The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

Year 10 Student Research Project 2016
Sophie Ma
Abstract

This experiment aimed to determine the effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians. The investigation was conducted amongst a group of 10 participants, five of which were currently studying music, the other five were not. Each participant’s resting heart rate and blood pressure was measured, and they then listened to three songs at different tempos; 40 beats per minute, 110 beats per minute and 180 beats per minute. After listening to the music for three minutes, their heart rate and blood pressure was recorded. This process was repeated a further two times to complete a total of three trials. The results of the experiment showed that listening to the fast tempo music increased heart rate and blood pressure, listening to a medium music tempo stimulated a slight increase in heart rate and blood pressure and listening to a slow music tempo decreased heart rate and blood pressure in adolescent musicians and non-musicians. There were no significant differences between the musicians and non-musicians.
Introduction

Why is the subject important?

Music has the ability to stimulate certain hormones in the brain and body, and promotes either an increased or decreased heart rate and blood pressure, depending on the genre and tempo. Dr Peter Sleight from the University of Oxford stated that music can “alleviate stress, improve athletic performance” and “improve movement in neurologically impaired patients” (Sleight, 2005).

Fast tempo music, generally around 120 to 130 beats per minute (bpm) is said to increase anxiety through an increase in both blood pressure and heart rate. Slow tempo music of approximately 50 to 60bpm has the opposite effect (Edworthy and Waring 2010) – soothing and relaxing the body through a decrease in blood pressure and heart rate.

In recent years “music therapy” has been introduced as a treatment modality, benefiting patients with anxiety, stress, pain, depressive syndromes and sleeplessness. Classical music is played to decrease heart rate and blood pressure (Trappe, 2010). Trappe also found that music increases one’s learning ability and memory through different interconnected processes in the brain.

Heart rate and blood pressure can be further increased by music tempo if the person has a background in music. An Oxford University study showed that musicians breathed faster and their heart rate increased more than non-musicians after listening to music (Sleight, 2013).

This experiment will be conducted among adolescents who will be divided into two distinct groups: non-musicians (controls), and musicians. Musicians are adolescents who currently study or are involved with music (either as a study or in a music co-curricular group). Non-musicians are adolescents who do not currently study music or are not involved in any music co-curricular groups. Their increase or decrease in blood pressure and heart rate will then be compared in order to determine which group has the greatest increase.

Why does this subject interest me?

I am particularly interested in music, and participate in many choirs and other music groups, and have often wondered whether certain genres or tempos stimulate a physiological response, whether it be a quickened reaction time, increased stress levels or a change in blood pressure or heart rate. If this experiment proves to increase or decrease either the non-musicians or musicians’ heart rate or blood pressure, this could potentially be used in time during periods of stress for adolescents. For example, if the slower tempo of music generates the greatest decrease amongst the musicians, in a particular time of stress they could listen to this specific tempo, which would decrease their heart rate and blood pressure potentially resulting in lower stress levels.
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What is the science behind the hypothesis?

The hypothesis states that the greatest increase or decrease in heart rate and blood pressure that occurs due to the music tempos will occur amongst the musicians. In an Oxford University study the musicians among the group experienced the greatest increase in heart rate, as they understood the complexity of the rhythms and adjusted their heart rates to match the beat (Quinn, 2013).

The fast tempo music may change stress levels, and the slow tempo music may have a calming effect. The fast tempo music should cause or increase anxiety levels, which stimulates the sympathetic nervous system. Adrenaline is then released in the blood stream and noradrenaline is released in the sympathetic nervous system, which results in an increased heart rate and blood pressure. Slow tempo music is likely to induce a calming effect that results in a reduction in sympathetic nervous system activity and adrenaline hormone levels in the blood.

Heart rate

Firstly, according to the American Heart Association, heart rate is the number of times your heart beats per minute. Heart rate depends on age, anxiety, stress levels, activity and fitness levels and medication (especially beta blockers which block adrenaline). These medications slow heart rate, and too much medication, such as thyroid medication will increase pulse.

Pulse depends on activity and fitness level, however a normal resting heart rate for adults (and children above 10 years old) is typically between 60 and 100 beats per minute. Below is a table of normal resting heart rates, (the highlighted row is the age group upon which I am conducting my experiment).

**Normal resting heart rates**

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Normal resting heart rate (beats per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborns</td>
<td>0-3mths</td>
<td>100-150</td>
</tr>
<tr>
<td>Infants</td>
<td>3-6mths</td>
<td>90-120</td>
</tr>
<tr>
<td>Infants</td>
<td>6-12mths</td>
<td>80-120</td>
</tr>
<tr>
<td>Children</td>
<td>1-10yrs</td>
<td>70-130</td>
</tr>
<tr>
<td>Children and adults</td>
<td>10+yrs</td>
<td>60-100</td>
</tr>
<tr>
<td>Well-trained athletes</td>
<td></td>
<td>40-60</td>
</tr>
</tbody>
</table>


BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
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Blood pressure

According to Better Health Victoria, blood pressure is the “pressure of blood in the arteries as it is pumped around the body by the heart”. It is affected by body position, breathing, emotional state, exercise and sleep. A high blood pressure places extra strain on one’s arteries and heart, which can result in heart attacks and strokes (Department of Health and Human Services, Victorian Government, 2015).

