Superiority of Temporal information in Musical pitch perception

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1 Introduction

Both place and temporal information are used in pitch perception. They are also used in musical pitch perception on single note explained as height and chroma. When melodies are perceived instead of single notes in musical pitch perception, it is not clear how place information and temporal information are used and are there any differences exist between melody and single note perception. This study discusses a hypothesis that temporal information is superior to place information in musical pitch perception on melodies.

2 Background

Fujisaki and Kashino showed that if there are any defferences existing in theuse of place and temporal information depending on musical experiences and abilities, pitch identification experiments with and without pitch references should be conducted for subject groups: absolute pitch group and non-absolute pitch group [1]. Three types of stimuli were used to manipulate place and temporal information independently: narrow band

noises (NBN), iterated rippled noises (IRN) and pure tones. It was found that chroma identification was poorer with NBN, and height judgment was poorer with IRN. These results indicate that the temporal information is 、 important for chroma identification and the place information is important for height judgement.

3 Stimuli

Stimuli's pitch are based on equal temperament of 12 degrees. For example, note named C is 261.63 $[Hz]$,D is 293.66 $[Hz]$, E is 329.63 $[Hz]$, F is 349.23 $[Hz]$, G is 392.00 $[Hz]$, A is 440.00 $[Hz]$ and B is 493.88 $[Hz]$. Each note name are based on Western music.

3.1 Narrow Band Noise

Narrow Band Noise (NBN) has strong place information and ambiguous temporal information. NBN has 50 $[cent]$ band width at the center of the frequency which suitable for each note. Its duration is 1 [s] and sampling frequency is 48 [kHz].

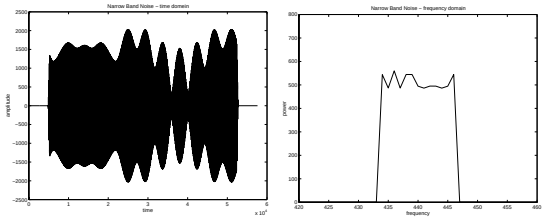


Figure 1: waveform and spectrum of NBN

3.2 Iterated Rippled Noise

Iterated Rippled Noise (IRN) has only temporal information. At first band noise which has 3000 [Hz](from 2000 [Hz] to 5000 [Hz]) band width is made. It is added to itself by d [ms], repetitively. d is 1/f, which f is the suitable frequency for each note. Thus IRN is made. Its duration is 1 [s] and sampling freqfuency is 48 [kHz].

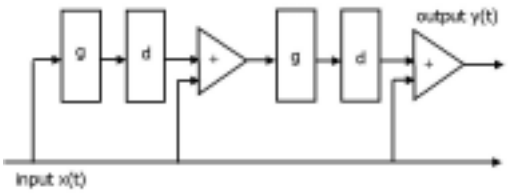


Figure 2: network of IRN

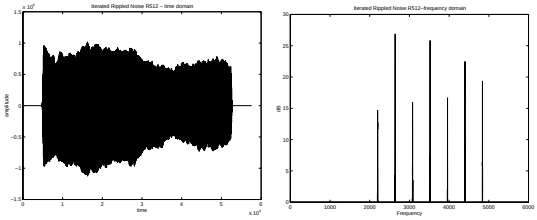


Figure 3: waveform and spetrum (Band noise is added to itself 512 times.)

4 Experiments

4.1 Aim

Graphs which were gathered from the experiments of single notes and melodies are compared. The aim of this section is to ascertain whether graphs of melodies are shifted from that of single notes or not. This is conductive to discuss my hypothesis.

4.2 Subjects

Seven graduate students who known to have normal healing abilities. Here, the musical experience was not required for the subjects.

5 Method

Two kinds of melodies were used in the experiments of melodies (see figure4). Style of melodies were made simply so that subjects could perceive in the expeliments easily. The three groups of single notes composing melodies -$(lowtone, hightone) = (D(239.66\,[Hz]), B(493.88\,[Hz])), (E(329.63\,[Hz]), A(440.00\ [Hz])), (F(249.23\ [Hz]), G(392.00\ [Hz]))$ - were used in experiment of single notes. When stimuli were synthesized, loudness of stimuli

