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Physiological Changes Associated with Varying Music Tempo

Abstract

Many studies have found that music induces physiological changes in individuals. Our study attempts to identify changes in heart rate, blood pressure, and muscle tension in relation to varying musical tempos. Eighteen students (nine male and nine female) between the ages of 20 to 25 were exposed to music of two different genres with two tempo variations. After analyzing the recorded data, no statistically significant results were found that correlated physiological changes and musical tempo. However, trends such as increased heart rate in males with increased musical tempo were observed. For one of the two musical genres tested, increase in muscle tension in females when exposed to a faster tempo was observed. It was concluded that further testing with a larger population and more controls may be necessary to identify statistically significant results.

Introduction

It has been observed in previous studies that the exposure to music can alter various physiological traits in the human body. It is known that listening to a faster paced song while exercising increases heart rate (Copeland and Franks, 1991). Music can also increase the potential to exceed one's normal exercise capacity (Costas et al., 2009). The results from these studies suggest that physiological changes in the body facilitated the human response to music. Many studies, such as the ones above focused on music and its effects during exercise. Our study was designed to expand on these studies by looking at the effects of music individuals at rest.

Previous research has explored music's effect in subjects at rest but usually relate it to mood. According to Kemper et al., exposure to music affects the autonomic nervous system. They demonstrated that music has psychological effects such as altering personal mood and anxiety levels (Kemper et al., 2005). Music proved to be an effective calming technique for hospital patients who took part in the study. Our study focuses on the unexplored gap between the divisions in current research on the body's response to music. Patients at rest have been monitored psychologically while exercising patients were examined for physiological changes. Our study focused on patients at rest while monitoring changes in heart rate, blood pressure and muscle tension (collectively, physiological variables) throughout exposure to four music selections. Our results will help establish whether the physiological changes attributed to fast tempo music in exercising subjects are also seen in resting subjects as a result of music tempo changes.

Recent research has also investigated the effect of rhythm on the change in muscle tension (Wilson, 2002). In the Wilson study, when individuals were exposed to strong rhythmic music, the subject's cortiocspinal system was influenced. This study leads us to believe that skeletal muscle may respond to music in addition to the other physiological changes seen in exercise studies. Therefore through our measurements of physiological variables, we can expose the music's indirect effects on skeletal, cardiac, and smooth muscle. Our study subjected individuals to two different tempos of two different songs, for a total of four audio stimuli. Prior to exposing the individual to the music, baseline measurements of the physiological variables were taken. These same measurements were recorded after each exposure to a song, for a total of five measurements. We hypothesize that at rest, varying music tempo induces changes in the heart rate, blood pressure and muscle tension indicative of physiological changes in all three muscle types of the body.

Materials and Methods

The materials that were used in our experiments included a pulse oximeter (used solely for heart rate measurement), a manual sphygmomanometer and stethoscope (for increased precision, all blood pressure readings were taken by the same individual), noise cancelling headphones, and surface electromyographic (EMG) recording software (Biopac Systems, Inc.). The following methods were used to further study the effect of varying music tempos on the physiological factors of heart rate, blood pressure, and muscle activity

Prior to our experiments, two pieces of music were selected and altered to be used in our tests. The alterations of tempo were used to determine if differing music tempo induced physiological effects. One piece of music was a ‘popular’ song, “The Reason” by Hoobastank which had a ‘natural’ tempo of 82.98 beats per minute (bpm). For our experiment, the tempo was altered using Virtual DJ computer software to 90.66 bpm. The second piece of music (Recipitoast, 2009) is considered more of ‘techno’ genre. The two tempo settings that were used for this song were 100 bpm and 200 bpm.

Subjects for our tests were volunteers of both genders between the ages of 20 and 25. At the time of the experiment, volunteers were asked to sit quietly for five minutes as we attached the monitors. The period of rest was to allow for a more accurate baseline measurement. EMG leads were attached to one forearm, sphygmomanometer was attached to the other, and the pulse oximeter was attached to the index finger of the blood pressure reading arm. Noise cancelling headphones were adjusted to comfort and the volume was set to volunteer preferences.

After the monitoring devices were set and at least five minutes had passed, baseline heart rate and blood pressure readings were taken. Next, ninety seconds of the first song ("The Reason" at 82.98 bpm) was played. Throughout the song, EMG readings were continuously recorded and after the time period had elapsed, heart rate and blood pressure readings were taken. The next three song segments were played in order of "The Reason" at 90.66 bpm, 'techno' at 100 bpm, and 'techno' at 200 bpm. The data recording procedure was repeated for each of these songs. After the test had been completed, EMG software was used to evaluate the mean, point to point, integral, and area of the tonus muscle tension recordings throughout each of the song segments.

