The Effect of Audio Concentration using Spectral Slope in Sound Signal

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Abstract. Generally, some music makes people feel excited and comfortable while some music makes people feel unpleasant and nervous. Like this, not all music and sounds help people. This phenomenon follows a law called (1/f). 1/f indicates an angle of inclination. If the property of the sound is close to a 1/f diagonal line, it makes people feel peaceful, relax and comfortable. Therefore, in this paper, the influence of the 1/f diagonal line on concentration is analyzed. Then, through experiment, it was confirmed that when inclination is less than 30°, music is boring and it doesn’t influence on concentration. However, when the inclination is more than 30°, the change of music or a sound make people pleasure and it influences on concentration positively.

Keywords: Spectral slope, Sound quality, Autocorrelation

1 INTRODUCTION

Sounds of nature such as waves, streams, rain, the song of a bird, and wind grazing leaves has the effect on making people relax. The reason why the sounds of nature make people relax is because of fluctuation of 1/F. As fluctuation of 1/F is caused by an uneven law, it attracts people’s attention since it makes people feel good.[3] Also, the reason why people feel comfortable when listening to classic music is because classic music contains a lot of fluctuation of 1/F.[2,4] the sound of heart beat is the power spectrum and an alpha wave that indicates comfortable state of mind and body is 1/F type.[1]

THEORETICAL BACKGROUND

The sound has wave energy. Power spectrum indicates relationship between power and frequency, which the wave has. Fluctuation that the music and the sound have through power spectrum is indicated as energy density per unit frequency. Fluctuation of 1/F can be expressed like the equation (1).

\[ P = \frac{1}{f} \] (1)
Here, P is power and f is frequency. Since 1/f is the inverse number of frequency, P becomes 1/2 when frequency becomes double. It is indicated as a log graph that horizontal axis is frequency and vertical axis is power like figure 1.

![Fig. 1 A 1/f fluctuation of Classical Music.](image)

Autocorrelation function $R(t, \tau)$ is a function which shows correlation between a signal at time $t$ and a signal in $t + \tau$. When $R(t, \tau)$ is wide-sense stationary process, it is independent from time $t$ and becomes $R(\tau)$ by defining $\tau$ function which is only a time difference. In autocorrelation function $R(t, \tau)$ of wide-sense stationary process, the formula of continuous signal is like equation (2),

$$R(\tau) = \int_{-\infty}^{\infty} v(t)v(t+\tau)dt$$

(2)

and the formula for discrete signal is like equation (3),[6]

$$R(\tau) = \sum_{t=-\infty}^{\infty} v(t)v(t+\tau)dt$$

(3)

In Autocorrelation function $R(\tau)$, let $\tau$ which is the time difference decreasing mutuality sharply be correlation time $\tau_c$. This correlation time $\tau_c$ of autocorrelation function is closely related to power spectrum.

$$v(t) = \begin{cases} |\tau| < < \tau_c, & v(t+\tau) \text{ Correlation High} \\ |\tau| > > \tau_c, & v(t+\tau) \text{ Correlation Low} \end{cases}$$

(4)

If power spectrum of $v(t)$, power spectrum($S_v(f)$) has white spectrum, correlation time $\tau_c$ of time signal $v(t)$ is closed to 0. Like this, since the music that $\tau_c$ is closed to 0 has the large change of sound, the sound is irregular. Also, if low frequency component of power spectrum is
larger than high-frequency component, $\tau_c$ is also large. Therefore, since the music that $\tau_c$ is large has low change of the sound, it becomes boring.

Correlation time of time signal having characteristic of $1/f$ spectrum is smaller than correlation time of time signal having characteristic of $1/ f^2$ and correlation time of time signal having characteristic of white spectrum is large. When listening to music having proper $\tau_c$, the music is not boring and it makes people feel good.

Like figure 2, when the inclination is large, generally it makes people feel comfortable and cheers people up. However, like figure 3, when listening to music that the inclination is gentle, the music is boring. Fig. 3 $1/f$ is small inclination

![Fig. 2 A 1/f is large inclination](image1)

![Fig. 3 A 1/f is small inclination](image2)

3 EXPERIMENT AND RESULT

The sounds of nature like below were used to study on concentration.

First, the experiment was divided into two classes.
1) One class listened to the music and the sounds of nature in table 1.

2) Another class listened to the music and the sounds of nature in table 2.

Ordinary male and female fifty university students were subject of experiment and in university classrooms, normal lectures were given for certain time and we made students memorize something while playing music and sounds in table 1 and 2. When playing the music in table 1, concentration became higher and students memorized well. On the other hand, when playing the music in table 2, it couldn’t influence on stability in mind, so the concentration became lower.

Table 1. A High inclination of 1/f

<table>
<thead>
<tr>
<th>Title of a sound [music]</th>
<th>Inclination</th>
<th>Classify Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bach - Air On The G String</td>
<td>45</td>
<td>Classic</td>
</tr>
<tr>
<td>Dvorak - Humoresque</td>
<td>40</td>
<td>Classic</td>
</tr>
<tr>
<td>Bach - Brandenburg Concerto No.1 in F major, BWV. 1046</td>
<td>42</td>
<td>Classic</td>
</tr>
<tr>
<td>Beethoven - Moonlight Sonata</td>
<td>39</td>
<td>Classic</td>
</tr>
<tr>
<td>Joyongpill – Friend (korean singer)</td>
<td>43</td>
<td>Popular Song</td>
</tr>
<tr>
<td>Heart Beat</td>
<td>38</td>
<td>Sound in the Human Body</td>
</tr>
<tr>
<td>The sound of the waves on the beach (Mongdol beach - korea beach)</td>
<td>45</td>
<td>Nature Sound</td>
</tr>
<tr>
<td>The sound of Emile Bell</td>
<td>37</td>
<td>Sound of a Bell</td>
</tr>
<tr>
<td>The sound of Bosingak Bell</td>
<td>35</td>
<td>Sound of a Bell</td>
</tr>
</tbody>
</table>

Table 2. A Low inclination of 1/f

<table>
<thead>
<tr>
<th>Title of a sound [music]</th>
<th>Inclination</th>
<th>Classify Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fragrance - DongGyu Kim (korean singer)</td>
<td>23</td>
<td>Classic</td>
</tr>
<tr>
<td>Traffic Noise (Subway)</td>
<td>20</td>
<td>Noise</td>
</tr>
<tr>
<td>Vivaldi - Four Season</td>
<td>30</td>
<td>Classic</td>
</tr>
<tr>
<td>The sound of the waves (small volume)</td>
<td>25</td>
<td>Nature Sound</td>
</tr>
</tbody>
</table>

Table 3. Questions used for survey

<table>
<thead>
<tr>
<th>Questions</th>
<th>Not at all</th>
<th>Normal</th>
<th>Mostly yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well as concentrate when studying.</td>
<td>5</td>
<td>10</td>
<td>35</td>
</tr>
</tbody>
</table>
To fifty students, the survey was conducted by asking and answering questions through subjective questions. As a result of the survey, 37 students said that psychological stability was influenced and 35 students said that the concentration was influenced.

4 CONCLUSION

In this study, how music influences on concentration was analyzed. 74% of students answered that the music and the sounds in table 1 made them feel relax and 70% of students answered that the music and sounds influenced on the concentration. On the other hand, the music and the sounds in table 2 couldn’t influence on concentration. As a result of this study, music and sounds which have certain inclination make people relax and comfortable, and help concentrate.

REFERENCES


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