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Listening is more immersive on text than reading: A pilot study

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Abstract

We found that listening to the text had higher β-wave intensity in the left frontal lobe, greater fluctuations in skin resistance, and higher blink frequency.

Introduction

Understanding the content of sentences is essential not only for learning but also for everyday life in general. Humans understand sentences in two ways: reading or listening. If the understanding efficiency of both functions and the characteristics of the mental internal state are clarified, it is possible to rationalize the information transmission / reception system in human society. However, there are still few studies that have examined psychological and physiological differences due to "reading" and "listening". Therefore, in this study, we examined the characteristics of biological signals while reading and listening to sentences. This paper reports the results of pilot experiments.

Methods

Experimental scheme

A total of 21 adults (20-38) participated in the study. The procedure of the experiment is shown in FIG. After 30 seconds of rest, the subject was presented with two types of sentences in the order of print → voice or speech → print. Sentences prepared two kinds of A and B. They were prepared in both print (A: 1272 letters, B: 1354 letters) and voice (A: 4 minutes and 15 seconds, B: 4 minutes and 34 seconds) format. The subjects were divided into 4 groups (6 people listening to B after reading A (6), groups reading 5 A after listening to B (5), and groups listening to A after reading B (5) , After reading A, read B (5). During the experiment, EEG, heart rate and skin resistance were measured at the same time.

Human EEG

Three healthy children (9 males and 12 females, 29.3 ± 7.1 years old, mean ± SD) participated in our EEG experiments. One EEG session took about 8 min. The human EEGs at AF7, Fpz, AF8, F3, Fz, F4, and Cz (following the international 10/10 coordinate convention) were collected at 500 Hz (the right earlobe was used as a reference) with a wireless EEG system (Polymate Mini AP108, Miyuki

Giken Co., Ltd, Tokyo, Japan) with pasteless dry electrodes (National Institute of Information and Communications Technology, Japan). Eye movements and blinks were simultaneously recorded with an electrode put on a left eye lid. The recorded EEG and eye blink–related signals were saved on a computer using Mobile Acquisition Monitor Program (NoruPro Light Systems) through a Bluetooth wireless connection (Naruse, 2014). The EEGs were analyzed using MATLAB. The raw data were preprocessed offline by a linear trend removal and a band-pass filtering (1 to 40 Hz). Additionally, EEG epochs that contained large potentials and abnormal spike or drifting components were excluded by visual inspections. These noisy epochs were generally derived from eye movements and blinks.

Cardiotachometry

A reflective pulse wave sensor attachable to the subjects' finger was used for heart rate recording. Instantaneous heart rate was calculated with the number of pulses of the last 5 seconds and updated continuously.

Electric skin resistance recording

Grove-GSR sensor (Seeed Technology Co.,Ltd, Shenzhen, China) was used for electric skin resistance recording. Instantaneous electric skin resistance was averaged with the data sampled during last 5 seconds and updated continuously.

Data analysis

The subjects who closed their eyes during recording were excluded from the EEG analysis because the intensity of the alpha wave was higher than that of the other subjects. In addition, EEG data, which contained noise for a long time during recording, was also excluded from analysis. Results We used data of 14 people (5 male, 9 female, 27 ± 7.0 years, mean ± standard deviation) for analysis of EEG. The amount of change in relative intensity of β wave (14–38 Hz) was calculated by the following equation.

$$\Delta\beta \text{ ratio} = \frac{\int_{14\,Hz}^{38\,Hz} p_{task}\,df}{\int_{1\,Hz}^{40\,Hz} p_{task}\,df} - \frac{\int_{14\,Hz}^{38\,Hz} p_{rest}\,df}{\int_{1\,Hz}^{40\,Hz} p_{rest}\,df}$$

,where p_{task} is the EEG power density when presenting a sentence. p_{task} represents the EEG power density in rest.

The signal mixed in the electrooculogram installed in the lower left eyelid was used for the blink detection. 17 subjects (7 males, 11 females, 28 ± 7.0 years old, mean) because data from subjects who had been closed during recording as well as data from EEG and data that contained noise for a long period were excluded from analysis. Data of ± standard deviation) were used for analysis. As for the analysis when listening to a sentence, the analysis was made by dividing the area of 10-4 dB or more as a section in which sound is flowing and the section of less than 10-4 dB as a section in which sound is not flowing.

