

# PSYCHOLOGICAL STUDY OF STRONG EXPERIENCES IN LISTENING TO MUSIC: A RELATIONSHIP BETWEEN PARTIAL AND OVERALL EVALUATIONS OF PHYSICAL REACTIONS

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## ABSTRACT

Previous studies have shown that ratings of SEM (Strong Experiences of Music) strongly relate to ratings of physical reactions at the conclusion of the music. As physical reactions are aroused by fluctuating acoustical features of the music, it has been suggested that ratings of physical reactions for each music passage differ. In this light this study makes an attempt to clarify the relationship between overall and partial evaluations of physical reactions in listening to music.

Four representatives of partial evaluations of physical reactions were calculated and it was hypothesized that one of them corresponded to overall evaluations of physical reactions. The four representatives considered were the mean, the median, the maximum, and the upper values of cumulative relative frequency distribution of partial evaluations.

Absolute values of differences between overall evaluations and partial representatives of physical reactions were calculated, and then averaged to indicate degrees of correspondence. As a result,  $R_{80}$ , the 80% value of cumulative relative frequency distribution, strongly corresponded to overall evaluations. This suggests that an overall evaluation is determined rather based on high partial evaluations than by averaging all partial evaluations.

This study is expected to contribute to the quantitative clarification of SEM in the future.

## 1. INTRODUCTION

Previously, Yasuda *et al*<sup>1</sup> showed there is a significant relationship between the rating of SEM (Strong Experience of Music, as defined by Gabrielsson & Lindström<sup>2</sup>), and five physical reactions: 1) goose pimples, 2) lump in the throat, 3) shivers down the spine, 4) being close to tears, 5) arousal. These five physical reactions were selected from a pilot survey based on a study by Sloboda<sup>3</sup>; SEM and physical reactions were rated at the conclusion of the music (overall evaluation), and their relationship examined.

A relationship between overall physical reactions and SEM was suggested by the above-mentioned study. As music develops in temporal sequences and therefore physical reactions may be induced by fluctuating acoustical features of the music, we may assume that these physical reactions

vary during different passages of the music. In this respect, Sloboda showed that particular musical passages with characteristic acoustical features provoke specific physical reactions. Additionally, other previous studies pointed out the importance of time serial approach in psychological investigations of music (e.g., Schubert<sup>4</sup>). This may suggest that physical reactions to music vary with the progress of time.

This raised the following issue: how does an overall evaluation of physical reactions in listening to music relate to partial evaluations (i.e., evaluations of each musical passage)? Although partial evaluations of physical reactions may vary with the time course, a way must exist in which to put them together so that we can evaluate overall physical reactions. How does this overall evaluation reflect in partial evaluations? To this end, the present study aims at revealing the relationship between overall and partial evaluations of physical reactions when listening to music.

There are some studies that investigated the relationship between overall evaluations and partial or continuous evaluations. Schubert<sup>5</sup> conducted experiments using 2DES (two-dimensional emotion-space) to investigate the validity of the continuous 2DES rating scales and he explored the relationship between overall ratings and averaged continuous ratings of 2DES. Brittin and Duke<sup>6</sup> carried out a study on emotional intensity in music that compared a summative rating with an averaged continuous rating. Schubert<sup>5</sup> and Brittin & Duke concluded that overall ratings were higher than the mean of continuous ratings. Yuki *et al*<sup>7</sup> compared the mean and the maximum of partial emotions to overall emotions in a study on the relationship between SEM and emotions. However, they could not conclude that either the mean or the maximum of the partial emotions correspond to the overall emotion. In a study on fluctuating sounds utilizing noise stimuli, Nakamura<sup>8</sup> compared overall ratings with the upper values of cumulative relative frequency distribution of short-term rating of noisiness. She showed that in this case the 90% value of cumulative relative frequency distribution of short-term ratings correlates well with overall impression ratings.

