International Journal of Music and Performing Arts
December 2017, Vol. 5, No. 2, pp. 1-7
ISSN: 2374-2690 (Print) 2374-2704 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/ijmpa.v5n2a1
URL: https://doi.org/10.15640/ijmpa.v5n2a1

# Characteristics of Professional Pianists' Psychophysiological Responses and Playing Time during Concerts

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**Abstract**

The purpose of this study was to investigate the characteristics of the psychophysiological responses and playing time of professional pianists during concerts. The participants were two female pianists. The Features of Agari Experience Questionnaire (FAEQ) was used to assess their negative psychological reactions during an actual performance and their heart rate (HR) was recorded to evaluate their physical reactions during a performance. The results suggested that, in 12 pieces of music played by the two pianists, the playing time in two pieces became longer during the actual performance than during practice, whereas it was similar for two other pieces during the actual performance and practice. The other eight pieces became shorter during the actual performance than during practice. We calculated how much the playing time changed during an actual performance compared to during practice (i.e., the playing time change rate; PTCR). A correlation analysis showed that there was no significant relationship between the PTCR and HR, but the PTCR was negatively correlated with the FAEQ ($r = -.63$, $p < .05$). These findings suggest that the playing time became shorter when negative psychological reactions were higher, although the playing time was not affected by the HR.

**Keywords:** professional pianists, psychological reactions, physical reactions, heart rate, playing time, Japan

## 1. Introduction

### 1.1Time Evaluation During a Piano Performance

It is often said that time flies when you are having a good time, but you feel as if a day has lasted forever when you are having a bad time. This subjective evaluation of the time course is called "time evaluation," and it is affected by the psychological burden (Matsuda, 1996). It is reported that during the performance of tasks, such as mental arithmetic and driving, the more difficult the task is, the shorter the evaluated time is (Iwanaga, 1996; Wilsoncroft, Stone, & Bagrash, 1978). Accordingly, time evaluation during the performance of tasks is generally affected by the type of task, especially the level of difficulty (Orihara, 1996).

The question then arises of what kind of characteristics do pianists show in terms of their time evaluation during a piano performance? Generally, pianists perform a complex technique with both hands, and they move the pedals down and up with both feet. Pianists usually play pieces of music in which they press thousands of keys in a minute, and their time evaluation is expressed in terms of the playing time. The playing time is considered to include a variety of factors that affect time evaluation, such as the artistic interpretation of a piece, negative physical and psychological reactions, and so on (Bannai, Kase, Kimura, &Oishi, 2017; Sloboda& Lehmann, 2001). In a former study, when professional pianists played a compulsory piece repeatedly both with and without an audience, their playing time per piece showed similar values under both conditions (Imanishi, Oishi, Bannai, Kimura,& Komatsu, 2016).However, since this finding was obtained ina laboratory study, so far, no study has reported the playing time of professional pianists during a concert.

### 1.2 Agari Responses during a Concert

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Accordingly, since time evaluation is considered to be affected by physical and psychological burdens, attention must be paid to "agari" responses during an actual performance in order to investigate the characteristics of pianists' playing time. In Japan, agari are defined as "negative physical and mental responses, including poor performance, to excessive emotional tension felt in the presence of an audience" (Hasegawa, 1979). The agari responses usually annoy a wide range of musicians from students majoring in music to well-known professional pianists (Asai, Asai, Sakaguchi, & Asai, 2005; Wesner, Noyes, & Davis, 1990).