After all trails had been completed, the data was compiled and subsequently assessed. Mean arterial blood pressure (MABP) values were calculated using the formula MABP = diastolic pressure + 1/3 pulse pressure (pulse pressure= systolic pressure – diastolic pressure) so that change in blood pressure between song tempos could be calculated. The change in heart rate values from each song to the baseline measurement was also determined. Next, a paired two sample Student's t-test was conducted to evaluate significance between changes of each measurement (heart rate, blood pressure (MABP), and muscle tension values (p-p, integral, mean, and area)) for each song pair. The Student's t-test was used because of our small sample size and our interest in significance between the two tempos of each song. Microsoft® Excel software was used to conduct these calculations.

When further analyzing heart rate and blood pressure, we determined that normalization was required. To normalize the heart rate and MABP values, we divided each trial value by the corresponding subjects' baseline value and multiplied by 100 to obtain a percent change from baseline for each tempo of each genre. This was done so that our data could be compared to data from other studies in a reproducible manor.

However, due to the small sample size and the nature of these measurements, the samples might not be normally distributed. To address this idea, the four tempo measurements for heart rate and MABP for both male and female was tested with the Jarque-Bera test for goodness-of-fit. No significant p-values were obtained. Therefore, the data would be better analyzed with a non-parametric test. The Wilcoxon Signed-Rank test was used to compare normalized samples with different tempos (within the same genre). Male and female datasets were analyzed separately. The results from the Jarque-Bera tests justified the use of Wilcoxon Signed-Rank test. The Jarque-Bera and Wilcoxon-Rank tests were done using Matlab® powered by MathWorks®.

Results

The results for the experiment are located in the Appendix. Tables 1 and 10 outline the data that was used in the Student's t-test analysis of the recorded heart rates in males and females respectively. The p-values for both male and female heart rate for both genders (all p-values > 0.100) indicate no significant heart rate changes with the change in tempo for both genres. Tables 2 and 11 correspond to the p-values for the normalized percent change in heart rate for both male and female respectively, after a Jarque-Bara Normality test was performed. These high p-values demonstrate that the datasets are not normally distributed. Tables 3 and 12 both display the data of the heart rate as a percentage of the baseline and the p-values for the Wilcoxon Signed-Rank Analysis. Again, the p-values for the Wilcoxon test showed little significance between the changes in heart rate and the changes in tempo for both genders (all p-values > 0.1359). We conducted a t-test analysis of the recorded MABP in males and females; this data is located in Tables 4 and 13 respectively. Tables 5 and 14 correspond to the p-values obtained of both male and female MABP datasets, respectively, after a Jarque-Bera Normality test was performed. Tables 6 and 15 both display the data of the MABP as a percentage of the baseline with the corresponding p-values for the Wilcoxon Signed-Rank Analysis. Table 7 and 16 present the EMG Peak to Peak (P-P) data for both males and females, respectively. Samples obtained from varying tempos showed no significant statistical difference. Table 8 and 17 present the data for the EMG mean tonus activity in both genders. Based on the P-values obtained, we observed no significant statistical difference between varying tempos. Lastly, Table 9 and 18 display the data collected for the EMG tonus integrals for both males and females. Again the calculated P-values also show no significant statistical difference.

In order to further represent the data in a more visual manner, we created graphs that present the percent change of heart rate and MABP as a function of tempo for each of the four tempo settings. Graphs 1 and 5 present the percent change of heart rate as a function of tempo (bpm) of "The Reason" in both males and females respectively. Graphs 2 and 6 show the percent change of heart rate as a function of tempo in both genders for the 'techno' song. Graphs 3 and 7 display the percent change in MABP as a function of tempo of "The Reason" in both males and females respectively. Lastly, Graphs 4 and 8 exhibit the percent change of MABP as a function of tempo in both genders for "Techno".

