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Heart Rate Variability During Singing and Flute Playing

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Abstract

The authors tested five professional singers' and four flute players' physiological performance arousal (4 male, 5 female) by means of Actiheart® recordings. In addition, they used a 5-point Likert-type scale to assess the subjects' nervousness. Every musician performed a relaxed and a strenuous piece with (concert) and without (rehearsal) an audience. A one-way analysis of variance in heart rate (HR) and heart rate variability (HRV) showed a significant difference across the four different conditions (easy/rehearsal, strenuous/rehearsal, easy/concert, and strenuous/concert) within subjects. There were no significant differences in heart rate reaction patterns between subjects. With regard to HRV, on the other hand, low frequency (LF) power and high frequency (HF) power reaction patterns in the four situations varied significantly between subjects. In addition, the authors found a significantly lower LF power during the concert in those who were nervous before the concert compared with those who were not nervous.

Keywords

autonomic nervous system, heart rate variability, music performance, performance anxiety, stress

Several studies have focused on musicians' performance anxiety. A search in the literature discloses a very consistent effect of the audience. The presence of an audience is associated with significant increases in physiological arousal and self-reported anxiety in music performers (Abel & Larkin, 1990; LeBlanc, Jin, Obert, & Siivola, 1997). Presence of an audience increases heart rate (Fredrikson & Gunnarson, 1992; LeBlanc et al., 1997; Tartalone, 1992), blood pressure, and respiratory rate (Tartalone, 1992), and there is also an increase in neuroendocrine activation when the audience is escalated—from private to public performance (Fredrikson & Gunnarson, 1992).

The aim of this study was to examine heart rate (HR) and heart rate variability (HRV) with and without an audience during different kinds of singing and flute playing. Analysis of HRV has become a popular noninvasive tool for assessing the activities of the autonomic nervous system. HRV analysis is based on the concept that fluctuations in HR may reflect changes of sympathetic and vagal activity. Some of the variations in HR are synchronized more or less clearly with breathing. Inhalation is associated with increased and exhalation with decreased HR (respiratory sinus arrhythmia [RSA]). RSA is associated with improved efficiency of pulmonary gas exchange by matching ventilation to perfusion within each respiratory cycle (Giordano, Glenny, Borson, & Chan, 2003). Clinical studies of within-subject variations have demonstrated that reduced RSA is associated with psychological stress (Allen & Crowell, 1989) and physical exercise (Hatfield et al., 1998), whereas increased RSA is associated with conditions of psychological relaxation (Skakibara, Takeuchi, & Hayano, 1994).

The increase in HR during inhalation is functional because an increased HR means an increased volume of blood being propelled per time unit and, hence, there will be more blood for oxygenation in the lungs when the fresh air enters the lungs during this breathing phase. If this coordination is trained, the effect will indeed be perceived as "increased lung volume" since the collaboration between breathing and oxygenation of blood will be optimized. Although speculative, this may be one of the most important components in professional singing or flute playing training. Less lung and heart work will be needed for the same length of a phrase, to express this in more concrete terms. Synchronization of the propelling of blood to the lungs with breathing is a central factor in optimal singing and wind instrument playing. To allow the heart to "rest"—beating slowly between breaths—and to accelerate its rhythm during the intake of oxygen may be one way of increasing effectiveness in singing and flute playing.

There are several other biological rhythms that influence HR. The parasympathetic system has several rhythms on its own (Porges, 2007), which means that there are regularly occurring periods of decrease in HR determined by increased activity in

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Table 1. Description of the Performances

Artist	Easy piece	Strenuous piece
Singer 1	Jag väntar månen (G. Nystroem)	Morgonsång ur "Höga visan" (E. Melartin)
Singer 2	Rejoice (aria from *Messiah* by G. F. Handel)	Rejoice (aria from *Messiah* by G. F. Handel)[a]
Singer 3	Stradella (duet) Quelto Petto	Musetta's Waltz (from *La Bohéme* by G. Puccini)
Singer 4	Tavaszi Szél (Hungarian folksong)	Által Mennék, Béres Legény (Hungarian folksongs)
Singer 5 (church)	Den enda Stunden (T. Rangström)	Här Dansar Fridolin (P. Berger)
Singer 5 (concert hall)	Der Leiermann (from *Winterreise* by F. Schubert)	Auf dem Flusse (from *Winterreise* by F. Schubert)
Flute player 1	Sonata for Flute and Piano, BWE 1031; second movement (J. S. Bach)	Sonata for Flute and Piano, BWE 1031; first movement (J. S. Bach)
Flute player 2	Adagio (W. Mozart)	Waltzer (B. Godard)
Flute player 3	Boels Dance (S. Sagvik)	Fantasy for Flute No. 1 (G. Telemann)
Flute player 4	Flute Concerto in D-Major, second movement (Franz Xavier Richter)	Flute Concerto in D-Major, first movement (Franz Xavier Richter)