Actually, it has been reported that a few musicians drink alcohol and take narcotic and psychotropic drugs in order to reduce the agari responses (Nagel, 1993; Wesner et al.,1990; Wills & Cooper, 1988). In addition,the agari responses can cause mental health problems, such as depression, in the long term (Bannai, Kase, Endo, &Oishi, 2016; Bannai et al., 2017). Steptoe (2008) pointed out that the agari responses during performance consist of two components: psychological reactions, such as anxiety, panic, or distraction, and physical reactions, such as heart rate (HR) elevations or excessive sweating. Former studies that focused on the psychological reactions have demonstrated that many kinds of anxieties can occur during an actual performance, such as anxiety about technical failure and disturbances in musical expression (Bannai et al., 2017). Additionally, previous studies of the physical reactions have stated that the HR of performers was elevated 30 beats per minute compared with that during rest, and their levels of adrenaline and cortisolin an audience-present condition increased substantially compared to that in a no-audience condition (Fredrikson & Gunnarsson, 1992; Haider & Groll-Knapp, 1981).Although it may be clear that the psychological and physical states of musicians during an actual performance are affected by the agari experience, no previous study has investigated both the psychological and physical responses of musicians during an actual performance.

### 1.3 Purpose

By revealing the characteristics of the playing time during an actual performance and the relationships between these characteristics and the agari responses, it could lead to an improvement in pianists' performance. Furthermore, by identifying that the playing time of an actual performance can reflect the agari responses, it may be possible to estimate the level of the agari responses from the playing time more easily and objectively. Therefore, the purpose of this study was to investigate the characteristics of the psychophysiological responses and playing time of professional pianists during a concert.

## 2. Methods

### 2.1 Participants

We chose participants who met the following criteria: people who have won awards in piano competitions, those who have graduated from university majoring in music, and those who have performed in concerts at least once a year as a professional pianist. The participants were two female pianists. The ages of the participants were 58 and 27 years, and their performing careers were 52 and 21 years long respectively. Details of the participants' careers and an outline of the concerts are displayed in Table 1.

**Table 1.Details of Participants' Careers and Outline of the ConcertsParticipant**

| Participant | Age (years) | Career | Outline of the concerts |
|---|---|---|---|
| P1 | 58 | She has won awards in international piano competitions. She has been giving recitals and performing with orchestras worldwide, and has released many compact discs. | ・Piano solo performance in a salon<br>・Performing classical and popular music pieces<br>・Total playing time is 1 hour 30 minutes |
| P2 | 27 | She has won awards in piano competitions in Japan. She has been giving piano solo and ensemble recitals. | ・Duet piano performance in a salon<br>・Performance pieces are all of classical music<br>・Total playing time is 45 minutes |

### 2.2 Ethical Considerations

This study was approved by the ethics committee of the authors' affiliated university (no. 2016-11). The participants provided written informed consent and then received surveys to be completed by hand (i.e., with pencil and paper) in a central location.

### 2.3 Subjective Evaluation and Recording of Physical Reactions during a Performance

#### 2.3.1 Evaluations of playing time and subjective agari responses

The participants were asked to record their performance during practice and in actual performances to investigate the playing time. Later, we calculated the playing time per piece from these recordings. We analyzed 12 pieces in which the playing time ranged from 170 seconds to 670 seconds per piece.

The Features of Agari Experience Questionnaire (FAEQ) that was developed by Arimitsu and Imada (1999) was used to assess the subjective agari response levels during an actual performance. This questionnaire comprises 52 items related to the sub-factors of self-insufficiency, physical insufficiency, trembling, pressure, physiological response, and awareness of others. The items are rated from 1 (strongly disagree) to 4 (strongly agree). We selected 28 items with factor loadings of $\geq 0.4$ so that the participants were not overloaded with questions. The item "I did not sleep well" was excluded from this study because it referred to the participants' pre-performance states. Thus, we used 27 items from the FAEQ to obtain the subjective agari responses. A high FAEQ score is associated with a high level of subjective negative mental and physical responses.

#### 2.3.2 HR and heart rate variability (HRV)

The frequency analysis of HRV was used to examine the physical agari response levels of each condition, and HR was recorded to evaluate this during a performance. A low frequency (LF)/high frequency (HF) ratio was used to represent HRV; that is, a higher HRV indicated higher sympathetic nervous system activity and vice versa (Washino& Nishida, 2011). Participants wore a Polar RS800CX HR monitor (Polar Electro, Kempele, Finland) that was used to record the HRand its inter-spike (R wave time lag:RR) intervals during rest periods and during performances. The obtained RR interval data were analyzed using the Polar ProTrainer 5 software (Polar Electro, Kempele, Finland). Then, the software's frequency analysis system was used to calculate the dominant frequency bands; that is, very low (0.03–0.04 Hz), low (LF: 0.04–0.15 Hz), and high (HF: 0.15–0.4 Hz). We calculated the LF/HF ratio from the LF and HF after canceling any artifacts.

