

Psychological evaluation of temporary varying sounds with L_{Aeq} and noise criteria in Japan

Sonoko Kuwano¹ and Seiichiro Namba²

(1) Osaka University, (2) Takarazuka University of Art and Design, Japan

INTRODUCTION

Steady state sounds of short duration were mainly used in the study of auditory perception until 1970's. However, it is important to investigate the perception of non-steady state sounds since our hearing system is not linear and most of the sounds in our environment are varying with time. The authors started the study of the perception of temporary varying sounds in 1960's. At that time, there was no equipment which could control various parameters of the sounds and the first step of our research was to develop the equipment in order to generate temporary varying sounds. The first equipment called "Automatic Stimulus Presenting System¹⁾" was developed in 1968, the second one "Programmable Sound Control System²⁾" in 1972 and the third one "Programmable Sound Control System II³⁾" in 1984. Various parameters of sounds could be independently and easily controlled with these systems. Many psychological experiments have been conducted with systematically controlled sounds and it was found that mean energy level (L_{Aeq}) shows good correspondence with subjective impressions as shown in Fig.1⁴⁾.

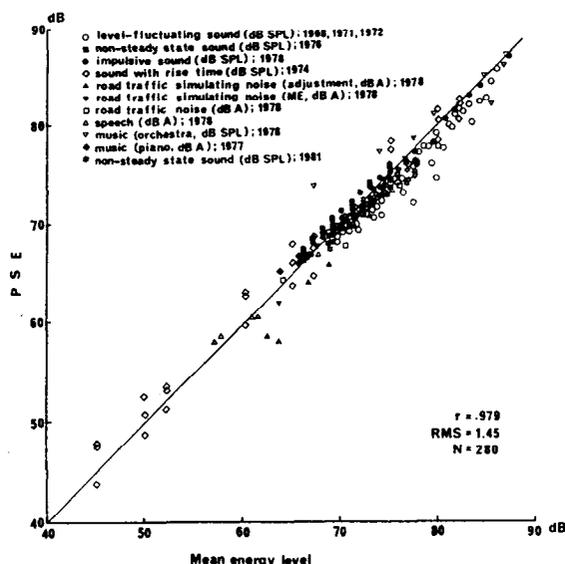


Fig.1

In Japan in September 1998, the environmental quality standard of noise⁵⁾ was revised adopting L_{Aeq} as a noise measure. It is true that L_{Aeq} has many advantages and is a good measure of various kinds of noise. Also it is used widely in many countries⁶⁾. But when it is adopted to various situations, there are some problems to be considered. They are, for example, (1) validity of A-weighting, (2) qualitative aspects of sounds and (3) cognitive aspects of sounds. These topics will be discussed on the basis of the experimental data.

VALIDITY OF A-WEIGHTING

A-weighting has advantages that it is easy to measure and it shows good correspondence with subjective impressions of sounds when the sounds consist of board-band frequency components. However, when sounds have prominent frequency components, A-weighting does not always show good correspondence with subjective impressions⁷⁾⁻¹⁰⁾. An example is shown in Fig.2⁸⁾. In such case, loudness level based on ISO 532B⁹⁾ which is modified so that it can be applied to level-fluctuating sounds¹⁰⁾ is a better measure than L_{Aeq} as shown in Fig.3⁸⁾. It should be better to use either L_{Aeq} or loudness level taking their advantages and disadvantages into consideration.

QUALITATIVE ASPECTS OF SOUNDS

Most of the effort to improve sound environment has been focused on the reduction of sound level. Recently, qualitative aspects as well as quantitative aspects have become to be paid attention. The impression of loudness and/or noisiness can be evaluated with L_{Aeq} . However, even if the value of L_{Aeq} is equal, qualitative aspects of sounds may differ^{11),12)}. An example is shown in Fig.4¹¹⁾. This figure shows that the impression differs according to the number of blades of helicopters even if the values of L_{Aeq} are equal. This suggests that qualitative aspects as well as quantitative aspects play an important role in the improvement of sound environment.

COGNITIVE ASPECTS OF SOUNDS

L_{Aeq} usually shows good correspondence with loudness as the first approximation. However, some difference can be found among sound sources even if L_{Aeq} values are equal¹³⁾⁻¹⁵⁾. An example of the effect of cognitive aspects is a rail bonus. The result of a laboratory experiment¹⁴⁾ is shown in Fig.5, which confirms the propriety of rail bonus adopted in many European countries.

