On stress induced by performing music

This is an attempt at quantifying stress generated by performing music. I have no training in any of the biological sciences so this document is a mere compilation of facts and data with attempted, albeit uneducated, interpretation. The data presented here concern only one individual over a single experiment. They are thus insufficient to draw meaningful conclusions.

From personal observation, I have noticed two types of stress manifestations. It can take an emotional form through feelings of discomfort (nausea, cold limbs, trembling, etc.) and a physiological form via metabolic rate increases, typically in anticipation of a fight-or-flight situation. I have also observed that these manifestations do not necessarily correlate in a strong way: public speaking rarely triggers emotional stress in me, while it tends to increase my heart rate. Conversely, medical appointments can drive me into a state of emotional stress while my basic biological indicators (heart rate, blood pressure, etc.) remain in their normal range.

I have measured my stress level during the most stressful and reproducible situation I have ever faced: a public piano performance. I have not attempted to quantify stress on the emotional level but, rather, physiologically via the monitoring of my heart rate. Although a person's heart rate is a simplistic measure of their metabolic rate, it is a piece of information easily accessed through activity trackers.

Methodology

I gathered my heart rate history during two consecutive days: Saturday 16 November 2019, a typical day, free from any stressful activities; and Sunday 17 November 2019, a similar day except for a planned piano performance. The data was collected by a Fitbit Charge 3, then downloaded using the third-party website: `squashleagues.org`, and suitably post-treated. Any activity occuring during these two days was recorded and reported when they incurred a significant heart rate increase.

The piano performance involved an audience of 6 fellow amateur pianists taking turns to perform to the others. I was the fifth person to perform. The event took place in a private and friendly setting on a Blüthner Model 10 that I had not tried before. I chose to perform two simple pieces by Chopin: a posthumous Waltz in A minor and his Mazurek Op.17 No.4 (also in A minor!). These pieces are slow and do not possess any major difficulties that would result in an increased heart rate due to fast physical motion or necessarily enhanced focus[1]. My total performance time was approximately 8 minutes, which I prefaced by a verbal introduction of the pieces, for a total of about 10 minutes of stress-inducing activity.

To smooth out the erratic character of the fluctuations in heart rate, I averaged the data over a period of 10 minutes centered on the data timestamp. This choice is motivated by the fact that it corresponds to the approximate duration of the performance.

[1] During a practice session in November 2019, I observed a heart rate of 75 beats per minute while practising the slow Chopin Nocturne Op.72 No.1, but recorded 112 beats per minute a few minutes later during some technical work on Beethoven Bagatelle Op.33 No.5.

Results

At the time of the experiment, I was a healthy 33-year old individual, with a resting heart rate of 54 beats per minute (hereafter bpm). When undertaking relaxing activities, such as reading, my heart rate is typically around 70bpm. Intense cognitive activity increases my heart rate to about 90bpm, while brisk walking on a flat terrain makes me reach 100bpm on average. Heart rates can be influenced by a large number of parameters and I chose to compile the data of two successive days to produce the fairest possible comparison between a non-stressful day and one with a musical performance.

My heart rate data during the two recorded days are presented in Figure 1.