[a] Different portions of the Handel aria were used for the easy and strenuous performances.

the vagal nerve and other parts of the parasympathetic system. In our previous research, we have observed that professional singers are more skilled than amateurs in establishing a pronounced HRV during singing (Grape, Sandgren, Hannson, Ericson, & Theorell, 2003). This could certainly partly be due to the training effect discussed above, but it could also partly be due to increased ability to maintain an optimal balance between the sympathetic arousal system and the parasympathetic anti-stress system. The fact that long-lasting arousal decreases the prevalence of such components of HRV (mainly "high frequency power variations" that are faster than or equal to the normal breathing rate) could be interpreted to mean that professional training in singing does have an effect on the ability to inhibit arousal during singing—in laymen terms, to master nervousness.

To disentangle some of the physical effects of singing experiences and flute playing, this study compared four different conditions: performing easy and strenuous pieces during a rehearsal and a concert. We also measured flute players in the same conditions and situations. Flute playing is based on different techniques from singing, although the singer and the flute player have very similar breathing techniques. The musicians performed solos with a piano accompaniment. Relaxed and strenuous pieces were performed with and without an audience. We analyzed HR and HRV to measure physiological effects of singing during these different situations. In measurements of HRV, it is very important to control breathing patterns because there is an effect on HRV primarily on high frequency (HF) power. Singers and wind players use the same breathing patterns when they perform the same pieces during a rehearsal and during a concert. Accordingly, this provides a good possibility to compare HRV.

The hypotheses to be tested were the following:

Hypothesis 1: The presence of an audience will increase heart rate and decrease heart rate variability during singing.

Hypothesis 2: Performing the strenuous piece will be associated with more elevation of heart rate and more depression of heart rate variability.

Method

Ethics Statement

The study was examined and approved by the Regional Research Ethics Committee in Stockholm (Number 2008/1308-31/4).

Participants

Nine professional musicians, five singers and four flutists (mean age = 35.3 years, $SD = 13.181$, range = 20-66) including five women and four men, were used as experimental subjects. All of the musicians had had many years of training and also experience of performing solos and in groups. None of the participants reported any somatic, psychiatric, or cardiac complaints. No participant was on medication or had illnesses that influence autonomic regulation such as heart disease, high blood pressure, or diabetes. Participants were asked not to consume beverages containing alcohol or caffeine or to smoke within 4 hours prior to the experiment. Swedish and Hungarian were the native languages for all the recruited persons. Participants were asked not to consume beverages containing alcohol or caffeine during the hours preceding recordings on that particular day. We followed the Helsinki research ethics declaration, which means that participants were informed both orally and in written form. The information was written in Hungarian and Swedish.

Procedure

Ten situation pairs were recorded with nine participants (one singer had two very different pairs). Every musician performed a relaxed and a strenuous piece with (concert) and without (rehearsal) an audience (see Table 1). We characterized the strenuous one as a piece with wide intervals and a relatively fast tempo (more than 100 beats per minute). Correspondingly, the relaxed (easy) piece had a slow tempo (fewer than 80 beats per minute) with narrower intervals. We also paid attention to the musicians themselves when we selected the strenuous or relaxed pieces—how familiar they were with the piece and how many times they had performed the piece. The strenuous piece was mostly less familiar for the musician during performance than the easy piece. The order of the strenuous and relaxed pieces was the same during the rehearsal as during the concert for each participant, but the order was balanced among the participants (half of the rehearsal/concert pairs started with the strenuous and half of them with the easy piece). Since we had difficulties finding older singers for the examination and age is an important confounder, we decided to use the oldest singer (age 66) twice. We tried to recruit other older participants. However, in the cases we tested, there were problems with medication and medical conditions. Therefore, we decided to do it in the way presented, with maximal difference between the two experimental sets with regard to musical pieces and circumstances.