Blood pressure readings consist of two numbers: systolic and diastolic. Systolic blood pressure is the highest level one’s blood pressure reaches when their heart beats. The bottom number, diastolic blood pressure is the lowest level blood pressure reaches as one’s heart relaxes between the beats. An ideal blood pressure for adults is 120/80, and high blood pressure (hypertension) begins to occur when the reading is about 140-159/90-99.

<table>
<thead>
<tr>
<th>Blood Pressure Category</th>
<th>Systolic mm Hg (upper #)</th>
<th>Diastolic mm Hg (lower #)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>less than 120</td>
<td>and less than 80</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>120 – 139</td>
<td>or 80 – 89</td>
</tr>
<tr>
<td>High Blood Pressure (Hypertension) Stage 1</td>
<td>140 – 159</td>
<td>or 90 – 99</td>
</tr>
<tr>
<td>High Blood Pressure (Hypertension) Stage 2</td>
<td>160 or higher</td>
<td>or 100 or higher</td>
</tr>
<tr>
<td>Hypertensive Crisis (Emergency care needed)</td>
<td>Higher than 180</td>
<td>or Higher than 110</td>
</tr>
</tbody>
</table>

Figure 1
Blood pressure readings and their meanings
Source: http://www.heart.org/HEARTORG/

Mean arterial pressure

Mean arterial pressure is the pressure that is primarily regulated – the average level of the blood pressure over several heartbeats. It can be derived from a patient’s systolic blood pressure (SBP) and diastolic blood pressure (DBP). The mean arterial pressure (MAP) is typically used as a surrogate indicator of blood flow, and also as an indicator of tissue perfusion (Medlej, 2016). MAP will be used later on in this research project, as an indicator of the average differences in blood pressure between the three songs and three trials. The formula for mean arterial pressure is as follows:

\[
Mean \text{ arterial pressure} = \frac{\text{Systolic BP} - \text{Diastolic BP}}{3} + \text{Diastolic BP}
\]

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What similar experiments have been done before?

There has been another experiment that investigated the effect of music tempos on heart rate and blood pressure on musicians and non-musicians, however not specifically on adolescents. At the University of Oxford an experiment was conducted that showed musicians breathed faster and had a higher blood pressure after listening to music with a fast tempo. Dr Peter Sleight (from the University of Oxford) stated "musicians breathe faster with faster tempi, and had slower baseline breathing rates than non-musicians". After a thorough internet search, I did not find any other experiments apart from this study, about the effect of music tempos on heart rate and blood pressure on adolescent musicians and non-musicians.

Aim

To determine the effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians.

Hypothesis

Listening to a fast music tempo will increase heart rate and blood pressure, listening to a medium music tempo will produce little to no change in heart rate and blood pressure and listening to a slow music tempo will decrease heart rate and blood pressure in adolescents. The greatest increases and decreases will occur amongst the musicians.

Equipment

- 1 x Omron Intellisense™ blood pressure monitor
- 1 x Dick Smith Electronic Table Top Timer Clock (stopwatch)
- 1 x iPhone 6
- 1 x pair of Sennheiser noise-cancelling headphones
- 1 x 180bpm song
  - Root Beer Rag – Billy Joel
- 1 x 110bpm song
  - Walking on Sunshine – Katrina and the Waves
- 1 x 40bpm song
  - I Love Paris – Ella Fitzgerald
- 5 x adolescent musicians
  - who are currently studying music (either as a subject or as an instrument)
    - or
  - are currently involved in a music group
- 5 x adolescent non-musicians
  - who are not currently studying music (either as a subject or as an instrument)
    - or
  - are not involved in any music groups

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Risk Assessment

Found on next page.

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Science Student Research Project Risk Assessment

Activity Description: The effect of different music tempos on heart rate and blood pressure on adolescent musicians and non-musicians. A group of 5 adolescent musicians and 5 adolescent non-musicians will have their heart rate and blood pressure measured, then listen to 3 minutes of slow tempo music, and then have their heart rate and blood pressure measured again. This would be repeated a further two times for the medium and fast tempos.

Mandatory precautions: Covered shoes, safety glasses, hair exceeding shoulder length tied back.