Results and Discussion

When listening to sentences, the beta wave intensity of the left frontal lobe was significantly higher than when reading. Previous research has found that neurofeedback training for beta waves increases alertness and alertness (Egner, Gruzelier, 2004), and it is thought that more attention is given to the development of sentences when you are listening than when you are reading Be In addition, it is considered that the fluctuation of skin resistance (Fig. 3) is a reflection of the change in the subject's emotion as the story develops. This fluctuation is significantly greater when listening than when reading, suggesting that listening is easier to immerse in the world of writing than reading.

In addition, the frequency of blinks was greater when listening than when reading (Fig. 4). It is inferred from the finding that the frequency of blinks is higher in active thinking than in passive thinking [14210774], and that the world of writing is more positively imagined when listening than when reading. Conceivable.

References

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Notes

 We declare no conflict of interest. Correspondence should be addressed to Yuji Ikegaya (yuji@ikegaya.jp).

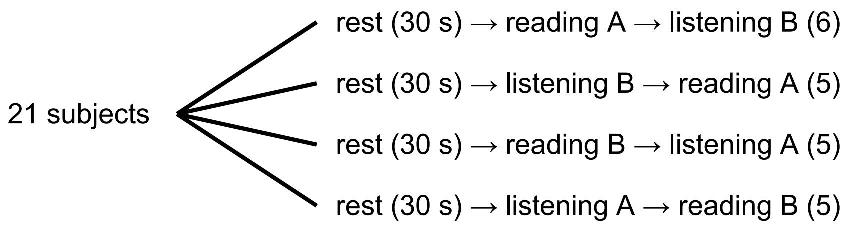

Figure1 Paradigm of the experiment

The time course of the experiment. 21 subjects were divided into 4 groups. The numbers in parentheses indicate the number of people in the group.

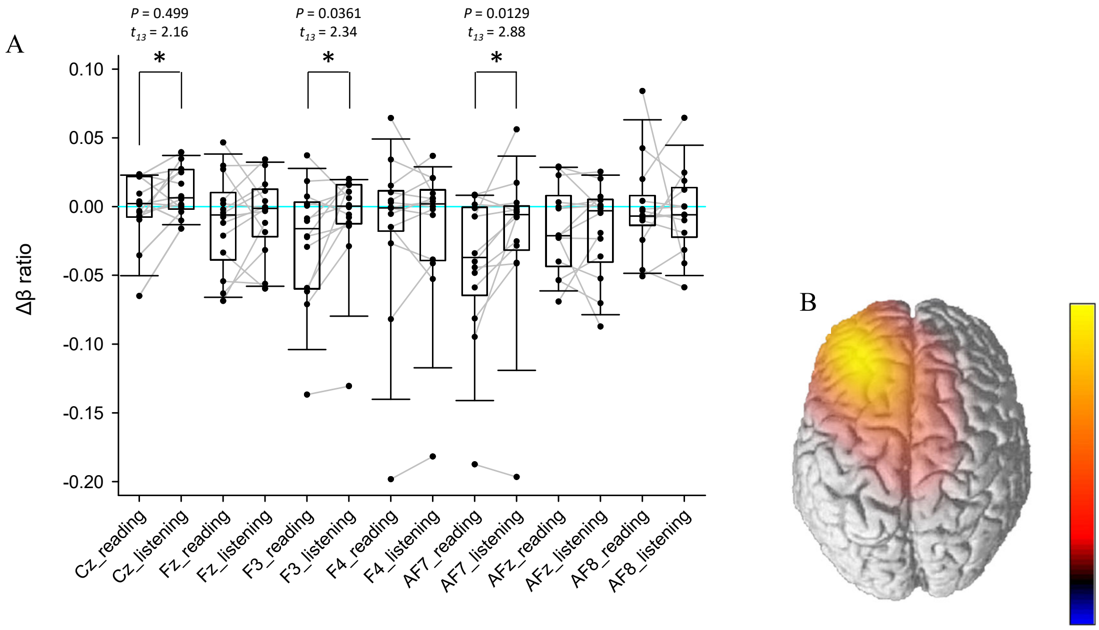

Figure2 The intensity of the beta wave is higher in the left frontal lobe when listening than when reading

A: The intensity of the β wave to the intensity of the whole frequency band is determined for each electrode for each of the reading and reading while listening to the sentence, and the difference (Δβ ratio) from the value in rest is calculated, 14 The data for each person are shown by box and whisker plot. In Cz, F3 and AF7, the amount of increase in β-wave intensity during rest was significantly higher when listening than when reading (Cz; * P = 0.499, t13 = 2.16, F3; * P = 0.0361, t13 = 2.34, AF7; * P = 0.0129, t13 = 2.88, paired t-test). *B*: The ratio to Δβ ratio at reading Δβ ratio at the time of listening was calculated for each electrode, and the median value of 14 persons was displayed as a pseudo color map.

