	12.3	%
Often	1.2	3.0	1.2	%
	1446	1470	910	Abs
My life appears to be monotonous and boring				
Never	46.3	61.3	52.2	%
Seldom	32.6	23.8	29.7	%
Sometimes	17.9	12.3	16.3	%
Often	2.5	2.6	1.7	%
	1449	1472	915	Abs

	ZH	GE	BS	

/78

I feel overworked

	ZH	GE	BS	
Never	30.1	34.8	34.8	%
Soldom	36.5	27.4	36.9	%
Sometimes	27.8	30.7	24.7	%
Often	5.1	7.1	3.6	%
	1451	1465	911	Abs

I drink alcohol

	ZH	GE	BS	
Never	16.6	29.6	16.6	%
Seldom	36.4	33.6	38.1	%
Sometimes	43.4	31.3	41.5	%
Often	3.4	5.5	3.8	%
	1456	1475	919	Abs

Question 71

Use of medication

I take pain tablets

	ZH	GE	BS	
One or more per day	3.4	5.3	4.1	%
One to two times per week	9.4	7.2	8.9	%
Less or never	87.2	87.5	87.0	%
	1434	1418	909	Abs

I take sleeping tablets

	ZH	GE	BS	
One or more per day	1.9	4.8	2.9	%
One to two per week	4.5	8.0	5.3	%
Less or never	92.1	87.1	91.8	%
	1412	1430	898	Abs

I take tranquilizers

	ZH	GE	BS	
One or two per day	3.9	5.2	3.9	%
One or two per week	7.3	7.7	7.3	%
Less or none	88.4	87.1	88.8	%
	1427	1432	904	Abs

APPENDIX 3

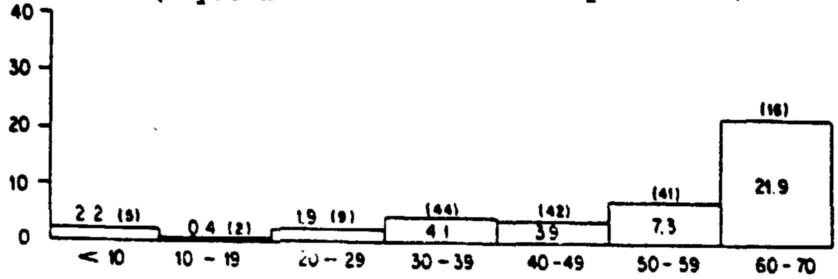
Representation in NNI

Figure 6.1.* **Influence on the person himself, depending on airplane noise exposure (NNI)**

"Did the airplane noise cause you or your family to...

a) "... use earplugs at night?"

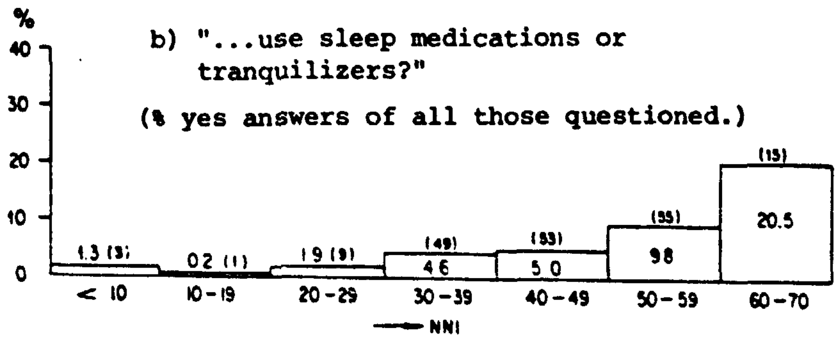
(% yes answers of all those questioned)



(p < .001 γ = -.40)

b) "...use sleep medications or tranquilizers?"