<table>
<thead>
<tr>
<th>Step 1: Identify the hazard</th>
<th>CSIS User code (for chemicals only)</th>
<th>Step 2: Strategies to minimise the hazard</th>
<th>Step 3: Assessment of risk (see table below)</th>
<th>Step 4: What if something goes wrong?</th>
<th>Step 5: Packing up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive constriction of blood flow from the blood pressure monitor cuff</td>
<td>n/a</td>
<td>Keep constriction levels within the recommended guidelines/limits, verbally communicate with participant and look for signs of excessive constriction (e.g. pale colour of skin, coldness in body).</td>
<td>1+1=2=LOW RISK</td>
<td>In case of excessive constriction of blood flow, instantly release blood pressure monitor cuff, then consult teacher or doctor.</td>
<td>Remove blood pressure monitor cuff with caution.</td>
</tr>
<tr>
<td>Music volume could be too loud and damage eardrums</td>
<td>n/a</td>
<td>Control music volume at a soft-medium level, ask participants not to change volume.</td>
<td>1+1=2=LOW RISK</td>
<td>In case of eardrum damage, consult teacher then doctor.</td>
<td>Remove earphones with caution</td>
</tr>
</tbody>
</table>

Date: 6th February 2016  Student Signature: ……………………………………………………

How do you assess the risk? For each hazard identified in Step 1, answer A then answer B. Then add A and B together to determine Risk and Action required

<table>
<thead>
<tr>
<th>A What is the potential impact or consequence of the hazard?</th>
<th>B What is the likelihood of the event happening?</th>
<th>Add the numbers in columns A and B together</th>
<th>How to assess the risk</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = MINOR First Aid required with little or no lost time</td>
<td>1 = LOW It could happen but only rarely</td>
<td>1 – 2 = LOW RISK</td>
<td>Proceed with caution</td>
<td></td>
</tr>
<tr>
<td>2 = MODERATE Medical treatment required, some lost time</td>
<td>2 = MODERATE It could occasionally happen</td>
<td>3 – 4 = MODERATE</td>
<td>Consult with teacher</td>
<td></td>
</tr>
<tr>
<td>3 = SERIOUS Medical treatment required, extended lost time</td>
<td>3 = HIGH It could frequently happen</td>
<td>5 – 6 = HIGH</td>
<td>Reassess the need to perform practical/ consult with teacher</td>
<td></td>
</tr>
</tbody>
</table>

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Method

1. Before commencing the experiment, the participant (aged between 10 and 18) read and signed the Informed Consent form for Young Scientist Research participants, and if under 18, their parents also signed the form.

2. The participant was taken to a quiet room and their resting blood pressure was measured using the Omron Intellisense™ blood pressure monitor and recorded. (See Figure 4)

3. The participant’s resting heart rate was measured by manually counting their radial pulse rate for 15 seconds using the Dick Smith LCD Digital stopwatch. This figure was then multiplied by four to find the participant’s heart rate over one minute. The result was recorded.

4. The participant listened to 3 minutes of the 40 beats per minute song, I Love Paris using the iPhone 6 (music application), at a volume level of six (out of 16), and the pair of Sennheiser noise-cancelling headphones. (See Figure 3)

5. After listening to the music their blood pressure was measured using the blood pressure monitor and recorded.

6. Their heart rate was then measured manually using the method in step 2, and recorded.

7. A two-minute rest period of silence occurred.

8. Steps 1-6 were repeated on the same participant for the 110 beats per minute song, Walking on Sunshine.

9. A two-minute rest period of silence occurred.

10. Steps 1-6 were repeated on the same participant for the 180 beats per minute song, Root Beer Rag.

11. All results were recorded and tabulated.

12. Steps 1-9 were repeated for the 11 other participants (musicians and non-musicians).

13. Steps 1-10 were repeated a further two times (on the same person) in order to complete three trials.

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**Figure 2**
Equipment used – clockwise from left: Sennheiser headphones, iPhone 6, Blood Pressure monitor, Stopwatch

**Figure 3**
Experimental setup – participant is listening to music with headphones, and blood pressure monitor and stopwatch is prepared for immediate use after the music is finished

**Figure 4**
Labelled experimental setup – participant having their blood pressure measured and heart rate before listening to music

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Experimental design

Independent Variables
- Music tempo
- Musical training

Dependent Variables
- Heart rate
- Blood pressure

Controlled Variables
- Audible volume of room experiment is conducted in
- Audible volume of music
- Silence between songs
- Type of headphones

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
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Results

**TRIAL 1**

**MUSICIANS**

Table 1: Blood pressure and heart rate of musicians after listening to 40 beats per minute song

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>108/61</td>
<td>77</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>116/60</td>
<td>79</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>108/74</td>
<td>85</td>
<td>72</td>
</tr>
<tr>
<td>4</td>
<td>103/61</td>
<td>75</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>102/68</td>
<td>79</td>
<td>72</td>
</tr>
</tbody>
</table>

Before listening to music:
- Average mean arterial pressure (MAP): 79 mm Hg
- Standard deviation of MAP: 3.7 mm Hg
- Average heart rate: 70 bpm
- Standard deviation of heart rate: 5.4 bpm

After listening to music:
- Average mean arterial pressure (MAP): 77 mm Hg
- Standard deviation MAP: 3.0 mm Hg
- Average heart rate: 68 bpm
- Standard deviation of heart rate: 2.8 bpm

