

## ABSTRACT

My Transformative Summer of Running: Replication of Four Studies Relating to Running Outside of a Laboratory Setting

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The objective of this project is to ascertain whether a person could improve their running performance by replicating a set of four scientific studies on running back-to-back over a six-week period outside of a laboratory setting. The studies in question deal with the effects of pre-workout caffeine consumption, pre-workout beetroot consumption, sprint interval training, and Pilates training. Additionally, various challenges that come with reproducing these studies outside of a laboratory setting, personal fitness triumphs and complications, and reflections on this journey are recorded daily in a colloquial register throughout the process. Varying degrees of success are achieved with each trial, and upon completion of the four trials, the author reflects upon significant personal and fitness growth that she has accomplished through this endeavor.

APPROVED BY DIRECTOR OF HONORS THESIS

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Dr. Jennifer Good, Modern Languages and Cultures

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MY TRANSFORMATIVE SUMMER OF RUNNING:  
REPLICATION OF FOUR STUDIES RELATING TO RUNNING OUTSIDE OF A  
LABORATORY SETTING

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Baylor University  
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## TABLE OF CONTENTS

List of Tables	iii
Acknowledgments	iv
Dedication	v
Chapter One: Introduction and Summary of Research	1
Chapter Two: Effects of Caffeine Consumption on Running Performance	13
Chapter Three: Effects of Beetroot Consumption on Running Performance	22
Chapter Four: Effects of Sprint Interval Training on Running Performance	31
Chapter Five: Effects of Pilates Training on Running Performance	50
Chapter Six: Conclusion	72
Bibliography	79

## LIST OF TABLES

Table 1: Baseline data points for an average run	5
Table 2: Data gathered during Caffeine trial	19
Table 3: Data gathered from Beetroot trial	29
Table 4: Pretest and Posttest Data from SIT trial	46
Table 5: Data from SIT training days	47
Table 6: Data gathered from non-SIT runs during SIT trial	48
Table 7: Table from Finatto et al. study indicating which exercises were performed during Pilates Training	53
Table 8: Data gathered from Pilates pretest and posttest	67
Table 9: Data gathered during Pilates training	69
Table 10: Data gathered during Pilates trial on days Pilates training was not completed	70

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## DEDICATION

This project is dedicated to my thesis advisor, Dr. Jennifer Good, without whom this thesis never would have been written, and without whom I likely would not have been able to graduate at all. When I entered her office the week before Spring Break 2020, I simply wanted her to sign a form for me to be officially allowed to leave the University Scholars program, and also Baylor University. I was distraught, homesick, and overwhelmed with the idea of writing a thesis. I had worked hard for three years in college and four years of high school to get to this point, and I felt that I had nothing left to give to academia. Dr. Good explained to me that I only needed two more classes and a senior thesis in order to graduate and encouraged me to consider continuing on the path toward graduation because she knew that it would be best for me. She believed in me when I did not even believe in myself, and for that I am eternally grateful.

## CHAPTER ONE

### Introduction and Summary of Research

#### *Introduction*

In this day and age, scientific research is readily available to the average person and much of the general public would identify scientific research as a credible source for information. They will take as fact anything that is the result of a scientific study. It is not uncommon to hear the adage, “do not believe everything you read on the internet.” I would further argue that believing everything in every scientific study applies to you, specifically when it comes to human research, is likely to be unwise. Studies will not necessarily have the same results with every person, or even every person that seems to match the participants in the study. A large part of scientific investigation involves conducting a study or trial about an isolated element and what it does or does not do. Researchers attempt to foresee and mitigate other variables so that they can focus and test for a specific element while conducting their study. In this way, one can really focus on the variable that is being tested. However, we do not live our lives in a vacuum. That means that numerous confounding variables may affect our decisions and we often may not even recognize the variable at work in our own lives. Outside of a laboratory setting, we cannot expect the same results. This thesis looks at whether scientific studies can yield similar results even in a less controlled setting.

In this project, I replicated four scientific studies on the topic of running performed in a controlled or laboratory setting using myself as the sole participant.

I made necessary changes to the study protocol, such as running on a bike path instead of a treadmill or 400-m track, and sometimes changing the duration of the study, in order to make the study fit my day-to-day life. The four studies replicated were all published within the last ten years, the oldest having been published in 2011 and the most recent from 2018. The studies were chosen because they focused on methods of improving running performance which were reasonable for a recreational runner to implement both for a study period and possibly long-term. The first two studies, which discussed effects of caffeine and beetroot on running performance, focused on pre-training supplements. Participants ingested a substance before running and measured for improvement in their running performance. The second set of studies, sprint interval training and Pilates training, used a supplement training regimen that one performs in the place of a daily run; these alternate trainings are standardized and directed, and the measurement of improved performance was combined with traditional running training.

My history of running both under the direction of a coach and as a recreational runner made me interested in these studies and attempting to improve my running performance. I have been running for seven years and ran competitively on my high school cross country team for the first four years. For personal reasons, I chose to take the last full calendar year prior to this study (2019) almost completely off from running. Before beginning these trials, I had been running consistently for about two months, so I had regained some level of running fitness.

My usual routine has been to run 3 or 4 days per week. I am currently running 3 miles per day and I will be continuing to run this distance throughout this study. I am a creature of habit, and thus I always run the same path. I live ½ mile from the bike path

that I run on, so the first and last ½ mile of each run are on sidewalks while the rest of the run is on the asphalt bike path. The bike path is interrupted by small side streets approximately every ¼ mile. I warm-up with 5 minutes of dynamic stretches followed by 5 minutes of walking, and my cool-down consists of 5 minutes of walking followed by 5 minutes of static stretches.

The shoes that I currently run in are two-year-old Saucony Ride 9's and have between 1,000 and 2,000 miles on them. I am well aware that they need replacing, but I have a lot of trouble breaking in new shoes and have not yet had any issues with my current shoes. I usually replace my shoes when my ankles become tight or sore after runs (this is very uncommon for me), which I take as a signal that my shoes are due for an upgrade.

I am no longer a competitive runner, so I do not have a coach guiding me through my running training each day. My motivation is a factor that affects whether or not I run. If the weather is grey and rainy, too cold, or too hot, I am far less likely to go running. If I feel a bit sick or am very tired when I awake, I am also less likely to go running. I run for enjoyment, so if I do not think I will enjoy running, I often do not go out running. This can be detrimental to overall training, as I also run for exercise. If I only exercised when I felt like it, I would certainly not stay physically fit. I would not be able to continue running as I want to, because I would not be able to keep myself in good running form. Thus, while I am very subject to motivation, I have learned to force myself to go running because I know I need the exercise.

I usually go to sleep between 10:00 pm and 11:00 pm, and wake up between 6:00 am and 7:00 am, so I get between 7 and 9 hours of sleep each night. I rarely drink

anything other than water, so I tend to be fairly hydrated. I drink between 1 and 1.5 L of water each day. My diet is a fairly standard American diet, though I do try to eat at least 5 servings of fruits and vegetables a day and attempt to limit my intake of processed food, sugar, and salt.

I usually try to live a fairly active life, but due to the COVID-19 pandemic, I have been more sedentary since March 2020, and that has not changed too much as the past four months have gone on. I spend the whole day in the house, and much of the day sitting down, usually studying, watching television, or reading. I remind myself to get up to stretch my legs every hour or so. I usually go on a half-hour walk each afternoon, but other than that, my primary energy expenditure is my morning run. Any changes to this level of activity have been noted in my daily reflections.

As part of the study, I have collected data on the weather while I run, and my energy levels, pain, and run duration. I recorded the temperature and humidity each time I went running, so that I could be aware of and consider large variations that could have affected the results. I also recorded energy levels during the workout, immediately after the workout, and after 2 hours of recovery. I chose to use energy as an indicator so that I could explore evidence that certain treatments gave me more energy or sapped my energy. For me, energy has always been very important because when I have more energy, I tend to be in a better mood and am able to finish more work. I find that I am prone to being unproductive if I do not feel I have the energy to finish a task. This is also relevant to running: more energy during the workout motivates me to run faster and more energy after the workout makes me more likely to repeat the workout the next day. Energy will be measured on a scale of 1 to 10. For me, a 1 out of 10 for energy means

that I feel so tired that I can barely move and a 10 out of 10 for energy means that I feel very awake, ready to be productive and do not feel fatigued at all.

Additionally, I recorded my level of aches and pains both during and after a run. Aches and pains in muscles or joints are common among those who exercise regularly, especially when trying something new, so I chose to do this in order to ascertain whether certain treatments affect my level of pain. Perhaps one treatment could cause an injury or help clear up some preexisting pain. Maybe I am in pain during a workout, but the pain disappears after the workout or vice versa. Aches and pains will be rated on a scale from 1 to 10. A 1 out of 10 is no pain, a 5 out of 10 means that I am in enough pain to use over-the-counter painkillers such as Tylenol or Ibuprofen, and a 10 out of 10 means I am seeking medical attention and may need prescription analgesics. Lastly, I collected data on the duration of my run using my GPS running watch (Garmin Forerunner 220), which also measures run distance and instantaneous average mile pace during a run, in order to measure an objective time on a measured 5K distance and any improvement that occurs in my running performance.

	<b>Energy during (1-10)</b>	<b>Aches/pains during (1-10)</b>	<b>Energy immediately after (1-10)</b>	<b>Aches/pains 2 hours after (1-10)</b>	<b>Energy 2 hours after (1-10)</b>
<b>Baseline</b>	5	1	4	1	9

*Table 1: Baseline data points for an average run*

As shown in the chart above, on a normal running day I would rate my energy at a 5 out of 10 during my run. I usually have less energy, a 4 out of 10, after I finish running, but by the time I have recovered for 2 hours, I feel much more energized, a 9 out of 10. I usually am not in any type of pain during my run and would rate it at a 1 out of 10 during the run and after recovery.

A substantial portion of this project is dedicated to my own reflections on this journey. Each day I wrote a short entry detailing my thoughts on how the trial is going, how I am feeling physically and mentally, any challenges I have faced in the completion of the trial, and various other relevant thoughts that occurred to me during or shortly after my workout.

### *Summary of Research*

#### *Caffeine*

In Chapter 2 of the thesis, I review, test and measure caffeine as a supplement to improve running time for a 5K. The first study that I replicated was published by O'Rourke, O'Brien, Knez, and Paton, 2006 and is entitled "Caffeine Has a Small Effect on 5 - Km Running Performance of Well-Trained and Recreational Runners." In the study, which studied both well-trained and recreational runners, participants participated in three separate 5-km time trials. The runners did a 10-15-minute warm-up, consisting of stretching and lower intensity cardiovascular exercise, before each trial. The first time trial established a baseline for each runner, and then participants were randomly administered a sugar pill or 5 mg kg<sup>-1</sup> of caffeine in pill form one hour before their

second time trial. For the third trial, participants who had received the sugar pill before the second trial were given a caffeine tablet, and vice versa.

This study concluded that caffeine enhances running performance by approximately 1%. This is a small improvement, and as the discussion portion of the paper posits, may not be considered worthwhile for some participants or readers. As a recreational runner who still hopes to improve her times, I will attempt to find out if I, too, will improve my performance by 1% after taking caffeine before a run. Additionally, I wonder how taking caffeine before a run affects how one feels during a run. Does it help one feel as if she has more energy during a run? Does it combat fatigue during the run?

My test of this study replicated the testing conditions to a certain degree. In the following ways I have altered the study to fit with my goals and my fitness. The study participants were asked to “eat approximately 8—10g of carbohydrate per kg of body weight, sleep a minimum of 7h, and drink enough fluid to ensure urine was clear in the hours preceding the 5-km time trail,” (O’Rourke et al. 2006, 2). Also, “participants were asked to refrain from caffeine ingestion and strenuous exercise 48h prior to all 5-km time-trials,” (O’Rourke et al. 2006, 2). I will not be putting those restrictions on myself, as they seem overly restrictive and unnecessary to do before each run for the purpose of improving my performance.

I developed the following plan for my study and documentation of my experience. For the 5K time trial, I decided to time my maximum effort running in the first baseline attempt. For the following 3 days, I took a 100 mg caffeine pill, one hour before again completing at 5K at my maximum effort. I completed a 10-15-minute warm-up like the

participants in the study did. In this way, I was able to see how the administration of pre-workout caffeine affected how I feel during a run and also how fast I am able to complete the given distance. The reason I chose to use this treatment more than one time as was described in the study, is that I was also interested to see if any effects indicated by the caffeine study persisted in my future running.