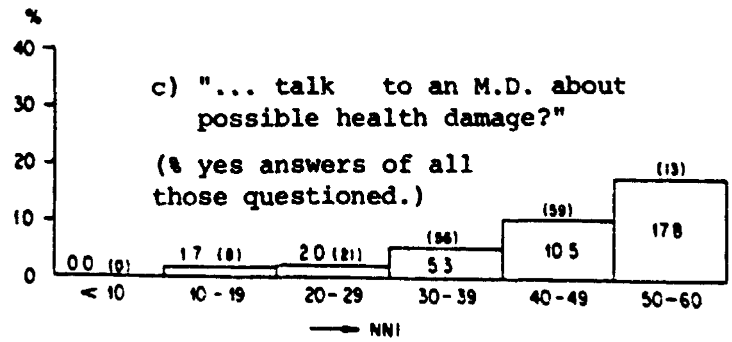
(% yes answers of all those questioned.)



(p < .001 γ = -.47)

c) "... talk to an M.D. about possible health damage?"

(% yes answers of all those questioned.)



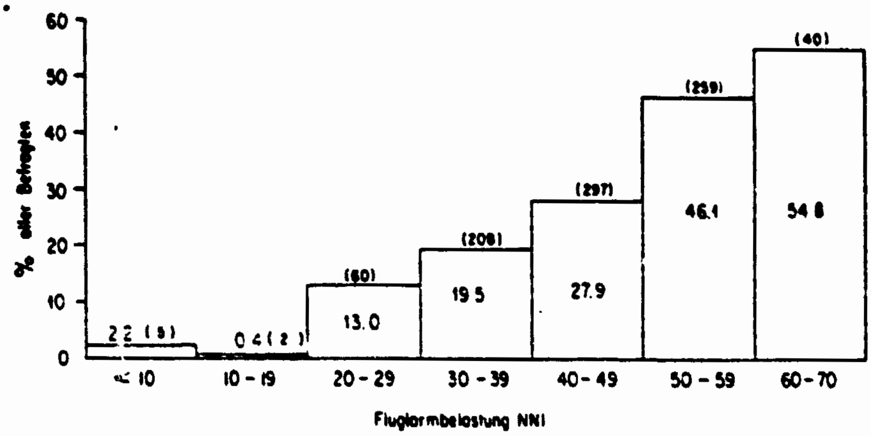
(p < .001 γ = -.63)

Figure 6.5.* Influence on the physical environment depending on airplane noise exposure (NNI) /80

"Did the airplane noise cause you or your family......

a) "... to keep windows and shutters closed?"

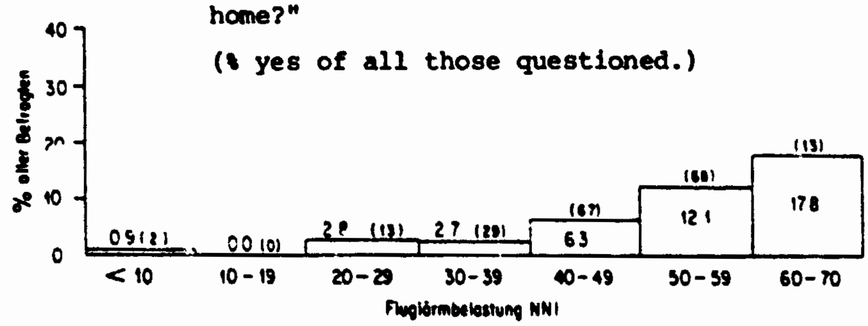
(% yes of all those who were questioned.)



(p < .001 γ = -.56)

b) "... to install sound insulation in your home?"

(% yes of all those questioned.)



