

Science Fair Logbook

RUNNING TUNED IN

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Daily Notes and Reflections

Date	Time (hours)	Tasks	Remarks/reflections
19/10/2025	1	Starting to think about project details/collaborative exploration	I already have an idea for my project, if I didn't I wouldn't be doing science fair. I am going to start working on my mini proposal
26/10/2025	1 1/2	Working on and finishing mini proposal	The mini proposal is now complete, I handed it in and Mr.Bykovhski approved it.
07/11/2025	3	Working on background research for letter of intent+ In class science fair period	Starting background research, it is going well so far. Just starting off with the basic info
09/11/2025(earlier in the day)	2	Working on background research for letter of intent	Continuation of background research for letter of intent, I have 2 set topic but I will need to find more as I need at least 3
09/11/2025	3	Working on background research for letter of intent	Found my 3rd, and 4th topic for background research. Finished the first topic, almost done second
10/11/2025	1	Working on background research for letter of intent	Finished working on 2nd topic, and 3rd as it was an easy one to research. There were not many complex words or ideas.
11/11/2025	2	Working on background research for letter of intent	Continuing to work on background research. At this point all of it is in jot form, but I will have to turn in into paragraphs soon

11/11/2025	1	Extra background research(will not be included in letter of intent)	Finished researching my 5th topic, which will be added to my proposal.
21/11/2025	3	Letter of intent in school science fair class	Finished background research, and started turning it into paragraphs. Finished objective, tentative timeline, materials and short significance.
27/12/2025	2	Letter of intent	Almost done turning research into paragraphs. I didn't use all of my research collected as it is only supposed to be one paragraph. Started working on introduction and conclusion
05/12/2026	2	Letter of intent+proposal+ period of time in class	Finished working on a letter of intent, and handed it in. Started working on my proposal
06/12/2025	3	Proposal	Took all my research from my letter of intent and copied it into my proposal. Started adding extra details, as well as my 5th research subject.

Date	Time (hours)	Tasks	Remarks/reflections
07/12/2025	1	Proposal	Finished my background research
08/12/2025	2 1/2	Ethics forms+ Proposal	I started working on ethics forms, and made my hypothesis as well as variables. I also made it by procedure, but in step by step form.
09/12/2025	3	Ethics forms	Continued working on ethics forms. This process has been stressful and confusing, but I've been getting help from my teacher and things are finally working out
11/12/2025	2	Ethics forms	Finished making all my ethics forms, and got approval from CYSF to hand them out. I started giving some to the people who showed interest in my project. Hopefully I get at least some people to join
18/12/2025	1	Miscellaneous stuff before my experiment	Making sure I have everything for my experiment, and preparing data table
19/12/2025	1	Science fair period in school	Nothing important to note, just asking some final questions to my teacher before my experiment
21/12/2025	6	Experiment	Overwhelming day. Many things did not go how I planned it to, but I got it done with

04/01/2026	30 min	Looking at data	Just looking into the data I gathered. I didn't actually do anything with it
09/01/2026	1	Science fair in class	Talking with my friends about science fair
17/01/2026	1	Significance(proposal)	Started and finished writing my significance. I was procrastinating a lot, so I'm happy to finally have finished it.
23/01/2026	1	School period for SF	Mostly just speaking with my teacher about a few things, and working on processing data
23/01/2026	30 min	Final report	Brought all of my data into my final report doc
24/01/2026	4	Analysis(Final report)	Started writing up my analysis, and organizing my data so it could be easier to read(still isn't). I wrote a lot for my analysis, but I still am not even close to finishing it :c This period also including processing my data
25/01/2026	2	Analysis(Final Report)	Continued working on analysis

26/01/2026	30 min	Analysis(Final Report)	Fished up my analysis
27/01/2026	5 1/2	Trifold+Slides+tying things off(Final Report)	Finished conclusion, method, abstract, organizing anything that needed it, and started+finished making my trifold. This day was long. I also made my slides for the online portion.
28/01/2026	2	Final details	I forgot to write up my sources of error, and final reflection so I did that last minute. As well as preparing for my presentation and setting up my trifold in school.
16/2/2026	30 min	Transferring project details to cysf website	
24/2/2026	1 ½	Working on tables and graphs	
02/3/2026	3	Writing script	
02/03/2026	2	Finishing project	