Physiological data (HR and HRV) were obtained from every participant during the two different situations. Self-ratings were performed retrospectively for the situation before and during the rehearsal and concert, respectively, using 5-point Likert-type scales to record their nervousness. The equipment (Actiheart®, Cambridge Neurotechnology, Inc.) was attached to the chest to measure HR and HRV during the concert and the rehearsal when they performed the two kinds of songs and flute pieces. The attachment and the technical check-ups associated with it lasted for at least half an hour, which means that there was a period of habituation before the recordings to be used in analysis started.

The concerts were held in different churches and a small concert hall in Sweden and Hungary. The number of listeners in the audience varied from 50 to 250 people during the concerts. The conditions were comparable across conditions in the same way for all individuals to minimize potential effects of uncontrolled variables that might influence autonomic regulation. The same equipment and concert hall or church were used for rehearsal and concerts. We also made sure that the temperature was the same in the two conditions. The participants performed the same pieces in the same tempo during the rehearsal and the concert. The measurement without an audience (rehearsal) was performed between 7 days and 1 half-day before the concert.

Wearing an Actiheart was reported to be comfortable for the participants during the experimental situations. We instructed the participants to behave naturally and as they would normally do in a rehearsal and a concert situation. The participants were informed that their HR and HRV and psychological experience would be recorded during rehearsal and during the concert.

Measurements

The main component of the Actiheart is a 7 mm thick sensor with a diameter of 33 mm. It houses a movement sensor, a rechargeable battery, a memory chip, and other electronics. The total weight is 8 g. The Actiheart is capable of measuring bodily acceleration, HR, HR variability, and electrocardiogram (ECG) amplitude for a set time resolution. Available epoch settings are 15 seconds, 30 seconds, or 1 minute (Brage, Brage, Franks, Ekelund, & Wareham, 2005). We analyzed the HR and HRV automatically in the Actiheart software in 1-minute epochs in the four conditions (rehearsal/relaxed piece; rehearsal/strenuous piece; concert/relaxed piece; concert/strenuous piece).

The Actiheart clips onto a single standard ECG electrode with a short ECG lead to another electrode that picks up the ECG signal. It is normally worn on the upper or lower chest. It is comfortable to wear continuously for long periods of time. The Actiheart contains a rechargeable battery, providing up to 21 days of continuous operation. The Actiheart simply clips on to the two 4 mm studs on the interface. The same interface is used for downloading data to a PC, where the data are analyzed using the Actiheart software.

We used a 5-point Likert-type scale (1 = *not at all* to 5 = *the most extreme you could imagine*) to asses the participant's self-rated nervousness before and during the two different situations (rehearsal and concert). We asked the participants, "How did you feel with regard to being nervous?"

Statistics

After the calculations of HR and low frequency (LF) power and HF power in HRV had been performed for each 1-minute epoch in the four contrasting conditions (easy/rehearsal, strenuous/rehearsal, easy/concert, and strenuous/concert), summary measures were created. The number of 1-minute epochs within a condition ranged from two to seven since the musical pieces/movements had different lengths. As expected, HR showed a normal distribution while LF and HF power showed skewed distributions. Before the statistical calculations were performed, all the 1-minute epoch LF and HF data were subjected to log normal transformations while corresponding HR data were used without transformations. After this, individual averages were calculated for each condition from the 1-minute epochs.

Since there were nine individuals and one of them performed two different programs in different circumstances, the total number of averaged data sets with four conditions was 10. This final data set was subjected to the following procedures:

1. One-way analysis of variance (for repeated measures). This provides information about means of averages and corresponding standard errors of means for each one of the four conditions as well as a calculation of the extent to which there is significant variation across the four conditions. In addition to this, post hoc tests were performed according to Scheffe with comparisons between each pair of conditions (e.g., easy piece during rehearsal compared with easy piece during concert). In the presentation of means (of averages from 1-minute epochs) and standard errors of means for the LF and HF data in the tables, back transformation was performed, which means that the numbers presented in the results are geometric means and

