GENDER & STRESS

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Gender & Stress

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Executive Summary

The existence of stress has been acknowledged in Ancient Greece. However, it was first systematically explored in the 19^{th} century and officially discovered in 1936 by Hans Selye. Since then, stress has been researched in almost every field of psychology and in all parts of life. Stress has even been found to be behind an overwhelming majority of doctor visits.

Stress is often viewed as an enemy, something that needs to be under control and manageable. However, the Stress Mindset Theory claims that if individuals have a positive attitude towards stress and view it as their *friend*, their reaction to stress will also be positive. The mindset of individuals affects the cognitive appraisal of stress which, in return, affects the coping methods.

Gender plays a role in the causes of stress, in the reaction to stress, and in the coping mechanism used. However, solutions to stress are not disaggregated based on gender, creating a gender data gap.

Many mHealth apps have been developed to help individuals with their stress. Literature about mHealth apps with data analysis being disaggregated based on gender does not exist, causing a gender data gap. Jamzone developed a mHealth app Brainjam that helps users understand their stress and use it as an asset. In order to amend the existing gender data gap in mHealth apps related to stress, an experiment was created where the perceived stress of participants was measured in the pre-test, followed by a manipulation video that presented stress as debilitating or enhancing in nature. A post-test measured the perceived stress again, collected demographics as well as life satisfaction, self-control, and grit. Participants of this experiment joined via Brainjam, survey sharing platforms, and via personal distribution. Participants that joined via Brainjam had their HRV measured, making it possible for their stress levels to be characterised via HRV.

In total 457 participants completed the experiment, titled *Gender & Stress*, of which 261 were women, 193 men, and 2 identified as non-binary/third gender. 232 respondents participated in the debilitating version and 217 in the enhancing version of the experiment. Majority of the respondents resided in the Netherlands (N=226) at the time of the experiment, 40 in the United Kingdom, 28 in the United States, 27 in Germany, 19 in the Czech Republic, and 117 in the rest of the world (e.g. Kenya, Australia, India, Antigua and Barbuda). Majority of the respondents were between the ages of 18-34 and were childless. Eight participants were removed from the final data analysis due to their inadequate English level and their nature as outliers, resulting in the final number of 449, of which 259 were women and 190 were men.

The manipulation videos have been found to be ineffective and were removed from the data analysis. Ten HRV data sets could have been analysed. However, the timestamps from Brainjam and the experiment did not match and, therefore, could not be analysed. Two dependent variables were used in linear regression: life satisfaction and the difference between pre- and post-test self-reported stress. Perceived stress has been found to be a good predictor of life satisfaction.

Self-reported stress has been found to have two significant results. The main result is duration, the longer the participants took to finish the experiment, the higher was their self-reported stress difference. One two-way linear result was found to be statistically significant. Men took longer to complete the experiment if their stress difference was higher, whereas women were more consistent in the time they took to complete the experiment, irrelevant of their self-reported stress.

Life satisfaction had more significant results. First, grittier participants reported higher life satisfaction. Second, two two-way interactions were found. High self-control had a significant impact on life satisfaction if one was a student or not. Low self-control had a lower impact on life satisfaction of (non-)students. As already mentioned, grit has been found to be important in the life satisfaction of an individual and its importance was even more prominent when paired with parenthood. Participants with children were reportedly more satisfied with their life. Finally, one three-way interaction has been found to be significant. Grit, parenthood, and age were found to have an effect on life-satisfaction. The

older the participants the more satisfied they were with their life when the aforementioned variables were added.

The performed research has its limitations. The manipulation videos were not effective, which could be due to the fact that the experiment was not performed in a controlled environment. Moreover, the results were not differentiated based on the country of residence, which certainly would have an effect on the perceived stress. Some respondents lived in pandemic-free countries (e.g. New Zealand), whereas others lived in countries that were heavily impacted (e.g. Italy).

In conclusion, one significant result has been found from the perspective of gender. Stress played a significant role in the duration of the experiment for men. Women's duration was not affected by the self-reported stress level.

Preface

Due to the pandemic, my whole thesis process has been shifted and my topic changed considerably. In the spring of 2020, my exams were cancelled and so I could not start my thesis. My first supervisor, Dr. Laurens Rook told me to take my time and do some research at a relaxed pace to figure out what I want to do. Not something one wants to hear, but luckily I listened. Amazon kept promoting to me a book called *Invisible Women: Data Bias in a World Designed for Men*. The only books I read are fantasy/sci-fi, so I really was not interested. However, every time I opened Amazon, which was a lot during Corona, the book was there. Eventually I clicked on the suggestion, in an attempt to get rid of it, and I was intrigued! The entire book is written based on statistical data and science. I bought the book and my mind was blown.

Caroline Criado Perez wrote the book that inspired me to do research that disaggregates data based on gender. When pitching the idea of the thesis to my first supervisor I was still hesitant to make my entire MSc. thesis about gender difference. However, Laurens encouraged me to take it all the way and focus on the differences. He was very supportive throughout the whole process, as was my original company supervisor MSc. Carien Kleibeuker.

Throughout my TU Delft journey I have never met students or academic staff who appreciated my short, to the point style of writing. I am thankful I have found a committee full of them. I would like to express my gratitude to Prof. Dr. Frances M. Brazier for pointing me in the right directions, and making my thesis better. Furthermore, I would like to thank Dr. Iulia Lefter for asking the hard questions, and making sure I explain everything properly. I am also very thankful to my company supervisor MSc. Iris Rosier for answering all my questions about Brainjam. Last but not least, I am very thankful to Dr. Laurens Rook who guided me through this process and for all the fun talks we had.

My thanks also goes to Dr. Alia Crum for allowing me to use her videos in my experiment, and Jesse Barrera for sending me the videos. Thanks also goes to Caroline C. Perez who inspired me to do this research.

My thanks also go to my family for all the support and patience. Especially I would like to mention my sister for sharing my experiment with a group of participants (35+ and parents) that I was having a hard time finding! Huge thanks goes to Radu for fixing my grammar, feeding me, keeping our home in order, and, together with Misty, giving me the lovin' I needed. Cornelia and Florin for being so supportive and encouraging.

I would like to thank all the friends and LinkedIn network for sharing and participating in my experiment! I cannot name all of you, but you are the reason I gathered so much data. Thanks also goes to Tugba for being there for me, and creating the most beautiful cover page for me; Wissi for checking up on me; Juan for all the jokes and showing me how not to plan my thesis; the ladies Lenka, Misa and Isabelle for showing me how a thesis can be done; Eli for lending me crutches and a sympathetic ear during recovery; Lana and Tina for all the long distance encouragements; my DARE, IP and JvB *families* for being who they are; Marina, Mirthe and Tom for the MoT thesis process support group; my PhD heroes Siddartha, Udai, Mannat and Marco for being so nice and encouraging; and to my oldest friend in Delft, Wo, for all the coffee breaks, dinners and weird talks.

I also would like to thank all the doctors and various medical staff who attended to my health during all the different trips to the hospital. Finally, I would like to thank Lia, without her I would not make it through TU Delft.

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Abbreviations

BSCS	Brief Self-Control Scale
GAS	General Adaptation Syndrome
HR	Heart Rate
HRV	Heart Rate Variability
PSS	Perceived Stress Scale
SMM	Stress Mindset Measure
SWLS	Satisfaction With Life Scale

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1
Introduction

Stress is part of life. However, by understanding it better, the day to day lives of humans on this planet could improve. In this chapter, the background and the current status of stress research can be found in Section 1.1. This is followed by Section 1.2, where the relevance of the research performed in this thesis is argued. The main research question and sub-questions of the thesis are presented in Section 1.3. Finally, the conclusion of the chapter and the outline of this document can be found in Section 1.4.