Abstract

This experiment's purpose is to find out and gather data on whether or not music affects how a person runs. By doing so, adding to the already gathered information on this topic, as well as hoping to inspire more interest in the sport. This project will provide insight into how music can be used to one's advantage when running, and as the interest in running has increased it targets a wider audience. The key finding of this experiment is that music does in fact affect how one runs, and can help with the mental challenge of running. Specifically through motivation and distraction; whichever one it is varies depending on the bpm, 'hardness of the run'. With distraction being more common for lower bpm runs, and motivation being more common in higher bpm runs.

Hypothesis

If music of one's liking is listened to when running, then the rate of perceived exertion will be lower, and the pace of the run will match the bpm of the music. This is because listening to music of liking provides a distraction from fatigue, and can increase serotonin levels making the run seem easier; as well as because people tend to match their step to the beat of a song. It is a prediction that heart rate will be higher after listening to higher bpm music when running.

Significance

Around 20% of people in Canada, and around 15% of Americans participate in some form of running or jogging. That's around 51 million people combined. After Covid-19 the interest in running increased greatly with one source saying that since 2020, 20 million people have started running, and 7 million have returned to running. That is only with data from the USA, worldwide there is even more. With this newfound interest in running, information about running becomes a lot more applicable to people, leading into why this experiment is significant. When people run they often listen to music for many reasons; it helps them run more, it makes the experience more enjoyable, some have said it even makes running easier, etc. This project is testing how music affects running, whether you can use it to better control your running, and how music actually helps make the experience more enjoyable, or easy as some have said.

There have been many papers done that show that music has a generally good impact on running, and that it can be used to your advantage. However, there are some papers that resulted in music having little to no impact on one's running. This experiment will expand the understanding of music and running by adding more evidence to the previous knowledge. Many people may benefit from this project, especially the one who does run. Simply because they can use the finding of this experiment to their advantage. Although not only the people who currently run will benefit from this because many love music, and knowing how it can be used in running may motivate them to start participating. And of course doing more activity when one may not do a lot is good for both their physical and mental health. If the results of this experiment favour

listening to music then music may become a more in practice thing than it already is, and a more decisive choice than just randomly picking a song or playlist and using that for running.

Introduction

Running is an important function that greatly benefits the health of humans. Any way to make people more interested in running is something to look into, for example music. This experiment will be testing how music affects the human body's ability to run in many ways. First, it will be testing how bpm affects the distance you can run in a certain time (5 minutes), along with the pace you are running at. Additionally, the rate of perceived exertion will be tested. The control experiment in the project will be running without any music. This topic is relevant to humanity because especially right now, there is an influx in interest in running. Many of these people have a newfound interest in running, but don't know where to start regarding many factors of running, including music. This project aims to bring some answers to questions runners may have as well as add to the growing knowledge of running.

Past Research

Overall this topic has been researched quite a bit before. There are many papers that go into depth about different factors in how music affects the brain; for example "The Influence of Music Preferences on Exercise and Performance: A Review" published by Christopher G. Ballmann, Department of Kinesiology at Samford University. This article goes into some of the specifics about the psychological, psychophysiological, and physiological effects music has on exercise. Another article of note is "The effect of music type on running perseverance and coping with effort sensations" written by G Tenenbaum, R Lidor, N Lavyan, K Morrow, S Tonnel, A Gershgoren, J Meis, and M Johnson. What makes this article fascinating is its results when compared to other research findings. Results of which showed that music did not influence rate of perceived exertion, heart rate, and sensation of exertion, however the music was perceived as a positive by the participants. The broad conclusion is that there are many papers done that show how music can have many effects, but there are still some that show no effects or very little; this encourages further inquisition into the topic.

