The effects of age on annoyance caused by low frequency noise

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Abstract A laboratory based survey has been carried out to examine the effects of spectral shape of sound on annoyance. Sounds of varying spectral shape and at different dB(A) levels were played to subjects who rated the sounds in terms of annoyance. Analysis of the annoyance ratings has shown that low frequency biased spectra were in general judged to be more annoying than other spectra at levels above 50 dB(A). It was also found that response to low frequency sound varied with age, the older subjects finding low frequency sounds more annoying than other spectra, while younger subjects found the mid and high frequency biased spectra the more annoying.

INTRODUCTION

A laboratory based survey has been carried out to investigate the effects of the spectral shape of sound on annoyance. Noise spectra of various spectral shapes and at different dB(A) levels were played to subjects in the laboratory. Three different groups of subjects were exposed to a series of sounds and asked to assess the sounds in terms of annoyance. The sounds played differed in level and/or spectral shape between the three groups, with approximately half the spectra being biased towards the low frequencies. These low frequency spectra contained peaks in different low frequency bands, and had varying rates of decrease in level from low to mid frequencies. This paper reports some preliminary findings of the analysis of the annoyance ratings of the first group of subjects.

THE LISTENING TEST

There were forty three subjects in the first subject group, mostly academic and technical staff at South Bank University. Of these, the results of six subjects were inconsistent and so were discarded from the subsequent analysis. The ages of the subjects ranged from twenty to sixty five with thirteen subjects in their twenties, six in their thirties, nine in their forties and nine over fifty. The distribution of the subject ages was similar for the other two subject groups.

The listening tests took place in a simulated living room. The subjects were exposed to a total of twenty four sounds, each of which lasted for twenty seconds. The sounds were of six different spectral shapes and each spectrum was played at 50 dB(A), 55 dB(A), 58 dB(A), and 61 dB(A). The spectral shapes were based upon those of commonly occurring environmental noises. The relative shapes of the spectra are shown in Figure 1 which illustrates the six spectra played at 50 dB(A). Three of the spectra had maximum energy in the low frequency region, with peaks in the 31.5 Hz, 63 Hz and 125 Hz octave bands. Low frequency spectra played to other subjects had greater peaks at low frequencies and varying rates of decrease in level from low to mid frequencies.

After listening to each sound the subjects were required to rate the sound for annoyance, using the absolute magnitude estimation method. That is, each subject assigned a number, which could be of any magnitude, to the sound to represent the annoyance caused by the sound. The scores of each subject were subsequently normalised to a mean of zero and standard deviation of one.

In addition to taking part in the listening test, each subject had an audiometric test so that annoyance responses could subsequently be compared with hearing levels.

RESPONSE TO LOW FREQUENCY SOUND

Analysis of the annoyance rankings and ratings of the sounds by all subjects showed statistically significant differences between the responses to the different spectral shapes. In general, at 55 dB(A) and above the spectra biased towards the low frequencies were judged to be more annoying than the other spectra. Furthermore, the rate of increase in annoyance with level was greater for the low frequency (LF) spectra than for the other, non low frequency (NLF), spectra as can be seen from Figure 2 which shows the regression lines relating annoyance to level for the two groups of sounds. At 61 dB(A) the low frequency spectra were judged to be more than twice as annoying as the other spectra. This result seems to be repeated for the other two groups of subjects.
The variation in response to the sound with age has been investigated. For this analysis the subjects were divided into four groups according to age: those in their 20s, 30s, 40s and those over 50. The responses of each age group to the low frequency and non low frequency spectra were in general consistent with the overall results in that at 50 dB(A) all age groups except the over 50s rated the low frequency sounds as less annoying than the other spectra, whereas at the higher levels the low frequency spectra were judged to be the more annoying sounds by all age groups.

However, differences were found when comparing the responses of the four age groups. Table 1 shows the averaged annoyance ratings of the four age groups for the two groups of sounds, the low frequency (LF) and non low frequency (NLF) spectra, at the different levels, rounded to one decimal place. At 50 dB(A), 55 dB(A), and 58 dB(A) the older subjects, that is those over forty, found the low frequency sounds more annoying than the subjects under forty. The non low frequency sounds were, in general, rated as more annoying by the subjects under forty than by the subjects over forty. At 61 dB(A) there was no difference in the annoyance ratings of the low frequency sounds between the different age groups, but the older subjects found the non low frequency sounds slightly less annoying than the younger age groups on average.

A similar analysis of the results of the other two subject groups shows the same distinctions between the responses of older and younger subjects to the low and non low frequency biased spectra.

The differences between the age groups suggested that the annoyance caused by sound might be related to hearing loss, as the older subjects could be assumed to have some high frequency hearing loss. However, a preliminary analysis of the correlation between response and hearing level is inconclusive. Questioning of the subjects after the tests suggested that association of the noise may be an important factor which affects the degree of annoyance caused.

**CONCLUSIONS**

The preliminary results from a laboratory study show that annoyance caused by a sound is dependent upon its spectral shape. At levels above 50 dB(A) spectra with significant low frequency components are judged to be more annoying than other spectra. It also appears that people over forty find sounds which are predominantly low frequency to be more annoying than do younger people, who are more annoyed by sounds with mid and high frequency biased spectra.