Chapter 8

Human Characteristics of Sound Localization under Masking for the Early Detection of Dementia

Kouji Nagashima  
Graduate School of Natural Science and Technology, Okayama University, Japan

Jinglong Wu  
Graduate School of Natural Science and Technology, Okayama University, Japan

Satoshi Takahashi  
Graduate School of Natural Science and Technology, Okayama University, Japan

ABSTRACT

Sound localization ability differs among people, such as between a young person, a senior citizen, and a dementia patient. Therefore, it is possible to detect dementia at an early stage by measuring a difference in this ability. Experiments for sound source localization in the horizontal plane show that the ability is improved by separating the presented locations between the signal and a masker. However, there are few data regarding sound localization in the vertical plane. The threshold in the perpendicular plane has been measured, but only experiments in the median plane regarding sound localization have been reported, and its characterization in other aspects has not been clarified. Previous studies about localization ability in the vertical plane have reported contradictory results. One is that the sound source from an upper direction is perceptually superior for a subject, and the other is that a lower direction is superior. The purpose of this study in this chapter is to clarify sound localization ability in the vertical plane and to detect dementia in the early stage using the aging tendency of aural characteristics.

INTRODUCTION

The frequency of dementia (Alzheimer’s disease, AD) increases drastically with an increase in the population of senior citizens. Because it is likely that dementia interferes with a patient’s general life, it is desirable to discover symptoms at an early stage. MMSE is used for the early detection of dementia, but it is vague. Therefore, an effective method to diagnose dementia is necessary. We
employ a human auditory characteristic for the early detection of the dementia.

A human being lives among various sounds in modern society and senses danger by understanding the direction of those sounds. If the sound source cannot be localized for various sounds, life in modern society becomes difficult. It may be said that sound source localization ability under sound masking is important.

A previous study has shown that there is a clear difference in sound localization ability between young people, senior citizens, and dementia patients. Therefore, it is thought that early detection of dementia is possible by examining the sound source localization ability of the subject. However, the sound source localization ability in the vertical plane between a physically unimpaired person and dementia patients was not elucidated in that study. The difference between subjects under the masking condition of daily, real-life noise is likewise unknown.

The difference between the horizontal plane and the vertical plane in sound source localization ability is the use of a head-related transfer function in the vertical plane but an interaural time difference or interaural level difference in the horizontal plane. Because the horizontal plane has many cues for localization, localization accuracy in the horizontal plane is higher than in the vertical plane. Sound source localization in the horizontal plane may be suitable for the early detection of dementia because it requires high localization ability. As for sound source localization in the vertical plane, it seems that a significant difference in ability exists between patients.

This study shows that sound source localization ability in the vertical plane is a means for the early detection of dementia. This is shown using a fundamental experiment about sound source localization ability in the vertical plane, and this study shows that the sound source localization ability is affected by a masking noise.

**SOUND LOCALIZATION**

Sound localization is an ability that allows a person to judge the direction of a sound source from the information of the sound. Figure 1 shows an example of masking. The cues for sound localization are interaural time and level differences and changes of the spectra. Interaural time and level differences are important in sound localization in the horizontal plane, and changes of the spectra are important in sound localization in the vertical plane.

**MASKING**

Masking refers to the inability to hear a signal because of a masker. There are various kinds of