Basics in BPM

BPM is the amount of beats per minute that a song or instrumental piece has. Also known as the heartbeat of music, depending on the amount of beats the person listening to the song may feel a variety of things. For example low BPM (normally 40-60) typically has a calming or sad effect, contrasted with high BPM (normally 140+) which tends to elicit excitement. Moderate BPM is a

nice in between and favors a relaxed and happy mood. In running BPM can be used to set a pace for the run as people often move with the beat. If one is looking for a high intensity run they can put on songs with a higher BPM and vice versa with a low intensity run. All in all BPM is a simple thing that can be used if need be.

Psychological Components of how music effects running

Music is unique, as it activates so many different parts of the brain all at once. Not only does it activate many areas of the brain, but depending on the genre of music certain parts of the brain have more or less activation. Regarding running, the turning on of these parts will affect how you run, and how you feel while running. Some parts of the brain that experience neural activation to note are the left inferior frontal gyrus, and the insular cortex. The former plays a part in response inhibition, and the latter plays a part in interoception, pain perception, and regulating the autonomic functions. The activation of these suggests an increase in cognitive processing speed, and movement organization, which is a great optimization for running.

Listening to music before has been shown to increase motivation, effort, and can help distract from fatigue, which can help push through exhaustion while running. Not only that, but a reduction in fatigue perception through dissociation and distraction is another possible effect from listening to music. A person's overall view of their run can be changed by music as well, because of an increase in serotonin levels.

Physiological Components of how music affects running

Within the context of listening to music someone prefers, it has been shown that music, even when doing high intensity exercises, improves a person's mood, no matter the level or how trained that person is. Not only that but it has been shown to increase a person's vigor while doing physical activity. Music also has the ability to reduce the rate of perceived exertion through dissociation and distraction. Things like muscle activation and catecholamines have displayed alterations by the presence of music while exercising. Specifically adrenaline levels, stress levels and heart rate have also been shown to be affected by music. High energy music can increase adrenaline and heart rate. While low energy music can do the opposite; decrease adrenaline, and lower heart rate. This is particularly good for after a run when you want to cool down. However, the majority of this has been shown to only happen when the person is listening to their preferred taste; when otherwise, the results that music has on you while doing things like running doesn't affect you, or even worsens your performance. Another possible downside is that the tempo of a song can affect your breathing patterns, which has a chance to worsen your endurance during running. Overall music can have some unique effects on various factors of running.

How music affects the brain

Humans developed a keen sense of hearing way back in the earlier days in order to survive, and now that evolution serves as the reason why music has such an effect on the brain. Music lights

up almost all of the brain, including the limbic system (in charge of pleasure, motivation, body's motor system), amygdala and hippocampus (both in charge of emotional responses through memory). Due to so many brain systems firing off at once is why music can be such a rich experience. When music goes through the temporal lobe it can influence the autonomic nervous system, which is why listening to suspenseful or calming music can alter the heart rate. It is also important to note that the positivity or valence of the song can influence the ANS as well.

Music has been shown to reduce stress and anxiety, regulate mood, and facilitate emotional processing, and that is just regarding some of the emotional effects of music. Focus and efficiency have displayed an increase when there is rapid modulation; activation in the prefrontal cortex and frontal lobe (control judgment and reasoning) are the cause for this, explaining why listening to background music can be a task or easily unmotivated. Additionally, cognitive processing also has some improvements such as reduction in reaction time, better focus, well-preserved memory, enhanced creativity, and increased spatial awareness. High energy music can also increase motivation. All in all, music has many effects on how the brain functions, and processes different things.

How genre affects the brain and possibly running ability

Various genres affect the brain differently due to separate sensitivities the frontal lobe has to different music, and how the auditory cortex processes pitch, melody, rhythm and timbre. To start, classical music has enhanced attention, activity in prefrontal cortex (due to complex structure), working memory, and self-referential processing; as well as being associated with relaxation, focus, and better cognitive process. While EDM shows more activation in motor regions, engagement with the motor cortex, increased dopamine in the nucleus accumbens, reduced self-awareness and increased sensory output (affected by changes in default mode network). Rock shares some connection with EDM as it also engages with the motor and auditory cortices, however it is more emotion driven with activation in the amygdala and hippocampus. Something to remark is that listening to non-preferred music/genres when running can increase RPE and decrease the ability to dissociate to the music, beyond that of no music. Overall, different genres of music have varying effects on neural activation.