were controlled not to affect perception of single notes and melodies as shown in table 1. Stimuli were presented as follows. $No.1 \sim No.7$ in table 1 , low tones (note named D, E, F) were made of IRN. High tones (note named B, A, G) were made of NBN. Sound pressure level of NBN was controlled from 42 $[dB]$ to 60 $[dB]$ by 3 $[dB]$. Meanwhile, sound pressure level of IRN was fixed 51 $[dB]$. These IRN and NBN were presented simultaneously (presenting pattern (a)). $No.8 \sim No14$ in table1, though stimuli used to make low and high tones were identical to those of $No.1 \sim No.7$, sound pressure lebel of NBN was fixed 51 $[dB]$ and that of IRN was controlled from 42 $[dB]$ to 60 $[dB]$ by 3 $[dB]$(presenting pattern (b)). $No.15 \sim No.21$ in table1, low tones were made of NBN. High tones were made of IRN. Sound pressure level of NBN was fixed 51 $[dB]$. Sound pressure level of IRN was controlled from 42 $[dB]$ to 60 $[dB]$ by 3 $[dB]$ (presenting pattern (c)). $No.22 \sim No28$ in table1, though stimuli used to make low and high tones were identical to those of $No.15 \sim No.21$, sound pressure lebel of NBN was controlled from 42 $[dB]$ to 60 $[dB]$ by 3 $[dB]$ and sound pressure level of IRN was fixed 51 $[dB]$ (presenting pattern (d)). These presenting pattern were common to three groups of single notes: (D, B), (E, A), (F, G) and two melodies. Number of stimuli presented in experiment were $84(28 \times 3)$ by each set, and 3 sets were done in each experiment. Duration of stimuli was 1 $[sec]$, time period between one stimulas and next stimulas was 5 $[sec]$. Order presenting stimuli was random. The subjects try to respond which single note (or melody) is clear with 7 grade scale (figure**??**). The results of experiments was shown as follows (subject1, 2, 3).

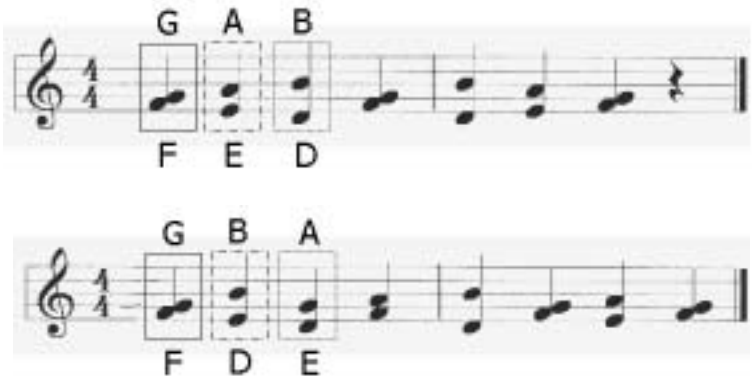


Figure 4: Groups of single notes composing melodies

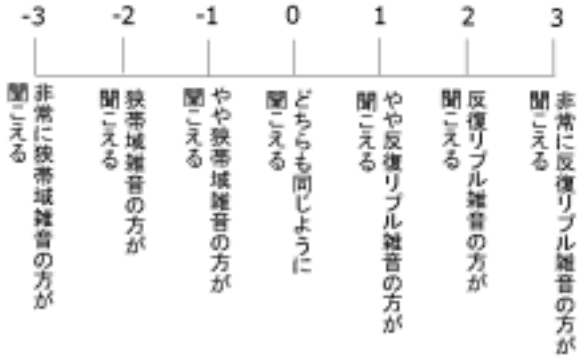


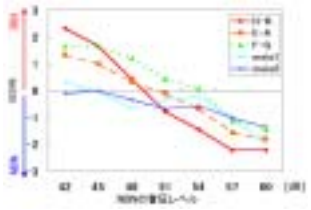
Figure 5: 7 grade scale

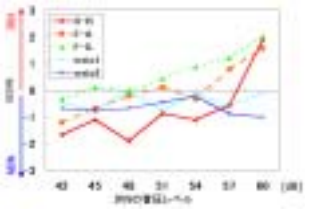
No	note:D, E, F	note:B, A, G
1	IRN - 51 [dB]	NBN - 42 [dB]
2	IRN - 51 [dB]	NBN - 45 [dB]
3	IRN - 51 [dB]	NBN - 48 [dB]
4	IRN - 51 [dB]	NBN - 51 [dB]
5	IRN - 51 [dB]	NBN - 54 [dB]
6	IRN - 51 [dB]	NBN - 57 [dB]
7	IRN - 51 [dB]	NBN - 60 [dB]
8	IRN - 42 [dB]	NBN - 51 [dB]
9	IRN - 45 [dB]	NBN - 51 [dB]
10	IRN - 48 [dB]	NBN - 51 [dB]
11	IRN - 51 [dB]	NBN - 51 [dB]
12	IRN - 54 [dB]	NBN - 51 [dB]
13	IRN - 57 [dB]	NBN - 51 [dB]
14	IRN - 60 [dB]	NBN - 51 [dB]