1.1. Background & Status Quo

Stress is one of the common denominators of all human beings. Everyone has experienced it in their life, ever since they were an infant, and then later on in school, work, personal life, and the list could go on. Stress is the body's standard response to changes (Cleveland Clinic, 2020). The response can be physical, mental, and emotional (Cleveland Clinic, 2020). Stress can be viewed positively, keeping humans alert to danger, but it can also be negative when a person is stressed for a prolonged time without any relief (chronic stress). However, the study performed by Crum et al. (2013) suggests that stress mindset is an important variable when determining individuals' reaction to stress.

According to Michael (2019), up to 90% of doctor's visits can be stress related. The American Psychological Association identified a direct connection between chronic stress and six leading causes of death (accidents, heart disease, lung ailments, cirrhosis of the liver, suicide, and cancer; Hartz-Seeley, 2014; Michael, 2019).

Another problem stress is linked to is absenteeism and lower productivity at work, a fact that company executives have admitted over 15 years ago (Atkinson, 2004). For instance, stress affects the speed of task completion (Hockey, 2013). Gender has been found to affect the reaction to stress (APA, 2012; Echouffo-Tcheugui et al., 2018; Handa & Chung, 2019). For example, when under stress, men complete tasks faster, when promised a reward, as compared to women (Lighthall et al., 2012).

Despite the obvious physiological differences between the male and female body, the male body has been "the primary object of [medical] research" (Schiebinger, 1999, p. 113) for almost as long as medicinal research exists. In the 1980's, mainstream medicine took notice that most studies and drug trials omit women from their research completely (Schiebinger, 1999). 20 years later, the medical community figured out that *women are not small men*, and the first centres for gender medicine were opened in the United States (2001), Sweden (2002), and Germany (2003) (Oertelt-Prigione & Regitz-Zagrosek, 2011). Despite this, however, the gender data gap had already been created.

The European Union requires that when a large grant is awarded, the grantees need to ensure a *gender dimension* in their research (Oertelt-Prigione & Regitz-Zagrosek, 2011). However, in the past two decades, scientists and researchers have not eliminated the gender bias. The size of a smartphone is designed to fit comfortably into an average male-sized hand (Perez, 2019). However, women have smaller hands. In her book, Perez discussed that large smartphones have a negative impact on women's health. Furthermore, the research conducted on the health effects large smartphones have on hands and arms does not address women and men equally (Abdelhameed & Abdel-aziem, 2016; Perez, 2019).

Mobile health (mHealth) apps are a widely used tool to help manage stress, diabetes, cancer recovery, weight loss, and many more aspects of our lives. A study by Apolinário-Hagen et al. (2019) found that participants in the study preferred to manage their stress using a mHealth app over online counselling, face-to-face group courses, medication, psychiatrist, and online self-help training. Considering many

aspect of today's *Western* life can be digital, such as shopping (groceries, clothes, medication) and education, it should not come as a surprise that many people prefer to manage their stress using mHealth apps.

Jamzone™ created a mHealth app, Brainjam, that allows users to monitor their stress (Jamzone™, 2021). Users receive a sensor that they connect through Bluetooth to their phone, where the data is processed, and they receive real-time stress feedback. Users then use Brainjam to train and better understand their stress.

1.2. Relevance

Caucasian, 25 to 30 years old and male. This is the *standard* human represented in research (Perez, 2019). It might sound implausible to many in today's world, but it is the sad truth. Even a cutting edge technology like artificial intelligence is biased (Smith & Rustagi, 2021). Why? The data inputted in the artificial intelligence algorithms is often not disaggregated based on gender (Perez, 2019; Smith & Rustagi, 2021). Some data is divided based on gender, however, that does not mean it is not biased. For example, a couple (male and female) that has applied for the same credit card was given different card limits, despite the fact that they had the same debt, income, and expenses (Smith & Rustagi, 2021). The only difference was that the female had a better credit score, yet her husbands' credit limit was almost double the amount compared to hers. Unfair? The only way to avoid such problems is to create unbiased data, and to disaggregate future data based on gender, or the problem will only exacerbate.

The gender data gap is a problem of the past, present and the future. Many health issues are considered to be gender neutral, yet it is not the case. *Gender neutral* designs could have caused some of the health issues. For example, car crash dummies are designed as 1.77 meters tall, with 76 kilograms and with a male spinal column (Perez, 2019). Women have lower bone density and are, on average, smaller and lighter. In a car crash, women are 71% more likely to be moderately injured, and 47% more likely to have a serious injury compared to men (Shaver, 2012). This is due to the fact that dummies used in crash tests are more robust than the average woman, which results in cars appearing to be safer than they are (Shaver, 2012). Furthermore, seat belts are designed for the male body, without taking into account the female anatomical differences (Perez, 2019).

Wang et al. (2020) analysed 62 studies of mHealth randomised controlled trial apps which they claim is the "first overview of the consideration of sex and gender as a primary variable in [randomised controlled trials] investigating mHealth for chronic medical conditions" (Wang et al., 2020, p. 3). What they found confirms the previous statements of this report about gender data gaps. Overall, female participation in the studies has been 46%, yet the concept of gender was analysed in exactly zero of the 62 analysed studies (Wang et al., 2020). Therefore, the gender data gap is present in mHealth apps as well.

1.3. Research Objective and Approach

Gender is underrepresented in studies. In today's western society, men and women are viewed equal in many aspects, such as access to education. However, when it comes to medical research, equality does more harm than good. Female and male bodies are fundamentally different, even on a cellular level (Perez, 2019). Therefore, not differentiating results based on gender creates results that do not tell the whole story. This in turn creates potential problems that scientists are becoming aware of only now. The objective of the proposed thesis is to help solve one of these problems, and help narrow down the gender data gap in stress research. The aim of this thesis is to better understand the role gender plays in stress, therefore, the following research question has been formulated.

What role does stress play in the well-being of an individual, and is it impacted by gender?

An experiment was created to help answer this research question. The experiment consists of four scales, general demographics questions, and manipulation videos. The manipulation videos are meant to have a debilitating or an enhancing effect on the participants. Stress is measured using a perceived stress scale. The scale should reflect the effect of the manipulation videos, as it is measured before and after the manipulation. In addition to the main research question, sub-questions (SQs) are formulated to aid in answering the main research question. The SQs can be found bellow.

1. In what way are grit and self-control connected with stress?
2. How do grit and self-control affect satisfaction with life?
3. How does having children affect perceived stress and life satisfaction?
4. How does age affect well-being?
5. Are stress and satisfaction with life affected by student status?

SQ 1 investigates the effects of self-control and grit on stress. Perceived stress has been found to be a good predictor of life satisfaction (Hamarat et al., 2001; Extremera et al., 2009; Lee et al., 2016). A scale measuring life satisfaction has been added to the experiment in order to observe if there are any differences compared to the perceived stress. This results in SQ 2, where grit and self-control are compared to satisfaction with life in order to see if they have the same or similar effect on life-satisfaction as the perceived stress has. Stress and life satisfaction (well-being) are compared to the other variables such as parenthood in SQ 3, age in SQ 4 and student status in SQ 5.