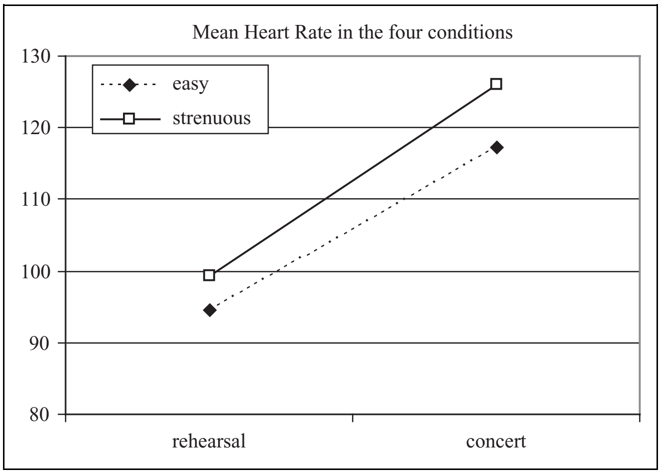

Figure 1. Mean heart rate in four conditions.

upper and lower limits of the corresponding standard errors. Self-ratings of nervousness were close to normally distributed and a one-way analysis of variance was therefore performed for these data as well.

2. Product-moment correlations between age and each one of the variables during each one of the conditions
3. Two-tailed Student's t tests (unpaired) for differences between men and women and between flutists and singers. The most crucial self-ratings of nervousness according to the participants were those before and during the concert. HR as well as log normal transformed LF and HF power of HRV during the concert were subjected to t tests comparing "not nervous" (score 1 or 2) with "nervous" (score 3 to 5) participants.

A p value of .05 was used as the limit of significance in all statistical tests.

Results

Physiological Outcomes

The one-way analysis of variance (for repeated measures) in HR showed a significant difference across the four different conditions (easy/rehearsal, strenuous/rehearsal, easy/concert, and strenuous/concert) within subjects ($F = 19.19$; $p = .0001$; see Figure 1). Scheffe post hoc tests showed several significant differences between the conditions. There were significant differences in HR between the performance of the easy piece during the rehearsal and the performance of the strenuous piece during the concert, and the performance of the strenuous piece during the rehearsal and the performance of the easy piece during the concert. We did not find any significant difference between the two different kinds of pieces (easy/strenuous) neither during rehearsal nor during the concert. The between-subject variance was not significant for HR, indicating that the pattern was similar across individuals (see Table 2).

LF power in the four situations varied significantly within subjects ($F = 7.52$; $p = .0001$; see Figure 2). There were significant differences in the post hoc tests (Scheffe) between the performance of the easy pieces during the rehearsal and the concert and that difference was also observed in the case of the strenuous pieces. There was a significant difference in the performance of the easy piece during the rehearsal and the performance of the strenuous piece during the concert. However, the other pairwise comparisons were nonsignificant. With regard to variation between subjects, this was observed to be significant ($p = .02$), indicating differences in patterns across individuals (see Table 3).

Also with regard to HF power, there was a significant variation between the four situations within subjects ($F = 7.33$; $p = .0001$; see Figure 3). Post hoc Scheffe tests showed a significant difference between the performance of the easy piece during the rehearsal and during the concert. We did not find a significant difference in the corresponding comparison between concert and rehearsal of the strenuous pieces. There was also a significant difference in HF power between performance of the easy piece during the rehearsal and the strenuous piece during the concert. We did not find any other significant differences with regard to HF power in the post hoc test. With regard to variation between subjects, this was observed to be significant ($p = .03$), indicating differences in patterns across individuals (see Table 4).

Psychological Outcomes

We found significant differences within subjects in the perceived nervousness (5-point Likert-type scale). There was no significant between-subject variance. Post hoc tests showed a significant difference only in one pair of the situations (before rehearsal–during the concert). The differences between the other situations were not significant (see Table 5).