Concluding

The main focus of all this research is learning how music could possibly affect one running, and how it is possible to use this information to one's benefit. Music affects running both regarding the brain, and things it controls like emotion and motivation; as well as physically with things like motor control, adrenaline, and heart rate. In general music has a big effect on the brain because it activates so many parts of it, and it is to be noted that the genre of the music can affect

said activation. The popularity of running is seeming to increase, and with that comes wanting to learn more about the subject. People may also want to know how to optimize their running to make it both easier and more enjoyable. This is where this project comes in; by testing how components like (but not solely) rate of perceived exertion are affected by music, people may become better informed of how they can change or add simple things to their running routine to improve the overall experience.

Methods

- Timer
- Phone or device to listen to music on
- Headphones
- watch (only if needed to measure distance)

First you must do the control test which will be done without any music. Get a timer, your test subject, and head to the start of your track or running area. Measure the heart rate of your test subject by putting your middle and ring finger on one of the measurable points (wrist or neck), then count the beats for 10 seconds and multiply the number of beats by 6 to get the final measurement. Record this in the data table under 'heart rate before'. Count down from 3 and start the timer once the runner has taken off, after 5 minutes has passed stop the runner and retake their heart rate, record the distance, as well as ask the specified question (will be placed at the end) and record. There are multiple ways to tell the distance ran, first is to pick a track with a set distance and estimate how many laps ran, second is to use a watch that keeps track of distance, and third is to use an app on your phone that also tracks distance and have the runner run with it. Repeat this process for the rest of the test subjects. Next will be the low bpm test, for which the range of music bpm is 80-110. For this test you will be doing the same steps as the control, except this time with music. Start the music and countdown from 3, start your timer once the runner has taken off. Use headphones and a device that can play music to do this part, make sure that any shared objects are sanitized in between participants. The music used will have been collected beforehand, and is specialized to each test subject, as the music needs to be of preferred taste. Make sure to record all results in the data table, and the average of all the songs bpm will be used in the data table ex: $(86+102+93)/3 = \text{Average}$. Repeat this for each test subject. Next is the moderate bpm test which plays out the exact same way as the low one (go to track, take heart rate, start music and timer for 5 minutes, retake heart rate after 5 minutes is over, ask questions, figure out distance, record all). The only difference is the bpm of the songs, for this category the bpm is 120-149. Repeat with every test subject, and record all that is needed. Finally, the last bpm test. This test is the same as the previous music test, with the exception of the songs bpm being 150-190. Repeat for each test subject, and record all that's needed.

Data Collection

Test	Test Subject	Heart Rate before	Heart rate after	RPE(6-20)	Distance Ran	Time	Average Pace	Qualitative	BPM (average)
Control	1	(not accurate)	102	12	1	5	8.695652174	N/A	0

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1(low)		120	168	12	0.7	5	7.142857143		85
2(moderate)		90	150	14	0.9	5	5.555555556		135
3(high)		102	180	15	0.92	5	5.434782609		155
Control	2	73	140	10	0.80 5	5	6.211180124	N/A	0
1(low)		84	192	12	0.9	5	5.555555556	distraction	90
2(moderate)		96	204	14	1	5	5	Distraction	126
3(high)		102	180	15	1.24	5	4.032258065	motivation	167
Control	3	78	132	13	1	5	5	N/A	0
1(low)		90	144	12	0.80 5	5	6.211180124		102
2(moderate)		96	126	15	1	5	5		130
3(high)		114	168	16	1.15	5	4.347826087		170
Control	4	84	138	11	0.7	5	7.142857143	The very last hundred meters.	0
1(low)		78	156	12	0.83	5	6.024096386	The middle-ish when “don't dream it's over” was ending- I think I picked up parser when tinnitus started playing- distraction	95
2(moderate)		84	162	13	0.96	5	5.208333333	Getting going was hard with the song “wildflower” playing, very end with Takedown playing was easier- slower at the end of wildflower that got faster at the start of takedown- distraction	144
3(high)		96	162	14	1.02	5	4.901960784	was pretty good, at the end I was getting tired because of the such high energy, American idiot was playing- whole thing was pretty consistent- motivation	183
Control	5	102	120	13	0.7	5	7.142857143	the whole 5min felt long as you didn't really know when it would end and it was kinda boring,	0
1(low)		96	180	9	0.93	5	5.376344086	Slightly less hard but made it feel really long because the music was slow, but laps were easier because of the music	110
2(moderate)		78	186	12	0.82	5	6.097560976	I think the last minute felt really hard because I was running a little faster because of the faster pace music, the music provided a distraction-made it easier	143