1.4. Summary

This chapter introduces the current state of stress research and the need to analyse collected data based on gender. The gender data gap is a real problem that is addressed in this thesis. The main objective of this thesis is to understand what role gender plays in stress.

The remaining document is structured in several chapters. First, a literature review is conducted in Chapter 2. This is followed by Chapter 3, where the methods used in this research are presented. The description of Brainjam can be found in the same chapter. The results of the created experiment are presented in Chapter 4. The results are then discussed in Chapter 5 as are the limitations of the experiment and future research. Finally, the conclusion of this thesis is presented in Chapter 6.

2
Literature Review

This chapter is divided into four sections. First, Section 2.1 describes stress from various angles and introduces the complexities of stress. Section 2.2 introduces the concept of heart rate variability and mHealth apps are discussed in Section 2.3. The research is then summarised in Section 2.4.

2.1. Stress

This section of the chapter familiarises the reader with the important aspects of stress. First, the history of stress is summarised in Section 2.1.1. Second, Section 2.1.2 introduces the coping methods for stress. Section 2.1.3 addresses variations in stress that are relevant to this thesis. The Grit Scale, Self-Control Scale, Perceived Stress Scale and Satisfaction With Life Scale are introduced in Section 2.1.4.

2.1.1. History

The history of stress dates back to Ancient Greece and perhaps even further. In Ancient Greek times, the word *stress* had not been invented, and so Plato and Aristotle described stress as *internal conflict among emotions and desires* in their work (Lazarus, 1999).

The first time stress was systematically explored was in the 19^{th} century by Claude Bernard (†1878), Sir William Osler (†1919) and William James (†1910) (Robinson, 2018). However, the biggest advances in technology and medicine were achieved during difficult times such as pandemics and wars. With the start of the First World War, research into stress had significantly increased even though it was not called stress yet. Soldiers experienced *shell shock*, coined by Myers in 1915, which was defined as "battle induced emotional breakdown" (Lazarus, 1999, p. 28). Walter Cannon (†1945) (Robinson, 2018) introduced the term *fight or flight* response (Cannon, 1915) also referred to as acute stress response (Fink, 2010).

In 1936, Hans Selye (†1982), a Hungarian-Canadian doctor, discovered stress in rats (Viner, 1999). During his life, Selye did not find a satisfactory definition for stress (AIS, 2020), but he settled on a generic definition: "stress is the non-specific response of the body to any demand" (Fink, 2010, p. 4). Selye developed the General Adaptation Syndrome (GAS) theory, also called Stress Syndrome, which has three stages (Selye, 1936). First, the *alarm reaction* occurs when the body first reacts to the stressor (source of stress) (Selye, 1950; Viner, 1999). This is followed by the *stage of resistance*, in which the alarm reactions have almost disappeared and the body is trying to adapt to this new standard (Selye, 1950; Viner, 1999). The *stage of exhaustion*, the third stage, is when the body exhausted all the energy in order to cope with this new standard (Selye, 1950; Viner, 1999). GAS theory has been since disproved (Fink, 2016).

After the end of the Second World War, it became clear stress was not solely the problem of soldiers. The stress industry grew fast in the 60s and 70s as it was discovered that stress is present even in our homes and schools. In the past, professionals and the general public used terms such as frustration, emotional distress, trauma, anxiety, and others to explain the difficulty to adapt to life. Stress is the common denominator uniting these terms (Lazarus, 1999).

Stressors can be divided into internal and external ones. Internal stressors, as the name suggests, come from within us. Pessimism, rigid thinking, and inability to adapt are all examples of internal stressors (Segal et al., 2020). External stressors come from our surroundings, for example, major life changes (e.g. death, divorce, war), work, children and family, to name a few (Segal et al., 2020).

Richard Lazarus (†2002) was among the first to dispute the GAS theory. Lazarus argued that individual responses to stress are unique (Robinson, 2018), and that an essential mediator of the GAS theory may be cognition (Lazarus, 1966). His *transactional theory of stress and coping* considers both internal and external stressors (Lazarus, 1966; Lazarus & Folkman, 1984). Unlike Hans Selye's earlier stress definition which only considers external stressors, Lazarus argues that the way people appraise a stressor affects their reaction. The same stressor can cause stress to some, while others might be unaffected.

Stress research is part of almost every field of psychology, and is linked to most mental health disorders (APA, 2013). Stress is known to affect physical health (Rahe et al., 1970). Stress has been studied in all parts of our life, ranging from workplace stress (Colligan & Higgins, 2006), academic stress and dating violence (Mason & Smithey, 2012), and post-traumatic stress disorder (Olff, 2017), to stress in health care workers during COVID-19 pandemic (Talaee et al., 2020).

Even in the present day and age, the American Institute of Stress claims it is impossible to define stress due to the fact that the same stressor does not cause stress to appear in all people (AIS, 2020). Up to a certain point, called *the hump*, stress can be positive and increases productivity (AIS, 2020). This *good* stress is also called eustress (Viner, 1999; Giannakakis et al., 2019; AIS, 2020). After the hump, stress becomes negative (distress) (Viner, 1999; Giannakakis et al., 2019) and decreases productivity (AIS, 2020). Depending on how we cope with stress and keep it under control, stressors can affect our psychological and physical health.

2.1.2. Coping Methods

Stress can have both debilitating and enhancing effects (Crum et al., 2013). In order to be able to deal with stress, each individual can evaluate if they are stressed (cognitive appraisal) and how they react to it (coping). Cognitive appraisal interprets and determines the reaction to a particular stressor (Lazarus & Folkman, 1984). *Coping* is defined as "constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus & Folkman, 1984, p. 141). Coping does not depend on its outcome, it is independent (Folkman, 1984). Stressful events can be appraised as threatening or challenging (Lazarus, 1966). Challenging events can enhance an individual's capacity to learn (Lazarus, 1966). On the other hand, threatening events can make individuals feel helpless (Lazarus, 1966). A coping process is what an individual does and thinks during a particular stressful event (Folkman & Lazarus, 1980).

Two main stress coping methods are problem focused coping, and emotion focused coping (Folkman & Lazarus, 1980). When individuals try to change the source of stress, they employ problem focused coping (Folkman & Lazarus, 1980). However, when they try to manage or reduce their emotional distress, they use the emotion focused coping method (Folkman & Lazarus, 1980).

According to Folkman et al., examples of problem focused coping are planful problem-solving and confrontative coping. Self-control, distancing, positive reappraisal, accepting responsibility (self-blame), and escape-avoidance are emotion focused coping methods (Folkman et al., 1986). Seeking social support represents both problem and emotion focused coping. People tend to use both coping mechanisms when dealing with stressors (Folkman & Lazarus, 1980). However, they are possibly not equally effective (Brannon et al., 2013).

The effects on health differ depending on the coping strategy and personal coping resources (optimism, social support, and personal control; Brannon et al., 2013). Seeking social support (problem-focused coping) contributes to good physical and mental health (Penley et al., 2002). However, emotion focused coping (e.g. wishful thinking) is connected with diminishing health (Penley et al., 2002).

Carver et al. (1989) developed a coping inventory to asses the coping mechanisms used by people to respond to stress. In addition to problem and emotion focused coping, Carver et al. added dysfunctional coping (e.g. denial, mental and behavioural disengagement, alcohol-drug use). Their definition of problem focused coping included mechanisms such as planning, restraint coping, and seeking social support for instrumental reasons. Humour, turning to religion, and acceptance are examples of Carver et al.'s (1989) emotion focused coping.

