A study on perception of alarm signals in car noise

Hideaki Uchiyama (510015)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 8, 2007

Keywords: alarm signal, SRM, ITD, IPD, BMLD.

1 Introduction

Alarm signals should be perceived accurately and efficiently for driver even in car environments to know when and what events occur. However, some interference in masking effects of noise occur such as car environments so that the perception of alarm signals is disturbed. This is a serious problem because this leads to many dangerous situations for the driver. Therefore, it is important to present alarm signals for driver that can be accurately perceived in car environments.

Spatial release from masking (SRM) is referred to as that the masked threshold can be improved using spatial cues in binaural hearing when the signal and masker are spatially separated. SRM was observed by Saberi *et al.*. In our previous work, Nakanishi *et al.* considered that if SRM occurs in real environments, it can suppress the influence of noise on alarm signals facilitating the perception of their existence and directions. SRM is depended on ITD and interaural level difference (ILD) as a cue of the binaural hearing. Perception characteristics that Saberi *et al.* obtained in free-field has the possibility that ITD and ILD become entangled intricately. Therefore, Nakanishi *et al.* considered that the importance of the ITD which is a cue of SRM should be investigated individually. Then, Nakanishi *et al.* used a headphone to present stimulus. Nakanishi *et al.* then investigated perceptual characteristics of the pulse train signal when

they had presented the pulse train signal of which only ITD was varied to the subject in a white noise. As the result of the experiment, Nakanishi *et al.* showed that SRM was occurred by only ITD. In addition, they used alarm signals and experimented as well as the pulse train signal. Then, Nakanishi *et al.* showed that SRM was occurred by ITD and IPD atcomponent frequency.

In this study, a car noise was used as a masker and binaural masked thresholds of alarm signals in noise were measured as a function of ITD of alarm signals changed the frequency of the components. Moreover, the obtained perceptual characteristics were considered.

2 Design of experiments

In general, alarm signals are used in real environments. Therefore, experiments should be carried out in real environments. However, headphone are used for presentation of stimulus and only ITD is set up and the percetion characteristic of alarm signals is investigated. This reason is for using not white noise but car noise as a masker.

3 Perception of alarm signals in car noise

3.1 Purpose

The spectrum of a white noise is constant. However, the spectrum of a car noise is similar to the pink noise. The aim of this experiment is to clarify whether the difference of these two noises influences the occurrence of SRM. The alarm signal of five kinds of component frequency (1.0, 1.5, 2.0, 2.5 and 4.0 kHz) was used as signals.

3.2 Procedure

Only ITD was set to signals. When the median plane was assumed to be 0°, the signal source was moved at the right of the subject (15°, 30°, 45°, 60°, 75° and 90°). The signal - noise configurations were described as follows. The condition that both the signal and the noise located at 0° is denoted by S_0N_0. Signal at 15° and noise at 0° ($S_{15}N_0$) and so on.

3.3 Results

As a result of the experiment, each perception of alarm signals was the similar tendency as the perception characteristic of the alarm signals in white noise. Thus, SRM occurred ITD and IPD at a cue in each alarm signals. On the other hand, it was shown that lower componemt frequency has the larger effect of binaural masking level difference (BMLD). But lower componemt frequency is influenced by noise.

4 The effect which the source of noise of the different arrival direction gives to the perception of alarm signals

4.1 Purpose

The aim of this experimentis to investigate perceptual characteristics in which ITD of the signal is varied and ITD of the noise is varied. This is because it is not only the median plane of a driver that noise comes in car. Therefore, it investigates whether the arrival direction of alarm signals and the masker affects SRM at occurrence.

4.2 Procedure

Only ITD was set to car noise. When the median plane was assumed to be 0°, the noise source was moved at the right of the subject (15°, 30°, 45°, 60°, 75° and 90°). The alarm signal of five kinds of component frequency (1.0, 1.5, 2.0, 2.5 and 4.0 kHz) was used as signals.

4.3 Results

As a result of the experiment, each alarm signals ecah perception of alarm signals was was the similar tendency as the result of Section 2. Thus, SRM occurred ITD and IPD at a cue in each alarm signals. In addition, the arrival direction difference of the source of noise and alarm signals source effects the perception of alarm signals.

5 Conclusion

In this study, in order to consider the presentation method of an effective alarm signals, two experiment results were shown. First, when car noise was used as a masker, it was shown that SRM occurs ITD and IPD at a cue. In addition, the arrival direction difference of the source of noise and alarm signals source effects the perception of alarm signals. On the other hand, it was shown that lower componemt frequency has the larger effect of BMLD. But lower componemt frequency is influenced by noise. Thus, considering the arrival direction of the masker, it is preferable to use the alarm signal in which ITD can be used as cue and present to become the antiphasic by both ears to convey warning accurately and efficiently without loss of information.