Discussion

In order to understand the relationship between music tempo and physiological effects, we exposed individuals to varying musical tempo and gathered physiological data of these individuals. Since we had a relatively small sample size, we began our statistical data analysis with Student's t-tests in an attempt to find any variations in physiological responses due to the difference in tempos. With an alpha value of 0.05 and using the difference between the trial

Comment [M1]: Somewhere in here we need to mention that we used two different sets of data for the different tests. For the Student's t-test, we used the trial values minus the baseline, and in the Jarque-Bera and Wilcoxon, we changed this and used the normalization which was the percent change. We need to note this as a potential problem.

values and the baseline values, none of our groups of t-tests showed any significance. After further discussion, we realized that although the t-test was one of the most powerful tests we could use, it assumed certain parameters and a normal distribution of our data sets. Additionally, at this time we determined that normalizing the heart rate and MABP data by taking the trial value as a percent of the baseline and using this change in our statistical test was a more appropriate way of evaluation. Therefore, we needed to test our normalized data sets for the existence of a normal distribution. We used the Jarque-Bera test to accomplish this. The non-significant values from the Jarque-Bera tests allow us to confidently conclude our data set is actually not normally distributed. The next logical step was to test our data with a non-parametric test. We chose the Wilcoxon-Rank test which is still a paired difference test but does not assume normal distribution of the data; however, it is a less powerful test compared to the Student's t-test. Although we did not find statistical significance using the Wilcoxon-Rank test, we believe this test provided us with the most reliable statistical evidence for our conclusion.

Despite the lack of statistical significance between physiological effects and the variation in musical tempo (perhaps due to the small number of subjects and other factors discussed below), we nevertheless saw various trends throughout our experiment. For example, there seemed to be an overall increase in heart rate in males after the faster version of the song for both the popular and the techno genre. Also, more female subjects exhibited greater muscle tension during the faster version of the popular song.

In terms of controls, in an attempt to eliminate potential influences and outside factors, we used the baseline blood pressure and heart rate (taken prior to the experiment) as a negative control. However, we did not have a control for muscle tension. We attempted to eliminate noise and other audio distractions by using noise-cancelling headphones. We were also consistent in our data taking process. Despite our efforts to conduct a well-controlled experiment, various factors that might have affected our results remained.

In terms of song choice, we used two sets of songs, one under the genre of 'popular' music and one under the genre of 'techno'. Since, in essence, we are only concerned with the tempo, we assumed the genre and song choice made little difference. However, individual preferences seemed to have an effect on the individual's heart rate. Individuals' associations to the songs seem to cause a rapid spike in heart rate at the beginning of the song but quickly fell after approximately thirty seconds into the song. However, since we only recorded the heart rate after the song ended, this trend was not noted in our data set. Yet, this is an interesting result that we did not necessarily expect.

We made a few assumptions that could potentially affect the significance of our data. First, we assumed that 90 seconds of each song would be enough time to elicit a reaction in the individual if physiological changes are affected by the tempo changes. However, 90 seconds could have been too short to affect the individual physiologically. We also did not give the individual a significant amount of time to relax and necessarily return to their initial condition in between songs. We assumed that throughout the 90-second segment of the song, the individual would return to their baseline and exhibit any physiological changes due to the new musical tempo. However, this might not be the case; the data might be more accurate if we allowed the individual more time to return to their baseline in between the songs.

It is important to note the possibility of natural "drift" factors throughout the experiment. Internal variables such as boredom, hunger, excitement etc. are unrelated to the musical influence but can contribute to "drift" or changes in physiological variables. Acknowledgement of this “drift” allows us to correct for these influences on a case by case basis, to eliminate other variables and help to strengthen the statistical power.

For future studies, we would perform the experiment in a larger population. We propose to include a variety of tempos of the same song instead of simply using two tempos. This will allow us to see the extent of the effect of tempo change. We would also allow more time in between the songs to isolate the effect of each song segment on the individual. A continuous recording of heart rate versus time would also be beneficial in identifying the affects of association and changes in heart rate throughout the song.

References

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Appendix

Table 1: Student's t-test Analysis of Male Heart Rate

Heart Rate (bpm)					
Subject	**Age**	**$R_{82.98}$-BL**	**$R_{90.66}$-BL**	**T_{100}-BL**	**T_{200}-BL**
Male 1	22	7	13	3	9
Male 2	21	3	2	5	8
Male 3	22	7	8	6	9
Male 4	21	3	2	7	-2
Male 5	21	-4	2	-1	0
Male 6	20	0	13	3	6
Male 7	21	-4	-6	-13	-8
Male 8	21	6	-3	-2	7
Male 9	25	5	1	-1	8
P value		0.655760373		0.10039924	