Also the impression of sounds changes depending on the visual information¹⁵⁾. The difference among sound sources cannot be explained by the difference of physical properties alone. Cognitive factors may contribute to the difference. When the permissible level of each sound source is determined, the effect of cognitive aspects has to be taken into consideration.

FINAL REMARKS

It is true that L_{Aeq} is a good index of temporary varying sounds with broad-band frequency components. However, when it is adopted to various situations, careful consideration may be needed.

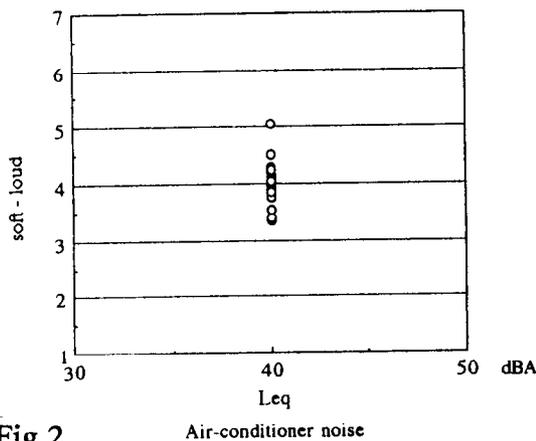


Fig.2

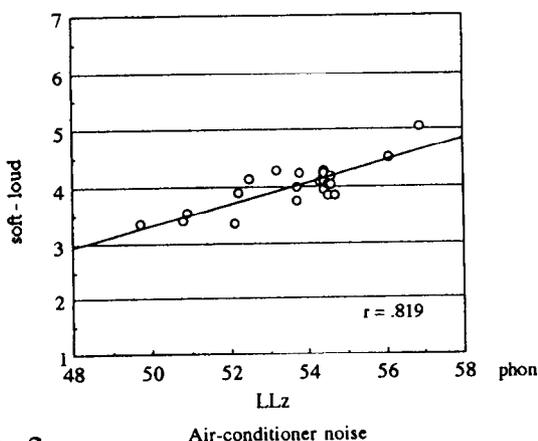


Fig.3

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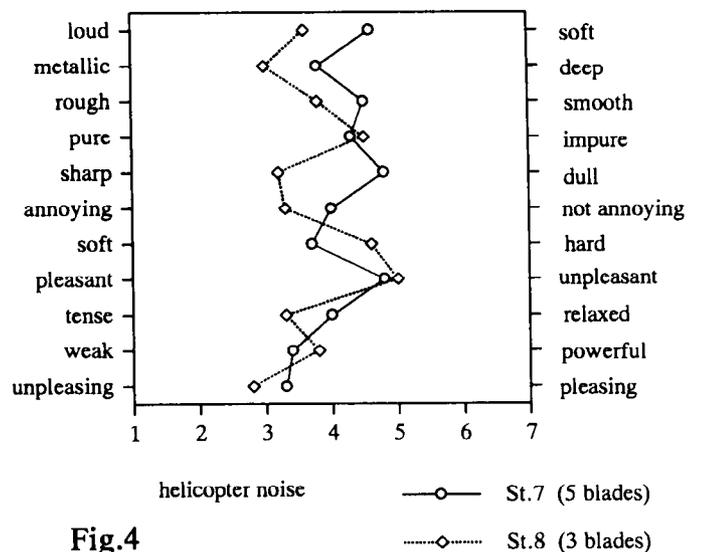


Fig.4

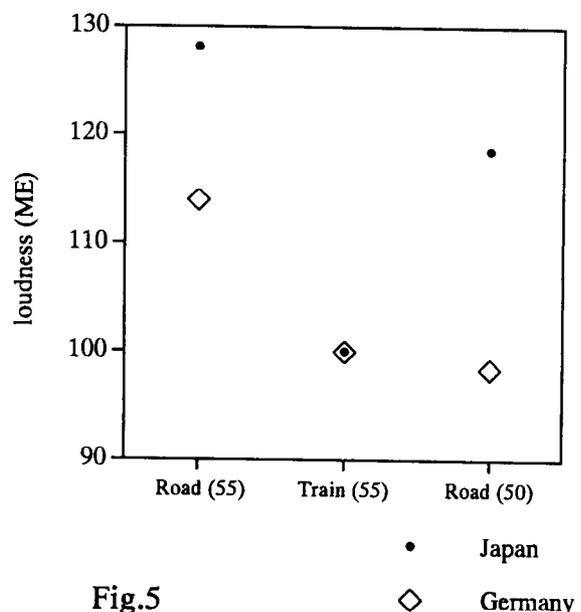


Fig.5