Some researchers have observed links between personality and coping (Nes & Segerstrom, 2006; Connor-Smith & Flachsbart, 2007). Numerous relationships were found between personality and cop-

ing in younger individuals (Carver & Connor-Smith, 2010). As individuals got older their personality had a lower effect on how they cope with stressors (Carver & Connor-Smith, 2010). Low-intensity stressors revealed poor relationship between personality and coping, whereas stressors with high-intensity had a more defined personality-coping relationship (Carver & Connor-Smith, 2010).

Over the years, research progressed, and additional stress coping methods were developed (Folkman & Moskowitz, 2004). Some of these methods are: future-oriented proactive coping (Aspinwall, 2005), social aspects of coping (Lyons et al., 1998), emotion-regulation (Gross, 1998; Wang & Saudino, 2011), and positive emotion and coping (Bonanno & Keltner, 1997; Carver & Scheier, 1994).

In recent years, a new view on stress has been proposed by Crum et al. (2013), under the name of Stress Mindset Theory. Most people view stress negatively. However, if the attitude towards stress changes (appraisal), the reaction changes too. Crum et al. argue that, if one adopts a *stress is enhancing* mindset, it can positively influence performance and health. On the other hand, a *stress is debilitating* mindset is more likely to have a negative impact on performance and health. An individual's mindset affects cognitive appraisal which, in turn, affects coping methods. The stress mindset theory is explored in this thesis.

It is important to note that stress and coping is a dynamic process (Folkman & Lazarus, 1980; Folkman et al., 1986). What works for some may not work for others. People respond differently to the same stressors and same coping mechanisms. Some of these differences can be due to culture, country of origin, or age.

2.1.3. Variations in Stress & Coping

Humans are exposed to many stressors during their lives and react differently to them. The reason for variations in stress reaction and coping are many, and one of such differences is age. Older people have a harder time dealing with stressors (Ricciotti & Hur, 2018). Culture is another variable. For instance, when Brits experience decreased personal control, they get stressed considerably more than the Japanese (O'Connor & Shimizu, 2002). To remain within the scope of the thesis, this section focuses on gender differences.

Men and women have different causes of stress (Matud, 2004; Perez, 2019), react to stress differently (APA, 2012; Echouffo-Tcheugui et al., 2018; Handa & Chung, 2019), and cope with stress differently (Ptacek et al., 1994; Deater-Deckard & Scarr, 1996; Matud, 2004). Compared to men, women are more likely to care for elderly relatives, take children to school, do house work, as well as work (Perez, 2019). Moreover, women who experience a higher daily stress are more empathetic, since part of the stressors they report are due to "family and health-related events experienced by other people in their environment" (Matud, 2004, p. 1411). Matud (2004) reported that stressors in men were mainly connected to finance, work, and relationships. However, a different study (Gentry et al., 2007) found that finance causes almost the same amount of stress in men and women. The study does reach the same conclusion about women's stressors being connected to health of friends and family, and men's stressors connected to work (Gentry et al., 2007). High levels of the stress hormone, cortisol, have been linked to impaired memory (Echouffo-Tcheugui et al., 2018). Echouffo-Tcheugui et al. found that women (young to middle-aged) are affected more than men by higher serum cortisol (Echouffo-Tcheugui et al., 2018).

In her study, Matud (2004) found that women use avoidance coping and emotion focused coping when dealing with stress, while men preferred detachment and problem focused coping styles. However, Gentry et al. (2007) report that men are more likely to use avoidance coping styles whereas women rather use adaptive (problem-focused) coping strategies. Both studies are self-reported and participants' answers might be skewed by their willingness to report (Matud, 2004; Gentry et al., 2007). Furthermore, Matud's study was conducted in Spain whereas Gentry et al.'s study was conducted in the state of Hawaii. It is possible that cultural differences between these two geographical locations might cause some differences in the results. Moreover, the subjects of the studies were not exposed to the same stressors.

Adams et al. (2002) reports that when men and women experience the same stressor their coping mechanisms are the same. However, when in a relationship where both partners are stressed, women

provide higher-quality support than men as they are better at regulating their emotional stress compared to men (Bodenmann et al., 2015).

Stress impacts both mental and physical health. Studies concerning mental health do not represent gender equally (Damico, 2020), creating a gender data gap. The same is true for physical health (Harnois & Bastos, 2018; Perez, 2019). Many studies do include women, however, they do not stratify the data accordingly (TED, 2014).

In 2010 Oertelt-Prigione et al. stated that medical research that accounts for gender differences is steadily increasing. A decade later however, Carcel et al. (2019) reports that, between the years of 2009-2019, the percentage of women in large scale controlled stroke trials remained practically constant, at 40%. The progress appears to have stalled at 40%, leaving a constant *gender data gap*.

2.1.4. Individual Differences

The following section discusses four Likert-type scales, namely: Grit, Brief Self-control, Perceived Stress, and Satisfaction With Life. Each scale has 5-13 questions, and is reported on a 5-point or 7-point (Satisfaction With Life) Likert scale. All the questions, from all four scales, can be found in Appendix B.

Grit

Grit is a non-cognitive skill that is a good predictor for perseverance (Duckworth et al., 2007), long-term goals that take a few years or even decades to achieve (Duckworth & Gross, 2014). Among others, grit has been used to estimate how many students are likely to drop out of the first semester, with results being more precise than any other predictors (e.g. self-control, IQ) (Duckworth et al., 2007). Lower grit is tied to the skipping behaviour in real-effort tasks (solving anagrams) (Gerhards & Gravert, 2015). Stress affects grit negatively (Meriac et al., 2015; Lee, 2017) and, in a work environment, grittier individuals appear to have different coping methods which allow them to deal with stress more effectively (Meriac et al., 2015). Grit is the same in men and women (Duckworth, 2021) and increases with age (Duckworth, 2016).

Self-Control

Self-control is the personal willpower that one exerts when delaying gratification for the sake of future goals. It is a skill that can already be observed in toddlers, and it improves with time and practice (Mischel, 2014). Furthermore, self-control ability in early age has a positive impact on an individual's long-term life (Tangney et al., 2004; Mischel, 2014). Self-control is a better predictor of academic performance than IQ (Duckworth & Seligman, 2005). In adolescence, self-control can be affected by stressful events (e.g. parents divorcing) (Duckworth et al., 2013).

It is a widely studied topic in social sciences (Duckworth, 2011). Individuals with higher self-control procrastinate less (Meier et al., 2018) and are better at mediating smartphone addiction due to stress (Cho et al., 2017). Self-control has an impact on overall life of a human in a very diverse way (e.g. better grades, good emotional lives) (Tangney et al., 2004).

Perceived Stress

Perceived Stress Scale (PSS) measures how stressful an individual's life is according to them (Cohen et al., 1983). It is not tied to a certain stressor, but rather to ongoing life circumstances (Cohen, 1988). For example, smartphone addiction has a negative effect on stress, but perceived stress has no effect on academic performance (Samaha & Hawi, 2016). On the other hand, Talib & Zia-ur Rehman (2012) found that stress has a negative effect on academic performance. The PSS is not affected by age or gender (Cohen et al., 1983).

Satisfaction With Life

Satisfaction With Life Scale (SWLS) is a cognitive measure of subjective well-being (Diener et al., 1985). The Grit scale and well being are connected. According to Duckworth (2016), emotionally healthy people are more gritty. When teachers were found to be satisfied with their lives, they performed better (Duckworth et al., 2009). Smartphone addiction has no effect on an individual's satisfaction with life (Samaha & Hawi, 2016). Self-control and grit are not the same, however. For example, if

people have high grit and/or self-control, they tend to have good emotional lives, and are satisfied with life (Wiese et al., 2018).