3(high)		84	168	14	1	5	5	This one didn't feel hard, the music made time go by faster, it felt fun	110
Control	6	138	174	12	0.86 2	5	5.800464037	the last quarter was pretty difficult- same all around otherwise, consistent pace during run	0
1(low)		120	150	13	0.69	5	7.246376812	halfway through it got difficult, got easier after that(not related to the song) focusing on the song, consistent pace all around	105
2(moderate)		114	206	15	0.8	5	6.25	when ever the beat was not interesting they slowed down, last stretch was easier because the music was hitting just right and they wanted to get it over with, 4 times pace was picked up, motivation through the music	133
3(high)		120	160	18	0.91	5	5.494505495	all around more difficult due to muscle fatigue, but was better because of the music, slower around the mid part but pace returned to normal afterwards(1 minute), distraction through music	185
Control	7	126	192	16	0.7	5	7.142857143	N/A	
1(low)		126	180	18	0.69	5	7.246376812	75% of the way through form started to worsen, first lap was the easiest, speed started faster and then got slower, and last lap increased again	109

2(moderate)		120	150	17	0.7	5	7.142857143	the slow part of the second song was harder, music did help through motivation and distraction, beginning was easier the song was motivating, slowed down towards the middle- not music related	146
3(high)		114	168	17	0.6	5	8.333333333	harder towards because of exhaustion, keep pace with the songs, chorus made running easier, consistent pace with the songs, motivation	153

Processing of Data

Look to graph above

Rpe Table	1	2	3	4	5	6	7
Control	12	10	13	11	13	12	16
Low	12	12	12	12	9	13	18
Moderate	14	14	15	13	12	15	17
High	15	15	16	14	14	18	17

Test	Average distance ran in each test
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Control	0.823857142857
Low	0.7921428571
Moderate	0.855
High	0.9771428571

Bpm	Av heart rate before	Av heart rate after
Control	100	142
Low	102	167
Moderate	96	169
High	104	169

How did music help?	Distraction	Dissociation	Motivation	Did not help
Low	3/5	0/5	0/5	2/5
Moderate	2.5/5	0/5	2.5/5	0/5
High	1/5	0/5	4/5	0/5

Analysis and Discussion

The data from this experiment shows that music can have an effect on the mental challenge of running. Furthermore an increase in bpm does increase the amount that one can run in a set period of time. For the low bpm tests the music had little effect on the real portion of running, and in one trial it even had a negative effect: making the run feel drawn out and harder due to the slow pace of the music. Heart rate in the low bpm tests did average lower than higher bpm rates with an average of 167 however, it was greater than the average heart rate for the control test which was 142. The difference between the average heart rate of the music test was only by a few, with moderate and high bpm having the same average of 169 beats per minute.

Along with this, the control test's average distance was similar to that of the moderate tests. This may imply that when running without any external influence one might naturally flow into a moderate tempo; as well as their heart rate may not increase as much. Regarding the increase in heart rate being at least 20 less than the rest of the tests, this could be due to the fact that it was the first test, or possibly because music can raise your heart rate faster than without. In order to get a clearer answer more testing should be done.