### *Beetroot*

In the third chapter I discuss my second study involving a supplement that I tested on myself. This research was published by Murphy, Eliot, Heuertz, and Weiss in 2011 and is entitled “Whole Beetroot Consumption Acutely Improves Running Performance.” According to the article, “nitrate intake has...been linked with beneficial effects, including enhanced endurance exercise performance, improved endothelial function, and lower blood pressure,” (Murphy et al. 2011, 1). However, the study also notes that nitrates have been linked to cancer and methemoglobinemia. Based upon previous studies, the researchers posited that, “it is possible that other components of nitrate-rich vegetables prevent the harmful effects of nitrates,” (Murphy et al. 2011, 1). They chose beetroot, which is known to be high in nitrates, to test the link between nitrate consumption and enhanced exercise performance.

In the study, participants consumed 200g of beetroot, 75 minutes before completing a 5km treadmill time trial. Half of the participants in this study were given a placebo of cranberry, which is not high in nitrates, instead of the beetroot. The beetroot was baked for 90 minutes, then peeled and chopped. Lemon juice (15 mL), cinnamon, and nutmeg (2 mg each) were added for flavor. The study did not state whether or not the participants were trained runners. The study found that those who consumed the beetroot

completed their run an average of 40 seconds faster than those who had taken the placebo. Additionally, the results showed that, “early in the 5-km run, running velocity was similar in the two trials but perceived exertion was lower in the beetroot trial, suggesting that early in the run, the participants may have been able to run faster in the beetroot trial but opted not to. Then later in the 5-km run, perceived exertion was similar for the two trials but running velocity was greater in the beetroot trial,” (Murphy et al. 2011, 3).

As with the caffeine study, not all conditions of the study were part of my experiment and observations. I will be running outside, not on a treadmill. As I will be outdoor on the same route for both trials, I doubt that this change will affect whether or not my running performance is improved after beetroot consumption. The article explains that the treadmill was kept at a 0% grade throughout the time trial, which is simply not realistic as an outdoor runner. I live in Illinois, a state known to be flat, and yet I would have difficulty finding a completely flat place to run near my home. The article states that, “participants were advised to refrain from taking dietary supplements and medications, and to avoid nitrate-rich foods for 72 hours before testing... Participants were also asked to refrain from alcohol and caffeine intake and from exercise for 24 hours, and to refrain from resistance training for 72 hours before testing,” (Murphy et al. 2011, 2). I will not be following these restrictions as they are overly restrictive. The participants also were asked to fast for at least 8 hours before their beetroot meal. I did not intentionally fast before my pre-workout beetroot consumption, as I run early in the morning, and thus have fasted for as long as I have slept (7 to 9 hours) before running. This study also monitored the heart rate and blood pressure of the participants during

their run, which I will not be doing, as these indicators do not interest me. I am most interested in attending to my running speed and how I feel during a run, so those will be my primary indicators.

I developed the following plan for my study and documentation of my experience. For the 5K time trail, I decided to time my maximum effort running in the first baseline attempt. Daily for 3 days, I will eat 200g of beetroot, 75 minutes before completing a 5K run at maximum effort. As with the previous study, I am interested to find out if any effects I feel from beetroot consumption will last as I become more accustomed to the effects and move into the new training regimens of the final two studies.

### *Sprint Interval Training*

In Chapter 4 I tested the conclusions of a study by Koral, Oranchuk, Herrera, and Millet, published in 2018 entitled, “Six Sessions of Sprint Interval Training Improves Running Performance in Trained Athletes.” In this study, trained athletes of both genders completed six sprint interval training sessions over a period of two weeks. They participated in a 3,000 m time trial before and after their training to assess their progress. After the training period, the researchers found that the participants ran their 3,000 m time trial an average of 5.7% faster than before.

Like the subjects in the study, I performed, “a 15-minute warm-up including light muscular contractions and 5 minutes of light aerobic exercise followed by 4 sets of 20-m progressive runs,” before my 3,000 m time trials (Koral et al. 2018, 3). I also completed six sprint interval training sessions over two weeks. The number of sprints began with 4 and increased to 7.

The researchers write that, “each training session consisted of repeated 30 seconds of “all-out” efforts using a shuttle run protocol interspersed by a period of 4 minutes of rest,”(Koral et al. 2018, 2). I modified the protocol to be running “all-out” for 30 seconds, followed by a period of 4 minutes to rest.

This study also measured maximum aerobic speed and time to exhaustion at maximum aerobic speed as indicators of the subjects’ improvement. I did not have the necessary resources or instruments to measure these indicators.

### *Pilates Training*

Chapter 5 is the second of two research studies in which a certain exercise or training pattern is used to measure its effect on running times. I replicated a study by Finatto, Soares Da Silva, Okamura, Almada, Oliveira, Peyré-Tartaruga published in 2018, called, “Pilates Training Improves 5-km Run Performance by Changing Metabolic Cost and Muscle Activity in Trained Runners.” The researchers hypothesized that Pilates training would improve running by strengthening the muscles of the core and legs that are responsible for the action of running.

In the study, trained runners were randomly split into two groups: one group completed a twice weekly running program, and the other completed the same running program in addition to twice weekly Pilates training (on alternate days from the running program). The runners completed a timed 5 km run before and after the training period. The study found that, while both the control group and the Pilates group had similar pre-training 5 km running times, the Pilates group ran significantly faster than the control group in the post-training time trial.

In planning my method of testing the study, I noted some differences in study subjects as well as making substantive changes to the study. This study was done with trained male runners, and I am a recreational female runner, so this may affect my results. I am more interested improving my times than the times themselves, so these factors only affect my ability to compare my times with those of the study group. More importantly, due to time constraints, I completed 5 Pilates sessions each week for 2 weeks, for a total of 10 sessions, instead of 2 sessions of Pilates training per week for 12 weeks, for a total of 24 Pilates sessions. This increased the intensity of the Pilates workouts, reduced rest days and reduced the number of Pilates sessions I participate in, a total of 10 Pilates sessions. I took this considerable difference between the amount of time and number of sessions of Pilates training into account when evaluating its effectiveness.

Like the participants in the study, I continued to run while completing Pilates training, running on days I did not complete Pilates training.

Like the participants in the study, I completed a pre-training 5km run and a post-training 5km run. I compared the time it takes me to complete each trial and also how I feel during and after the run to evaluate whether or not the Pilates training had a beneficial effect on my performance.

In this study, Finatto et al. also electromyographically measured activation of key muscles and looked at oxygen consumption as an indicator of metabolic cost. I did not have access to the correct instruments to measure these criteria.

## CHAPTER TWO

### Effects of Caffeine Consumption on Running Performance

#### *Introduction*

The study that will be replicated was published by O'Rourke, O'Brien, Knez, and Paton in 2006 and entitled "Caffeine has a small effect on 5-km running performance of well-trained and recreational runners." The participants included 15 trained runners and 15 recreational runners. The gender of the participants is not specified but based on the running times reviewed in the study, the participants are likely men. It is unlikely that this will impact the level of performance benefit I achieve from caffeine consumption. The participants in the well-trained group all had at least 5 years club-level competition experience. The recreational runners mostly had a history of playing team sports. The article does not specify if the recreational runners chose to run outside of what was required when playing team sports, so it is uncertain how much running training these recreational runners actually had.

None of the participants used caffeine habitually, and prior to all time trials they refrained from any caffeine consumption for 48 hours. Additionally, the participants were asked to "eat approximately 8—10g of carbohydrate per kg of body weight, sleep a minimum of 7h, and drink enough fluid to ensure urine was clear in the hours preceding the 5-km time trail," and to refrain from strenuous exercise for the 48 hours preceding all time trials (O'Rourke et al. 2006, 2).

In my study, I will be eating, drinking, sleeping, and exercising as normal prior to my time trials to demonstrate how caffeine will affect me on a regular day without all the specific controls of the study.

The study parameters included two separate time trials. The article does not indicate the period of time between the time trials. The procedure of the study was that each participant took a pill containing either 100 mg caffeine or a placebo, waited 60 minutes, then ran 5 km on a 400 m track. For the second time trial, the procedure was repeated with the difference that each participant was given the pill they had not received previously. In this way, each participant completed the time trial both with and without caffeine, without knowing before which trial they had taken caffeine. Before all time trials, participants performed a warm-up which consisted of “low to moderate cardiovascular exercise and stretching for approximately 10—15min” (O’Rourke et al. 2006, 2). Additionally, the recreational runners completed a 5 km run on the track two weeks before the two time trials in order to familiarize themselves with the track. I have chosen a trail route for my 5K and will not be using a placebo pill during the study. I will be performing the same warm-up before each run.

The article also explains that the participants were given  $5 \text{ mg kg}^{-1}$  of caffeine. I decided not to take that amount of caffeine. The average cup of black coffee contains about 100 mg of caffeine. If I were to take  $5 \text{ mg kg}^{-1}$  of caffeine, I would be approaching 400 mg of caffeine. That is the equivalent of four cups of coffee, which I would be taking in pill form all at one time. I do not think this would be healthy and would likely result in negative side-effects such as tremors, heart palpitations, or headaches. In my study, I decided to take 100 mg of caffeine.

As outlined above, there are various aspects of the procedure in the study conducted by O'Rourke et al. that I have modified to be consistent with my normal routine. I am not changing my nutrition, hydration, or sleep habits. I am continuing to be fairly sedentary and have recorded any changes to my level or type of activity.

The results of the trial showed that caffeine produced a 1% performance enhancement for both the recreational and trained runners. The trained runners completed the 5 km time trial in an average of  $1058 \pm 68$  s with the placebo and  $1047 \pm 69$  s with caffeine. The recreational runners finished the trial in  $1298 \pm 84$  s with placebo and  $1286 \pm 86$  s with caffeine. These times indicate that "the magnitude of performance enhancement in the 5-km trial following caffeine ingestion was similar for both groups and equivalent to 1.0% for the well-trained runners and 1.1% for the recreational runners" (O'Rourke et al. 2006, 3).

As my final observation in enacting my version of this study, I want to note that I have limited experience with caffeine. I have never liked the taste of coffee or tea, so I never drink either, nor do I drink energy drinks. When I do wish to ingest caffeine, I take it in pill form to avoid both the bitter taste of coffee or tea, and to avoid the sugar and extra chemicals in energy drinks. In the past, I have taken caffeine pills to help me stay awake all night to study for an exam or finish an assignment for a class. This usage happened three or four times a semester during the three years I have been in college. While this is very different from the experience the average American has with caffeine, the study that I am replicating included participants who, like me, were not habitual caffeine users. My limited use of caffeine makes me more similar to the participants in the study and my results are likely to be similar to their results.

### *Pretest Description and Reflection*

The day of the pretest for the caffeine trial, the temperature was 73°F with 73% humidity. Energy during the run was rated as a 5 out of 10, and immediately after energy was rated at 3 out of 10. After two hours of active recovery, energy was rated at a 5 out of 10. Pain during the run was rated at a 1 out of 10 and after two hours of active recovery was rated at an 8 out of 10. The duration of the 5 km run was 33 minutes and 30 seconds.

Today was a pretest run for my caffeine trial; the goal was to establish a baseline for the duration of my run and how I feel during a run without caffeine before I begin the test tomorrow, but it did not go as planned. I have just returned from a rather strange run. Despite a fairly normal temperature and humidity, I felt that my run was much more difficult than normal; I felt like I had no energy to run. I am unsure as to why this was as I did not change anything about my regular running routine. I did check my recent running times on my watch, though, and my time today does not deviate too far from my usual 5 km running time. Along with the unusually difficult run, I also find that I feel much more spent than I am used to and that my muscles are much more sore than usual right now. Hopefully this will not last too long.

Two hours after my run I felt completely drained of energy. It is likely this is largely due to the fact that I spent the day babysitting two very active toddlers. As previously mentioned, though, I was exhausted before I began babysitting. By the end of the day, my muscles were as sore as they have ever been, and I had to take a nap in the evening when I returned from babysitting. This is probably due to my busy day and not necessarily related to my run, but I cannot be sure that I would feel completely normal had I not gone to babysit today. Overall, a strange day that was likely not the best day to

evaluate my usual running routine and recovery. During this trial, I will be comparing how I feel during the run and recovery to how I usually feel, as described in the Introduction to Chapter 1, and not necessarily to how I felt today since it was an anomaly.

### *Day 1 Description and Reflection*

The first day of the caffeine trial, it was 71°F with 83% humidity. Energy was rated as an 8 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the 5 km run was 33 minutes and 5 seconds.

My first run after having taken a 100 mg caffeine pill was great. Within 10 minutes after I took the pill, I did have some minor heart palpitations, but this common symptom of caffeine use disappeared after I laid down and rested for 15 minutes. By the time I left for my run I was back to normal and felt very energized and eager to run. I was surprised by how much more energized I felt during my run, especially in comparison to the previous day. Just after my run, I still felt fatigued, but definitely less than normal, and by the time two hours had passed I felt completely reenergized. I have a great feeling about caffeine and exercise. I am starting to understand why caffeine use is so ubiquitous.

### *Day 2 Description and Reflection*

The second day of the caffeine trial, it was 75°F with 80% humidity. Energy was rated as an 8 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a

1 out of 10 after 2 hours of recovery. The duration of the 5 km run was 33 minutes and 9 seconds.