2.2. Heart Rate Variability

Stress level can be characterised by heart rate variability, HRV in short (Jobbágy et al., 2017). HRV is a measure between two R-waves, or RR for short, which is the interval between two consecutive heart beats (Camm et al., 1996). The lower the HRV, the faster the heart is beating and vice-versa.

The HRV of healthy people is affected by age and gender (Jensen-Urstad et al., 1997). The heart beats faster as people age, resulting in lower HRV (Jensen-Urstad et al., 1997). Women have been found to have lower HRV than men (Jensen-Urstad et al., 1997). However, when age was taken into account, the difference disappeared after the age of 50 (Umetani et al., 1998). The most prominent difference in HRV is under the age of 30, where all measures collected showed women to have lower HRV than men (Umetani et al., 1998). The difference is smaller between the ages of 30-50, but it is still present (Umetani et al., 1998).

2.3. mHealth Apps

Alhasani et al. (2020) reviewed 60 mHealth apps related to stress. The four most popular primary task support strategies are personalisation (53 apps), self-monitoring (39 apps), simulation (18 apps), and tailoring (14 apps) (Alhasani et al., 2020). However, despite the existence of over 318 distinct stress related apps on Google Play and Apple Store (Alhasani et al., 2020), once the app is downloaded, it is often underused (Vo et al., 2019). The biggest complaint users have is the lack of personalisation the reviewed mHealth apps provide (Vo et al., 2019). Moreover, privacy, security, cost, and validity of the provided information is often questioned (Vo et al., 2019).

A study by Ghavanini et al. analysed the effect of a mHealth app that tracks mood and helps with stress of married and single people. They found that the mHealth app works well on single people. However, the app was found to have no effect on the stress of married users as they did not use it as much (Ghavanini et al., 2018).

Unfortunately, Ghavanini et al. (2018) did not differentiate the results based on gender. As mentioned in Section 1.2, Wang et al. (2020) analysed 62 studies about mHealth apps and found that not one study disaggregates its results based on gender, creating a gender data gap.

2.4. Summary

This chapter discusses the historical development of stress research from the 19th century to the present day. Various coping methods and variations in stress coping based on gender are also discussed. The scales used in the experiment conducted for this thesis are listed, with all the questions of the experiment being presented in Appendix B. Furthermore, the differences of heart rate variability in gender and age were presented. Finally, mHealth apps and the non-existence of studies that dissagregate their data based on gender was presented.

3
Methods

The following chapter outlines the details of the experiment that has been conducted. First, Section 3.1 introduces the participants of the study, followed by the formal procedures in Section 3.2. The details of Brainjam are introduced in Section 3.3. This is followed by Section 3.4, where the covariance and dependent variables are introduced. The chapter's summary can be found in Section 3.5.

Ethics Approval

The Human Research and Ethics Committee of TU Delft has officially approved this experiment on 15^{th} March 2021.

3.1. Participants

The total initial sample consisted of 457 participants, of which 193 were men, 261 were women and 3 were non-binary/third gender. A detailed overview of the sample description can be found in Table 3.1. Data was collected via Jamzone, two survey sharing platforms (Survey Circle and Survey Swap), and via personal distribution (e.g. LinkedIn, student and parents Facebook groups, Reddit, Slack, etc.). The top five countries in which majority of the respondents reside in can be found in Table 3.1, and a complete list can be found in Section C.2.

Table 3.1: Sample Descriptions.

Sample Descriptions	Summary	N (Total = 457)
Data	Jamzone	25
	Survey Circle	19
	Survey Swap	130
	Personal Distribution	283
Gender	Female	261
	Male	193
	Non-Binary/Third Gender	3
Age	Under 18	7
	18 - 24	150
	25 - 34	210
	35 - 44	51
	45 - 54	24
	55 - 64	9
	65 - 74	5
	75 - 84	1
Country of Residence	Netherlands	226
	United Kingdom	40
	United States of America	28
	Germany	27
	Czech Republic	19

Table 3.1: Sample Descriptions.

Sample Descriptions	Summary	N (Total = 457)
	Other	117
English	Sufficient	452
	Not sufficient	5
Reliability	BSCS	0.85
	Grit	0.77
	SWLS	0.87
	Pre-Test PSS	0.80
	Post-Test PSS	0.90

Some participants had to be removed from the sample due to a number of reasons. First, the last question of the experiments asked if the participants' English was adequate, five participants reported their English was not. In order to not get skewed results, some outliers were removed. Only one participant reported their age to be between 75-84, and, therefore, the participant was removed. After the above mentioned filters, only two participants that reported their gender to be non-binary remained. Due to the large sample of traditional binary genders, the non-binary participants were removed too. This resulted in $N = 449$ (190 men, 259 women), which is the number of participants used henceforth.

3.2. Procedure

Brainjam users were sent a newsletter by Jamzone™, a screenshot of which can be found in Appendix A. The Brainjam participants had access into the Brainjam tab, custom made for this experiment (presented in Figure 3.5-3.7), for three weeks. Reminders were sent each week. The newsletter referred users to a link in Qualtrics, where they were given instructions on how to proceed. They completed these tasks in the following order:

<1 min ↓ Start HRV[1] measurement in Brainjam
2 min ↓ Pre-Test in Qualtrics
≈3 min ↓ Manipulation Videos in Qualtrics
10 minutes ↓ Post-Test in Qualtrics
<1 min ↓ End HRV measurement in Brainjam

The pre-test and post-test questions are presented in Appendix B. The used manipulation videos can be accessed using the following link (Crum et al., 2017b).

Other participants were subjected to the same set of tasks. The only difference is that their HRV data was not recorded during the experiment.

At the end of the test, participants were thanked for their participation and debriefed. Participants were informed that the stress videos are an experiment and their feelings will fade away in a few minutes.

3.3. Materials & Equipment

The equipment used during the experiment is described in Section 3.3.1. The mHealth app used in the experiment is described in Section 3.3.2. Section 3.3.3 introduces the videos used in the manipulation part of the experiment.

3.3.1. Heart Rate Belt

Suunto Smart Sensor is used by Jamzone™ to record the users heart rate (Suunto, 2021). The heart rate belt is worn around the chest, directly on skin and not over clothes throughout the experiment.

[1] Heart Rate Variability.

3.3.2. Brainjam

Jamzone™ developed the Brainjam mHealth app to help people understand their stress. The innovations company argues that, if stress is viewed as a *helper* rather than a negative, our life could improve and that the attitude one has towards stress affects one's relationship with it. When stress is viewed as a negative, it will have a negative effect on our health (both mental and physical; Crum et al., 2013). However, if stress is viewed as an asset to finish tasks quicker and better, our well-being does not suffer (Jamzone™, 2021).

In order for Brainjam to be operational, users are required to wear a smart heart rate belt (described in Section 3.3.1) and have their Bluetooth and location on. The belt connects via Bluetooth with Brainjam and records the heart rate of the wearer. The mHealth app then converts these measurements into live heart rate variability (HRV) data. In order to determine the individual's base HRV level, the app requires an initial calibration to the user's stress level.

Calibration Stage

Brainjam users are required to provide their date of birth and an email before they are able to start the app calibration and then use it. Calibration of the app consists of answering questions that measure their stress mindset, followed by a simple breathing exercise. The Stress Mindset Measure (SMM) has been developed by Crum et al. (2013) and consists of eight questions. Since the entire mHealth app is in Dutch, the questions are also given in Dutch.