### 2.4 Procedure

This study was conducted using the following procedure.

1) The participants were asked to individually record their HR ina run-through performance during practice that was conducted 1 week before their actual performance (practice).
2) The participants were asked to record the same content as in (1) during their actual performance. Additionally, we asked them to remember their actual performance and to answer the FAEQ for each piece (actual performance).
3) Regarding the psychological pressure experienced during the actual performance, we asked participants to record their HR during a rest period during the day after their actual performance (rest).

The statistical analyses were conducted using IBM SPSS Statistics 20 (IBM Corp., Tokyo, Japan).

## 3. Results and Discussion

### 3.1 HR and HRV

The HR data during the rest, practice, and actual performance are shown in Figure 1. The HR was highest in the actual performance, followed by during practice, and then during rest. This finding is consistent with that of former reports (Haider & Groll-Knapp, 1981). Additionally, the HR changed in each piece. This change might have been affected by some factors, such as psychological tension and the intensity of the exercise with the movement of the arms and torso. However, since the findings were not clear, further studies should be conducted to investigate these factors.

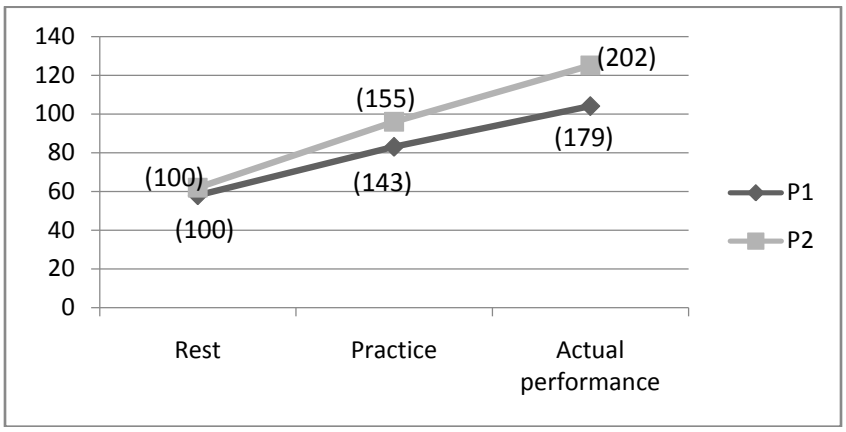


**Figure 1.The heart rate in each condition**

Note. The brackets contain the relative values based on the rest period ([rest/practice or actual performance] ×100). P1 indicates participant No. 1, P2 indicates participant No. 2.

The LF/HF ratio data during each condition are shown in Figure 2. The LF/HF ratio was highest during the actual performance, followed by during practice, and then during rest. Bannai and Imanishi and Oishi (in press) reported that the LF/HF ratio of the professional pianists was higher in an audience-present condition than in a no-audience condition, and the HR showed similar values under both conditions. Accordingly, these results indicate that the sympathetic activity of the pianists was higher during the concerts compared to in the experimental and/or practice conditions.

