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# How the temporal amplitude envelope of speech contributes to urgency perception

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## Introduction

The speech is one of the main tools when person communicates. Various information are included in speech. Speech has not only linguistic information but also non-linguistic information and para-linguistic information. For example, non-linguistic information is speaker identification and vocal emotion. Para-linguistic information is emphasis and intention. These are significant on communication. There are fundamental frequency and formant frequency as main speech features. The main reason is that speech information can be thought to be derived from human vocal organs. The contributions of typical acoustic features communicated in speech, such as F0, spectral envelope, and power fluctuation, were investigated. There are temporal amplitude envelope and temporal fine structure focus on temporal frequency of speech. Shannon et al. showed that temporal amplitude envelope of speech contribute linguistic information perception by the experiments conducted with noise-vocoded speech. Noise-vocoded speech is speech have only information of temporal amplitude envelope. Noise-vocoded speech synthesized temporal fine structure was changed to white Gaussian noise. Zhu et al. showed around 4 Hz of modulation frequency plays important rolls for linguistic information perception of temporal amplitude envelope. In addition, they showed temporal amplitude envelope of speech plays important rolls for non-linguistic information perception. The cues of non-linguistic perception on temporal amplitude envelope of speech were clarified by the experiments of speaker identification and vocal emotion. Zhu et al. of studies on noise-vocoded speech showed that temporal modulation cues provided by the temporal amplitude envelope affect how vocal emotion and speaker individuality are perceived. However, it is still unclear whether the temporal modulation cues also play an important role in the perception of para-linguistic. Understanding the mechanism of how human can perceive para-linguistic information from speech should be very important for solving of the mechanism of speech perception. This study to investigate the contribution of temporal amplitude envelope of speech on para-linguistic information focus on perception of urgency. Natural disaster be frequent in Japan. The study of disaster prevention and the refuge instruction advances. In the cases, it is important to communicate sense of urgency with speech. Noise-vocoded speech is explain as hearing of cochlea

implant. The hearing of cochlear implant will be improve if it is clarified the roll of temporal amplitude envelope of speech on urgency perception.

## **Purpose**

This study aims to investigate whether temporal amplitude envelope of speech affects urgency perception or not. Here, we experimentally investigated if the temporal amplitude envelope of speech affects the perception of para-linguistic information, particularly urgency. There were two questions. First, it clarify whether the perception of urgency was included in temporal amplitude envelope. The order of urgency perception were compared between evacuation calls and noise-vocoded speech. The order will be the same if the perception of urgency is included in the temporal amplitude envelope of speech. Second, it clarify that modulation frequency cues on the urgency perception. The phycology scale of urgency perception were compared with the stimuli were limit modulation frequency. It was clarify important components of modulation frequency for the urgency perception.

## **Method**

Synthesizing method of noise-vocoded speech as stimuli is explained. The input signal was divided a band by auditory filter bank. Auditory filter bank is frequency resolving power like normal hearing. It was multiplied that temporal amplitude envelope and noise divided into each band. The provided amplitude modulation noise was made to add in whole area. In first experiments, it clarify whether the perception of urgency was included in the temporal amplitude envelope. Four evacuation calls and corresponded noise-vocoded speech as stimuli were used. The stimuli were presented in order of AB. The experiment participants were asked comparison with A B about how much urgency. The experiment participant was ten. Each of determine the number of times were 12 times. Determine the number of times on each conditions were 12 times. The psychological scale were calculated from evaluation values of urgency perception with paired comparison of Sheffe. As results, the order of psychological scale on urgency perception was the same. Thus, it clarified that urgency perception of speech is included in amplitude envelope. Psychological scale of urgency perception of each stimuli were compared. The psychological scale of urgency perception on noise-vocoded speech was large. Sharpness was calculated to examine the factor. The sharpness of the noise-vocoded speech of the same original stimuli were high overall. It suggested that the high sharpness is factor to have felt that urgency perception. 4Hz of at least modulation frequency is

important to linguistic information perception of the amplitude envelope of speech. Second experiments, it find that the cues of modulation frequency relation on urgency perception. The temporal resolution of noise-vocoded speech was controlled by varying the upper limit of modulation frequency for the stimuli. In the condition, cut-off frequencies of low-pass filter were 7 conditions (2, 4, 6, 8, 12, 16 and 32 Hz) and high-pass filter were 7 conditions (4, 6, 8, 12, 16, 24 and 32 Hz). The question was the same in the first experiments. Determine the number of times on each conditions were 756 times. These were compared noise-vocoded speech in which the temporal amplitude envelopes were identical to those of the original speech, and noise-vocoded speech in which the temporal amplitude envelopes had undergone low-pass or high-pass filtering. Urgent scales were derived from a paired comparison of the results and used to investigate the relationship between the temporal modulation components and urgency perception. Results of the experiment in modulation frequency on low components. The psychological scale of urgency was decline from less than 6 Hz of cut-off frequency. Results of the experiment in modulation frequency on high components. The psychological scale of urgency was decline from more than 8 Hz of cut-off frequency. Thus, it was clarified that the components from more than 6 Hz to less than 8 Hz of modulation frequency contribute perception of urgency. In experiment using LPF, around 8 Hz to 16 Hz is important to the non-language information of amplitude envelope.

## **Conclusion**

Three things that this study clarified were indicated. The degree of urgency of the noise-vocoded speech stimuli was perceived as being similar to that of the original. Temporal modulation components of noise-vocoded speech upwards of 6 Hz were significant cues for urgency perception. Temporal modulation components of noise-vocoded speech downwards of 8 Hz were significant cues for urgency perception. The results suggest that temporal modulation cues in the temporal amplitude envelope play an important role in urgency perception.