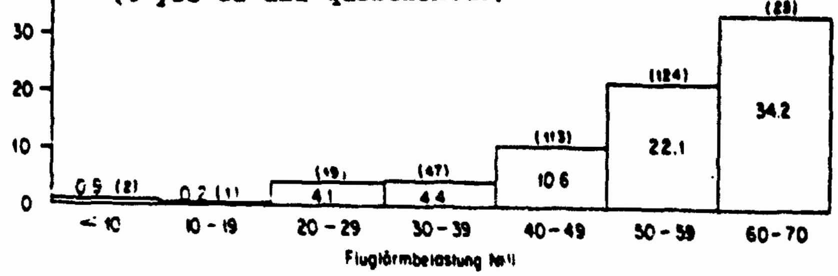
(p < .001 γ = -.56)

Figure 6.6* Disengagement from area of stress causes by mobility depending on airplane noise exposure (NNI) /81

"Did the airplane noise cause you or your family.......

a)"...to stay less outside than you would want to?"

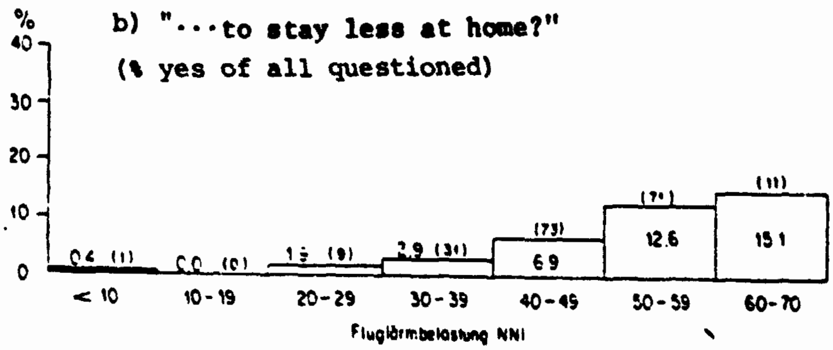
(% yes of all questioned.)



(p < .001 γ = -.62)

b) "...to stay less at home?"

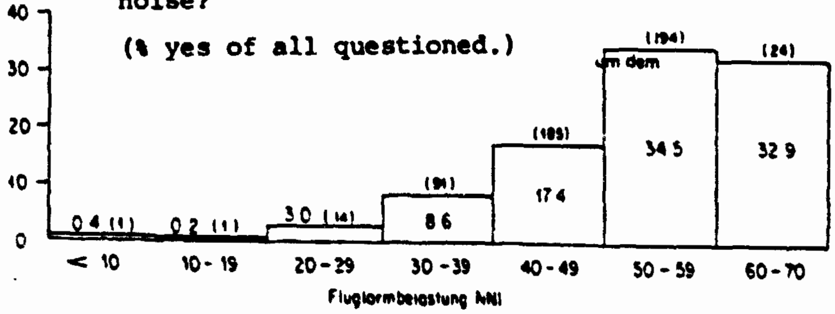
(% yes of all questioned)



(p < .001 γ = -.59)

c) "... to sometimes consider moving away?" in order to escape the airplane noise?"

(% yes of all questioned.)