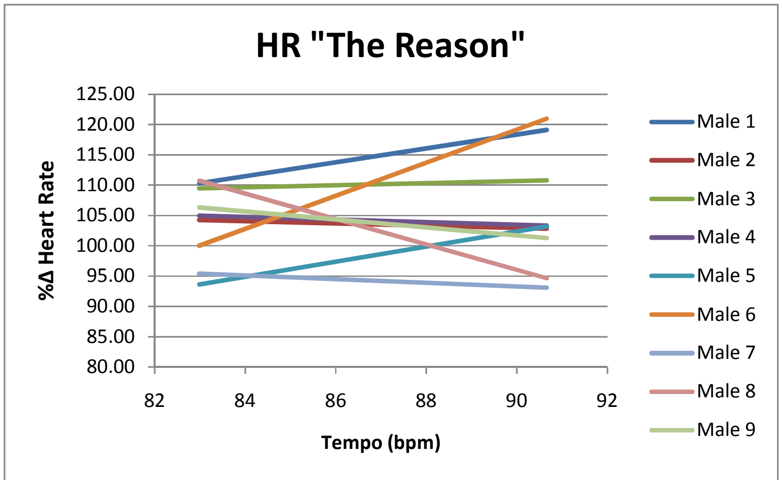
Table 2: Jarque-Bera Normality Test p-values

	($R_{82.98}$/BL)*100	**($R_{90.66}$/BL)*100**	**(T_{100}/BL)*100**	**(T_{200}/BL)*100**
Male HR	0.6484	0.7231	0.5837	0.4839

Table 3: Wilcoxon Signed-Rank Analysis of Normalized Male Heart Rate Changes

Heart Rate (bpm) Percentage of Baseline						
Subject	**Age**	**Baseline**	**($R_{82.98}$/BL)*100**	**($R_{90.66}$/BL)*100**	**(T_{100}/BL)*100**	**(T_{200}/BL)*100**
Male 1	22	68	110.29	119.12	104.41	113.24
Male 2	21	70	104.29	102.86	107.14	111.43
Male 3	22	74	109.46	110.81	108.11	112.16
Male 4	21	60	105.00	103.33	111.67	96.67
Male 5	21	63	93.65	103.17	98.41	100.00
Male 6	20	62	100.00	120.97	104.84	109.68
Male 7	21	87	95.40	93.10	85.06	90.80
Male 8	21	56	110.71	94.64	96.43	112.50
Male 9	25	79	106.33	101.27	98.73	110.13
P value			1		0.1359	

Graph 1



Graph 2

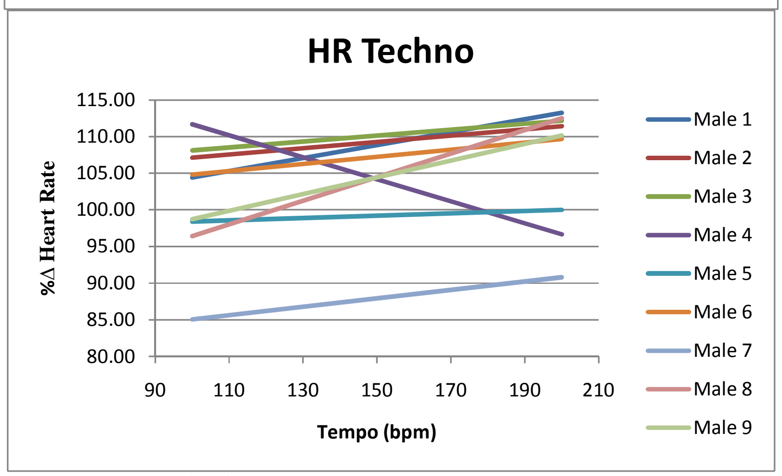


Table 4: Student's t-test Analysis of Male MABP

MABP (mmHg)					
Subject	**Age**	**$R_{82.98}$-BL**	**$R_{90.66}$-BL**	**T_{100}-BL**	**T_{200}-BL**
Male 1	22	-8	-6	-8	-2
Male 2	21	0	-4.666666667	0	-2
Male 3	22	1.333333333	-0.666666667	2	4
Male 4	21	1.333333333	0	0	2.666666667
Male 5	21	3.333333333	3.333333333	1.333333333	-2
Male 6	20	6.666666667	-5.333333333	3.333333333	2
Male 7	21	4	-5.333333333	-8.666666667	-2.666666667
Male 8	21	-6.666666667	-1.333333333	-0.666666667	1.333333333
Male 9	25	-2.666666667	5.333333333	0.666666667	0.666666667
p value		0.490299827		0.26225475	