As the bpm increases to moderate and high, the difficulty changes with moderate being easier than low, but high being more difficult than moderate but easier than low. For one test subject the high bpm test was the easiest because the music pushed them through it. The rest of the test subjects thought it was harder due to fatigue. This fatigue may have been caused by the fast pace of the music, making the muscles exhaust faster. However, it also could have been caused by overall fatigue from having to run multiple times, and every person's body having a different time requirement for rest(all test subjects were given the same amount of rest time). It is certainly something to take note of, and possibly a source of error. If this test was done in a way that ensured that the participants got fully rested in between tests, the outcomes may change. The upbeat Moderate though, no one seemed to suffer through fatigue, and the music did help. In the end this test seemed to be the easiest for most participants. Most likely because the music was still engaging while also having a pace that wouldn't push the body to an above average speed. In each of the tests the amount of subjects that said motivation through music helped varied, but one thing all tests had in common was no one found that music helped through dissociation. This could be because music engages with so many parts of the brain, as well as the exercise adding an additional barrier to get through in order to dissociate. It is hard to focus on just the mind and the imagination when there are multiple outside stimuli.

For the low bpm test, music either didn't help at all or helped through distraction. This is contrary to the high bpm test where most participants answered that music helped through motivation. Distraction may have been more prominent on the low bpm test because the pace of the song was causing the person to perceive their fatigue or exhaustion easier, and in order to counteract that they focused on the music. Lower bpm music also tends to have emotional lyrics that could make the test subject think about the song therefore, causing them to focus more on the music. The moderate bpm test had pretty mixed responses between both motivation and distraction. High bpm songs most likely had the opposite reaction because you can passively listen to them easier, but also they tend to be more upbeat and energetic. Which has been shown to increase catecholamine levels(adrenaline, dopamine, epinephrine)

From the tests it is proven that bpm does in fact impact the amount of your run, with the relationship being the higher the bpm the longer the distance. The average distance for each test is low: 0.79 km, moderate 0.85 km, and finally high with an average of 0.97 km($P=T/D$). This also goes hand in hand with how the pace decreases which is directly affected by distance. Even if the average is not looked at, and instead it is looked at case by case all of the people's distance and pace increase with the increase of bpm except for test subject 5 in moderate test and subject 7 in the high test. With the overwhelming majority though these tests results can be ruled as an outlier in the data. The motor cortex is a very important part of the brain for this specific data point because the reason for you matching a pace or increasing pace with different bpm's is due to the activation of this area.

The rate of perceived exertion typically increased along with the bpm, with the last test being the hardest. This does make sense with all of the other data points that show that the run did become harder like increase in heart rate, and running a longer distance as the bpm changed.

Nevertheless, the RPE staying consistent with these factors suggest that music, while it may have made the run easier mentally, did not take away the physical strain that people felt while running. An explanation for this could be that since music has been shown to increase adrenaline levels, while on the run adrenaline levels were higher and the music was helping. After the music stopped though and the adrenaline levels inevitably went down, and the exhaustion set in, thinking back on how the run felt in this state may have increased the RPE. The only way to truly test this is to take adrenaline levels which is not something for the level of this experiment. There is the other thought that the music just didn't do anything to help with the RPE as it is a more physically driven factor.

Conclusion

In conclusion my hypothesis was partially correct. The pace of the person did go up along with the increase in bpm, but the RPE was affected very little by the music or at least the music did not decrease the rate of perceived exertion. This experiment had many qualities that could be improved upon. First of all the organization of the testing, specifically the timing of it all was not thought through as well as it should have been. With this leading to the qualitative questions having to be asked not immediately after the run due to time restraints. As well as not even getting the qualitative results for some participants. This could be fixed with planning out a larger time period for each test, or taking smaller groups of participants at a time. Another weakness of this experiment is the small test group. While this was mostly not something that could be controlled due to budget and social reach, it is still a weakness as a larger pool of subjects provides more data to analyse; which would've greatly improved the credibility and understanding of results.