Today I completed another wonderfully caffeinated run. I noticed that I did not have any palpitations in the hour after I took the pill. Just like yesterday, I felt that I had so much more energy than usual during the run and that I did not get as tired as usual. I have no aches or pains to report and within two hours of the end of my run, I felt completely recovered.

### *Day 3 Description and Reflection*

The third day of the caffeine trial, it was 72°F with 75% humidity. Energy was rated as a 7 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 3 out of 10 during the run and a 2 out of 10 after 2 hours of recovery. The duration of the 5 km run was 33 minutes and 16 seconds.

During today's run, I felt more achy than usual. I felt a dull pain in the back of both calves and on the inside of both shins intermittently throughout the whole run. Perhaps I did not cool down and stretch adequately after my run yesterday. I doubt it had anything to do with the caffeine, though. I was not expecting caffeine to have any protective effects in terms of everyday running aches, but now I know that to be true. All in all, still a relatively good running day.

## *Results*

<u>Caffeine</u>	Pretest	Day 1	Day 2	Day 3
Humidity (%)	73	83	80	75
Temperature (degrees F)	73	71	75	72
Energy during (1-10)	5	8	8	7
Aches/pains during (1-10)	1	2	1	3
Energy immediately after (1-10)	3	4	4	4
Aches/pains 2 hours after (1-10)	8	1	1	2
Energy 2 hours after (1-10)	5	10	10	10
Total Run Time (min: sec)	33:30	33:05	33:09	33:16

*Table 2: Data gathered during caffeine trial*

The differences between my workouts after taking a 100 mg caffeine pill are clear: increased energy during the workout, increased energy after the run, increased energy after two hours of recovery, and a slightly shorter run duration for a 5 km run. During my pretest, I rated my energy during my run at a 5, which I feel is normal for me as discussed in the Introduction to Chapter 1. During my trial, I rated it at a 7 or 8. I attribute this sensation of increased energy to the caffeine. It is possible that this could be a placebo effect because this is not a blind trial and I know that I have ingested caffeine and that increased energy is a result of caffeine use. I actually do not think that this is an issue, though, because whether or not it is actually a physiological result of caffeine use, I do feel that I have more energy, which is definitely a benefit for me either way. Throughout the trial, my level of aches and pains during my run fluctuated from a 1 to a

3, which is normal for me, so this was likely not affected by the caffeine. With similar temperature and humidity throughout the days of my trial, the weather likely did not affect the changes in my workout.

Being in pain after my run is not normal for me, and the 8 in the “aches and pains 2 hours after” category on the day of my pretest represents an anomaly. As such, the caffeine did not seem to affect my level of discomfort either during or after my run. In terms of energy after recovering from a run, I usually am largely recovered two hours after finishing a run. As previously mentioned, the 5 under the “energy 2 hours after” category on the pretest day is not representative of my usual run. I would usually rate my recovery in the first two hours at an 8, which means that caffeine does aid in a quicker recovery in terms of energy post-run, but not as much as the raw data may lead one to believe.

Lastly, there is the matter of run duration. With my pretest time at 33:30, my three caffeinated runs came in at 33:05, 33:09, and 33:16. This demonstrates that I ran an average of 20 seconds faster, which is very close to a one percent speed increase. My pretest time was 2,010 seconds, so one percent faster would be 20.1 seconds.

### *Conclusion*

I would (and will) certainly be using caffeine in the future to improve my runs. My running times improved by approximately one percent. My results confirm those of the study conducted by O’Rourke et al. Additionally, the effects of caffeine were found to be similar between the laboratory setting of O’Rourke’s study and my more natural one. Though caffeine did marginally improve my running times, this is not the main (or only) reason I found it to be so useful, nor the reason that I am interested in continuing to use it.

If I were to use caffeine in order to improve the quality of my runs, I would do so on days when I do not feel motivated to run, such as when I am weary, or the weather is bad. The extra energy will help me to run on days that I do not have the impulse to do so. I would not want to use caffeine more than once a week, though, in order to avoid joining the vast ranks of caffeine-addicted Americans.

When I went running after having taken a 100 mg caffeine pill, I simply felt that my runs were more enjoyable and that I was more energized during the run. As I did not have a blind trial, this could be partly due to my expectations that I would feel that I have more energy when running after having taken caffeine. During my trial, I did not tire as quickly and felt that I had more energy throughout and immediately after my workout. When I feel better during a workout, I am more likely to repeat it the next day. Therefore, I believe that more enjoyable runs due to pre-workout caffeine will help motivate me to continue to run regularly.

## CHAPTER THREE

### Effect of Beetroot Consumption on Running Performance

#### *Introduction*

The study of this chapter was published by Murphy, Eliot, Heuertz and Weiss in 2012 and is entitled, “Whole Beetroot Consumption Acutely Improves Running Performance.” The authors chose beetroot because it is high in nitrates, which have been linked to improved athletic performance. Nitrate intake has been linked to other benefits, such as improved endothelial function and lower blood pressure, however, nitrates and their derivatives have also been linked to serious conditions such as cancer and methemoglobinemia. The authors state that, “it is not known why dietary nitrate has been associated with healthful effects in some instances and harmful effects in others. However, it is possible that other components of nitrate-rich vegetables prevent the harmful effects of nitrates,” (Murphy et al. 2012, 1).

The design of the trial was as follows: “Participants underwent two experimental trials in random sequence separated by a 1-week washout period. In one trial, participants consumed beetroot before performing a treadmill time trial; in the other trial, cranberry relish was used as a placebo,” (Murphy et al. 2012, 2). First, participants ate the beetroot or cranberry dish, then waited for one hour. Once that hour had passed, their supine blood pressure was recorded. After this, they completed a 10-minute warm-up consisting of 5 minutes on the treadmill and 5 minutes stretching or continuing to warm-up on the

treadmill. During the treadmill warm-up, participants chose the fastest speed that they thought they could maintain for the whole 5 km run. This was used as their starting speed for the trial. I will continue to complete my usual walking and stretching warm up, as described in the Introduction to Chapter 1; instead of the treadmill, I will be running on a bike path.

Though participants were not allowed to view running speed or running time during the trials, they were able to view distance and to adjust running speed as they felt comfortable. After each mile, participants' heart rate and level of perceived exertion was recorded. The article also states that treadmill grade remained at 0% for the entirety of both time trials. Even in the relatively flat state of Illinois, the path I run on regularly has a few small hills.

This was a double-blind study; the article explains that, "for investigator blinding, test meal administration and the data collection procedures were performed by separate personnel," (Murphy et al. 2012, 2). As I am the participant, meal administrator, and data collector in my trial, my study is not a blind study. The indicators measured in the study were heart rate, resting blood pressure, perceived exhaustion, and running velocity. I do not have access to the correct tools to measure my heart rate and blood pressure, so those elements will not be present in my trial data. Running velocity is related to run duration (the faster one runs the shorter the run duration), so I will be using shorter run duration as an indicator of increased running velocity. Perceived exhaustion and energy level are also similarly related, so I will be using the same indicators described in the Introduction of Chapter 1: energy during workout, immediately after, and after recovery (in addition to run duration and pain during workout and after recovery).

The participants in this study were 5 males and 6 females between the ages of 21 and 29. Participants reported that they routinely completed 45-75 minutes of moderate to vigorous intensity exercise, 4-6 days a week. All participants had no history or evidence of cardiovascular disease or hypertension, did not smoke and were not pregnant or nursing. None of the participants had history of conditions that might interfere with the ability to run 5 km or comply with the dietary requirements of the study. My exercise habits and medical history are similar to that of the participants in this study.

For 72 hours before testing, participants refrained from taking dietary supplements and medications, eating nitrate-rich foods, and resistance training. For 24 hours before testing, participants also abstained from exercise and alcohol and caffeine intake. I will not be making any particular effort to follow the above guidelines, though I do not usually do resistance training or consume alcohol or caffeine anyways. Specifically, for the 72 hours before my trial, I will be exercising as usual, I will continue to take any dietary supplements and medications as normal, and I will not be refraining from consuming nitrate-rich foods that are part of my regular diet .

Cranberry was used a placebo for the beets and was prepared in the same way as the beets so that it would taste as similar to them as possible. The writers state that “[the] beetroot was baked (90 minutes at 177 C) in a commercial oven ...peeled and chopped in a food processor... and divided into 200-g portions. To each portion, 15 mL lemon juice and 2 mL each ground nutmeg and cinnamon were added for flavor,” (Murphy et al, 2012, 2). While the beetroot and cranberry dishes did not taste the same, participants did not know which of the dishes was expected to improve running performance. In my trial, I prepared the beetroot as described above, but did not use a placebo.

After completing the study and data analysis, the authors of the article found that running velocity was 3% (0.4 km/hr) faster and that participants finished the 5 km run an average of 41 seconds faster after consuming beets compared to the placebo. Running velocity after one mile was similar between the trials, but by the third mile running velocity was faster in the beetroot group. Conversely, perceived exertion was lower in the beetroot group as compared to the control at the end of the first mile, but by the third mile, both groups reported nearly identical levels of exertion. The writers theorized that, “it is possible that the participants were reluctant to change the treadmill speed from the standardized starting speed until later in the run,” implying that perhaps the beetroot group had more energy and could have been running faster near the beginning, but chose not to (Murphy et al. 2012, 3). This is why the running velocity of the two groups was comparable near the beginning, but the beetroot group ran faster near the end. The authors of the article did not find any statistically significant difference in resting blood pressure or exercise heart rate in the comparison between trials.

Before conducting this trial, I researched beetroot is and how it is related to beets and found them to be two words for the same vegetable. In the United States and Canada, the vegetable is called a “beet,” while elsewhere in the world, it is referred to as “beetroot” because the part of the plant we eat is the taproot of the plant and grows underground. I will be using the two names interchangeably.

#### *Pretest*

The day of the beetroot pretest, it was 74°F with 70% humidity. Energy was rated as a 5 out of 10 during the run, a 3 out of 10 immediately after the workout, and an 8 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 2 out

of 10 after 2 hours of recovery. The duration of the 5 km run was 33 minutes and 25 seconds.

Today's run was average; I was not in any pain during my run and my energy level dropped as my run progressed. I was mostly recovered from my run within two hours, as usual. Later in the day, I prepared the beets for consumption over the next few days. I followed the instructions in the article describing the study, which I found to be rather labor intensive, especially in comparison to the caffeine study for which I simply swallowed a pill. In hindsight, it is likely that I could have found prepared beets in a can, but it is possible that canned beets have additives that would have affected my results. In full disclosure I had never actually eaten beets before, and, I am a rather picky eater. After preparing the beets and taking the first bite, I realized that eating the beets for the study was itself going to be a problem. They were very unappetizing. In the end, I blended the beets and drank the preparation in smoothie form so that I could ingest them as quickly as possible.

### *Day 1 Description and Reflection*

The first day of the beetroot trial, it was 70°F with 53% humidity. Energy was rated as a 6 out of 10 during the run, a 4 out of 10 immediately after the workout, and an 8 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. Run duration was 33 minutes and 20 seconds.

I had a pretty good run on this first day; the weather was very pleasant, and I felt good during my run. While I did have an enjoyable run, I do not feel that it was any different than other pleasant runs when I had not eaten beets beforehand. Despite blending the beets, I still had some trouble getting them down.

### *Day 2 Description and Reflection*

The second day of the beetroot trial, it was 70°F with 53% humidity. Energy was rated as a 5 out of 10 during the run, a 3 out of 10 immediately after the workout, and a 9 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the 5 km run was 33 minutes and 18 seconds.

Today during my run the skies were threatening rain the whole time. I would have loved some rain to cool me off, but alas, the whole run was grey with no rain. As I was concentrating on the weather throughout my run, I was not paying too much attention to how I felt during my run. I prefer a bit of distraction, such as from weather or other interesting sights on my running path, when running. I have not experienced that this type of distraction causes me to forget about my running form or slow down my pace. When I am distracted during a run, I do not focus on how much more of my run I have left or how tired I feel at the moment. My body just continues in its usual form, and I tend to run a similar pace on my run. Overall, I felt good during my run.

### *Day 3 Description and Reflection*

The third day of the beetroot trial, it was 75°F with 65% humidity. Energy was rated as a 5 out of 10 during the run, a 3 out of 10 immediately after the workout, and an 8 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the 5 km run was 33 minutes and 19 seconds.

I could not be any happier that today was my last time eating beets before running. I plugged my nose as I drank the beet smoothie and tried to think happy thoughts. I now know that I strongly dislike beets, though that is not saying much as there are various other foods that I equally loathe. I also found the beet taste in my mouth lingered considerably. To remedy this aftertaste, I used a strongly flavored mint mouthwash. Regarding my exercise for the day: I have no complaints about my run today. The weather was very pleasant and not too humid, which is rare for morning runs as it tends to be more humid in the mornings here in Illinois, and I overall had a very satisfying run today.