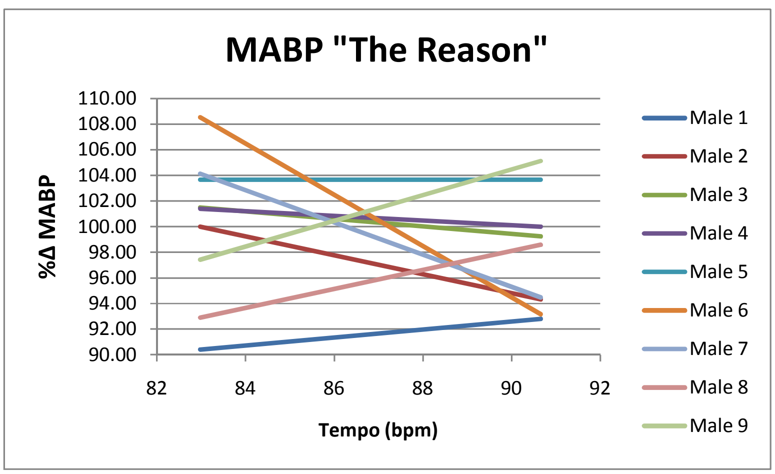
Table 5: Jarque-Bera Normality Test p-values

	$(R_{82.98}/BL)*100$	$(R_{90.66}/BL)*100$	$(T_{100}/BL)*100$	$(T_{200}/BL)*100$
Male MABP	0.824	0.6841	0.4622	0.6436

Table 6: Wilcoxon Signed-Rank Analysis of Normalized Male MABP Changes

MABP (mmHg) Percentage of Baseline						
Subject	**Age**	**Baseline**	$(R_{82.98}/BL)*100$	$(R_{90.66}/BL)*100$	$(T_{100}/BL)*100$	$(T_{200}/BL)*100$
Male 1	22	83.33	90.40	92.80	90.40	97.60
Male 2	21	82.00	100.00	94.31	100.00	97.56
Male 3	22	88.67	101.50	99.25	102.26	104.51
Male 4	21	95.33	101.40	100.00	100.00	102.80
Male 5	21	90.67	103.68	103.68	101.47	97.79
Male 6	20	78.00	108.55	93.16	104.27	102.56
Male 7	21	96.67	104.14	94.48	91.03	97.24
Male 8	21	94.00	92.91	98.58	99.29	101.42
Male 9	25	104.00	97.44	105.13	100.64	100.64
P value			0.4232		0.7456	

Graph 3



Graph 4

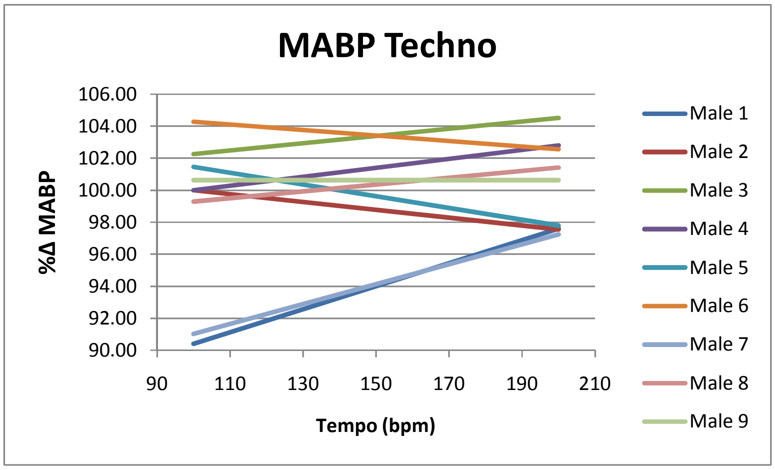


Table 7: Student's t-test Analysis of Male EMG-P-P

EMG - P-P					
Subject	**Age**	**$R_{82.98}$**	**$R_{90.66}$**	**T_{100}**	**T_{200}**
Male 1	22	0.15216	0.25214	0.3783	0.17249
Male 2	21	0.21899	0.05682	0.08563	0.03229
Male 3	22	0.08783	0.0741	0.06732	0.10199
Male 4	21	0.07874	0.21057	0.14001	0.24133
Male 5	21	0.06445	0.17255	0.0506	0.02124
Male 6	20	0.07172	0.04993	0.08636	0.29334
Male 7	21	0.19324	1.40942	0.82495	0.54309
Male 8	21	0.09598	0.08453	0.08316	0.07248
Male 9	25	0.8562	0.41016	1.08472	0.56067
P value		0.527524865		0.283142478	