**NON-MUSICIANS**

Table 2: Blood pressure and heart rate of non-musicians after listening to 40 beats per minute song

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>127/63</td>
<td>84</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>96/60</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>98/63</td>
<td>75</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>115/72</td>
<td>86</td>
<td>56</td>
</tr>
<tr>
<td>5</td>
<td>95/58</td>
<td>70</td>
<td>68</td>
</tr>
</tbody>
</table>

Before listening to music:
- Average MAP: 77 mm Hg
- Standard deviation of MAP: 7.2 mm Hg

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Average heart rate: 64bpm
Standard deviation of heart rate: 6.3bpm

After listening to music:
Average MAP: 79mm Hg
Standard deviation of MAP: 13.5mm Hg
Average heart rate: 64bpm
Standard deviation of heart rate: 10.2bpm

MUSICIANS

Table 3: Blood pressure and heart rate of musicians after listening to 110 beats per minute song
Walking on Sunshine

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>104/72</td>
<td>83</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>101/58</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>102/77</td>
<td>85</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>92/60</td>
<td>71</td>
<td>68</td>
</tr>
<tr>
<td>5</td>
<td>95/67</td>
<td>76</td>
<td>70</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 77mm Hg
Standard deviation of MAP: 6.3mm Hg
Average heart rate: 69bpm
Standard deviation of heart rate: 2.3bpm

After listening to music:
Average MAP: 82mm Hg
Standard deviation of MAP: 13.0mm Hg
Average heart rate: 70bpm
Standard deviation of heart rate: 4.6bpm

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NON-MUSICIANS

Table 4: Blood pressure and heart rate of non-musicians after listening to 110 beats per minute song Walking on Sunshine

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>114/62</td>
<td>79</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>116/65</td>
<td>82</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>66</td>
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<tr>
<td>2</td>
<td>95/62</td>
<td>73</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95/62</td>
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<td>118/77</td>
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<td>74</td>
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<td></td>
<td></td>
<td>62</td>
</tr>
</tbody>
</table>

Before listening to music:
- Average MAP: 81mm Hg
- Standard deviation of MAP: 10.4mm Hg
- Average heart rate: 62bpm
- Standard deviation of heart rate: 10.8bpm

After listening to music:
- Average MAP: 82mm Hg
- Standard deviation of MAP: 8.8mm Hg
- Average heart rate: 66bpm
- Standard deviation of heart rate: 10.1bpm

MUSICIANS

Table 5: Blood pressure and heart rate of musicians after listening to 180 beats per minute song Root Beer Rag

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
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<td>94/56</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>5</td>
<td>104/69</td>
<td>81</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>98/65</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>76</td>
</tr>
</tbody>
</table>

Before listening to music:
- Average MAP: 78mm Hg
- Standard deviation of MAP: 3.0mm Hg

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

Average heart rate: 71bpm
Standard deviation of heart rate: 8.2bpm

After listening to music:
Average MAP: 75mm Hg
Standard deviation of MAP: 6.4mm Hg
Average heart rate: 74bpm
Standard deviation of heart rate: 6.1bpm

NON-MUSICIANS

Table 6: Blood pressure and heart rate of non-musicians after listening to 180 beats per minute song
Root Beer Rag

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP(sys/dia)</td>
<td>MAP(mmHg)</td>
<td>HR(bpm)</td>
</tr>
<tr>
<td>1</td>
<td>127/64</td>
<td>85</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>82/52</td>
<td>62</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>115/78</td>
<td>90</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>113/74</td>
<td>87</td>
<td>48</td>
</tr>
<tr>
<td>5</td>
<td>97/68</td>
<td>78</td>
<td>60</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 80mm Hg
Standard deviation of MAP: 11.2mm Hg
Average heart rate: 62bpm
Standard deviation of heart rate: 11.5bpm

After listening to music:
Average MAP: 84mm Hg
Standard deviation of MAP: 12.2mm Hg
Average heart rate: 65bpm
Standard deviation of heart rate: 14.3bpm

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

**TRIAL 2**

**MUSICIANS**

Table 7: Blood pressure and heart rate of musicians after listening to 40 beats per minute song, *I Love Paris*

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>103/43</td>
<td>63</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>95/55</td>
<td>68</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>105/83</td>
<td>90</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>101/60</td>
<td>74</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>104/77</td>
<td>86</td>
<td>68</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 76mm Hg
Standard deviation of MAP: 11.5mm Hg
Average heart rate: 67bpm
Standard deviation of heart rate: 5.9bpm

After listening to music:
Average MAP: 75mm Hg
Standard deviation of MAP: 7.5mm Hg
Average heart rate: 65bpm
Standard deviation of heart rate: 4.4bpm

**NON-MUSICIANS**

Table 8: Blood pressure and heart rate of non-musicians after listening to 40 beats per minute song, *I Love Paris*