We hypothesized that one of the following representatives of partial ratings of a physical reaction will correspond to an overall physical reaction rating: 1) the mean, 2) the median, 3) the maximum, and 4) the upper values of cumulative relative frequency distribution of partial evaluations. The selection of these representatives was based on the above-mentioned studies. The mean and the

median are generally used as a data representative. Yuki *et al* utilized the maximum as a representative of partial evaluations. The use of the upper values of cumulative relative frequency distribution of partial evaluations was suggested by the study of Nakamura.

## 2. METHOD

### Participants and Stimuli

149 students of Osaka University and Soai University in Japan took part in the study. They were divided into 2 groups; participants in each group listened to different musical stimuli. A pilot study confirmed that these stimuli produced completely different impressions on listeners (Yasuda *et al*<sup>9</sup>).

77 participants (56 male, 21 female) listened to “Nocturne in E minor, No. 19 Op. 72-1” (Composer: F. Chopin, Performer: Daniel Barenboim, Duration: 4’19”, Catalogue number: Polydor K.K. POCG-7068). This group was labeled “Nocturne”. Some participants in this group were tested in a soundproof room and some in a lecture room of Osaka University. They ranged in age from 18 to 31 years old (mean age = 19.6, SD = 2.42).

72 participants (32 male, 40 female) listened to an excerpt from “Polonaise HEROIQUE in A flat major, No. 6 Op.53” (Composer: F. Chopin, Performer: Martha Argerich, Duration: 3’01”, Catalogue number: Gakken AE-1004). This group was called “Polonaise”. The participants in this group were tested in a soundproof room of Osaka University or a lecture room of Soai University. They ranged in age from 18 to 30 years old (mean age = 20.8, SD = 2.33).

### Procedure

All participants were asked to evaluate the degree to which five physical reactions occurred: 1) goose pimples, 2) lump in the throat, 3) shivers down the spine, 4) being close to tears, and 5) arousal, on seven-point monopolar scales (0: not at all, 6: very strongly). This subjective rating procedure was adopted in this study as actual physiological measurement of these particular physical reactions is very difficult to carry out.

For partial evaluations, the musical stimuli were played using a psychological rating method for level-fluctuating sound developed by Nakamura. As shown in Fig.1 which exemplifies this method, the musical stimuli were divided into segments based on musical structures suggested by an experienced piano player. 6 segments for “Nocturne” (ranging from 22 to 64 seconds), and 10 segments for “Polonaise” (ranging from 8 to 25 seconds) were applied. While playing the pieces representing the stimuli, each segment to be evaluated was signaled by a visual cue displayed on a monitor all through the segment, without interrupting the music. Participants evaluated all segments of “Nocturne” in two trials, and all segments of “Polonaise” in three trials. For example, in the case of “Nocturne”, visual cues in the 1st trial were presented during segments 1, 3 and 5, and consequently participants evaluated their physical reactions during these segments, and in the second trial they evaluated the remaining segments. Participants were required to start evaluating their physical reactions aroused during a segment right

after the visual cue went off and finish as quickly as possible, before the beginning of the next visual cue.

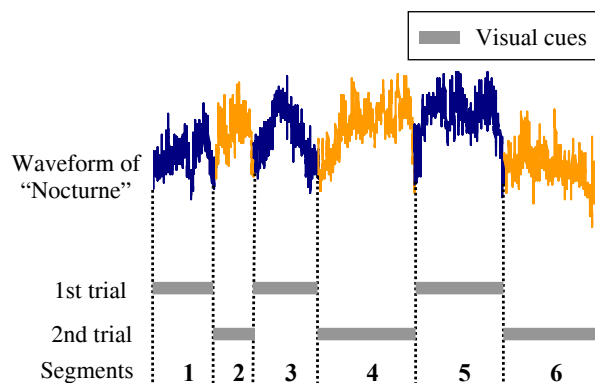
There are some advantages to using this rating method. First, it enables participants to evaluate each segment without disrupting the continuity of music, which brings it near to usual music listening situations, thus preserving the ecological validity of the experimental design. Second, in continuous rating (e.g. Continuous Response Digital Interface) it is difficult to examine the relationship between acoustic features of the music and physical reactions, as ratings of physical reactions are slightly delayed and may not correspond anymore to the particular acoustic features that caused them; however, by appointing in advance the passage to be rated, the physical reactions ratings will correspond to the specific musical passages that provoked them, and therefore our method allows an accurate examination of the acoustic features – physical reactions relationship. As we intend to examine the relationship between acoustic features and partial evaluations of physical reactions in a future study, we selected this rating method as more appropriate.