Table 8: Student's t-test Analysis of Male EMG- mean

EMG - mean					
Subject	**Age**	**$R_{82.98}$**	**$R_{90.66}$**	**T_{100}**	**T_{200}**
Male 1	22	-0.00469	-0.00464	-0.00466	-0.00486
Male 2	21	-0.0047	-0.00471	-0.00471	-0.0047
Male 3	22	-0.00465	-0.00468	-0.00468	-0.00468
Male 4	21	-0.00942	-0.0094	-0.0094	-0.00939
Male 5	21	-0.0047	-0.0047	-0.00471	-0.00469
Male 6	20	-0.00472	-0.00479	-0.00476	-0.00473
Male 7	21	-0.00951	-0.00937	-0.00942	-0.00738
Male 8	21	-0.01182	-0.01178	-0.01184	-0.01178
Male 9	25	-0.00941	-0.00937	-0.00946	-0.100949
P value		0.340181981		0.357837363	

Table 9: Student's t-test Analysis of Male EMG-Integral

EMG - Integral					
Subject	**Age**	**$R_{82.98}$**	**$R_{90.66}$**	**T_{100}**	**T_{200}**
Male 1	22	-0.53209	-0.4756	-0.34999	-0.32279
Male 2	21	-0.53821	-0.51703	-0.36635	-0.32687
Male 3	22	-0.39534	-0.49909	-0.3615	-0.34752
Male 4	21	-2.2969	-2.09233	-0.82081	-0.43173
Male 5	21	-0.82921	-0.9851	-0.36432	-0.37057
Male 6	20	-0.52185	-0.51906	-0.33281	-0.34758
Male 7	21	-1.0621	-1.38227	-0.76585	-0.80007
Male 8	21	-1.31573	-1.18592	-0.84684	-0.80919
Male 9	25	-1.03954	-0.93851	-0.68567	-0.67461
P value		0.898511		0.265394244	

Table 10: Student's t-test Analysis of Female Heart Rate

Heart Rate (bpm)					
Subject	**Age**	**$R_{82.98}$-BL**	**$R_{90.66}$-BL**	**T_{100}-BL**	**T_{200}-BL**
Female 1	20	2	-1	2	1
Female 2	22	4	2	4	5
Female 3	22	-4	-3	-5	-4
Female 4	21	8	11	11	12
Female 5	21	6	7	5	2
Female 6	21	-2	15	9	5
Female 7	20	1	8	1	0
Female 8	20	-12	-6	-7	-11
Female 9	21	1	4	0	1
p-value		0.103087669		0.205962143	

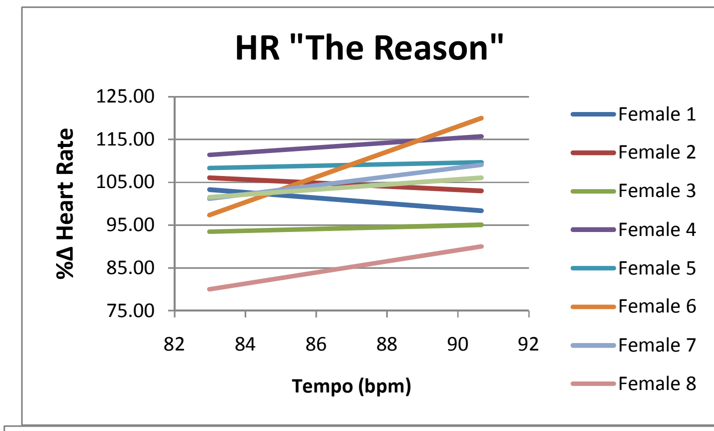
Table 11: Jarque-Bera Normality Test p-values

	($R_{82.98}$/BL)*100	**($R_{90.66}$/BL)*100**	**(T_{100}/BL)*100**	**(T_{200}/BL)*100**
Female HR	0.0764	0.5	0.5	0.5

Table 12: Wilcoxon Signed-Rank Analysis of Normalized Female Heart Rate Changes

Heart Rate (bpm) Percentage of Baseline						
Subject	**Age**	**Baseline**	**($R_{82.98}$/BL)*100**	**($R_{90.66}$/BL)*100**	**(T_{100}/BL)*100**	**(T_{200}/BL)*100**
Female 1	20	61	103.28	98.36	103.28	101.64
Female 2	22	66	106.06	103.03	106.06	107.58
Female 3	22	61	93.44	95.08	91.80	93.44
Female 4	21	70	111.43	115.71	115.71	117.14
Female 5	21	72	108.33	109.72	106.94	102.78
Female 6	21	75	97.33	120.00	112.00	106.67
Female 7	20	88	101.14	109.09	101.14	100.00
Female 8	20	60	80.00	90.00	88.33	81.67
Female 9	21	66	101.52	106.06	100.00	101.52
P value			0.3519		0.8819	