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>118/72</td>
<td>87</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>85/61</td>
<td>69</td>
<td>66</td>
</tr>
<tr>
<td>3</td>
<td>112/75</td>
<td>87</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>113/71</td>
<td>85</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>94/73</td>
<td>80</td>
<td>60</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 82mm Hg
Standard deviation of MAP: 7.6mm Hg
Average heart rate: 62bpm
Standard deviation of heart rate: 7.1bpm

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

After listening to music:
Average MAP: 79mm Hg
Standard deviation of MAP: 9.4mm Hg
Average heart rate: 60bpm
Standard deviation of heart rate: 9.6bpm

MUSICIANS

Table 9: Blood pressure and heart rate of musicians after listening to 110 beats per minute song
Walking on Sunshine

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>137/98</td>
<td>111</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>92/52</td>
<td>65</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>108/76</td>
<td>87</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>101/56</td>
<td>71</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>99/64</td>
<td>76</td>
<td>68</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 82mm Hg
Standard deviation of MAP: 18.1mm Hg
Average heart rate: 68bpm
Standard deviation of heart rate: 4.6bpm

After listening to music:
Average MAP: 78mm Hg
Standard deviation of MAP: 9.8mm Hg
Average heart rate: 71bpm
Standard deviation of heart rate: 3.9bpm

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

NON-MUSICIANS

Table 10: Blood pressure and heart rate of non-musicians after listening to 110 beats per minute song Walking on Sunshine

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>116/60</td>
<td>79</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>88/58</td>
<td>68</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>111/75</td>
<td>87</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>114/72</td>
<td>86</td>
<td>47</td>
</tr>
<tr>
<td>5</td>
<td>94/65</td>
<td>75</td>
<td>64</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 79mm Hg
Standard deviation of MAP: 7.9mm Hg
Average heart rate: 63bpm
Standard deviation of heart rate: 9.6bpm

After listening to music:
Average MAP: 80mm Hg
Standard deviation of MAP: 7mm Hg
Average heart rate: 67bpm
Standard deviation of heart rate: 12bpm

MUSICIANS

Table 11: Blood pressure and heart rate of musicians after listening to 180 beats per minute song Root Beer Rag

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>98/55</td>
<td>69</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>90/66</td>
<td>74</td>
<td>68</td>
</tr>
<tr>
<td>3</td>
<td>108/63</td>
<td>78</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>90/64</td>
<td>73</td>
<td>66</td>
</tr>
<tr>
<td>5</td>
<td>100/67</td>
<td>78</td>
<td>64</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 74mm Hg
Standard deviation of MAP: 3.8mm Hg

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

Average heart rate: 66bpm
Standard deviation of heart rate: 2.0bpm

After listening to music:
Average MAP: 77mm Hg
Standard deviation of MAP: 6.7mm Hg
Average heart rate: 72bpm
Standard deviation of heart rate: 4.3bpm

NON-MUSICIANS

Table 12: Blood pressure and heart rate of non-musicians after listening to 180 beats per minute song

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>111/63</td>
<td>79</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>86/58</td>
<td>67</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>111/73</td>
<td>86</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>109/74</td>
<td>86</td>
<td>46</td>
</tr>
<tr>
<td>5</td>
<td>97/65</td>
<td>76</td>
<td>64</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 79mm Hg
Standard deviation of MAP:
Average heart rate: 63bpm
Standard deviation of heart rate:

After listening to music:
Average MAP: 81mm Hg
Standard deviation of MAP:
Average heart rate: 66bpm
Standard deviation of heart rate:

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

TRIAL 3

MUSICIANS

Table 13: Blood pressure and heart rate of musicians after listening to 40 beats per minute song I Love Paris

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>107/59</td>
<td>75</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>110/66</td>
<td>74</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>104/80</td>
<td>88</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>98/68</td>
<td>78</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>103/75</td>
<td>84</td>
<td>68</td>
</tr>
</tbody>
</table>

Before listening to music:
- Average MAP: 80mm Hg
- Standard deviation of MAP: 6.0mm Hg
- Average heart rate: 66bpm
- Standard deviation of heart rate: 4.6bpm

After listening to music:
- Average MAP: 77mm Hg
- Standard deviation of MAP: 5.6mm Hg
- Average heart rate: 62bpm
- Standard deviation of heart rate: 4.6bpm

NON-MUSICIANS

Table 14: Blood pressure and heart rate of non-musicians after listening to 40 beats per minute song I Love Paris

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>111/69</td>
<td>83</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>94/53</td>
<td>67</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>98/60</td>
<td>73</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>113/72</td>
<td>86</td>
<td>56</td>
</tr>
<tr>
<td>5</td>
<td>96/62</td>
<td>73</td>
<td>64</td>
</tr>
</tbody>
</table>

Before listening to music:
- Average MAP: 76mm Hg

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

Standard deviation of MAP: 7.9mm Hg
Average heart rate: 65bpm
Standard deviation of heart rate: 8.9bpm

After listening to music:
Average MAP: 76mm Hg
Standard deviation of MAP: 9.7mm Hg
Average heart rate: 62bpm
Standard deviation of heart rate: 8.3bpm