### *Results*

The study conducted by Murphy et al. found that consuming beetroot before running led to completing a 5 km run an average of 41 seconds faster. My trial did not come to the same conclusion. After consuming beetroot, I ran an average of just 6 seconds faster. I rated my energy during my pretest run as a 5 out of 10, and during the beet trial I rated it between a 5 and a 6 out of 10. Energy was rated at a 3 out of 10 immediately after the pretest and fluctuated between a 3 and a 4 out of 10 during my trial. After 2 hours of recovery on my pretest day, I rated my energy at an 8 out of 10 and this value fluctuated between an 8 and a 9 out of 10 throughout the trial. These inconsistent, small changes in my perceived energy do not constitute a consistent significant difference in energy level during the trial. On my pretest day, I did rate my pain level 2 hours after as a 2 out of 10, which is not an anomaly. I have been having a lot of pain in the back of my heels lately. On the trial days, I rated my pain 2 hours after recovery as a 1 out of 10,

but I think it is unlikely that this change is due to the beets. The temperature and humidity did not fluctuate considerably past the usual and likely did not affect the trial.

### *Conclusion*

<b>Beetroot</b>	<b>Pretest</b>	<b>Day 1</b>	<b>Day 2</b>	<b>Day 3</b>
<b>Humidity (%)</b>	70	53	83	65
<b>Temperature (degrees F)</b>	74	70	78	75
<b>Energy during (1-10)</b>	5	6	5	5
<b>Aches/pains during (1-10)</b>	1	1	1	1
<b>Energy immediately after (1-10)</b>	3	4	3	3
<b>Aches/pains 2 hours after (1-10)</b>	2	1	1	1
<b>Energy 2 hours after (1-10)</b>	8	8	9	8
<b>Total Run Time</b>	33:25	33:20	33:18	33:19

*Table 3: data gathered during beetroot trial*

In the future, I will not be consuming beetroot before running to improve my performance. My reasoning behind this decision is twofold. First, the treatment did not improve my running performance enough to justify the extra effort of using this supplement. This could be related to the fact that I am completing my running trials back to back and there is a limit to how much my performance will improve over a short period of time. Second, and more importantly in my case, beets are extremely unappetizing to me and I do not want to go through the trouble of preparing and consuming them in exchange for such a small performance benefit. I remember thinking

the first time I consumed the beets that this treatment would have to give me super speed for me to be willing to repeat it and that remains my belief.

## CHAPTER FOUR

### Effect of Sprint Interval Training on Running Performance

#### *Introduction*

The study that was replicated in this chapter is by Koral, Oranchuk, Herrera, and Millet in 2018 and is entitled, “Six Sessions of Sprint Interval Training Improves Running Performance in Trained Athletes.”

The experimental protocol consisted of a pretest, 2 weeks of sprint interval training (SIT), and a posttest. The sprint interval training procedure consisted of “4-7 bouts of 30 seconds at maximal intensity interspersed by 4 minutes of recovery, 3 times a week,” (Koral et al. 2018, 1).

Of 16 participants, 12 were male and 4 were female, all between 18 and 28 years of age. The subjects were all trained runners who had been running at least 50 km per week for the last three years. Unlike these runners, I have been a recreational runner for the past three years, running 30-40 km a week. Additionally, as noted in Chapter 1, I took most of last year (2019) off from running, running only about 50 km the entire year. Consequently, I am not nearly as well trained as the participants in this study.

Participants were not allowed to complete any intense interval training during the three months preceding the study, nor were they allowed to have any kind of outside physical activity during the experiment. Participants were instructed not to change dietary

or hydration habits during the study. I will not be changing my dietary or hydration habits and did not participate in any intense interval training in the past three months. However, during my study trial, I will be running 5 km at an easy pace on alternate days from my sprint interval training.

This study used six different indicators to determine whether sprint interval training improved the runners' performance: time to exhaustion at maximum aerobic speed, 3,000-m time trial, maximum aerobic speed (MAS), peak power, mean power, and fatigue index. Peak power was defined as the longest distance a subject traveled during one 30 second bout. Mean power was defined as total distance traveled during the SIT session divided by the number of repetitions. Fatigue index was defined as the difference between the longest and shortest distances traveled in each session. I focused on the 3,000 m time trial as my primary indicator of improved running performance, due to my limited resources.

Before the training period, participants completed baseline tests of maximum aerobic speed, time to exhaustion at maximum aerobic speed, and a 3,000 m time trial. These tests were each completed on a separate day with each test 48 hours apart. The actual training procedure, which was completed on a 400 m track, "consisted of a standardized program performed 3 times a week over 2 weeks. The SIT volume increased from 4 to 7 bouts over the first 5 sessions and was reduced to 4 bouts in the last session (total of 6 sessions). Each training session consisted of repeated 30 seconds of "all-out" efforts using a shuttle run protocol interspersed by a period of 4 minutes of rest," (Koral et al. 2018, 2). A 15-minute standardized warm-up was also performed before all training

sessions, baseline testing, and posttest. I performed my usual walking and stretching warm up before training sessions, baseline testing, and posttest.

I trained with the same frequency as indicated in the article, completing the same number of sprints as the participants in the study, and using the same time intervals of a 30 seconds sprint followed by a 4-minute rest. I did not use a 400-m track for my interval training. Additionally, I did not use a shuttle run protocol. The article explains why the shuttle run protocol was part of the study, saying that the shuttle run protocol allowed the participants to motivate each other by “competing,” along with allowing more people to run at a time and use less space. These reasons do not apply to me since I ran alone. Therefore, I substituted running for 30 seconds as fast as I can in one direction. In the study, all testing and training was performed in the afternoon, between 3 and 5 pm. I ran between 6:30 and 8:30 am.

At the end of the study, the results showed an improvement in maximum aerobic speed, time to exhaustion at maximum aerobic speed, 3,000 m time trial, peak power, and mean power, but not a significant improvement in fatigue index. Maximum aerobic speed increased by an average 0.41 km/hr, a 2.8% improvement. Time to exhaustion at 90% maximum aerobic speed increased by 158.9 seconds, a 42% improvement. Peak power improved by 3.06 m, a 2.4% improvement. Mean power increased by 13.9 m, a 2.9% improvement. Time to finish the 3,000 m time trial decreased by 50.4 seconds, a 5.7% improvement.

I do have some limited experience with SIT from my time on the track team in high school. I ran long distance, usually the 800 m or the mile, and we did some sprint training similar to this study, but usually such speed workouts involved longer distances

than could be run in 30 seconds. I remember workouts with distances this short being part of training only once or twice a season.

### *Pretest Description and Reflection*

The day of the SIT pretest, it was 72°F with 57% humidity. Energy was rated at a 6 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 9 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the 3,000 m run was 19 minutes and 20 seconds.

Today, I ran the pretest for my sprint interval training (hereafter referred to as SIT) trial. It was a little strange as the SIT study I am replicating used a 3,000 m time trial (which is about 1.8 miles) instead of a 5 km time trial, like the other studies I will be repeating.

### *Day 1 SIT Description and Reflection*

The first day of SIT, it was 73°F with 92% humidity. Energy was rated at a 7 out of 10 during the run, a 5 out of 10 immediately after the workout, and an 8 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 2 out of 10 after 2 hours of recovery.

I quite enjoyed my first day of SIT. The workout was considerably shorter than my usual, which I did not mind, and I spent much of the workout walking between bouts of speed. I completed four sprints of 30 seconds; each sprint was separated by four minutes of rest. In total, I ran only for two minutes. Of course, the two minutes I ran were much more intense than my usual runs, but I do not know if I feel that my workout for the day was really complete or as effective as usual. The four minutes recovery after just

thirty seconds of sprinting seemed almost too long to me, and I found the walking boring and waited impatiently for the four minutes to be up. Logistically, I also ended up having some problems with where I ran my sprints; I finished my thirty second sprint, then walked forward for four minutes and sprinted again. Unfortunately, after four minutes of walking, I found myself on a part of the path that was unsuitable for sprinting, either because there was a large hill or because the trail crossed a street within the distance I wanted to be sprinting. To avoid these issues, I walked farther forward or turned around, looking for a better place to sprint. Additionally, I realized that it is nearly impossible to sprint at the same speed for thirty seconds. During each sprint, I exerted myself the same amount for the entire duration of the sprint, but my speed dramatically decreased throughout the sprint. The first fifteen seconds or so, I ran considerably faster than the next ten seconds. By the last five seconds of my sprint, I was running even slower than before. Every time, I ran out of steam at the same intervals. Although my exertion remained constant, I felt myself slowing down. For each sprint, I ran fastest for 15 seconds, then slower for 10 seconds, and slowest for the last 5 seconds according to my watch.

#### *Non-SIT Day 1 Description and Reflection*

The first day of non-SIT running during my SIT trial, it was 73°F with 68% humidity. Energy was rated at a 6 out of 10 during the run, a 4 out of 10 immediately after the workout, and an 9 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 2 out of 10 after 2 hours of recovery. The duration of the run was 33 minutes and 29 seconds.

Nothing about this run felt any different from the usual; I had a pleasant run without any complications. One session of SIT did not appear to have affected my running. During my run, I scouted locations for my next SIT session, so that I would not have the problems I had last time. During my SIT workout the first day, I noticed that I ran between 0.07 and 0.1 miles each sprint, so as I ran today, I took notice of the length of different sections of the trail on which I run. I found one section of the trail very near my home that is 0.22 miles long, which served as a good length for me to sprint for 30 seconds and then walk for 4 minutes before turning around for future SIT sessions.

### *Day 2 SIT Description and Reflection*

The second day of SIT, it was 59°F with 65% humidity. Energy was rated at a 7 out of 10 during the run, a 4 out of 10 immediately after the workout, and an 8 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 2 out of 10 after 2 hours of recovery.

Today at the end of my workout, I found myself more drained of energy than after my first SIT session. I completed five sprints of 30 seconds; each sprint was separated by four minutes of rest. Perhaps that added fifth sprint was responsible for that. I switched up the location of my sprints and it was very effective and much easier. I ran on a stretch of the path that was just the right length for thirty seconds of sprinting and four minutes of walking. After my sprint, I simply continued walking in the same direction for four minutes, then turned around and ran the opposite direction. I feel a bit silly for not starting out this way; it seems like the simplest and most sensible option. At least it only took me one SIT session to come upon this solution. As for the length of the rest, I found that it still felt too long between sprints one and two and between sprints two and three.

However, after a sprint three, I felt that the four minutes was an appropriate length of time to recover, and I needed the whole four minutes to do so.

### *Non-SIT Day 2 Description and Reflection*

The second day of non-SIT running during my SIT trial, it was 70°F with 57% humidity. Energy was rated as a 5 out of 10 during the run, a 5 out of 10 immediately after the workout, and an 9 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 2 out of 10 after 2 hours of recovery. The duration of the run was 33 minutes and 25 seconds.

Today I enjoyed another lovely summer morning while running. I am very thankful for the great weather here in Illinois right now, because it allows those who are becoming stir-crazy with COVID-19 stay-at-home orders to get outside regularly. I do not know how well I would be coping with this situation if I were not able to get out for a run each morning. My run did not feel different from before beginning SIT. I did note that I prefer running at a constant pace to sprinting and recovering, at least for a daily workout. I did enjoy the change of trying a different type of workout, though, because running the same route and usually the same distance each day can be monotonous. For these reasons, if SIT does improve my times, I may consider completing SIT workouts when training for a race.

### *Day 3 SIT Description and Reflection*

The third day of SIT, it was 73°F with 92% humidity. Energy was rated as a 7 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 9 out of 10 after

2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 3 out of 10 after 2 hours of recovery.

The weather on SIT session day three was cooler and less humid, but the sun was shining. It was a beautiful day for running. As I increased the number of sprints during my session, I noticed that it is harder to push myself during my last sprint. Today's session was six sprints and that sixth sprint was very difficult and certainly slower than I would have liked. Nonetheless, I still pushed myself to run the fastest that I could at that moment. I found that I longed for my regular run today because it was a perfect running day; with the sun shining and the weather so temperate, I just wanted to run free and not concern myself with how fast I was running or the duration of my run. That feeling of running free out in the open on a lovely summer morning is why I love to run so much. It makes me feel as if I am a wild mustang galloping through God's green creation without a care in the world. In comparison, SIT is much more scheduled and regulated. I like most things in my life to be described like this, but not my running. My morning workout is the one time that I am not on a schedule, if only for a little while. This is one reason that I may not be interested in completing SIT workouts after this trial is over. It seems that there are both pros and cons to SIT, so whether or not I complete SIT workouts after the completion of this trial will be dependent on the outcome.

### *Non-SIT Day 3 Description and Reflection*

The third day of non-SIT running during my SIT trial, it was 78°F with 65% humidity. Energy was rated as a 5 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out

of 10 during the run and a 2 out of 10 after 2 hours of recovery. The duration of the run was 33 minutes and 19 seconds.