Graph 5



Graph 6

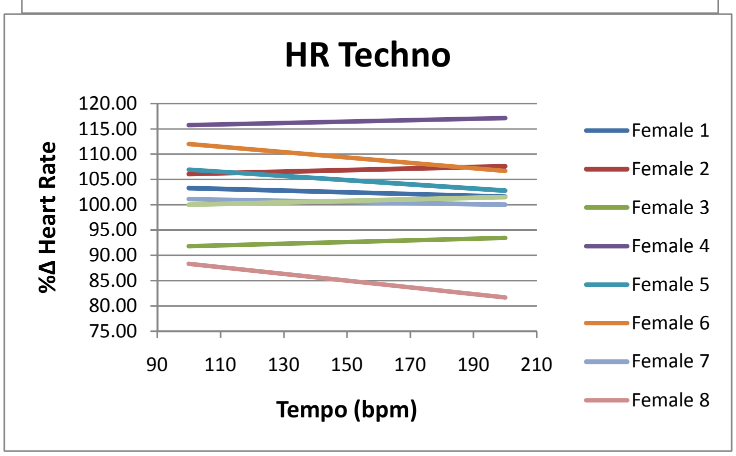


Table 13: Student's t-test Analysis of Female MABP

MABP (mmHg)					
Subject	**Age**	**$R_{82.98}$-BL**	**$R_{90.66}$-BL**	**T_{100}-BL**	**T_{200}-BL**
Female 1	20	-4	-6	-8	-5.333333333
Female 2	22	-6	-1.333333333	-9.333333333	-7.333333333
Female 3	22	-3.333333333	-2.666666667	0	0.666666667
Female 4	21	-4	-12.66666667	-14	-8
Female 5	21	0	3.333333333	2	1.333333333
Female 6	21	4.666666667	0	4.666666667	-2
Female 7	20	-7.333333333	-4	-6	-8.666666667
Female 8	20	-4.666666667	-6	-4	-7.333333333
Female 9	21	2	-1.333333333	0.666666667	-2
p-value		0.556537548		0.692816349	

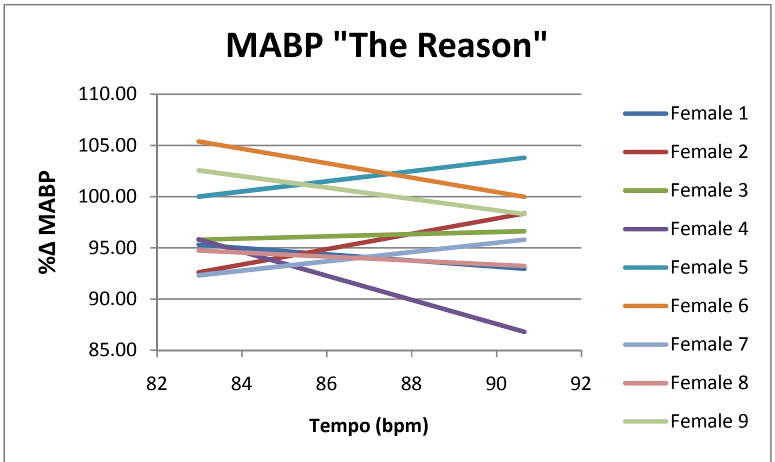
Table 14: Jarque-Bera Normality Test p-values

	($R_{82.98}$/BL)*100	**($R_{90.66}$/BL)*100**	**(T_{100}/BL)*100**	**(T_{200}/BL)*100**
Female MABP	0.2247	0.5	0.5	0.2203

Table 15: Wilcoxon Signed-Rank Analysis of Normalized Female MABP Changes

MABP (mmHg) Percentage of Baseline						
Subject	**Age**	**Baseline**	**($R_{82.98}$/BL)*100**	**($R_{90.66}$/BL)*100**	**(T_{100}/BL)*100**	**(T_{200}/BL)*100**
Female 1	20	85.33	95.31	92.97	90.63	93.75
Female 2	22	81.33	92.62	98.36	88.52	90.98
Female 3	22	79.33	95.80	96.64	100.00	100.84
Female 4	21	96.00	95.83	86.81	85.42	91.67
Female 5	21	88.00	100.00	103.79	102.27	101.52
Female 6	21	86.67	105.38	100.00	105.38	97.69
Female 7	20	95.33	92.31	95.80	93.71	90.91
Female 8	20	88.67	94.74	93.23	95.49	91.73
Female 9	21	78.00	102.56	98.29	100.85	97.44
P value			0.9831		0.9314	