Two-tailed t tests for independent samples comparing nervous and not nervous participants before the concert according to self-ratings with regard to HR as well as LF and HF power of HRV during the performance of the strenuous piece during the concert were performed. The results for LF power are presented in Table 6. There was a significantly lower LF power in this situation among participants who reported a high degree of nervousness before the concert. The corresponding findings for HR and HF power were not significant. In addition, there were no significant findings for any of the three physiological parameters when the corresponding analysis was made comparing the nervousness ratings during the concert and no significant findings for the corresponding analysis of the performance of the easy piece during the concert. Accordingly, the "before concert nervousness rating" was the only rating that showed an association with LF power during the performance of the strenuous piece during the concert while all the other comparisons were nonsignificant. Statistics are based on log normal transformed data, but the table shows back-transformed means and corresponding standard errors of mean intervals (GSEM).

Table 2. Mean Heart Rate (standard error of mean) in Four Situations (beats/min)

	Rehearsal easy piece	Concert easy piece	Rehearsal strenuous piece	Concert strenuous piece
Mean	94.5 (4.6)	117.3 (5.1)	99.3 (4.8)	126.0 (4.7)
Range	74–117	96–147	77–128	100–144
Within subjects			$F = 19.19$	$p = .0001$*
Between subjects			$F = 1.80$	$p = .11$

Post hoc (Scheffe) tests for heart rate (significance at $p < .05$)

Rehearsal/easy	Concert/easy	significant
Rehearsal/easy	Rehearsal/strenuous	—
Rehearsal/easy	Concert/difficult	significant
Concert/easy	Rehearsal/strenuous	significant
Concert/easy	Concert/strenuous	—
Rehearsal/strenuous	Concert/strenuous	significant

Discussion

The underlying hypothesis was that the presence of an audience would increase HR and decrease HRV during singing. This hypothesis was supported—the presence of an audience increases HR and reduces HRV in the participants. The fact that HR increases in such a condition has been well established in previous literature (LeBlanc et al., 1997). Fredrikson and Gunnarson (1992) concluded that HR is a sensitive measure of situational determinants of performance-related distress. A one-way analysis of variance in HR showed a significant difference across the four different conditions. Post hoc tests showed that the mean HR was higher during the concert than during the rehearsal when the artists performed the easy and also the strenuous pieces. HRV was more depressed during the concert than during the rehearsal. LF power and HF power differed significantly in the four conditions. Post hoc tests showed a significantly lower LF power in the concert during the performance of the strenuous and also during the performance of the easy pieces than in the rehearsal. There was a significantly lower HF power in the concert when the participants performed the easy pieces, and we also found a lower mean in HF in the concert during the performance of the strenuous pieces, but the difference was not significant.

The second hypothesis—that performing the strenuous piece would be associated with more elevation of HR and more depression of HRV—was only partly supported. We did not find significant differences between the two kinds of pieces in the same conditions (rehearsal or concert) in HR. The mean HR of the strenuous pieces was higher than that of the easy pieces with and without an audience; however, the differences were not significant according to the conservative post hoc tests. The less rigorous paired two-tailed t test did indicate a significance ($t = 3.54$, $p = .006$ during rehearsal and $t = 3.44$, $p = .007$ during concert). Accordingly, these differences were smaller and less convincing than those between rehearsal and concert. This finding suggests that the audience puts more pressure on the artist and adds more performance anxiety than increasing difficulty as it was defined in this particular study (LeBlanc et al., 1997). In the corresponding analyses of LF power and HF power, the means were clearly lower during concerts than during rehearsals, whereas according to post hoc tests, the differences were consistently nonsignificant between strenuous and easy pieces both during the concert and during rehearsal. This means that the difficulty dimension had less importance to HRV.

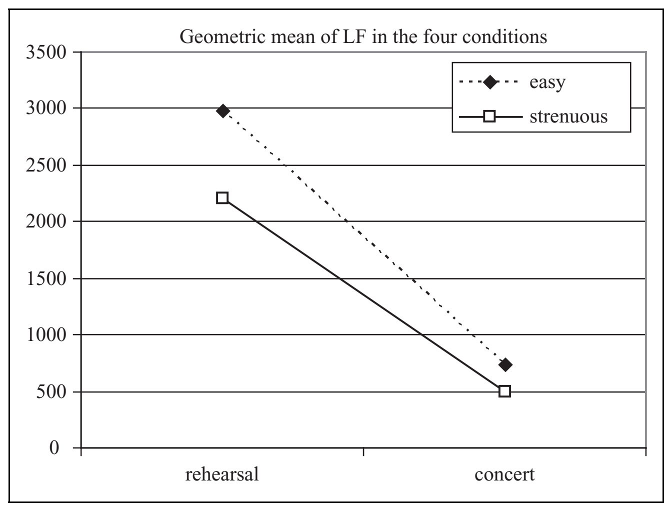

Figure 2. Geometric mean of low frequency power in four conditions.