At this point in the study, I still did not have much to report in terms of SIT affecting how I feel during my daily runs. I have continued to enjoy my morning run, but I do not feel any different than usual. I have noticed, however, that I have dropped 10 seconds off of my 5 km time since starting SIT. Midway through the sprint interval training regimen I have implemented, it does appear as if my running performance began to improve.

#### *Day 4 SIT Description and Reflection*

The fourth day of SIT, it was 60°F with 80% humidity. Energy was rated as a 7 out of 10 during the run, a 5 out of 10 immediately after the workout, and a 9 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 3 out of 10 after 2 hours of recovery.

When I went out to run for SIT session four, it was somewhat chilly, which is my perfect running weather. I completed six sprints of 30 seconds; each sprint was separated by four minutes of rest. I really dislike sweating, which I know is ridiculous for a running enthusiast, but because of this I prefer cooler running temperatures. I like it to be warm enough that I can run in shorts, but cool enough that I return home after my run without being drenched in sweat. Anyway, today was perfect for that, so I was excited about my sprint workout, and it did not disappoint. I suppose that the four minutes between sprints is not meant for one to fully recover, and I again noticed that my sprints became progressively more difficult and progressively slower. My fastest pace during my first sprint (according to my GPS watch) was at the pace of a 5:50 mile and decreased to that

of a 6:45 mile during my last sprint. I also walked very slowly during my recovery time; my watch indicated that I was walking at the pace of a 25-minute mile.

Lastly, I found that I was quite sore on this day, both during and after my workout. My heels have been bothering me and the insides of both my calves felt very tight near the beginning of my workout. I should report that I rushed through my cool-down after yesterday's workout, which may be part of the problem. The recurring pain in my heels worries me, though I hope it is simply caused by my very old running shoes. I am certainly long over-due for new running shoes, but I have had trouble breaking in new running shoes, so I put off buying new shoes as long as possible. I am wary of injury because I hope to begin training for a half marathon at the end of the month.

#### *Non-SIT Day 4 Description and Reflection*

The fourth day of non-SIT running during my SIT trial, it was 65°F with 85% humidity. Energy was rated as a 6 out of 10 during the run, a 4 out of 10 immediately after the workout, and an 9 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 3 out of 10 after 2 hours of recovery. The duration of the run was 33 minutes and 11 seconds.

Throughout my run, the insides of both my calves were sore again. This is worrying to me, as I rarely am in pain during a run, though it is not uncommon for me to be sore after a run, especially a long run or if it is particularly hot or cold outside. The persistent pain signals to me that something may be amiss. On the other hand, the pain in my heels seems to have disappeared.

### *Day 5 SIT Description and Reflection*

The fifth day of SIT, it was 60°F with 75% humidity. Energy was rated as a 7 out of 10 during the run, a 5 out of 10 immediately after the workout, and a 9 out of 10 after 2 hours of recovery. Pain was rated at a 3 out of 10 during the run and a 3 out of 10 after 2 hours of recovery.

When I left my house for my workout, it was a bit chilly, but still sunny and supposed to warm up to the lower 80's from the 60° temperature during my run. In fact, these types of mornings are my favorite kind, though it is difficult to explain why. This type of morning makes me feel as if I am being rewarded for waking up before it became hotter, and my prize is a breezy, cool, sunny morning. I feel like I am the early bird and I just got the worm. I love mornings so much, especially in the summer when the sun rises so much earlier than the winter. There is no better way to start a day than with an early morning run in lovely, sunny-but-not-too-sunny weather. I feel as if the joy of mornings is like a secret that morning people keep from non-morning people. It is only for us, and they will never get to appreciate it. There is nothing wrong with not being a morning person, but I feel bad for those that will never be able to appreciate the morning. Anyway, enough about mornings; I will get back to the workout.

When I began to run for my warm-up, my calves were again sore. The lower back portion of both legs ached, and the inside of my right shin was also bothering me. This dissipated as I ran longer. I completed seven sprints of 30 seconds; each sprint was separated by four minutes of rest. About 15 minutes into my workout, I realized that I had forgotten to apply bug repellent, and from that moment on, I could not think about anything other than getting bitten by insects. I tend to get bitten very frequently. Often if I

am outside in a group, I will be bitten multiple times and no one else will get bitten at all. It is a rather unfortunate situation. The part of the trail where I run is wooded and the trees are set back from the trail. Between the trail and the trees, there is a small strip of grass, then a small ditch and an area filled with weeds, brush, bushes, and other plants that grow low to the ground. When it rains, the small ditch along the path fills with water, and this stagnant water is a perfect breeding ground for mosquitos. The brush makes a good home for the mosquitos when it is dry, and thus, even when it has not rained recently, there is an abundance of mosquitos. When I am walking slowly after a sprint, I am the ideal target for all kinds of insects. Needless to say, my legs are now covered in mosquito bites.

Oddly, during today's cool-down I felt that I had what I call "winter lung" after my workout. Anyone who has ever participated in strenuous exercise outdoors when the temperature is below 25 or 30°F has experienced this. "Winter lung" is difficult to describe to anyone who has never experienced it, but I will say that it feels like the inside of one's lungs is frozen. I don't think there are actually sensory receptors inside the human lung, but that is the best way to describe it. This "winter lung" renders breathing a bit more difficult until it disappears, which is usually within half an hour after strenuous exercise. Anyway, I just found it rather strange, considering the weather, while a chilly 60°F, was not really cold.

#### *Non-SIT Day 5 Description and Reflection*

The fifth day of non-SIT running during my SIT trial, it was 79°F with 76% humidity. Energy was rated as a 6 out of 10 during the run, a 5 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out

of 10 during the run and a 3 out of 10 after 2 hours of recovery. The duration of the run was 33 minutes and 06 seconds.

I was shocked today when I finished my run and checked my watch; since beginning SIT, I have cut 24 seconds off of my 5 km time. While I am excited about this, it is not quite as impressive as it sounds, as I had only been training consistently for about 2 months (since taking a year off from running) before beginning this trial. My lifetime personal record for a 5 km race is just over 20 minutes, though it has been four years since that race. The insides of my shins bothered me again on my run today, so I put ice on them for half an hour after returning from my run. I do not know if this will make much of a difference in my pain level while running, but it did immediately help the pain while I was recovering.

#### *Day 6 SIT Description and Reflection*

The sixth and final day of SIT, it was 64°F with 70% humidity. Energy was rated as a 6 out of 10 during the run, a 5 out of 10 immediately after the workout, and a 9 out of 10 after 2 hours of recovery. Pain was rated at a 3 out of 10 during the run and a 3 out of 10 after 2 hours of recovery.

Today I completed four sprints of 30 seconds; each sprint was separated by four minutes of rest. I noticed that after my first two sprints, I had a cramp in my right shoulder that seemed to be centered over my clavicle. The stitch would disappear after I walked and took deep breaths for about 2 minutes. On the third sprint, I focused on taking deep breaths during my sprint and keeping my shoulders down to avoid cramping, and it seemed to work. On the up side, this distracted me from focusing on sprinting, but on the down side, it distracted me from focusing on sprinting. Let me explain this. On the one

hand, concentrating on those two objectives pulled my focus away from focusing on running hard and helped the time to go faster while sprinting, but I also believe that the distraction kept me from pushing myself to run as fast as possible, so my last two sprints were not as fast as the first two.

The dull pain on the inside of both of my shins continued to bother me during my workout today. It is becoming more and more difficult to ignore this and brush it off as a random running pain. I fear I may be injured.

### *Posttest Description and Reflection*

The day of the SIT posttest, it was 60°F with 93% humidity. Energy was rated as a 6 out of 10 during the run, a 4 out of 10 immediately after the workout, and a 9 out of 10 after 2 hours of recovery. Pain was rated at a 4 out of 10 during the run and a 4 out of 10 after 2 hours of recovery. The duration of the 3,000 m run was 18 minutes and 42 seconds.

To be totally honest, today's posttest to evaluate the merits of SIT was pretty painful. Each time my foot landed on the ground, I felt that dull pain inside my shin. During my run, I decided that I cannot ignore this any longer; I will try to ice my shins for 20 minutes every 3 hours for as long as this pain persists.

I knew that there was a possibility for a bias in this posttest, as I expected that my time would be faster after the SIT. For this reason, I tried not to look at the time on my watch during the run. The way my watch is laid out, the mileage is shown near the top of the watch face, your pace is shown on near the bottom of the watch, and the run time is in the middle. Consequently, it is not too difficult to look only at the top or bottom of the

watch face and avoid seeing the run time. I attempted to do this to avoid seeing my run duration throughout my run.

After my run, I iced my shins for the first time, and my shins felt much better. Hopefully if I continue this, I will be able to heal without taking a significant break from running. After this trial, I will be replicating a study on Pilates training, and I will not be running on the days I complete Pilates training, so I will have a short break from running without completely losing my progress.

*Results*

**SIT TRAINING      Pretest      Posttest**

<b>Humidity (%)</b>	57	93
<b>Temperature (degrees F)</b>	72	60
<b>Energy during (1-10)</b>	6	7
<b>Aches/pains during (1-10)</b>	1	4
<b>Energy immediately after (1-10)</b>	4	4
<b>Aches/pains 2 hour after (1-10)</b>	1	4
<b>Energy 2 hours after (1-10)</b>	9	9
<b>Total Run Time (3,000 m)</b>	19:20	18:42

*Table 4: Pretest and Posttest data from SIT trial*

Between the pretest and the posttest for the SIT trial, 3,000 m time trial duration decreased by 38 seconds. Pretest time trial duration was 19 minutes and 20 seconds, while posttest time trial duration was 18 minutes and 42 seconds. The 38 second decrease in run time represents a 3.7% improvement in performance. This is less than the improvement in the study conducted by Koral et al. At the end of their study, they found

a 50.4 second improvement in time trial, which represented a 5.7% improvement in performance. While the improvement in this trial was less than the average improvement in the original trial, it is still significant. Also, it is possible that due to my improvement during previous trials, there was simply less room for me to improve. Energy during the workout increased from a 6 out of 10 during the pretest to a 7 out of 10 during the posttest and was rated at a 4 out of 10 immediately after both trials and a 9 out of 10 two hours after both trials. Pain was rated at a 1 out of 10 during and after the pretest but was rated at a 4 out of 10 during and after the posttest. This pain was likely due to a minor injury that came up during the SIT trial.

<b>SIT TRAINING</b>	Training Day	Training Day	Training Day	Training Day	Training	Training
	1	2	3	4	Day 5	Day 6
<b>Humidity (%)</b>	92	65	57	80	75	70
<b>Temperature (degrees F)</b>	73	59	56	60	60	64
<b>Energy during (1-10)</b>	7	7	7	7	7	6
<b>Aches/pains during (1-10)</b>	1	1	2	2	3	3
<b>Energy immediately after (1-10)</b>	5	4	4	5	5	5
<b>Aches/pains 2 hour after (1-10)</b>	2	2	3	3	3	3
<b>Energy 2 hours after (1-10)</b>	8	8	9	9	9	9

Table 5: Data from SIT training days

Throughout the 6 SIT training sessions, there were few changes in energy, but considerable changes in pain level and perhaps an injury. Energy was rated at a 7 out of 10 during the first 5 training sessions and was rated at a 6 out of 10 for the last session. Energy was rated at a 5 out of 10 for the first and fourth through sixth sessions and was rated at a 4 out of 10 for the second and third training sessions. Energy after two hours of recovery was rated at an 8 out of 10 for the first and second sessions and at a 9 out of 10 for the third through sixth sessions. These small fluctuations in energy are not significant or consistent enough to make the assumption that these changes are the result of the sprint interval training. Pain during SIT training was rated at a 1 out of 10 the first two days, a 2 out of 10 the next two days, and a 3 out of 10 the last two training sessions.

<u>Non-SIT Training</u>	<b>Day 1</b>	<b>Day 2</b>	<b>Day 3</b>	<b>Day 4</b>	<b>Day 5</b>
<b>Humidity (%)</b>	68	57	65	85	76
<b>Temperature (degrees F)</b>	73	70	78	65	79
<b>Energy during (1-10)</b>	6	5	5	6	6
<b>Aches/pains during (1-10)</b>	1	1	1	2	2
<b>Energy immediately after (1-10)</b>	4	5	4	4	5
<b>Aches/pains 2 hours after (1-10)</b>	2	2	2	3	3
<b>Energy 2 hours after (1-10)</b>	9	9	10	9	10
<b>Total Run Time (5km)</b>	33:29	33:25	33:19	33:11	33:06

*Table 6: Data gathered from non-SIT runs during SIT trial*

Similarly, pain after recovery was rated at a 2 out of 10 the first two days and a 3 out of 10 the last four days. As previously mentioned, this is at least partially the result of a minor injury that worsened during the SIT trial.