Once the app is calibrated, the HUB opens (Figure 3.1). The HUB is the main page of Brainjam and is used to access other parts of the mHealth app. The personal tab, *JijNu*, has three sections and records live stress levels (see Figure 3.2) as well as HRV and heart rate (see Figure 3.3). The first section has a live stress meter, where orange represents a high stress level and blue shows a low stress level. Under the stress meter, six "boxes" are placed to provide additional information to the user, where HR refers to heart rate, which is followed by current HRV and stress level. The stress level indicates how easy it is to move from focus (orange) to relaxation (blue). The remaining boxes focus on HRV: lowest HRV, average HRV, and highest HRV, respectively. The third section of the personal tab, presented in Figure 3.3, records and displays live heart rate (HR) and HRV data.

Brainjam is partially calibrated every time the mHealth app is opened. The users no longer need to answer SMM questions, but the app records the HR of the participants for one minute. Based on this short calibration, the Brainjam algorithm calculates the HRV and estimates if the user is relaxed or stressed. The stress level is displayed on the stress meter, of which the orange and blue sections are not equal. Multiple users can use the Brainjam app since the app is calibrated for 60 seconds each time it is opened.

Training Stage

From the HUB, users can access the Exercise section (Oefeningen). This section focuses on training. The training has two main themes. The first theme of the training tab focuses on calmness and relaxation, Figure 3.4. Users can train in three different boxes: calmness through breathing, calmness through attention, and how do you relax. Relaxation is different for every person. However, is our relaxation relaxing? One can use the *how do you relax* section of the tab to find out. Users record themselves and observe their stress levels through the live stress meter and try to keep the arrow in the blue region.

The second theme helps users with Focus and Stress (Figure 3.5). Brainjam users can choose from three boxes, namely: focus by muscle tone, focus by concentration, and how to focus. For example, the *focus through concentration* shows a live stress meter. The user then focuses on a small piece of a room and can observe if their stress level is in the orange section or blue.

Figure 3.1: Main Page of Brainjam, Know your Superpowers.

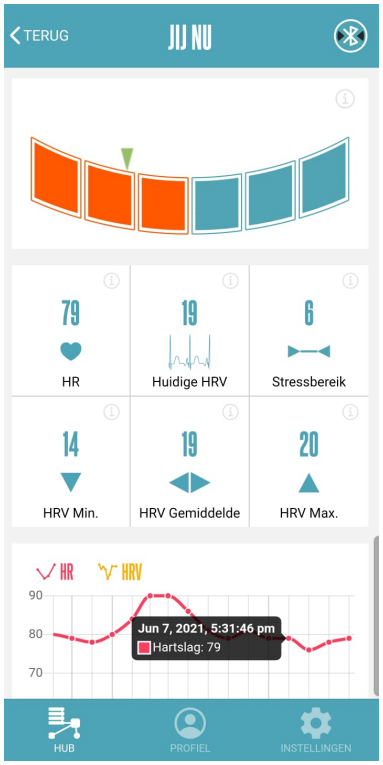

Figure 3.2: Live Feedback.

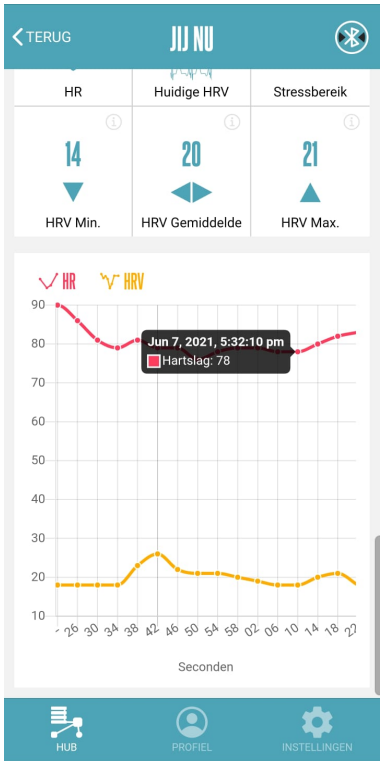

Figure 3.3: Live HRV and HR Graph.

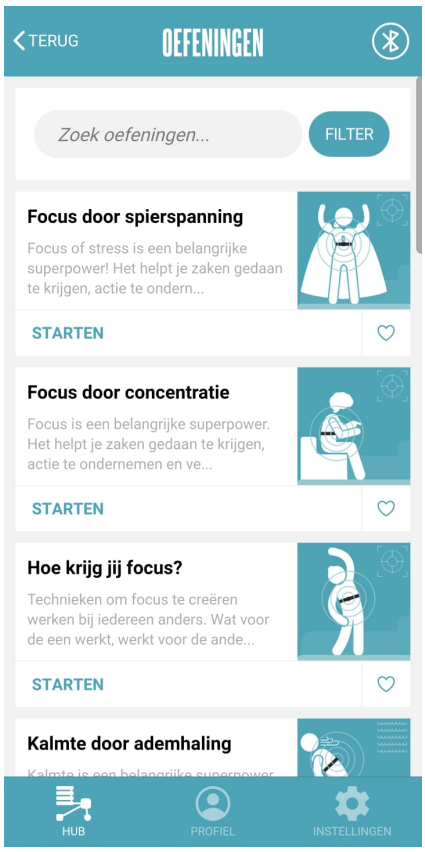

Figure 3.4: Training Tab, Focus Section.

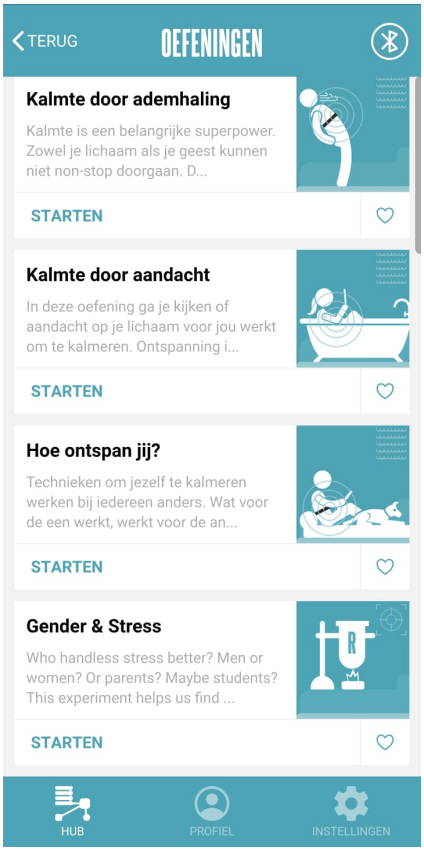

Figure 3.5: Training Tab, Calm Section and Experiment Exercise.

The last box in the training section, as shown in Figure 3.5, shows the experiment created for this thesis, *Gender & Stress*. Figure 3.6 shows the introductory text accompanying the exercise. Figure 3.7 then provides instructions on how to begin the experiment. The users are required to start the recording themselves. A maximum time limit of 30 minutes is established as to not record HR and HRV data longer than necessary in case the participants forgot to stop the recording.