There was a wide variation in LF and HF activation between subjects. This probably means that the sympathetic and parasympathetic activation in HRV during the two situations (rehearsal/concert) also varied. In some participants, HRV was not depressed during the concert. It is important to unravel some of the uncontrolled effects of the performance that cause unpredictably high or low performance anxiety in the individuals. In our experience, a concert situation with an audience causes acute stress for musicians. Studies on healthy individuals show that acute stress increases LF power and decreases HF power, suggesting the activation of the sympathetic nervous system as well as withdrawal of activity in the parasympathetic nervous system under stress (Pagini et al., 1997).

LF power has been assumed to reflect a mixture of sympathetic and parasympathetic activity, whereas HF power is

Table 3. Geometric Mean (lower/higher limit of geometric standard error) of Low Frequency Power in Four Situations

	Rehearsal easy piece	Concert easy piece	Rehearsal strenuous piece	Concert strenuous piece
Geometric mean	2981	735	2208	493
GSEM range	2208–4024	493–1097	1636–2981	299–812
Within subjects			$F = 7.52$	$p = .0001$*
Between subjects			$F = 2.69$	$p = .02$*
Post hoc (Scheffe) tests for low frequency power (significance at $p < .05$)				
Rehearsal/easy	Concert/easy		significant	
Rehearsal/easy	Rehearsal/strenuous		—	
Rehearsal/easy	Concert/strenuous		significant	
Concert/easy	Rehearsal/strenuous		—	
Concert/easy	Concert/strenuous		—	
Rehearsal/strenuous	Concert/strenuous		significant	

GSEM = geometric standard error of the mean.

influenced almost exclusively by vagal activity (Porges, 2007). In addition, HF power is influenced by breathing to a greater extent than LF power (Berntson et al., 1997). In this case, the breathing cycles have been identical with and without an audience since the singers and flutists were sufficiently trained to plan their breathing. Therefore, our comparisons between concert and rehearsal could not have been confounded by differences in respiratory rate, at least not when we are doing pairwise comparisons between concert and rehearsal for the easy and the strenuous pieces, respectively. Bernardi et al. (2001) have pointed to the synchronization of breathing with some of the cycles in HRV. During relaxed pieces in a slow tempo (similar to mantra and rosary prayers), a synchronization between LF power and breathing seems to take place. Whether this could be a factor in our analyses of relaxed pieces remains to be established.

With regard to the participants' perceived performance nervousness, we found significant differences within subjects across the four conditions but no significant differences between subjects in the tests. This means that the different kinds of situations affected the individual participants in similar ways. When we compared physiological outcomes in our study, we found that LF power during the strenuous pieces showed a significant correlation with nervousness scores before the concert. It means that a high level of nervousness before the concert was associated with a low LF power during the strenuous piece in the concert condition.

We also examined the degree of nervousness during the concert in relation to LF power during the strenuous pieces. There was no corresponding significant relationship between this self-rating and the same measure of LF power during the strenuous pieces, although the tendency was in the same direction. HR was not associated in any situation with perceived nervousness, which suggests that the LF power in HRV may be a more sensitive tool to measure performance-related anxiety in musicians. The self-ratings of nervousness were based on a simplified one-item 5-point Likert-type scale, which does not allow for more sophisticated analyses.

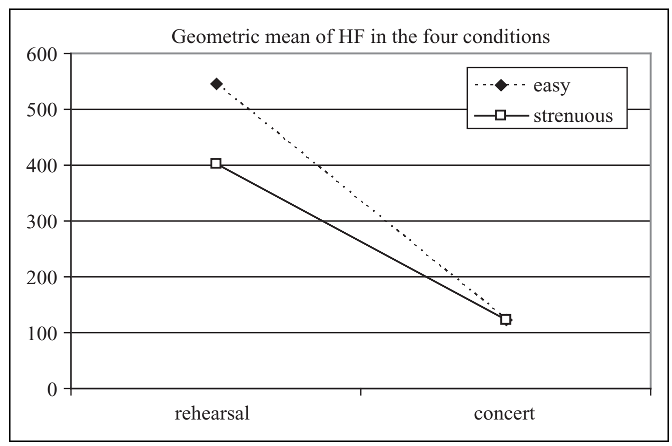

Figure 3. Geometric mean of high frequency power in four conditions.