On days during the SIT trial when I went running, but did not complete a SIT workout, there were few changes in energy. Energy during the workout fluctuated between a 5 out of 10 and a 6 out of 10. Energy immediately after the run was rated at either a 4 out of 10 or a 5 out of 10, and energy after recovery was rated between a 9 out of 10 and a 10 out of 10. Pain during the run increased from a 1 out of 10 to a 2 out of 10 and pain during the run increased from a 2 out of 10 to a 3 out of 10. This further demonstrates the exacerbation of a minor injury that I experienced during the trial. Run time for a 5k did decrease over the period of the study from 33 minutes and 29 seconds to 33 minutes and 6 seconds.

### *Conclusion*

I will be completing sprint interval training in the future, both because I enjoyed the change of pace and because of the 3.7% improvement in running performance after the six SIT sessions completed. I will likely be completing one SIT session a week when training for any kind of race, such as the half marathon for which I will soon begin training. I did have a considerable amount of trouble and pain throughout the trial, but I know from past experience that this is more likely due to my very old running shoes, and not a result of the sprint interval training. Despite the fact that I did not experience as much improvement as the participants in the study that I replicated, I would still consider this trial a success.

## CHAPTER FIVE

### Effect of Pilates Training on Running Performance

#### *Introduction*

The study replicated in this chapter was published by Finatto, Soares Da Silva, Okamura, Almada, Oliveira, and Peyré-Tartaruga in 2018 and entitled, “Pilates training improves 5-km run performance by changing metabolic cost and muscle activity in trained runners.”

This article evaluated the effects of a 12-week Pilates Training program on running performance of trained, male athletes. Participants were randomly split into two groups: a control group and a treatment group. Both groups completed running training 2 days a week, and the treatment group also completed 2 Pilates training sessions a week on days that running training was not completed. Due to time constraints in my trial, I performed 10 Pilates sessions over 2 weeks, as compared to the 24 sessions completed by the participants in the original study over 12 weeks. I also ran on all the days that I did not complete Pilates training. The shortening of the trial duration and increased frequency of training are significant changes that likely affected my results.

The reason Pilates training was chosen as a method to improve running performance is that this type of training places emphasis on strengthening the muscles of the core and improving stability of the core. This may then improve running efficiency, which would ideally improve running performance.

The indicators that were measured in the original study were time of completion of a 5 km run, metabolic cost, and maximum amplitude of electromyographic (EMG) signal during maximum voluntary isometric contraction (MVIC). According to the authors of the article, metabolic cost relates to moving economically and, “corresponds to the oxygen consumption spent to move a certain distance by running at a submaximal intensity,” (Finatto et al. 2018, 2). The more energy one consumes during an activity, the more oxygen will be required, and the higher the metabolic cost. Thus, if one is moving economically, that results in less energy consumption, less oxygen requirement, and has a lower metabolic cost. Electromyography is the recording of electrical activity of a muscle using electrodes attached to the skin or inserted into the tissue. For this study, electrodes were placed at key points on the body to measure activity in the muscles in question while contracting these muscles with as much force as possible (maximum amplitude of EMG signal during MVIC). These muscles are the latissimus dorsi, gluteus medius, vastus lateralis, biceps femoris, longissimus, oblique externus abdominus and oblique internus abdominus muscles. They are used when running and are located in the abdomen, back, thighs, and buttocks. Participants were evaluated before and after training, with 72 hours between evaluation and any training. This was a blind trial, so assessors did not know which participants had completed Pilates training and which participants had only completed running training. I will also be completing a pretest and a posttest of a 5 km time trial to evaluate my running performance. Out of the aforementioned indicators, I will only be measuring time of completion of a 5 km run due to my limited resources in my home study.

The 32 participants in this study were male and between the ages of 18 and 28. None had any known medical conditions that could affect the results of the study. All participants had been training as runners for at least six months prior to the study and ran an average of two times per week. I fit the profile of the participants in everything except gender. I acknowledge that gender may affect results.

The results of the study showed a significantly lower metabolic cost in the Pilates group as compared to the control group. The study reports no significant difference in times between the two groups during the pretest, but during the posttest, the Pilates group finished the 5km run an average of 1 minute and 22 seconds faster than the control group. In the posttest, the MVIC of the oblique externus abdominus, oblique internus abdominus, gluteus medius and longissimus muscles was significantly higher in the Pilates group than in the control group, indicating that the muscles were able to contract with more force in the Pilates group than in the control group.

The authors of the study provided a figure outlining which exercises the participants performed during the training sessions. They did not, however, indicate how many repetitions of each exercise were completed. I watched multiple videos of Pilates workouts online and noticed that Pilates is a very low repetition practice. It is preferable in Pilates training to complete few repetitions and to concentrate and be present fully in each one. So, I concluded that one set of 10 repetitions of each exercise would be sufficient, and worked to stay focused on each repetition, ensuring correct muscle activation and breathing patterns. I do not have experience in Pilates training, so I had to learn the exercises that were listed on the chart provided by the authors. I followed videos

from a YouTube channel called “PilatesAnytime,” which provided instructional content on how to perform specific exercises.

The figure below indicates that the participants completed Pre-Pilates during the first week of their training, basic mat Pilates during weeks 2-6 of their training, and intermediate mat Pilates during weeks 6-12 of the training. I noted that week 6 is listed twice. I do not know if this is a mistake, or if it indicates basic mat Pilates was performed during the first training session that week and intermediate mat Pilates was performed during the second training session that week. In the intermediate mat Pilates, the exercise called Neck Pull is also listed twice. I assumed this is an error since no other exercise is listed twice in the same column. I decided to complete pre-Pilates in sessions 1-3, basic mat Pilates in sessions 4-5, and intermediate mat Pilates in sessions 6-10.

	<b>Week 1</b>	<b>Weeks 2 to 6</b>	<b>Weeks 6 to 12</b>
Initial section	Fundamentals 1 to 7	Fundamentals 5 to 12	Fundamentals 13 to 17
Main section	Pre-Pilates	Basic Mat Pilates	Intermediate Mat Pilates
Final section	Relaxation	Relaxation	Relaxation
<b>Exercises that composed the various levels</b>			
<b>Fundamentals</b>	<b>Pre-Pilates</b>	<b>Basic Mat Pilates</b>	<b>Intermediate Mat Pilates</b>
1. Breathing	1. The Hundred	1.The Hundred	1. The Hundred
2. Imprinting	2. Roll Down	2. The Roll Up	2. The Roll Up
3. Pelvic Bowl	3. Roll Up	3. Single Leg Circles	3. Leg Circles
4. Knee Sway	4. Single Leg Circles	4. Rolling Like a Ball	4. Rolling Like a Ball
5. Knee Folds/Stirs	5. Rolling Like a Ball	5. Single Leg Stretch	5. Single Leg Stretch
6. Leg Slides	6. Single Leg Stretch	6. Double Leg Stretch	6. Double Leg Stretch
7. Spinal Bridging	7. Double Leg Stretch	7. Legs Up and Down	7. Single Straight Leg
8. Prone Hip Extension	8. Spine Stretch Forward	8. Spine Stretch Forward	8. Double Straight Leg
9. Cervical Nod		9. Saw	9. Criss-Cross
10. Nose Circles		10. Single Leg Kicks	10. Spine Stretch Forward
11. Head Float		11. Beats	11. Open Leg Rocker
12. Ribcage/Angel Arms		12. Double Leg Kicks	12. Corkscrew
13. Rotating Arms			13. Saw
14. Torso Twist			14. Neck Pull
15. Flight			15. Single Leg Kicks
16. Cat			16. Double Leg Kicks
17. Bowing			17. Neck Pull
			18. Side Kicks Series
			19. Teaser
			20. Seal

Table 7: Table from Finatto et al. study indicating which exercises were performed during Pilates Training

As I completed my Pilates Training indoors, I did not record temperature or humidity for the Pilates workout days, in contrast to the previous three studies. Also, I

took two days off of running due to a minor injury between the conclusion of the SIT trial and the start of this trial.

### *Pretest Description and Reflection*

The day of the running pretest for the Pilates trial, it was 60°F and 88% humidity. Energy was rated at 6 out of 10 during the run, 4 out of 10 immediately after the run, and 9 out of 10 after 2 hours of recovery. Pain was rated at a 4 out of 10 both during the run and after 2 hours of recovery. The duration of the run was 32 minutes and 50 seconds.

Throughout the pretest run today, the insides of both my ankles continued to ache as they have been for the past few days. Despite this, my run could have been much worse. I would have been more discouraged by the pain had I planned to run tomorrow. Due to the nature of the Pilates training regimen I followed, I run 2 times per week for the 2 weeks, which will be a nice break for my body. I also hoped that the change in routine would allow me time to heal what is hopefully only a minor injury that accompanied my third study. I continue to ice my shins for 20 minutes every 3 hours, as I noted in my Chapter 4 Posttest Reflection.

### *Day 1 Pilates Training Description and Reflection*

The first day of Pilates Training, energy was rated as an 8 out of 10 during the workout, an 8 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

During the first day completing Pilates Training the biggest challenge with was correctly performing all of the exercises. Part of correctly practicing Pilates is breathing

and actively being present in each exercise. Each movement has a breathing pattern, i.e. “inhale as you stretch your leg away from you and exhale as you flex it back toward your body.” For me and my lack of any previous Pilates experience, it was difficult to simply perform all of the exercises correctly, and more difficult to focus on being present and correctly inhaling and exhaling as part of the exercise. I found it quite mentally stimulating and mentally tiring, which some might like in their workouts. My past experience has been that I prefer something simple and I prefer an exercise where I do not have to focus too hard on the actual action I am completing. As a runner, I am used to setting my body on autopilot and letting my mind wander free wherever it wishes to go, so Pilates also gave me the opportunity to think about how I approach exercise that requires more connection and work for both body and mind. Perhaps I will become accustomed to and begin to enjoy this very different type of exercise. Most of the exercises, once I figured out how to correctly complete them, were not physically difficult to perform. They helped to stretch out my body and work on mobility of my joints, and I enjoyed this. My back was a very stiff at the start of the Pilates on the first day. I did have some trouble with two exercises called The Hundred and the Double Leg Stretch exercises. Both of these exercises are aimed at strengthening the core, and I felt my abdomen shaking with the effort of holding still near the end of my sets for both of these exercises. I suppose I had not realized how weak my core has gotten lately. Hopefully, my core will be a little stronger by the end of this trial.

### *Day 2 Pilates Training Description and Reflection*

The second day of Pilates Training, energy was rated as a 9 out of 10 during the workout, a 9 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of

recovery. Pain was rated at a 1 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

The second Pilates Training day was a bit easier than the first day. I did not have as much trouble with performing the exercises correctly as I had already performed them in my first Pilates Training session. This took some of the burden off of my mind. This time, I did know physically what I should be doing with my body in each exercise, though I still had some trouble connecting the movements to my breathing and focusing my mind on using the appropriate muscle groups. This correlates with what some people call “mind-body connection.” I continued to work on this, and I continued to find The Hundred very difficult and struggled to finish the required repetitions. This exercise will be a good gauge of how my core is being strengthened, as it was rather difficult the first two times. I hoped it would become easier as I continued my Pilates Training.

#### *Non-Pilates Day 1 Description and Reflection*

The first non-Pilates Training day during the Pilates Trial, it was 72°F and 83% humidity. Energy was rated at 7 out of 10 during the run, 6 out of 10 immediately after the run, and 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the run was 32 minutes and 51 seconds.

My first day running in this trial was quite the eventful day: after a break for an injury, my first day running after two Pilates Training sessions, my first day running in new shoes, my running watch was almost out of battery power, and it poured rain for half of my run. During my SIT trial, I started noticing pain on the inside of my shins during workouts, and throughout the trial the pain became increasingly worse both during

workouts and afterwards. I attributed this pain to my worn-out shoes, long overdue for replacing, but pushed through to finish that trial by icing my shins periodically throughout the day. I took 2 days to completely rest and the next 2 days completed Pilates Training for this trial. So, it had been 4 days without running. After 2 days without running and diligent application of ice every 4 times a day for 20 minutes on each ankle, I felt completely recovered. I no longer felt pain or tightness on the inside of my shins. I had planned to replace my shoes after the end of this trial to avoid changes in my running while breaking in the shoes. However, out of a healthy fear that I might continue to injure myself by running on dead shoes for three more weeks, I purchased new shoes. I took a trip to a local running shoe store, where the very knowledgeable owner helped me pick out new shoes. We decided on the Saucony Iso Ride 10, which is essentially the same shoe that I had before, but is a newer version, as the Saucony Ride 9 is no longer being manufactured.