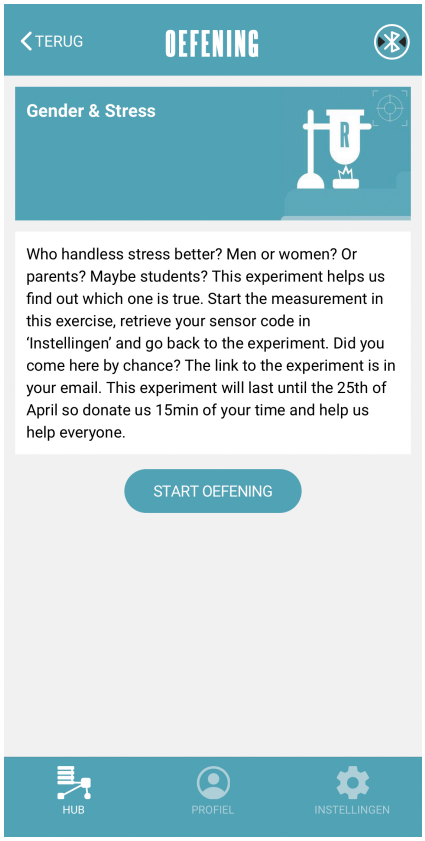

Figure 3.6: Exercise Introduction.

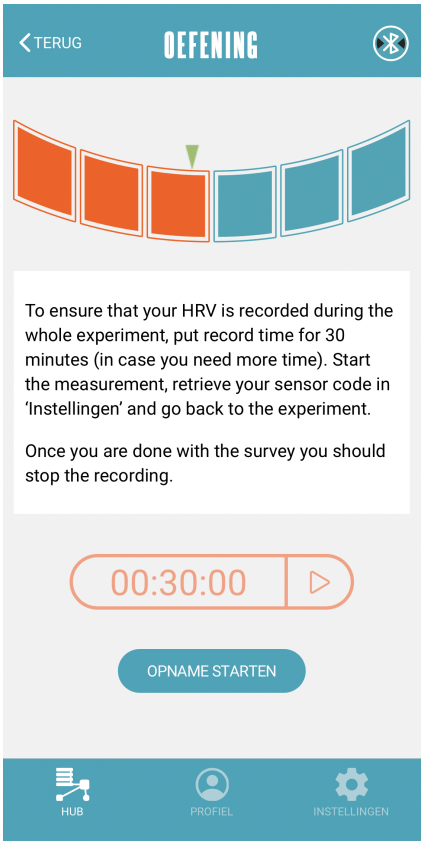

Figure 3.7: Start Page of Exercise.

As it can be observed in Figure 3.1, Brainjam has more to offer than the aforementioned exercises. For example, a digital coach provides users with tips and tricks on how to understand their stress. The digital coach and other aspects of Brainjam are out of the scope of this thesis and are not discussed further.

3.3.3. Manipulation

Jamzone™ follows the theories developed by Crum et al. (2013), which state that stress can be our friend. The stress of the participants has been experimentally manipulated using two videos from the Stanford Mind & Body Lab. They have been developed by Crum et al. (2017a) to determine if individuals' mindset towards stress can be changed.

The stress is *enhancing* video is 3 minutes and 16 seconds long and its screenshot can be found in Figure 3.8. The video presents factual information about stress and how it improves our performance such as that of surgeons and fighter pilots, who give their best performance when under great stress. It claims that "the most influential leaders make their greatest decisions in the greatest crisis" (Crum et al., 2017b).

On the other hand, the debilitating cognitive performance video (2 minutes 58 seconds long) claims the opposite. The video draws parallels between bad decision-making and high-stress situations. The

main message of the video is that stress is bad and one should learn to manage it and ideally avoid it, as can be seen in Figure 3.9.

Both videos have been embedded in the Qualtrics Questionnaire. The first video is meant to trigger better performance under stress, whereas the second video is meant to worsen performance under stress.

Figure 3.8: Video Enhancing Cognitive Performance (Crum et al., 2017b).

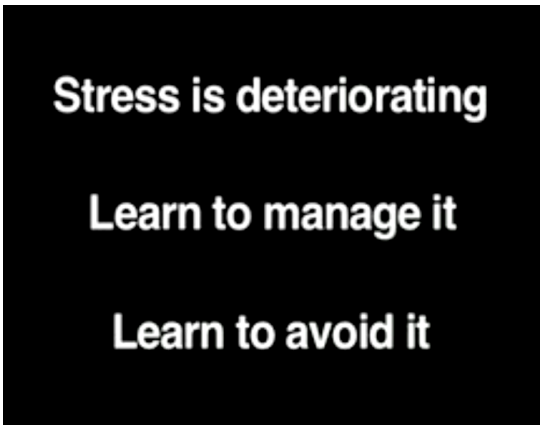

Figure 3.9: Video Debilitating Cognitive Performance (Crum et al., 2017b).

Half the population received the debilitating version of the experiment, while the other half received the enhancing version, dividing them into two subgroups. The subgroups had a close gender representation. 98 and 95 men participated in the debilitating and enhancing version, respectively. 137 women completed the debilitating experiment and 124 the enhancing experiment. Participants that reported their gender to be non-binary/third gender completed the debilitating experiment twice and the enhancing version once.

3.4. Measures

The following section introduces the measures obtained during the experiment.

Heart Rate Variability

Heart rate variability is used by the Brainjam app to identify the stress level of an individual. The higher the HRV, the less stressed an individual is and vice versa.

Perceived Stress

The Perceived Stress Scale (PSS) measures how much a situation in a person's life can be stressful (Cohen et al., 1983). All questions and further explanation of PSS can be found in Appendix B and Section 2.1.4, respectively. The scale originally consisted of 14 questions (PSS14) (Cohen, 1988). Further research into the scale found that PSS10 (10 question scale) has better internal validity (α = 0.78), and the same correlation as PSS14 (Cohen, 1988). In (Nielsen & Dammeyer, 2019) it is suggested that PSS10 should be only used for statistical analysis and group comparison, and not large studies. PSS10 is part of both the pre- and the post-test. Both pre- and post-test have a good internal reliability with Cronbach's α coefficient of 0.80 and 0.90, respectively.

Grit

The Grit Scale helps predict Brainjam users' perseverance. Grit and passion play a more important role in achieving long-term goals when faced with obstacles. Grit also increases as we age, therefore, it is expected that older participants have higher grit (Duckworth, 2016). The 8-question scale (Grit-S) has an internal reliability (Cronbach's α) ranging between 0.73 - 0.87 (Duckworth & Quinn, 2009). The internal reliability of Grit in this experiment is α = 0.77 (Cronbach).

Self-Control

Self-control is a good indicator of the ability to achieve short-term goals (avoiding temptation). Users with higher self-control are expected to have 'optimal emotional lives' (Tangney et al., 2004). Self-reported self-control (voluntary regulations of behaviour) can be collected using Brief Self-Control Scale (BSCS). Tangney et al. found BSCS Cronbarch's α to be 0.83 and 0.85. The reported Cronbach's α = 0.85. The scale is a good way to investigate correlations between self-control and achievement-related outcome variables (Lindner et al., 2015). Duckworth & Seligman (2005) used BSCS in her research about self-discipline, IQ, and good grades. This was before Duckworth developed her Grit Scale.

Psychophysiological Analysis

The experiment outcome measures are to identify if Brainjam works differently for women and men. This was done by measuring the HRV of each Brainjam participant during the experiment. Additionally, the change in HRV indicates if subjects were stressed (or not) and to what level.