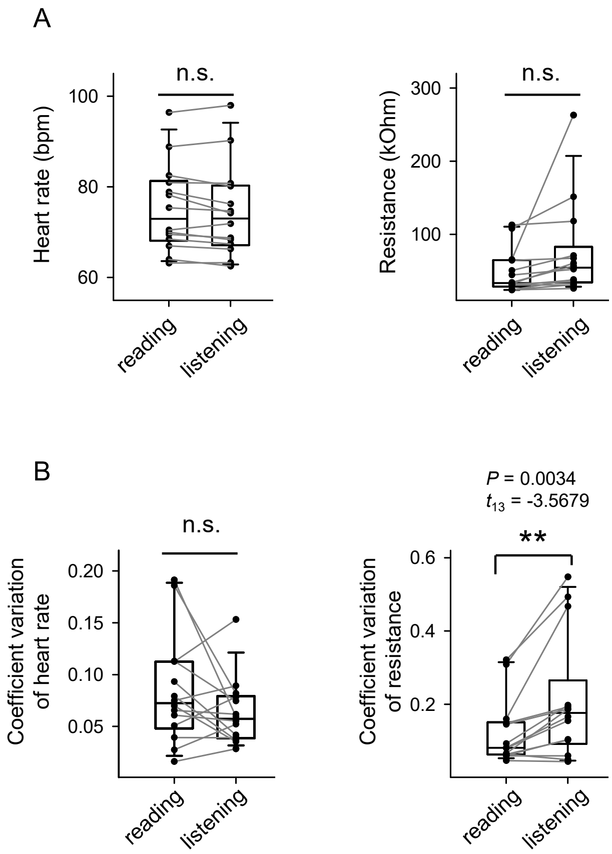

Figure3 The coefficient of variation of skin resistance is higher when listening than when reading *A*, Heart rate (left) and skin resistance (right) when listening and reading. *B*, coefficients of variation of heart rate (left) and skin resistance (right) when listening and reading. The coefficient of variation of skin resistance was significantly higher when listening than when reading (Heart rate; $P = 0.0866$, $t_{13} = 1.8540$, Resistance; $P = 0.0799$, $t_{13} = -1.8997$, CV of heart rate $P = 0.1421$, $t_{13} = 1.5630$, CV of resistance; * $P = 0.0034$, $t_{13} = -3.5679$, paired t-test).

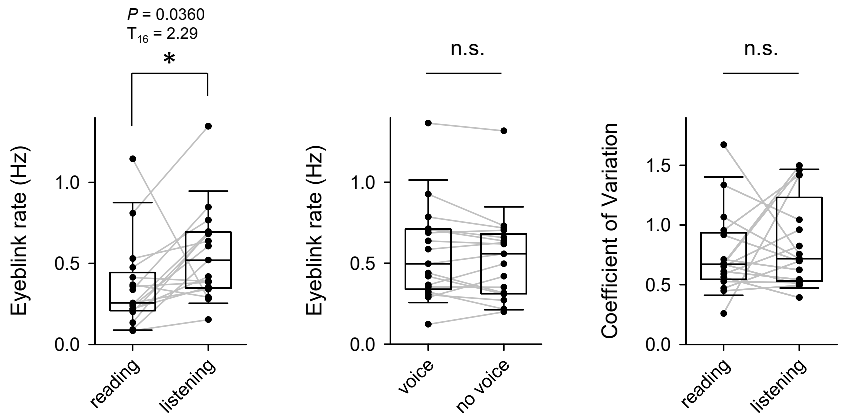

Figure4 Blink frequency is higher when listening than when reading

Left, frequency of blinks while reading and listening to sentences. *Middle*, the blink frequency in the section where the voice is flowing while listening. *Right*, coefficient of variation in blink frequency when reading and listening. The frequency of blinks was significantly higher at the time of listening than at the time of reading (Left; * P = 0.0360, t13 = 2.29, Middle, P = 0.3282, t13 = 1.01, Right, P = 0.4080, t13 = 0.85, paired t-test)