The shoes were very comfortable for the first half mile, but after that, the bottoms of my feet began to ache, and around mile 1.5 of my run, the bottoms of my feet became numb. Though not ideal, this is pretty standard for me when breaking in running shoes. Halfway through my run, my watch began to buzz and showed a low battery warning. I had forgotten to charge it and hoped it could last until I finished my run. I periodically checked my watch for my run duration, in case the watch died, but this did not happen, and fortunately I was able to accurately record my run duration. My last obstacle during the first run of the Pilates trial was the weather. It was cloudy when I left for my run and I knew there was a high chance that I would be rained on during my run. A little after the halfway point in my run, at around 1.6 miles, the skies opened, and it began to pour down

rain on me. I actually enjoy running in the rain when it is warm outside, and soon after the rain began I noticed that my pace had dropped from 11:20 to 10:40. It continued to rain for the duration of my run, but just my luck, the rain ceased as soon as I finished my run. Because there were so many other unusual factors about my run, it was difficult to attribute any judgement as to if and how the Pilates Training affected my running.

### *Day 3 Pilates Training Description and Reflection*

The third day of Pilates Training, energy was rated as a 9 out of 10 during the workout, a 9 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

I again enjoyed my Pilates Training; The Hundred was less difficult for me than in the previous two sessions, so I took that as a sign that I was improving. I experienced a bit of pain during the Knee Sway exercise. It involves lying on your back with your knees bent, then letting the knees fall to one side while keeping the upper back and shoulders on the ground, gently twisting the spine. The exercise is meant to stretch one's back, but it only made me feel that I needed to twist my back further in order to "crack" my back. I was worried that if I did this, I may hurt myself, though, so I continued to follow the guidelines of the exercise, albeit stiffly.

### *Day 4 Pilates Training Description and Reflection*

The fourth day of Pilates Training, energy was rated as a 9 out of 10 during the workout, a 9 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of

recovery. Pain was rated at a 1 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

With this workout I moved from “pre-Pilates” to “basic mat Pilates.” I performed some new exercises and no longer performed some exercises from the first three sessions. Also, the exercises I completed for the first time today were a little more difficult than those from the “pre-Pilates.” I actually had less trouble understanding how to complete these exercises the first time than I did completing the “pre-Pilates” exercises for the first time. Perhaps I started to understand how Pilates works a little more. This time, my back was less stiff when lying on the ground, so it is possible that my back released without having to “crack” it, or perhaps the stretching of the previous workout has had a cumulative effect. The Hundred exercise continued to become progressively easier for me to perform.

### *Non-Pilates Day 2 Description and Reflection*

The second non-Pilates Training day during the Pilates Trial, it was 73°F and 88% humidity. Energy was rated at 5 out of 10 during the run, 3 out of 10 immediately after the run, and 9 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the run was 32 minutes and 09 seconds.

This morning when I awoke and began my run, I felt extremely sluggish. I felt as if I did not have enough energy to go running, or to push myself to run hard. On my run, I noticed the high humidity quite a bit. Between my lack of energy and the high humidity, I felt that I would not have an enjoyable or successful run, so in order to counteract my feelings and have a successful run, I pushed myself harder than usual. I hoped to finish

only slightly slower than my last run. In the end, I found that I had pushed myself much harder than I knew, and, despite the low energy and weather, I finished over 40 seconds faster than my last run. I believe that running is 50% training and 50% mental tenacity, and this run demonstrated this perfectly. If I had not pushed myself, I probably would have had a very slow run, as I expected at the start from how I felt. Instead, I decided that I would not waste a training day and ended up running much faster than expected.

During my run I continued to experience some shoe-breaking-in symptoms. Around 0.5 miles into my run, the balls of my feet began to feel very sore, and around 1.4 miles they went numb. This was pretty similar to my last run. Today, however, the balls of my feet stopped feeling numb around 2.6 miles into the run and again became very sore.

#### *Day 5 Pilates Training Description and Reflection*

The fifth day of Pilates Training, energy was rated as an 8 out of 10 during the workout, a 7 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

During my Pilates training today, I felt tired for the first time. The first four sessions, I felt as if I was simply loosening up my body and relaxing, but with this workout I felt the exercises in my core and began to sweat about halfway through the workout. This was the first day that Pilates felt like a workout, as opposed to simply stretching. I felt very good completing the Hundred today. It has become considerably easier through my practices and compared to the first time, indicating that my core has become stronger over these five sessions. Today I noticed that two exercises, called Spine

Stretch Forward and Saw, were quite difficult for me. These exercises both involve sitting upright with the legs stretched out straight in front and bending over the legs, reaching for the feet. Both exercises involve a deep stretch of the back of the legs and made me very aware of how tight the muscles in the back of my legs are. My body has always been very stiff and inflexible, even when I was a dancer and was constantly stretching. After many years of stretching continuously for ballet, I became more flexible, but when I quit ballet and became a runner, I quickly lost that flexibility.

### *Day 6 Pilates Training Description and Reflection*

The sixth day of Pilates Training, energy was rated as an 8 out of 10 during the workout, an 8 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

With the workout today, I moved to intermediate mat Pilates, and it was quite a difficult transition. Not only were there 9 new exercises to learn, but many of the exercises were very difficult to perform in terms of the strength required, and some were simply difficult to perform in terms of the coordination required. I noted that the sixth session in the original study was three weeks in, and at that point participants were still learning basic mat Pilates. They did not begin intermediate mat Pilates until their 11<sup>th</sup> or 13<sup>th</sup> training session, 6 or 7 weeks into the program (I am unsure on this due to the error in the figure from the study, mentioned in the introduction to this chapter), while this is only the 8<sup>th</sup> day since I began my Pilates Training. This means that the participants had much more time to learn and become accustomed to these exercises, not to mention that, unlike me, they had the luxury of a teacher with them in person. Four exercises that I did

not have trouble with were the Single Straight Leg, Double Straight Leg, Crisscross, and Side-Kicks Series. The Crisscross exercise is essentially the same as bicycle crunches, which I have done before and enjoy. Single Straight Leg and Double Straight Leg were nice deep stretches, which while they can be painful due to my tight muscles, are not difficult to perform, and Side-Kicks Series is a relaxing hip opener. The other five exercises, Open Leg Rocker, Corkscrew, Neck Pull, Teaser, and Seal, all gave me trouble in this first workout. Successful completion of these exercises required core strength that I did not possess, so I struggled through this workout with only semi-successful completion of the new exercises.

### *Non-Pilates Day 3 Description and Reflection*

The third non-Pilates Training day during the Pilates Trial, it was 78°F and 53% humidity. Energy was rated at 6 out of 10 during the run, 5 out of 10 immediately after the run, and 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the run was 32 minutes and 25 seconds.

This run felt very enjoyable and productive. I think that my 5k run time for this third running day is more indicative of where I actually am, as compared to my previous running day. As I mentioned in my reflection for that run, I pushed myself much more than usual, to the point that I was far more tired than usual after my run was. My run today was more my usual pace, and my time reflected that fact. I found that the back pain mentioned in previous Pilates training day reflections was not present during my run. However, I did visit my chiropractor later on this day because some daily activities, such as bending over, twisting my body, and stretching to one side or the other, have been

eliciting back pain. For reference, I would rate this periodic back pain as a 5 out of 10. I noticed this pain upon commencement of my Pilates training, and I hope the chiropractor does not decide that the Pilates training is the source of my pain.

### *Day 7 Pilates Training Description and Reflection*

The seventh day of Pilates Training, energy was rated as an 8 out of 10 during the workout, an 8 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

After visiting my chiropractor, my Pilates training felt more comfortable. Lying on the ground and moving my limbs in various ways for the training did not produce any pain, and in fact felt great. My chiropractor knows me and my history with running and told me that Pilates training is almost certainly not the source of my problems, especially if I am being careful to perform the exercises correctly. He thinks that lying on the hard ground, which is often problematic for peoples' backs, may have shown me how misaligned my back was. He postulated that my back had been out of alignment for a while and that I simply did not notice until I began lying on the ground and completing Pilates training. He explained that all spines tend toward misalignment, though not equally in all people or all parts of a person's life.

This reminded me of the principal of entropy used in chemistry. The simple definition often used for entropy is that it is the measure of the randomness or disorganization of the universe. The law of entropy essentially states that if humans did not intervene, the universe would tend toward higher and higher entropy, that is the universe would tend toward becoming less organized. All things tend toward disorder,

and it sounded to me as if this applies to the human spine also. The chiropractor performed some chiropractic manipulation, which always seems like magic to me, the patient, and my back immediately felt better. I continued to have considerable difficulty completing some of the new exercises. Today, however, I did not have trouble with coordinating all the correct movements in a given exercise. I attribute this to having learned in the previous practice how exactly to perform the exercises. This does not mean I suddenly had the core strength to do so well, but I did understand exactly how I am supposed to be moving.

#### *Day 8 Pilates Training Description and Reflection*

The eighth day of Pilates Training, energy was rated as an 8 out of 10 during the workout, a 9 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 2 out of 10 during the workout and a 2 out of 10 after 2 hours of recovery.

I began my Pilates workout knowing I would again be facing the difficult exercises that have given me trouble the past couple sessions. Open Leg Rocker, Corkscrew, Neck Pull, Teaser, and Seal were coming along better for me, but I decided that on this day I would not let them get the best of me. I prevailed and I believe that I successfully completed the exercises. By the end of the workout, I was covered in sweat and my abdominal muscles ached, but I was proud of myself. I worked hard today, and I felt the remnants of the workout in my abdominal muscles for the next hour.

### *Non-Pilates Day 4 Description and Reflection*

The fourth non-Pilates Training day during the Pilates Trial, it was 81°F and 62% humidity. Energy was rated at 6 out of 10 during the run, 5 out of 10 immediately after the run, and 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the run was 32 minutes and 12 seconds.

I noticed during my run that I had very few problems my running shoes, no longer experiencing the breaking-in period. I have been wearing them wherever I go since I purchased them, and simply walking around in them has helped the process of breaking in the shoes. During this run, I only had a small bout of pain and numbness in the balls of my feet from about 1 mile in, until about 2 miles into the run. Hopefully during my next run, any issues with them will have dissipated.

### *Day 9 Pilates Training Description and Reflection*

The ninth day of Pilates Training, energy was rated as an 8 out of 10 during the workout, a 9 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

On this day, I actually looked forward to the 5 difficult exercises in my Pilates training regimen. I completed them, not without difficulty, and enjoyed the “burn” in my abdominal muscles. Looking back at where I started, I am proud of how far I have come in terms of my ability to complete some of the difficult Pilates exercises.

### *Day 10 Pilates Training Description and Reflection*

The tenth day of Pilates Training, energy was rated as an 8 out of 10 during the workout, a 9 out of 10 immediately after the workout, and a 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the workout and a 1 out of 10 after 2 hours of recovery.

I have remarked more than once throughout this project how I enjoy running for its mental health benefits. My mind and thoughts are a balloon that I hold onto, often too tightly, like a child attempting to keep their colorful, helium-filled prize from floating away into the sky. Usually when I am running, I am able to release my hold on the balloon and watch it float away. Sometimes, however, running forces me to ruminate on my problems, as I am free from other distractions. In contrast, I find that Pilates forces the mind to focus on the successful completion of the exercise, the correct breathing, and engaging the correct muscles. With all of this on my mind, I cannot possibly worry about my day-to-day problems during a Pilates workout. Pilates may be even better for my mental health than running.

### *Posttest Description and Reflection*

The day of the Pilates posttest, it was 80°F and 50% humidity. Energy was rated at 6 out of 10 during the run, 5 out of 10 immediately after the run, and 10 out of 10 after 2 hours of recovery. Pain was rated at a 1 out of 10 during the run and a 1 out of 10 after 2 hours of recovery. The duration of the run was 32 minutes and 03 seconds.

I had a very pleasant run on this day, until I realized that this is my last run for this project. I have enjoyed creating this project and finding new ways to improve my running, and I am sad to see it come to an end. That was a bit disheartening, but I did not

let it affect my time. I finished in just over 32 minutes, which means I took almost a full minute off of my 5k time simply by completing Pilates training. I would call this trial an unqualified success. I can tell my core is considerably stronger than it had been and am excited to continue using Pilates to increase my strength and running efficiency.

*Results*

<b><u>Pilates</u></b>	<b>Pretest</b>	<b>Posttest</b>
<b>Humidity (%)</b>	88	50
<b>Temperature (degrees F)</b>	60	80
<b>Energy during (1-10)</b>	6	6
<b>Aches/pains during (1-10)</b>	4	1
<b>Energy immediately after (1-10)</b>	4	5
<b>Aches/pains 2 hours after (1-10)</b>	4	1
<b>Energy 2 hours after (1-10)</b>	9	10
<b>Total Run Time</b>	32:50	32:03

*Table 8: Data gathered from Pilates pretest and posttest*

The most significant difference between the pretest and posttest for the Pilates trial was the 5km run time. The duration of the pretest run was 32 minutes and 50 seconds and the duration of the posttest run was 32 minutes and 3 seconds, a difference of 47 seconds. This improvement does seem small in comparison with the average 1 minute 22 second improvement in the original study. Recall, however, that the participants in the original study completed 24 Pilates training session while the

participant in this trial completed only 10 Pilates training sessions. One may consider the return for the duration of this study, as compared to the original. A 47 second improvement in 2 weeks versus a 1 minute 22 second improvement in 12 weeks. Another consideration is the return on the number of sessions. A 47 second improvement in 10 sessions versus a 1 minute 22 second improvement in 24 sessions. It is unlikely that I would actually improve by 47 seconds every two weeks if I continued Pilates training for a total of 12 weeks, or 47 seconds every 10 sessions if I continued for a total of 24 sessions, but it is unlikely that I would not continue to improve. With that in mind, the 47 second improvement appears much more substantial.