Graph 7



Graph 8

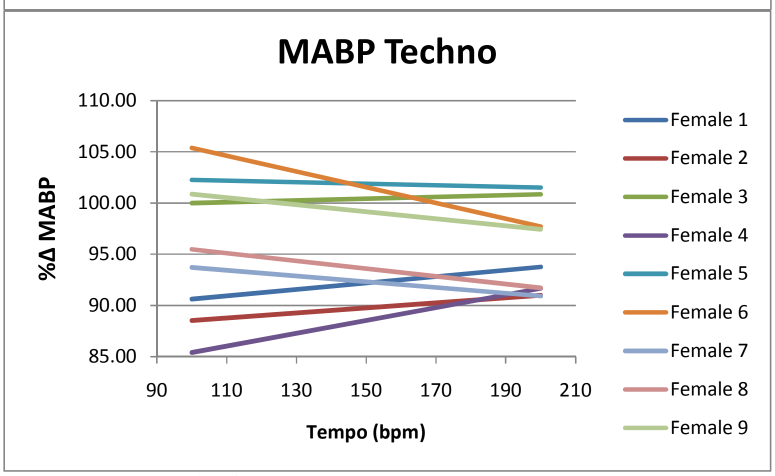


Table 16: Student's t-test Analysis of Female EMG-P-P

EMG - P-P					
Subject	**Age**	**$R_{82.98}$**	**$R_{90.66}$**	**T_{100}**	**T_{200}**
Female 1	20	0.21698	0.05847	0.08398	0.19714
Female 2	22	0.06628	0.0564	0.072227	0.0708
Female 3	22	0.2583	0.11145	0.06213	0.04712
Female 4	21	0.02368	0.02148	0.07092	0.13184
Female 5	21	1.44409	0.06628	0.09033	0.06152
Female 6	21	0.36414	0.39331	0.14917	0.10156
Female 7	20	0.99158	0.11365	0.44287	0.79944
Female 8	20	0.16956	0.11194	0.22241	0.09753
Female 9	21	0.02319	0.12512	0.03625	0.02893
p-value		0.137222751		0.481379231	

Table 17: Student's t-test Analysis of Female EMG-mean

EMG - mean					
Subject	**Age**	**$R_{82.98}$**	**$R_{90.66}$**	**T_{100}**	**T_{200}**
Female 1	20	-0.00467	-0.00467	-0.00469	-0.00467
Female 2	22	-0.00942	-0.00943	-0.00945	-0.00943
Female 3	22	-0.0094	-0.00939	-0.00936	-0.0094
Female 4	21	-0.0094	-0.00939	-0.00942	-0.00942
Female 5	21	-0.00938	-0.00936	-0.0094	-0.00938
Female 6	21	-0.00949	-0.00948	-0.00947	-0.00938
Female 7	20	-0.00944	-0.00943	-0.0095	-0.00942
Female 8	20	-0.00954	-0.0095	-0.00939	-0.00939
Female 9	21	-0.00943	-0.0095	-0.00932	-0.00939
p-value		0.831486715		0.453264739	

Table 18: Student's t-test Analysis of Female EMG-Integral

EMG - Integral					
Subject	**Age**	**$R_{82.98}$**	**$R_{90.66}$**	**T_{100}**	**T_{200}**
Female 1	20	-0.53769	-0.47933	-0.34928	-0.32961
Female 2	22	-0.97132	-0.96247	-0.66324	-0.67195
Female 3	22	-1.79796	-1.11062	-0.58025	-0.7826
Female 4	21	-1.07802	-0.99206	-0.87227	-0.90425
Female 5	21	-0.99022	-1.02521	-0.77807	-0.87436
Female 6	21	-1.00115	-0.99043	-0.71929	-0.70805
Female 7	20	-1.00629	-0.97012	-0.71281	-0.68564
Female 8	20	-0.993	-0.97455	-0.67632	-0.69287
Female 9	21	-1.04689	-0.99265	-0.70941	-0.67325
p-value		0.202200428		0.285927577	

Legend:
$R_{82.98}$ – "The Reason" at 82.98 bpm
$R_{90.66}$ –"The Reason" at 90.66 bpm
T_{100} – techno song at 100 bpm
T_{200} – techno song at 200 bpm
BL – baseline measurement