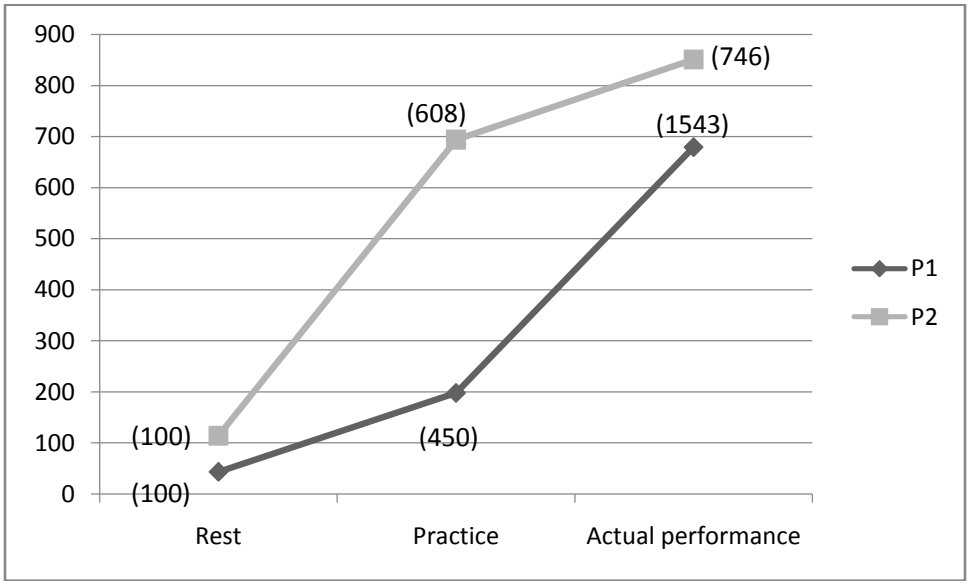


**Figure 2. The heart rate variability in each condition**

Note. The brackets contain the relative values based on the rest period ([rest/practice or actual performance] × 100).

### 3.2 Playing Time

The playing time change rate (PTCR) per piece is shown in Figure 3. We calculated how much the playing time during the actual performance differed from that during practice. In the 12 pieces performed by the two pianists, the playing time in two pieces became longer during the actual performance than during practice (i.e., the PTCR was above 100), whereas for two other pieces it was similar during the actual performance and practice. The other eight pieces became shorter during the actual performance than during practice (i.e., the PTCR was below 100). The average change rate was 94.6%.As previously discussed, Imanishi et al. (2016) have reported that the playing time of professional pianists was not affected by the audience compared with amateur players in the experimental condition. Therefore, the above results showed that the playing time of the professional pianists during a concert was different from that in an experimental condition.

Additionally, the playing time during an actual performance became shorter than during practice even for the professional pianists due to psychological and physical tension. Bannai and Oishi(2015) reported that before an actual performance, Japanese music majors felt anxiety about the tempo of playing the piece, possibly becoming faster in the actual performance. They may have experienced the tempo of playing the piece becoming faster in their past concerts, and the experience then evoked the anxiety that occurred before the actual performance. In the future, it will be desirable to investigate the relationship between anxiety that occurs before an actual performance and anxiety that occurs during an actual performance.

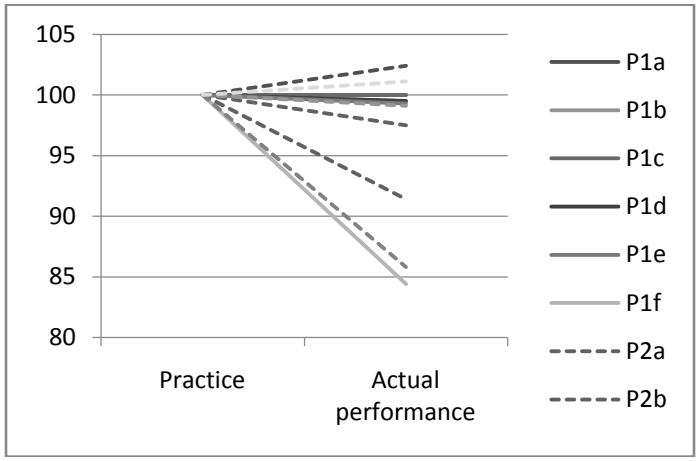


**Figure 3. The playing time change rate of each piece of music during practice and an actual performance**

Note. The actual performance was indicated by the relative values based on the practice ([practice/an actual performance]) × 100). The alphabetic characters (a–f) indicate each piece for each participant.