MUSCNIANS

Table 15: Blood pressure and heart rate of musicians after listening to 110 beats per minute song Walking on Sunshine

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>105/70</td>
<td>82</td>
<td>66</td>
</tr>
<tr>
<td>2</td>
<td>98/58</td>
<td>71</td>
<td>68</td>
</tr>
<tr>
<td>3</td>
<td>103/75</td>
<td>84</td>
<td>72</td>
</tr>
<tr>
<td>4</td>
<td>93/62</td>
<td>72</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>97/63</td>
<td>74</td>
<td>60</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 77mm Hg
Standard deviation of MAP: 6.0mm Hg
Average heart rate: 66bpm
Standard deviation of heart rate: 4.5bpm

After listening to music:
Average MAP: 82mm Hg
Standard deviation of MAP: 6.5mm Hg
Average heart rate: 70bpm
Standard deviation of heart rate: 4.6bpm

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

NON-MUSICIANS

Table 16: Blood pressure and heart rate of non-musicians after listening to 110 beats per minute song
Walking on Sunshine

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>111/75</td>
<td>87</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>90/62</td>
<td>71</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>109/72</td>
<td>84</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>114/75</td>
<td>88</td>
<td>56</td>
</tr>
<tr>
<td>5</td>
<td>93/59</td>
<td>70</td>
<td>60</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 80mm Hg
Standard deviation of MAP: 8.8mm Hg
Average heart rate: 65bpm
Standard deviation of heart rate: 7.7bpm

After listening to music:
Average MAP: 83 mm Hg
Standard deviation of MAP: 9.5mm Hg
Average heart rate: 65bpm
Standard deviation of heart rate: 4.4bpm

MUSICIANS

Table 17: Blood pressure and heart rate of musicians after listening to 180 beats per minute song
Root Beer Rag

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>116/65</td>
<td>82</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>94/64</td>
<td>74</td>
<td>68</td>
</tr>
<tr>
<td>3</td>
<td>102/69</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>104/66</td>
<td>79</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>103/72</td>
<td>82</td>
<td>64</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 79mm Hg
Standard deviation of MAP: 9.3mm Hg

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

Average heart rate: 65bpm
Standard deviation of heart rate: 10.2bpm

After listening to music:
Average MAP: 84mm Hg
Standard deviation of MAP: 10.1mm Hg
Average heart rate: 70bpm
Standard deviation of heart rate: 9.4bpm

NON-MUSICIANS

Table 18: Blood pressure and heart rate of non-musicians after listening to 180 beats per minute song
*Root Beer Rag*

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Before listening to music</th>
<th>After listening to music</th>
<th>Difference (before and after listening to music)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP (sys/dia)</td>
<td>MAP (mmHg)</td>
<td>HR (bpm)</td>
</tr>
<tr>
<td>1</td>
<td>116/71</td>
<td>86</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>86/54</td>
<td>65</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>114/71</td>
<td>85</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>112/73</td>
<td>86</td>
<td>52</td>
</tr>
<tr>
<td>5</td>
<td>98/64</td>
<td>75</td>
<td>60</td>
</tr>
</tbody>
</table>

Before listening to music:
Average MAP: 79mm Hg
Standard deviation of MAP: 9.3mm Hg
Average heart rate: 65bpm
Standard deviation of heart rate: 10.2bpm

After listening to music:
Average MAP: 84mm Hg
Standard deviation of MAP: 10.1mm Hg
Average heart rate: 68bpm
Standard deviation of heart rate: 9.4bpm

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians
*All calculations are done to the nearest unit, except standard deviations which are done to 2 significant figures*
The effect of different music tempos on heart rate and blood pressure of adolescent musicians and non-musicians

Table 19: Average changes in heart rate and mean arterial pressure for all three trials

<table>
<thead>
<tr>
<th>Song tempo (BPM)</th>
<th>40BPM</th>
<th>110BPM</th>
<th>180BPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Musicians</td>
<td>Non-musicians</td>
<td>Musicians</td>
</tr>
<tr>
<td>Avg. change in MAP (mm Hg)</td>
<td>-0.7</td>
<td>-1.3</td>
<td>+2</td>
</tr>
<tr>
<td>Avg. change in heart rate (bpm)</td>
<td>-2.7</td>
<td>-1.7</td>
<td>+2.7</td>
</tr>
</tbody>
</table>

Graph 1: Average changes in heart rate and mean arterial pressure for all three trials

Average changes in mean arterial pressure and heart rate for all three trials

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians

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Graph 2: Average change in mean arterial pressure before and after listening to 40bpm song

Graph 3: Average change in heart rate before and after listening to 40bpm song

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**Graph 4: Average change in mean arterial pressure before and after listening to 110bpm song**

Walking on Sunshine

**Graph 5: Average change in heart rate before and after listening to 110bpm song**

Walking on Sunshine

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians

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**Graph 6: Average change in mean arterial pressure before and after listening to 180bpm song**