For an overall evaluation, the stimuli were played back without visual cues and participants rated the same five physical reactions as for partial evaluations, after listening to the musical stimuli.

All participants in each group evaluated both partially and overall their physical reactions. First, they had a practice trial in order to become familiar to our rating method, then they proceeded with the partial evaluations task, followed by the overall evaluation task.

### Apparatus

The musical stimuli and visual cues were recorded on DVD-R and played back using a DVD player (Panasonic DVD-LA95), 2 speakers (SONY SS-AL5), an amplifier (SONY TA-V88ES) and a TV monitor (SHARP LC-15E2) in the experiment taking place in the sound proof room, and speakers, screen and projector for the experiment taking place in the lecture room.



**Figure 1:** The method of psychological rating for level-fluctuating sound for “Nocturne”.

### 3. RESULTS

To verify our hypothesis, four representatives of partial ratings of physical reactions were calculated for each item and each participant. The four representatives considered were: 1) the mean, 2) the median, 3) the maximum, and 4) the upper values of cumulative relative frequency distribution of the partial evaluation. Following the calculation of the four representatives, degrees of correspondence between overall evaluations and partial representatives were computed. To this end, absolute values of the differences between overall ratings and the representatives of partial ratings were calculated, and further averaged.

The results are shown in Table 1. Numerical values represent degrees of correspondence between overall evaluations and representatives of partial evaluations, lower values indicating higher correspondence. We selected three types of the upper values of cumulative relative frequency distribution of partial evaluations in Table 1:  $R_{70}$ ,  $R_{80}$  and  $R_{90}$ .  $R_{70}$ ,  $R_{80}$  and  $R_{90}$  represent respectively the 70%, 80% and 90% values of cumulative relative frequency distribution of partial evaluations. Fig.2 exemplifies the calculation method for  $R_{80}$ .

All items in each group in Table 1 showed that the upper values of cumulative relative frequency distribution of partial evaluations, particularly  $R_{80}$ , have higher degrees of correspondence to the overall evaluations than any other representatives. This tendency was common to both groups, which represent two different stimuli that produced completely distinct impressions. The  $R_{80}$  value indicates the highest degree of correspondence to the overall evaluation for almost all items (nine out of ten items).

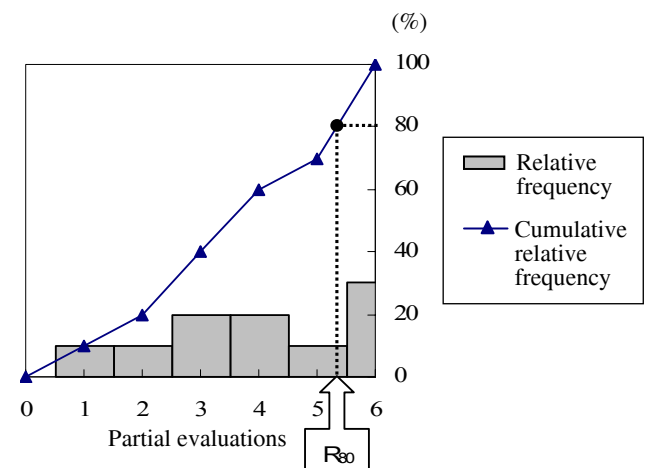
### 4. DISCUSSION

To examine the relationship between overall and partial evaluations based on our hypothesis, the degrees of correspondence between overall evaluations and the four representatives, i.e., the mean, the median, the maximum,

and the upper value of cumulative relative frequency distribution of the partial evaluation, were computed. As a result,  $R_{80}$  shows the highest correspondence to the overall evaluation for almost all items.

Fig. 3 illustrates the relationship between overall ratings and  $R_{80}$  for the item "lump in the throat", clearly showing the tendency mentioned above.