The effect of age, sex, and instrument (song/flute) was examined. We did not find significant differences with regard to these factors. However, other researchers have found significant differences in gender. According to LeBlanc et al. (1997), gender is a significant predictor of HR during performance, with female performers attaining higher HRs. Our small sample size may preclude a significant gender difference.

One illustration of this is given by the only subject who participated in two pairs of rehearsal/concert situations. In the first one, the program was more popular (Swedish songs) and the audience more well known to the performer than in the second one (Schubert's *Winterreise*). In the first situation, the audience was much more supportive and the whole experience much more relaxed during performance of the difficult piece.

In summary, we measured HRV and perceived performance nervousness during two different kinds of pieces with and without an audience. Although we have presented only 10 pairs of comparisons, we feel that the analysis of HRV may be a fruitful area of research. Both HR recordings and self-ratings of nervousness indicate that we have been able to construct four contrasting conditions. With regard to HR, there

Table 4. Geometric Mean (lower/higher limit of geometric standard error) of High Frequency Power in Four Situations

	Rehearsal easy piece	Concert easy piece	Rehearsal strenuous piece	Concert strenuous piece
Geometric mean	545	122	403	122
GSEM range	446–735	81–181	299–545	74–200
Within subjects			$F = 7.33$	$p = .0001$*
Between subjects			$F = 7.33$	$p = .03$*
Post hoc (Scheffe) tests for high frequency power (significance at $p < .05$)				
Rehearsal/easy	Concert/easy		significant	
Rehearsal/easy	Rehearsal/strenuous		—	
Rehearsal/easy	Concert/difficult		significant	
Concert/easy	Rehearsal/strenuous		—	
Concert/easy	Concert/strenuous		—	
Rehearsal/strenuous	Concert/strenuous		—	

GSEM = geometric standard error of the mean.

Table 5. Mean of the 5-Point Likert-Type Scale Assessing Perceived Performance Anxiety

	Before the rehearsal	During the rehearsal	Before the concert	During the concert
Mean	1.50 ± 0.22	1.90 ± 0.18	2.60 ± 0.16	3.70 ± 0.21
Within subjects			$F = 039.35$	$p = .001$*
Between subjects			$F = 0.73$	$p = .68$
Post hoc (Scheffe) tests for perceived performance anxiety (significance at $p < .05$)				
Before the rehearsal	During the rehearsal	—		
Before the rehearsal	Before the concert	—		
Before the rehearsal	During the concert	significant		
During the rehearsal	Before the concert	—		
During the rehearsal	During the concert	—		
Before the concert	During the concert	—		

Table 6. Two-Tailed *t* Tests for Independent Samples Comparing Nervous and Not Nervous Participants Before the Concert According to Self-Ratings With Regard to Low Frequency Power of Heart Rate Variability During the Performance of the Strenuous Piece During the Concert

	Nervousness before the concert	Low frequency power during the concert
Not nervous $n = 6$	mean = 7.39	Geometric mean = 1620
Scale value = 1–2		GSEM range = 898–2981
Nervous $n = 4$	mean = 5.33	Geometric mean = 206
Scale value = 3–5		GSEM range = 110–365
t test		$t = 2.36$, $p = .046$

Statistics are based on log normal transformed data but the table shows back-transformed means and corresponding standard errors of mean intervals (GSEM).

was no difference in response patterns between subjects. For HRV, there were, on the other hand, intersubject differences in reaction patterns. Accordingly, there were differences in physiological reaction patterns—as reflected in HRV—across individuals. Such differences may be due to differences in personality as well as differences in other parameters not assessed in this study.

In conclusion, the individual differences in HRV reactions were quite pronounced between the studied conditions. This points to the potential importance of analyzing HRV in singers and wind players.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article. They have no commercial connection with Actiheart® or its manufacturer, Cambridge Neurotechnology, Inc.

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