No	note:D, E, F	note:B, A, G
15	NBN - 51 [dB]	IRN - 42 [dB]
16	NBN - 51 [dB]	IRN - 45 [dB]
17	NBN - 51 [dB]	IRN - 48 [dB]
18	NBN - 51 [dB]	IRN - 51 [dB]
19	NBN - 51 [dB]	IRN - 54 [dB]
20	NBN - 51 [dB]	IRN - 57 [dB]
21	NBN - 51 [dB]	IRN - 60 [dB]
22	NBN - 42 [dB]	IRN - 51 [dB]
23	NBN - 45 [dB]	IRN - 51 [dB]
24	NBN - 48 [dB]	IRN - 51 [dB]
25	NBN - 51 [dB]	IRN - 51 [dB]
26	NBN - 54 [dB]	IRN - 51 [dB]
27	NBN - 57 [dB]	IRN - 51 [dB]
28	NBN - 60 [dB]	IRN - 51 [dB]

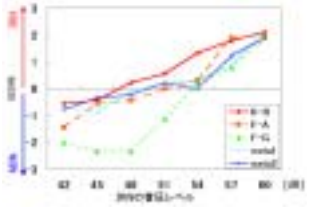
Table 1: Table of stimuli's sound pressure lebel presented in the experiments

(a) (b)





(c) (d)



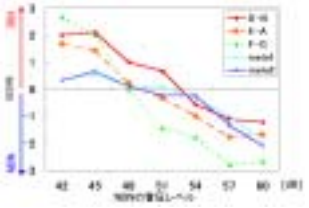
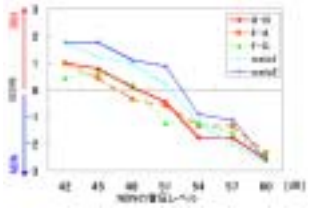
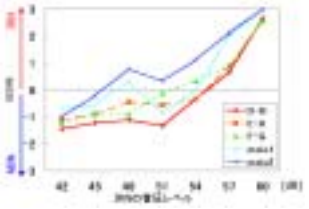


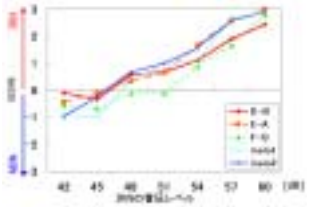
Figure 6: results of subject 1

(a) (b)





(c) (d)



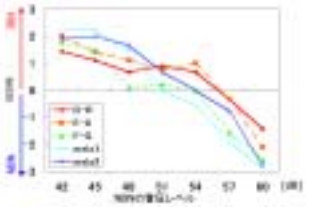
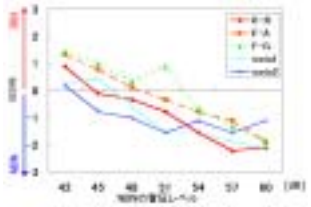
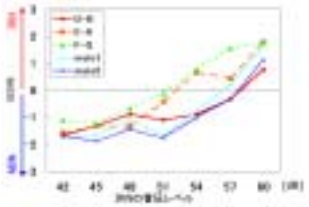


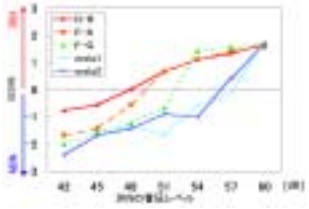
Figure 7: results of subject 2

(a) (b)





(c) (d)



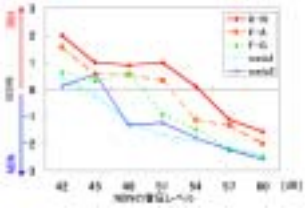


Figure 8: results of subject 3

5.1 Results

Graph of melodies were shifted from the place located graph of single notes to IRN side or NBN side. Subjects whose graph of melodies were shifted from the place located graph of single notes to IRN side may use temporal information better than place information when they listened to melodies (subject2, 5 – temporal information group). Subjects whose graph of melodies were shifted from the place located graph of single notes to NBN side may use place information better than temporal information when they listened to melodies (subject3, 4 – place information group). Subjects whose graph of melodies were not shifted may not use either information mainly (subject1, 5, 6 – non changed group).

6 Conclusion

In this paper, a hypothesis that temporal information is superior to place information in musical pitch perception on melodies could not be proved. This is because method of experiments is not good enough, or the hypothesis is not true etc. Subjects whose results support the hypothesis are more musically experienced than the others. If all subjects who participate in

experiments are musically experienced enough,

References

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