### 3.3 Subjective Agari Responses during an Actual Performance

The data of the FAEQ scores and HR per piece is shown in Table 2. We calculated T-scores to help compare scores. Regarding studies that have used the 27-item version of the FAEQ, Bannai et al. (2016) reported that the mean score was 69.1for the most recent performance in public in students majoring in music. Bannai et al. (in press)have also pointed out that the mean score was 60.8 in amateur piano players during an experimental condition, and 34.0 in professional pianists. In this study, the mean score was 40.2.

Thus, the agari responses of professional pianists are lower than those of students majoring in music and amateur piano players. Additionally, the levels of professional pianists' subjective agari responses in the actual concert may be higher than those in the experimental condition. There was a variation in subjective agari responses per piece (Table 2). This finding shows that the subjective tension was different in each piece, even for professional pianists. A former study has demonstrated that professional pianists felt anxiety caused by the characteristics of the piece (Bannai et al., 2017). Accordingly, the characteristics of the piece caused not only anxiety but also the subjective agari responses, including confusion and impatience.

**Table 2.Descriptive Statistics of the FAEQ Scores and HR**

| Piece | The FAEQ scores | HR |
|---|---|---|
| P1a | 46 (54.5) | 115 (59.0) |
| P1b | 49 (59.9) | 107 (47.0) |
| P1c | 41 (45.5) | 102 (39.4) |
| P1d | 34 (32.9) | 110 (51.5) |
| P1e | 43 (49.1) | 118 (63.6) |
| P1f | 48 (58.1) | 102 (39.4) |
| P2a | 32 (44.7) | 116 (49.2) |
| P2b | 52 (65.8) | 126 (64.3) |
| P2c | 46 (59.5) | 120 (55.3) |
| P2d | 30 (42.6) | 114 (46.2) |
| P2e | 31 (43.7) | 106 (34.2) |
| P2f | 31 (43.7) | 117 (50.8) |
| Mean ± *SD* | 40.3 ± 8.2 | 112.8 ± 7.4 |

Note. The brackets contain the T-score. The alphabetic characters (a–f) indicate each piece of music. FAEQ: Features of Agari Experience Questionnaire; HR: heart rate; SD: standard deviation.

### 3.4 Relationships between Playing Time, HR, and Subjective Agari Responses

As described before, no previous study has investigated the relationships between mental and physical negative responses and the playing time. In this study, a correlation analysis was conducted to investigate the relationships between these variables (Table 3). This analysis showed that there was not a significant relationship between the PTCR and HR, but the PTCR was negatively correlated with the subjective agari responses ($r = -.63$, $p < .05$). These findings suggest that the playing time became shorter when the subjective agari responses were higher, although the playing time was not affected by the HR.

Bannai et al. (2017) reported that anxiety and negative physical conditions that occur during an actual concert lead to poor performance. Despite our findings in this study of the relationship between the PTCR and the pianists' subjective agar responses, the levels of quality and/or satisfaction with their performances are not clear. Therefore, further studies should be conducted to investigate the relationships among the mental and physical reactions of the agar responses, playing time, and subjective performance evaluation.

**Table 3.Relationships Between the Playing Time Change Rate and the T-Score of the Features of Agari Experience Questionnaire Scores and the Heart Rate During an Actual Performance**

| | *T*-score of the FAEQ scores | *T*-score of HR |
|---|---|---|
| PTCR | -.63* | -.54 |

Note. PTCR means how much the playing time during the actual performance changed from that during practice [(playing time of practice/playing time of an actual performance) × 100]. FAEQ: Features of Agari Experience Questionnaire; HR: heart rate; PTCR: playing time change rate.
*$p < .05$.

## 4. Limitations and Direction for Future Research

One limitation of this research was the difficulty of obtaining the cooperation of professional pianists. Additionally, we could not record the LF/HF ratio for each piece because of the limitation of the actual piano concerts. In the future, it would be desirable to increase the number of professional pianists and to record the HRV. Moreover, further studies are needed to clear the differences in the characteristics of the pieces, such as the degree of difficulty and exercise intensity, in addition to measuring subjective performance evaluation.

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