Our results indicate that the overall evaluation corresponds to the higher ratings in the distribution of partial evaluations rather than to their mean. That is to say, the overall evaluation concentrates not around the averaged values, but rather around high values of the partial evaluations. This suggests that highly rated musical passages strongly affect overall evaluations of the entire musical piece.



**Figure 2:** The calculation method for the upper values of cumulative relative frequency distribution (An example of  $R_{80}$ ).

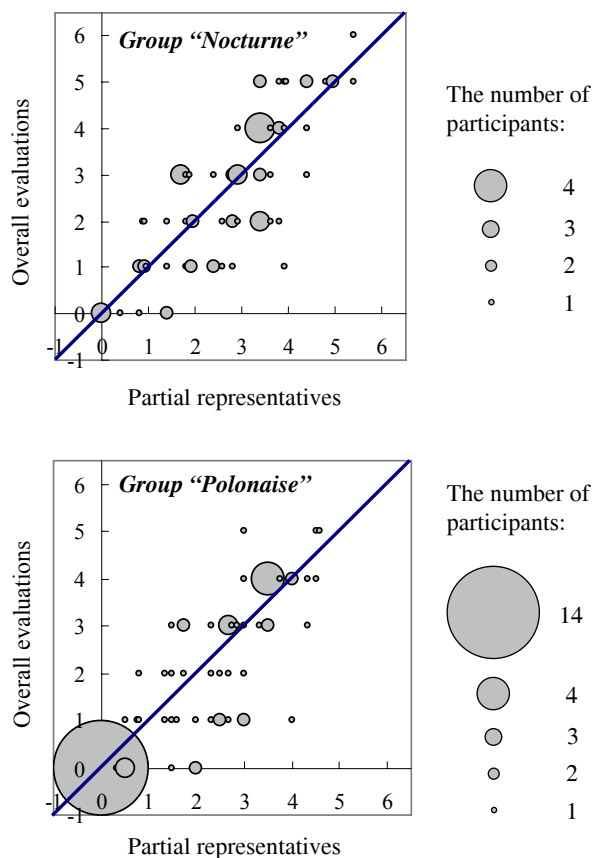
**Table 1:** Degrees of correspondence between overall evaluations and partial representatives

		mean	median	maximum	upper values of cumulative relative frequency distribution		
					$R_{70}$	$R_{80}$	$R_{90}$
group "Nocturne"	goose pimples	0.83	0.92	0.90	0.82	<b>0.75</b>	0.79
	lump in the throat	0.85	0.83	1.17	0.79	<b>0.74</b>	0.95
	shivers down the spine	0.81	0.77	1.14	<b>0.76</b>	<b>0.76</b>	0.96
	being close to tears	0.94	0.97	0.92	0.88	<b>0.85</b>	0.91
	arousal	0.95	1.01	1.19	0.94	<b>0.87</b>	1.00
group "Polonaise"	goose pimples	1.79	0.75	1.32	0.75	<b>0.72</b>	0.93
	lump in the throat	0.69	0.69	1.19	<b>0.63</b>	<b>0.63</b>	0.70
	shivers down the spine	0.71	0.74	1.49	<b>0.70</b>	0.75	0.94
	being close to tears	0.58	0.63	1.08	0.58	<b>0.51</b>	0.64
	arousal	0.91	0.97	1.15	0.86	<b>0.80</b>	0.85

Note. Lower values indicate higher correspondence between overall evaluations and partial representatives.

Since overall evaluations showed higher values than averaged partial evaluations in Brittin & Duke's study, they suggested that high emotional intensity points of the stimulus have greater weight than the low points in the perception of overall effect. Our results support their conclusion and supply quantitative evidence for it. Also, as we experience such phenomena in daily life when we listen to music, our results are reasonable from both empirical and scientific perspectives.

This study provides meaningful information that will contribute to the quantitative clarification of SEM (Strong Experiences of Music) in future research.



**Figure 3:** The relationship between overall ratings and  $R_{80}$  representing partial ratings for "lump in the throat".

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