Energy during the run was rated as a 6 out of 10 in both the pretest and the posttest. Energy immediately after the run was rated at a 4 out of 10 in the pretest and a 5 out of 10 in the posttest, and energy after 2 hours of recovery was rated at a 9 out of 10 in the pretest and a 10 out of 10 in the posttest. This slight increase in post-run energy could be due to increased running efficiency from the Pilates training, but both sets of values are still within the subject's normal experience and could simply be normal differences in energy among different training days.

Pain was rated at a 4 out of 10 during and after the pretest and was rated at a 1 out of 10 during and after the posttest. This disparity is not due to the Pilates training, as there was a preexisting injury present during the pretest, which was resolved prior to the posttest. Temperature and humidity were considerably different from the pretest to the posttest, but still within normal for summer in Illinois, so likely did not affect the outcome.

<u>Pilates</u>	Training									
<u>TRAINING</u>	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Energy during (1-10)	8	9	9	9	8	8	8	8	8	9
Aches/pains during (1-10)	1	1	2	1	2	2	1	2	1	1
Energy immediately after (1-10)	8	9	9	9	8	8	8	9	9	9
Aches/pains 2 hours after (1-10)	1	1	1	1	1	1	1	2	1	1
Energy 2 hours after (1-10)	10	10	10	10	10	10	10	10	10	10

Table 9: Data gathered during Pilates training

On days of Pilates training, energy was rated between an 8 and a 9 out of 10 both during and immediately after the workout. Energy was rated at a 10 out of 10 for all workout days after 2 hours of recovery. Pain was rated between 1 and 2 out of 10 during and after training. This consistent high energy reflects the generally less physically strenuous nature of a Pilates workout, as compared to a running workout. Pilates workouts did tend to be longer than my running workouts, which were usually shorter than 35 minutes. The pre-Pilates phase was a bit shorter, usually 30 minutes, but the basic mat Pilates workouts lasted about 45 minutes and the intermediate mat Pilates workouts lasted close to an hour.

<u>Non-Pilates</u>	Day 1	Day 2	Day 3	Day 4
<u>Training</u>				
Humidity (%)	83	88	53	62
Temperature (degrees F)	72	73	78	81
Energy during (1-10)	7	5	6	6
Aches/pains during (1-10)	2	2	2	1
Energy immediately after (1-10)	6	3	5	5
Aches/pains 2 hours after (1-10)	1	1	1	1
Energy 2 hours after (1-10)	10	9	10	10
Total Run Time	32:51	32:09	32:25	32:12

Table 10: Data gathered during Pilates trial on days Pilates training was not completed

On the days when Pilates training was not completed, a 5 km run was completed, and the above chart represents data from those days. Energy was rated between a 5 and a 7 out of 10 during the run, and between a 3 and a 6 out of 10 immediately after the run. After 2 hours of recovery, energy was rated between 9 and 10 out of 10. Pain was rated between 1 and 2 out of 10 during the run and was rated at 1 out of 10 after 2 hours of recovery. While, the values from day 2 are somewhat anomalous due to events during the run that day (see Non-Pilates Day 2 Reflection) they are still within normal and not irregular enough to warrant outlier status.

### *Conclusion*

In the end, I very much enjoyed Pilates training, and will be continuing with it. My 5 km time improved by 47 seconds which was very satisfying, but more than that, I also enjoyed working on my mobility and strength in a very low stress, non-strenuous manner. As the action of running is so repetitive, there are various muscles in a runner's body that become very tight over time. I found that Pilates helped me with my sometimes uncomfortably tight muscles while also strengthening my core. As such, I will be continuing Pilates training once a week, on a day that I do not run.

## CHAPTER SIX

### Conclusion

One of the first hurdles I encountered in writing this thesis was choosing a topic. I began this journey without a clue where it would lead me. I began by creating a list of my interests and realized that most cannot be turned into a workable thesis topic. I landed upon using my passion of running as the general theme for my writing and knew I did not want to write a strictly research-based thesis, but still had not solidified what exactly my thesis would entail. My thesis mentor, Dr. Good, helped to put the pieces of the puzzle together for me, allowing me to decide on this hybrid research/reflection format for this project. I remember I practically jumped for joy when she proposed the idea of replicating scientific studies relating to running to see if I would achieve similar results and chronicling my journey along the way. This topic combines my interest in running, research, and some creative writing. Most importantly, I was not obliged to sit behind a desk the entire time I was writing my thesis. A large part of my thesis was going out into the world to run and train. I came into the thesis process legitimately scared about how difficult it would be to write this thesis. I was certain it would be like pulling teeth for me to write something like this, but with this unique format I was able to enjoy the process more than I ever thought I would.

During my research I found 40 articles relating to improving running performance that interested me. I certainly could have continued researching and found many more, but I decided to look over the articles had I had already found and continue my research

if I did not find enough studies that I thought would be plausible for me to replicate. Of the 40 articles I found, there were about 6 that I thought I could replicate. Of those 6 studies, 2 were very similar to the ones I ended up choosing, so I eliminated them. There were also various articles that I found fascinating and would have loved to replicate but would not have been feasible with my limited resources. For instance, one article I found was called “The Effects of Backward Running Training on Forwards Running Economy in Trained Males,” with the aim of discovering how training to run backwards can improve one’s running in the forward direction. I was disappointed upon reading this article, as the study protocol was far too complicated for me to implement on my own and would have required more than my limited resources with respect to instrumentation to measure various indicators related to running. I found an article called, “Quality of Life of Female and Male Vegetarian and Vegan Endurance Runners Compared to Omnivores – Results from the NURMI Study (Step 2),” which interested me, as someone who has tried out a vegan diet in the past, but this article actually came from a large survey of endurance runners, and thus was not a candidate for replication by me. I came upon a few studies on the topic of barefoot running, which piqued my interest, but the idea of running barefoot terrifies me. I fear that I would step on a rusty nail or something of the sort and hurt myself, or even develop tetanus. I read multiple noteworthy studies on the effects of carbohydrate loading before a race, but the procedures used in all of these studies were again too complicated and required resources to which I do not have access.

In the end, I landed on the four studies which have been explored at length in the earlier portions of this thesis. I had various reasons for deciding upon these articles, but

have not really considered them until now, long after having done so. Looking back, the most important factor in my decision was the ease with which I could replicate the studies. The only tangible resources I needed for the studies I chose (besides running shoes, my GPS watch, and a computer) were caffeine pills and beetroot. I already possessed a bottle of caffeine pills as I use them on occasion to keep me awake all night studying for exams or writing papers, and beets are inexpensive and readily available at my local grocery stores. I needed no sophisticated instruments or obscure supplements. I chose studies that took place over a short period time, with the exception of the Pilates study, which I adjusted to fit my needs. When reading through procedures for studies, I eliminated any study whose protocol was overly complicated and difficult to implement with only one person. The other important factor which came into play was my interest in the topic of the article. I have some experience with how caffeine affects one's mental state but had never considered how it affects humans physically until reading the study that I chose to replicate. My limited personal experiences with caffeine made me interested in its effects on running and prompted me to replicate the study. I had never eaten beets before but found it extremely surprising that this obscure vegetable could improve running performance. The unique treatment of beetroot compelled me to add it to my roster of studies to repeat. In high school I had some experience with sprint interval training but had never attempted to measure its effect on my performance. The wish to find out whether or not completing sprint workouts in high school was reasonable and useful is the primary reason I chose to include it. In high school we took a yoga class each Friday during Track season. While Yoga is different than Pilates, the two practices have always seemed similar to me, and certainly do have some commonalities, such as

the focus on breathing. In spite of the complex path to its conception, this thesis has had quite an impact on me as scholar, a runner, and in my personal life.

After all is said and done, all four studies achieved some degree of success in my attempt to increase my speed and running performance. The caffeine trial improved my running performance by 20 seconds, or about 1%. This is comparable to the results of the subjects in the original study. I also found that I felt significantly more energized while running after having consumed caffeine. Using caffeine as an occasional motivation aid to get me running is an option for me, but I do not plan to do this habitually to avoid becoming dependent on caffeine. I would consider the beetroot trial to be the only failure. While I did improve by 6 seconds, this is small compared to the 41 second average improvement in the original study. I found that I am disgusted by beets, which is a very strong deterrent from consuming beets again before running. For me, the benefit of the small improvement in running from consuming beets beforehand is not worth the difficulty of preparing them and the unpleasant taste, so I will not be using beetroot in the future to improve my running performance.

After two weeks of sprint interval training, my 3 km time improved by 38 seconds, which amounts to a 3.7% improvement in running performance. While I was not able to achieve the 5.7% improvement from the original study, I still believe that the improvement I saw from SIT is worthwhile. I did enjoy SIT, and this satisfaction with the training is a strong motivator towards continuing this type of training. I will continue to complete SIT training once a week when I am training for a race. After the Pilates trial, I saw a 47 second improvement in my 5 km time as compared to a 1 minute 22 second improvement found in the original study. It must be noted, however, that I completed 10

Pilates training sessions, as compared to the 24 sessions in the original study, so a much lower level of performance enhancement is to be expected. Additionally, before this trial I had already improved from a time of 33:30 to 32:50 during the previous four weeks. It is possible that I had come to the point of diminishing returns before the Pilates trial due to the progress I had made in the 3 studies previously completed. I found Pilates training to be somewhat restful in that it was not as intense a workout as running. This type of training is quite a departure from how I usually workout, which is one stimulus toward my desire to continue Pilates training. Due to the improvement in my 5 km running time and the fact that I found Pilates training therapeutic and enjoyable, I will be completing Pilates training once a week in the future.

While the aim of this project was fundamentally to replicate these studies in order to improve my running performance, this has also been a time of great personal growth and transformation. Before embarking on this project, I would run 3 or 4 times per week, and now I am running 5 or 6 times a week. With this increased frequency of running, I found that I also lost about 10 pounds over the course of this trial, without trying to do so. Before this trial, my 5km time was 33 minutes and 30 seconds, and at the end of this 6-week trial, I finished the same distance in 32 minutes and 3 seconds, an improvement of 1 minute and 27 seconds.

Though this is difficult to quantify, I feel that running has become easier and less of a chore for me. I think this may be due to both my legs becoming stronger, which would make the physical act of running easier, and my cardiovascular system becoming stronger, which would increase the ease with which I breathe while running, allowing more air into my lungs.

Writing about my experiences each day has prompted me to consider daily journaling as well. I have never been one to keep a journal, but I enjoyed consistently putting my thoughts down on paper. I found it somewhat cathartic having an outlet even just for reflecting on my running experiences. I imagine it would be even more freeing to have a place for my emotions and frustrations to flow out in a positive way.

I found it interesting that the relatively quicker “fixes,” such as caffeine and beetroot seemed to bring about less significant gains than the longer-term training, such as SIT and Pilates training. It is often suggested that “quick fixes” are not the answer to life’s problems and that working hard at a solution over a long period of time will be more effective in the long run. I think that this thesis has proved that this does hold true for running, and this observation serves to solidify my belief that nothing worth having comes easily in life. Advances, whether in fitness or life, are best sought after through long-term hard work. This is a lesson that I will take with me as I make my way in the world post-college.

This thesis was written during a time of transition and uncertainty, both in my life and in the world at large. Throughout the writing of this thesis, I was close to graduating and considering what the rest of my life may hold, while outside the battle against COVID-19 continued to be fought. Writing this thesis helped to ground me in this time of turmoil; I had much to accomplish and did not have time for worrying about what comes next for me. I focused on completing this project and not on the insecurity of my future. Now that I have finished, I have had time to consider my options and am considerably less anxious about the prospects, but without the solace that writing this thesis provided, I

would have struggled much more with the question of what my future holds during these last few months.

I learned something about myself and my running in every study I attempted, and it was very enlightening to learn that the results of most of the scientific studies hold true even outside of a laboratory setting. Before I began this project, I worried that these results would not hold true for a recreational runner such as myself, that the changes I made to the protocol would affect the results, and that these studies would only yield results in a controlled setting. None of these fears were realized. The project was a resounding success for me, and I am grateful for the opportunity to undertake a project such as this and for the resulting improvement in my running performance as well as personal growth.

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