Measurement of the laterality threshold of a tone with an interaural intensity difference under temporal masking conditions

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1. Introduction

In the previous studies, the laterality threshold was mainly investigated using a tone with an interaural time difference (ITD) [1], and there are few studies on laterality using interaural intensity differences (IID). In these studies using IIDs, a click or noise is usually employed as a stimulus [2–6]. The aim of the present experiment is to study the laterality using tone bursts with IIDs as stimuli under several temporal masking conditions.

2. Experimental procedure

Three males participated in two experiments, i.e., (a) a detection experiment, and (b) a laterality experiment. Figure 1 shows the stimulus time patterns used in the detection experiment. The duration of a test tone is 5 ms with a rise/

fall time of 1 ms. The frequencies of the test tone were 0.5, 1, 2 and 4 kHz. The masker was a 100 ms tone burst (frequency of 1 kHz or 4 kHz) with a rise/fall time of 1 ms.

The inter-stimulus interval (ISI) is defined as the time between the masker and the test tone. A two interval, two alternative forced choice procedure (2I-AFC) was used in the experiments and the participants were asked to choose the interval in which they detected the test tone. The level of masker was 70 dB SPL and the masker was presented in both intervals at the same level to both ears with an interval of 500 ms. A test tone with an IID of 5 dB was presented in one of the two intervals at random. The level of the test tone was changed depending on participants' responses following the 3-down 1-up adaptive method.

Figure 2 shows the stimulus time patterns used in the laterality experiment. The test tone was the same as that used in the detection experiment. An interferer was presented

Fig. 1 Stimulus configuration used in the signal detection experiment.

Fig. 2 Stimulus configuration used in the experiment of laterality judgment.

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Fig. 3 The detection threshold and the laterality threshold obtained in the three stimulus configuration: simultaneous, forward and backward masking condition. The central part of this figure shows the data obtained under a simultaneous condition, the right side shows the results obtained in the forward condition, and the left hand side shows the results in the backward condition. The data of three subjects (A, B and C) are shown in these figures. The frequency of masker or interferer is 1 kHz.

without IID and a test tone with an interaural level difference of 5 dB, was presented, prior to or followed by the interferer. The laterality threshold was measured using the adaptive technique 2AFC method. The detection and laterality thresholds were measured at three different conditions: simultaneous, forward and backward masking or interfering conditions. In both experiments, the stimuli were presented through headphones (STAX-SA-Pro). The participants were, in their twenties, possessing normal hearing ability.

3. Results

The results obtained are shown in both Figs. 3 and 4. Figure 3 shows the results in the case where the masker or interferer was 1 kHz tone, and Fig. 4 shows those at 4 kHz. In both figures, the abscissa represents the ISI in ms, and the ordinate shows the threshold level of detection or laterality in dB. The center of these figures corresponds the results under

Fig. 4 The detection threshold and the laterality threshold. The format of this figure is the same as Fig. 3 except that the frequency of a masker or an interferer is 4 kHz.

the simultaneous conditions, the right-hand and left-hand sides correspond ones under forward and backward condition, respectively. In these figures (Figs. 3 and 4) the thresholds in no masker condition, are shown in right hand side of each figure. The data from the three participants are shown by triangles, squares and circles and all of them show a similar tendency. When the frequency difference between masker/interferer and signal tone is large (Fig. 3(d)) and Fig. 4(a) (b)) thresholds are unaffected by the masker/interferer and are nearly constant, despite a change in ISI. On the other hand, when the frequencies of the signal tone and masker/interferer are equal (Figs. 3(b) and 4(d)), significant effects were observed in both thresholds. In the backward condition, (Figs. 3(b) and 4(d)) the decrease in the laterality threshold is very small despite increase in ISI.

4. Conclusion

The characteristic feature of the results is that the interference to the laterality threshold is extremely large in backward condition when the frequencies of the test tone and the interferer are the same. This result provides a strong contrast with our previous experiment [1] using the tones with

interaural time difference (ITD), in which the effect of interference to the laterality is not so large in the backward condition. Secondly, when the frequencies of the test tone and the interferer are unequal, the interference to the laterality is very small compared with that observed in our previous experiment.

As the data vary widely between subjects in this laterality experiment, further experiments with more participants are required. In addition, further investigation should be made to elucidate the reason why the interference to the lateralization was prominent in the backward condition when the frequencies of the test tone and the interferer are equal.

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