Source of Error

- During the first round of testing(5 participants) in order to make sure people get the set amount of time resting, as well as start the next person running, the qualitative questions were not asked. A form was set out afterwards to remedy this but some of the participants never answered
- During the first test of the day instead of using the manual of getting heartbeat a watch was used that clearly did not accurately measure heart rate, after this was when it was switched to manual measuring
- Test subject got more rest in their before their low bpm test
- For a few tests the track had to be switched to one of the more inner tracks due to other people using the facilities at the time. This did not change things like the distance calculations, but it did mean that the track was shorter, which could have some effect mentally

Final Reflections

Overall, this project was interesting because it was something that I have been wondering about for a long time. What inspired this project was my own experiences with working out, and listening to music. Over time I started to notice that certain songs made the run feel easier than others, and I started to wonder why? Being able to answer this question is probably what made this project the most interesting to me, and hopefully other people. Another thing that made this project interesting is that my results(especially the RPE results) were different than I thought they would be, and it is always interesting when something defies your expectations. Plus, figuring out why the results are different adds another layer of interest.

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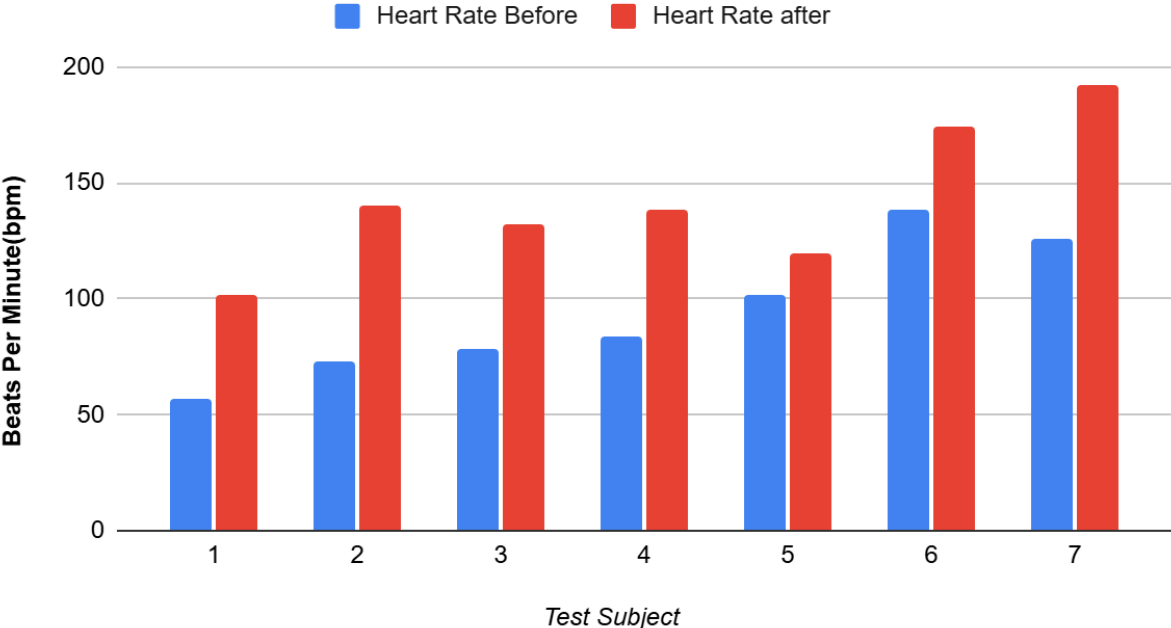
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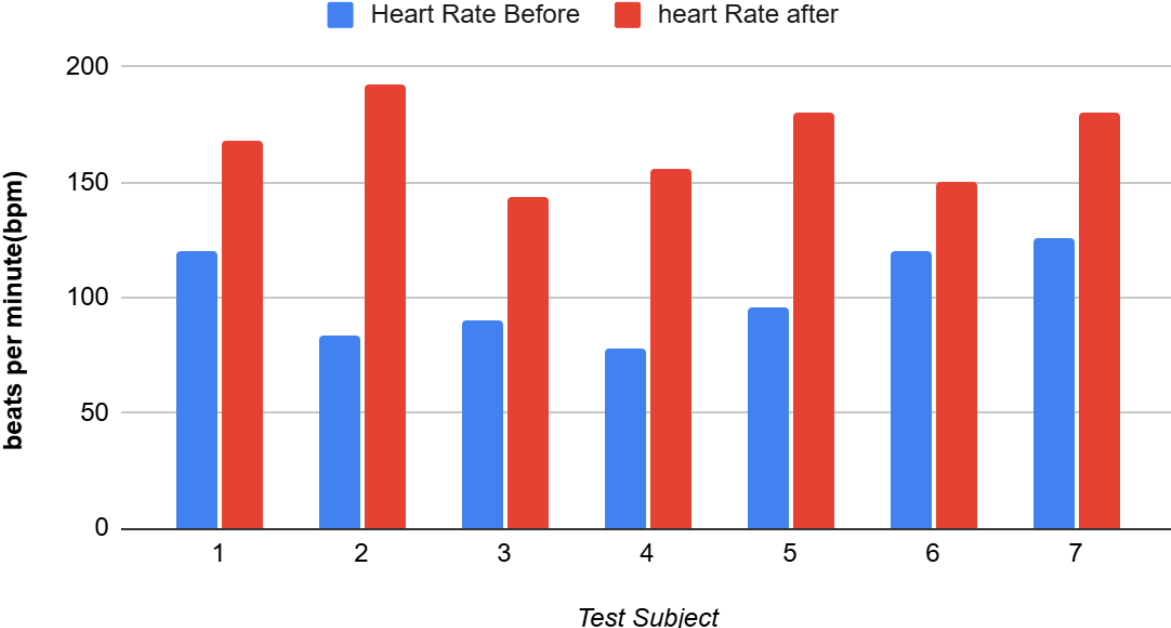
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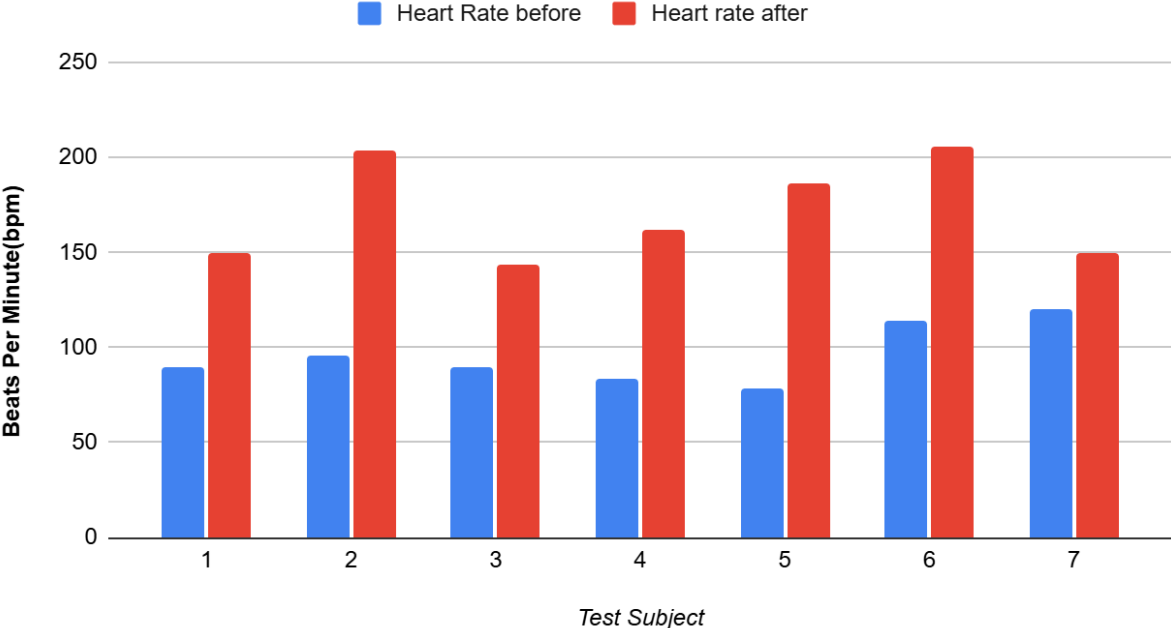
Heart Rate Before and Heart Rate after- Control



Heart Rate Before vs Heart Rate After- low



Heart Rate Before vs Heart Rate After- Moderate



Heart Rate Before and Heart Rate After- High