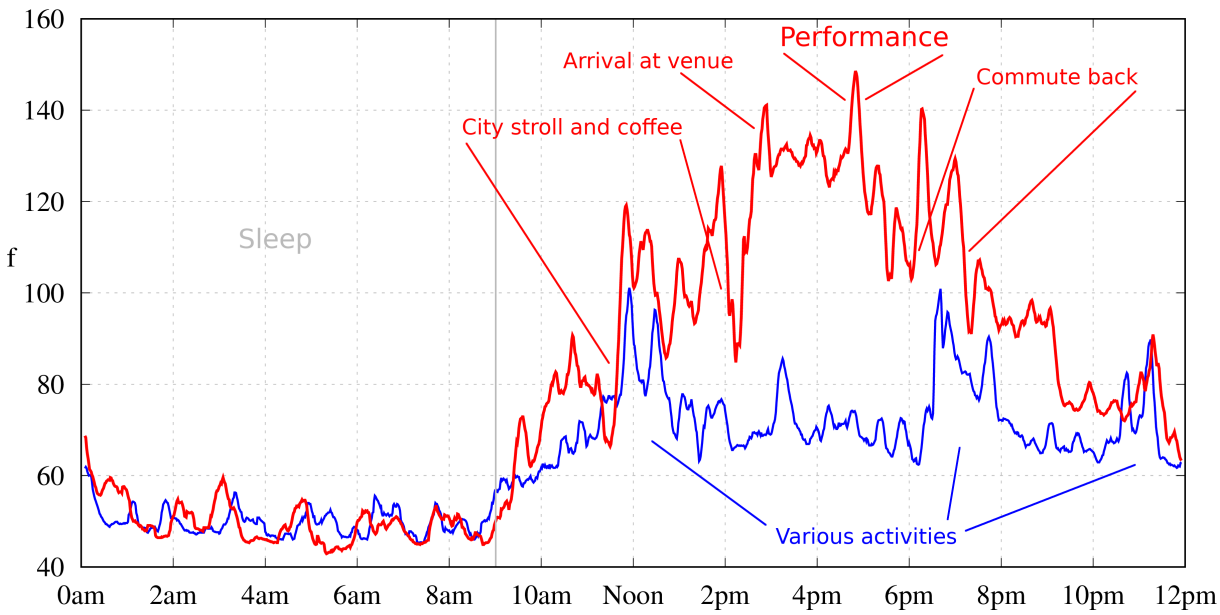

Figure 1: Heart rate f expressed in number of beats per minute as a function of the time of the day for the days of Saturday 16 November 2019 (blue) and Sunday 17 November 2019 (red). The quantity f is represented for each day from 0:05 until 23:55 with one-minute increments as the average heart rate over a period of 10 minutes centered on the time at which f is reported. Special events are indicated for analysis purposes.

During both days, I slept from about 23:30 until about 9:00. The sleeping periods, with a heart rate of about 50bpm, can be seen to match on these two days. On Saturday 16 November 2019 morning, my heart rate increased steadily until I went shopping in town from 11:30 until 12:30. Following this activity and until I did some house cleaning and cooked (18:30–20:00), my heart rate remained quite steady around 70bpm. One last burst of activity occurred at 22:30 for about one hour: piano practising, with a focus on the performance of the next day and, incidentally, some stress induced by dreaded last-minute memory lapses.

The effect of the performance stress can be felt from the moment I woke up on Sunday 17 November 2019 (red curve). The increase in heart rate is more abrupt on that day, with the 80bpm bar crossed at about 10:00, two hours earlier than on the day before. Some more practising took place until 11:30, when I went out for a stroll in the city, had lunch and a coffee, waiting for my 14:12 train. Between 11:30 and 14:00, my heart rate oscillated quite violently, averaging around 100bpm with a peak at 130bpm shortly before 14:00. This is not explainable by my level of physical activity: I was mostly seated at a coffee shop, reading. I arrived at the

venue shortly before 15:00, where my heart rate can be seen peaking at 140bpm before slowing down to a mere (!) steady 130bpm until the performance time of 16:45. During the performance, my heart rate averaged 149bpm, which is the maximum recorded during these two days. As soon as the performance ended, my heart rate slowed down, but remained above 100bpm despite the relaxing activities undertaken: listening to music and discussing. The commute back, from 18:00 until 19:00, saw an unexpected burst in my heart rate, with one peak at 140bpm (at 18:17) and a second one at 129bpm (at 19:00). The level of physical activity during the commute back was similar to that observed during the shopping activity on Saturday 16 November 2019 noon. It is thus apparent that the performance resulted in an increase of my base heart rate continuing after the performance and on top of which activities remain somewhat additive. Even at home on the evening of the performance (19:00 onwards), my heart rate remained substantially higher than on the previous day, only catching up shortly before midnight, a time that coincides with sleep.

Conclusion

From the data gathered during this experiment, it is obvious that performing music has a dramatic impact on my physiological stress. Stress was understandably present before the performance, as shown by the faster increase in heart rate following wake up and the higher rates maintained throughout the day. Interestingly, finishing the performance did not lead to a fast return to a normal heart rate. Rather, it took several hours for my heart to slow down. In this specific experiment, the 7 hours gap between the end of the performance and sleep were not sufficient for my heart to recover its normal rhythm, which was achieved during sleep.

Owing to the fact that my levels of physical activity during these two days were similar, the effect of this 10-minute musical performance at 16:45 on me can be approximated by the difference in my heart rate averaged throughout the awake periods between both days. On the resting day, between 9:00 and 24:00, my heart rate averaged 74.5bpm[2], or 20.5bpm above my resting heart rate. During my awake time on performance day, my heart rate averaged 97.5bpm, or 43.5bpm above my resting heart rate, more than double the demands of the resting day. I find it remarkable that these striking differences are the consequence of a single 10-minute musical performance. Or... I just have stage fright!

[2] A similar calculation averaged over November 2019 working days yields an average of 81.1bpm.