*Root Beer Rag*

![Graph 6: Average change in mean arterial pressure before and after listening to 180bpm song](image)

**Graph 7: Average change in heart rate before and after listening to 180bpm song**

*Root Beer Rag*

![Graph 7: Average change in heart rate before and after listening to 180bpm song](image)

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians

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Discussion

The results of this experiment proved one part of the hypothesis, however disproved the other. It proved that listening music with a fast tempo increased heart rate and blood pressure, listening to medium music tempo produced a slight increase in heart rate and blood pressure and listening to a slow music tempo decreased heart rate and blood pressure in adolescents. However, there was little difference in heart rate and blood pressure change between musicians and non-musicians, thus disproving part of the hypothesis. Mean arterial pressure, a measurement used to describe average blood pressure, was used in this experiment for graphs and averages, as it was a better indicator of both systolic and diastolic scores. The formula for mean arterial pressure is as follows:

\[ \text{Mean arterial pressure} = \text{diastolic BP} + \frac{\text{systolic BP} - \text{diastolic BP}}{3} \]

Likewise, the results of this experiment included the calculation of standard deviation. Within the context of heart rate and blood pressure, there were low standard deviation values relative to the raw data values. This indicates a higher level of accuracy within the experimental method. On the other hand, there were several outliers for trials, including that of Trial 2 for the non-musicians exposed to music of a rate of 110PBM produced a standard deviation of 18.1mm Hg. This indicates that there were other limitations to accuracy, in the presence of outliers.

Overall, these results suggest that music could potentially be used at times of stress for adolescents to decrease their heart rate and blood pressure thus possibly lowering stress levels. Alternatively, fast tempo music could be used at times where increased heart rate and blood pressure assist in performance, for example before a race.

In *I Love Paris*, the song with the slowest tempo at 40 beats per minute, the musician’s heart rate decreased more than non-musicians, however non-musicians experienced a greater decrease in blood pressure. As evident in graph 1, which displays the average changes in heart rate and mean arterial pressure for all three trials, the musicians experienced an average 0.7mm Hg decrease in mean arterial pressure, and a 2.7bpm decrease in heart rate. Meanwhile the non-musicians experienced an average 1.3mm Hg decrease in mean arterial pressure and 1.7bpm decrease in heart rate.

In *Walking on Sunshine*, at 110 beats per minute (a medium tempo), both musicians and non-musicians experienced the same increase in heart rate. The greater increase in blood pressure occurred amongst the musicians. The musicians experienced an average 2mm Hg increase in mean arterial pressure and a 2.7bpm average increase in heart rate. Similarly, the non-musicians for this tempo, experienced an average 1.7mm Hg increase in mean arterial pressure and a 2.7bpm increase in heart rate.

Finally, in the music with the fastest tempo, 180 beats per minute, *Root Beer Rag*, the non-musicians experienced a greater increase in blood pressure whilst the musicians experienced a greater increase in heart rate. The musicians for this high-tempo song, experienced an average 1.7mm Hg increase in mean arterial pressure, and 4.7bpm increase in heart rate. On average, the non-musicians experienced a 3.7mm Hg increase in mean arterial pressure, and a 3bpm increase in heart rate.
There was a clear trend to increasing heart rate and blood pressure with increasing music tempo. There was, however, no clear difference in heart rate and blood pressure changes between musicians and non-musicians. At times non-musicians experienced a greater increase or decrease in heart rate and blood pressure than musicians and vice versa. If differences did occur, as seen in the averages table, the differences were minor and relatively insignificant. For example, after listening to the 110 beats per minute song, *Walking on Sunshine*, the difference in changes in blood pressure between musicians and non-musicians was only 0.3mm Hg, which can hardly be considered as a difference.

The lack of difference between musicians and non-musicians could be due to several reasons:

- The sample size may not have been high enough, and thus the experiment may not be able to detect a big enough difference in heart rate and blood pressure between musicians and non-musicians.
- The choice of music and tempo may not have been obvious or fast or slow enough to stimulate a more noticeable difference in heart rate and blood pressure.
- It may be possible that both musicians and non-musicians have a similar emotional response to music, and even a larger sample size may not have shown that there is a significant difference between the heart rate and blood pressure of musicians and non-musicians.
- The time between trials was often not strictly controlled which may have allowed cumulative effects to affect the heart rate and blood pressure and hence could have resulted in a lack of difference between musicians and non-musicians.

**Errors and improvements**

There are many improvements that could be made to this experiment next time that it is conducted to make it more accurate, reliable and valid. These include the following:

- The definition of non-musician allowed people who had previous musical experience to be defined as a non-musician. This definition could have influenced results, and made them more similar to the musician results.
- Due to the availability of some interview rooms, different interview rooms were used for different participants and trials. There may have been greater audible volume or background noise in one of these rooms, possibly influencing heart rate and blood pressure.
- The time between trials was not taken into account, for example for some participants completed trials consecutively, although some completed the trials on different days. This time period should have been a controlled variable, as heart rate and blood pressure could have significantly varied in between this time.
- There could have been a more accurate methods or monitors available to measure blood pressure, and instead of measuring heart rate for 15 seconds and multiplying this number by four, I could have counted the heart rate for 60 seconds to determine accuracy.
- Other factors such as stress levels or exercise could have influenced blood pressure and heart rate. In order for heart rate and blood pressure to return to resting, time should have been allocated at the commencement of each trial.