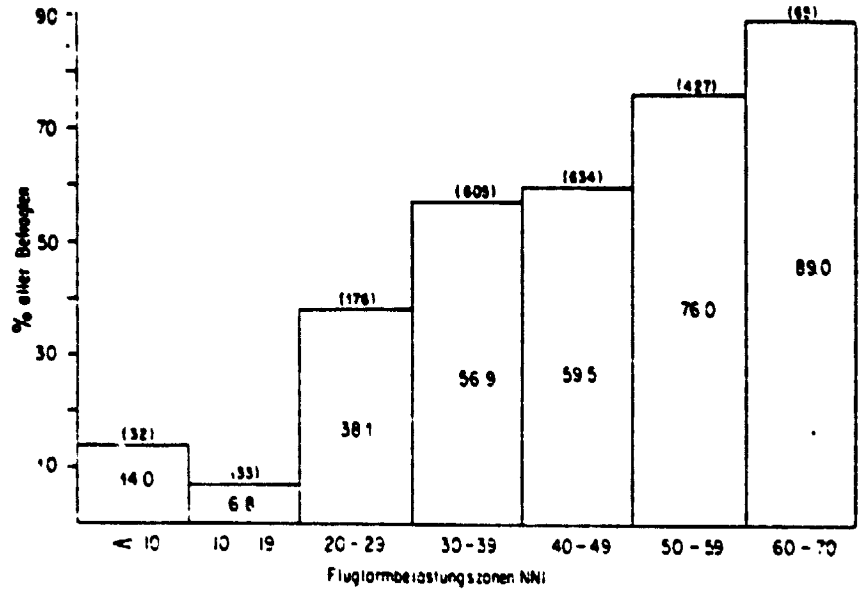


(p < .001 γ = -.65)

Figure 6.9* Use of political articulation depending on airplane noise (NNI) /82

a) "Do you believe that more should be done against airplane noise?"

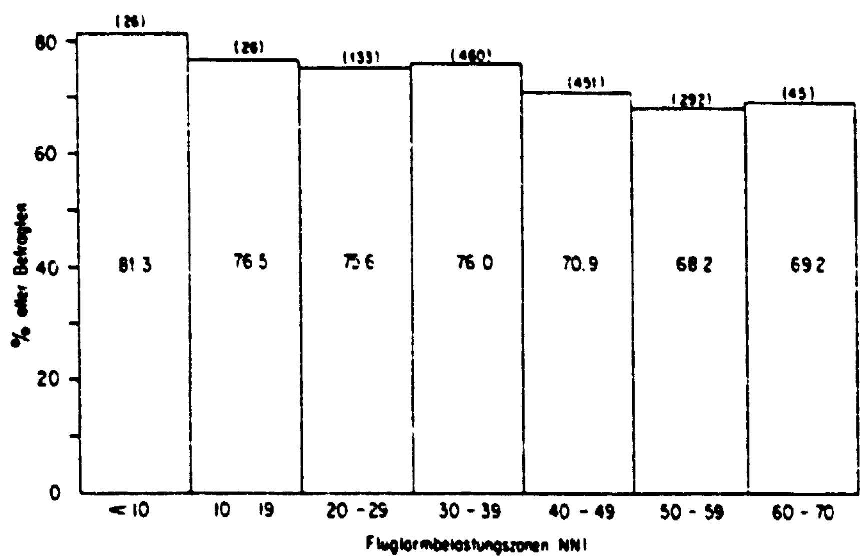
(% of yes answers of all those questioned.)



(p < .001 γ = -.54)

b) Would you yourself support measures actively which you consider effective?

(% yes answers of all those questioned who felt that more should be done against airplane noise.)



(p < .001 γ = .11)

c) "Have you or someone in your family ever complained to an administration or to a newspaper in writing, by phone or in person?
(% of yes answers of all those questionea.) /83

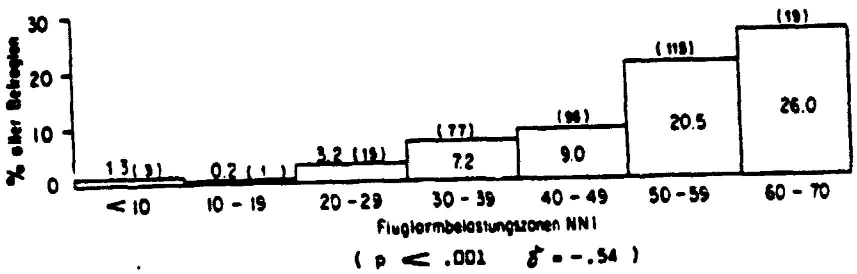


Figure 6.14* Satisfaction with living situation and perceived evaluation by others depending on airplane noise, street traffic noise and total noise exposure

Satisfaction with living situation:"If you think of you residence, do you like it very much, quite well, not very much, not at all?"(% of the "very much" answers of all those questioned.)

Evaluation by others: "If you have visitors from out of town do they find your living situation very good, good, not so good?" (% of "very good" answers of all those questioned