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trial to ensure that the experiment started on a resting heart rate and blood pressure (not influenced by any external factors).

Accuracy, reliability and validity

Accuracy could have been improved in this experiment, as the methods of measurement (of heart rate and blood pressure in particular) were not entirely accurate or reliable, and other factors such as gender and age differences and music preference may have made the results less accurate and reliable.

Firstly, as the manual method of counting the pulse was used, and heart rate was counted for 15 seconds and then multiplied by four. Alternatively, to ensure accuracy, the pulse could have been counted for 60 seconds. The blood pressure monitor may not have been entirely accurate or reliable, and since there was only one cuff size, for many participants the cuff size could have been incorrect, making the blood pressure measurement less accurate.

Other factors like gender and age differences could have influenced the results and made them less reliable. The demographic that I conducted my test on may have been too wide and thus could have also influenced accuracy. Finally, depending on the individual’s music preference, heart rate and blood pressure may have fluctuated depending on his or her enjoyment of the song.

Through the use of controlled variables, the validity of the experiment was increased. These included:
- Audible volume of room experiment is conducted in
- Audible volume of music
- Silence between songs
- Type of headphones

An extensive statistical analysis of these results was beyond the scope of this study, however in order to further validity, a statistical analysis is required.

Method Explanation

Why is the method appropriate for investigating the selected hypothesis?

The selected method is valid for investigating the hypothesis as the experimental procedure clearly tests what it states it is testing. The hypothesis states: Listening to a fast music tempo will increase heart rate and blood pressure, listening to a medium music tempo will produce little to no change in heart rate and blood pressure and listening to a slow music tempo will decrease heart rate and blood pressure in adolescents. The greatest increases and decreases will occur amongst the musicians.

Firstly, the equipment used within the method allows valid testing of the hypothesis. The blood pressure is made by Omron, which is known to be an accurate and precise manufacturer of blood pressure monitors. The manual method of measuring heart rate is often more accurate than a heart rate monitor, which also assists in allowing valid testing of the hypothesis. These methods helped to ensure the measurements were as accurate as possible. The equipment – Omron Intellisense™ blood pressure monitor, Dick Smith stopwatch, noise-cancelling headphones and

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iPhone 6 used were all suitable for the experiment.

The method includes listening to each song for three minutes, and two minutes of silence in between (for blood pressure and heart rate to return to their resting rates). The entire experiment was repeated three times in the same conditions on the same participant to determine reliability.

The controlled variables included the audible volume of room the experiment is conducted in, audible volume of the music, silence between songs and type of headphones. The experiment was conducted in a quiet interview room (in the Senior School Staffroom), with minimal noise. All extra noise was mostly blocked with noise-cancelling headphones. The two minutes of silence between songs to allow heart rate and blood pressure returned to their resting rates. The volume of every song in every trial was kept at the same level (six out of 16 on iPhone dial). All these variables were controlled in the best way possible to determine reliability.

Through the controlled procedure and variables, accurate measurements and suitable equipment, the selected method is valid for investigating the hypothesis.

Conclusion

Listening to the fast tempo music increased heart rate and blood pressure, listening to a medium music tempo stimulated a slight increase in heart rate and blood pressure and listening to a slow music tempo decreased heart rate and blood pressure in adolescent musicians and non-musicians. There were no significant differences between the musicians and non-musicians

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Appendix

Informed Consent form for participants

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Signatures of participants (taken from consent forms)

Consent:
By signing this form I am attesting that I have read and understand the information above and I freely give my consent to participate or permission for my child to participate in this activity.

Participant: [Signature] Date 18/3/13

Parent/Guardian: (if participant is under 18) [Signature] Date 18/3/13

Consent:
By signing this form I am attesting that I have read and understand the information above and I freely give my consent to participate or permission for my child to participate in this activity.

Participant: [Signature] Date 12/3/16

Parent/Guardian: (if participant is under 18) [Signature] Date 12/3/16

Consent:
By signing this form I am attesting that I have read and understand the information above and I freely give my consent to participate or permission for my child to participate in this activity.

Participant: [Signature] Date 12/3/16

Parent/Guardian: (if participant is under 18) [Signature] Date 12/3/16

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By signing this form I am attesting that I have read and understand the information above and I freely give my consent to participate or permission for my child to participate in this activity.

Participant: [Signature] Date 12/3/16

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(if participant is under 18)

BP – Blood pressure, sys/dia – systolic/diastolic, HR – heart rate, MAP – mean arterial pressure, M – musicians, NM – non-musicians

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