Dependent Variables

Satisfaction With Life Scale (SWLS) is a short scale used to measure the participants' well-being. SWLS's Cronbach's Alpha is 0.82-0.87 (Diener et al., 1985), and is valid for all ages (Pavot et al., 1991). Furthermore, no significant gender differences have been observed (Pavot et al., 1991). Reported Cronbach's α coefficient has been found to be 0.87.

The participants of the experiment self asses themselves by filling in the PSS. A difference between the pre- and post-PSS results should be observed based on which manipulation video participants were assigned. The difference between the tests is a dependent variable.

Demographics

As the experiment is performed (also) on non-English native speakers, a question regarding their ability to follow the experiment was present as the last question in the post-test. Depending on their indication, participants with an insufficient English language understanding were excluded from the experiment. The country of residence, age group as well as gender data is also collected. Additionally, the number of children a participants has and their student status is also collected.

3.5. Summary

In this chapter, the steps the Brainjam users and the general population took when performing the experiment of this research have been discussed. Brainjam is described as well as the visuals of the experiment in the mHealth app. The manipulation videos and their effects on respondents are presented. The measures that are obtained during the experiment as well as how they are collected can also be found in this chapter.

4

Results

This chapter describes the findings of the experiment. First, the manipulation check of the experiment is discussed in Section 4.1. This is followed by sample characteristics in Section 4.2. Section 4.3 presents the HRV data collected through Brainjam and the comparison between perceived stress and life satisfaction in Section 4.4. Significant findings are reported in Section 4.5 and Section 4.6. The chapter's summary can be found in Section 4.7.

4.1. Manipulation Check

In order to be certain that participants of the experiment followed the instructions, a manipulation check is included in the post-test. The results of the manipulation check indicate if (and how well) participants paid attention, or if they even watched the manipulation videos. The test consists of two questions. The first manipulation check question is '*What was the name of the video you watched?*', where participants had to choose one of two possible answer, namely *A) Stress is enhancing* or *B) Stress is deteriorating*. The second question, '*The video showed me that I should:*', also had two possible answers, *A) Utilise my stress* or *B) Learn to manage my stress*. The answers to the questions differ based on the video they watched.

417 participants out of the 449 participants had both manipulation questions correct. 25 participants had one of the questions correct and seven had both questions wrong. Six out of the total of seven participants who had both manipulation questions wrong participated in the debilitating experiment and of 25 participants with one wrong question answer 17 participated in the debilitating experiment.

Table 4.1 shows the frequency distribution of manipulation and its effect. It can be observed that the debilitating video was effective in 38.24% of women and 30.21% of men. The enhancing manipulation was effective in 59.35% of women and 44.68% of men. Overall, the debilitating manipulation and enhancing manipulation worked on 34.91% and 53.00% of the population, respectively.

Table 4.1: Contingency Table.

		Gender		
Manipulation Worked	Manipulation Type	Men	Women	Total
No	Debilitating	67	84	151
	Enhancing	52	50	102
	Total	118	134	252
Yes	Debilitating	29	52	81
	Enhancing	42	73	115
	Total	71	125	196

In spite of the promising looking data from Table 4.1, an additional manipulation check is necessary to establish if the manipulation videos had a statistically significant effect on the participants. A linear regression analysis was performed to establish the effect of the manipulation videos. Linear regression identifies linear relationships between dependent variables and covariates. The dependent variable in Table 4.2 is the result of the manipulation (post-PSS subtracted from pre-PSS) and the covariates are listed under variables. The *Student* and *Kids* variables were re-coded as binary variables (yes/no). The manipulation variable should be significant in order to consider the manipulation a success. However, as

it can be observed in Table 4.2, the relationship between the dependent variable and the manipulation is insignificant with $p = 0.104$. This leads to the conclusion that the manipulation videos had no statistically significant effect on the perceived stress of the participants. Therefore, the manipulation variable is excluded from the future analysis in this report.

Table 4.2: Manipulation Check (N=449).

				95% Confidence Interval	
Variable	β	t	p	Lower	Upper
Constant	0.103	0.091	0.928	-2.131	2.337
BSCS	-0.009	-0.339	0.735	-0.060	0.042
Grit	-0.209	-0.611	0.541	-0.881	0.463
Kids[a]	0.314	0.638	0.524	-0.654	1.283
Age	-0.058	-0.289	0.773	-0.456	0.339
Gender[a]	$-7.068 \cdot 10^{-4}$	-0.002	0.998	-0.580	0.579
Student[a]	0.433	1.276	0.203	-0.234	1.099
Manipulation[a]	-0.474	-1.631	0.104	-1.045	0.097
Duration	$7.583 \cdot 10^{-6}$	1.059	0.290	$-6.488 \cdot 10^{-6}$	$2.166 \cdot 10^{-5}$

BSCS = Brief Self-Control Scale.
[a] Binary variable.
β=Unstandardised regression coefficient.

4.2. Sample Characteristics

After the filters are applied to the original sample, the final data overview is presented in Table 4.3. Only binary genders are represented. More women participated in the experiment compared to men. The student distribution has been re-coded to Yes/No from no/BSc/MSc. The number of students and non-students is very close. Majority of the participants are childless and under the age of 35. In the following sections, children distribution has been re-coded to Yes/No in order to avoid skewed results.

Table 4.3: Refined Sample Descriptions.

Sample Descriptions	Summary	N (Total = 449)
Experiment Type	Debilitating	232 (96 men)
	Enhancing	217 (94 men)
Student	Yes	227 (89 men)
	No	222 (101 men)
Children	No	366 (156 men)
	One	34 (15 men)
	Two	30 (10 men)
	Three	12 (5 men)
	Four or more	7 (4 men)
Age	Under 18	5 (3 men)
	18 - 24	148 (55 men)
	25 - 34	208 (103 men)
	35 - 44	51 (17 men)
	45 - 54	23 (8 men)
	55 - 64	9 (3 men)
	65 - 74	5 (1 man)

The correlation between some covariates (gender, BSCS, Grit) and dependent variables (SWLS, Pre- and Post-Test) is presented in Table 4.4. The correlations reported in the table are Pearson's product moment correlation, also referred to as Pearson's r. Pearson's r investigates the linear correlation between two data sets.

Bivariate correlations can be observed between BSCS, Grit, SWLS, pre- and post-test. Furthermore, significant bivariate correlation is found between gender and pre- and post-test. The mean and standard deviation (SD) are also reported in Table 4.4. BSCS has a possible range of 13.00 to 65.00. A range of 1.00 to 5.00 can be observed in grit, SWLS can have a range of 5.00-35.00. Perceived stress scale (pre- and post-test) can range from 0 to 40.00.

Table 4.4: Mean, Standard Deviation and Pearson's Correlations (N=449).

		Mean	SD	1	2	3	4	5	6
1	Gender[a]	1.58	0.50	–					
2	BSCS	41.35	8.00	0.021	–				
3	Grit	3.34	0.61	-0.013	0.711**	–			
4	SWLS	23.28	6.40	-0.040	0.313**	0.287**	–		
5	Pre-Test	19.35	6.77	0.177**	-0.300**	-0.265**	-0.515**	–	
6	Post-Test	18.52	6.81	0.179**	-0.326**	-0.295**	-0.543**	0.898**	–

BSCS = Brief Self-Control Scale, SWLS = Satisfaction with Life Scale.
[a] Binary variable.
** $p < .001$.

4.3. Brainjam Data

HRV data was collected during the experiment using Brainjam. A total of 25 participants joined via Brainjam in Qualtrics. Jamzone™ collected 15 HRV samples from Brainjam users, three of which did not complete the experiment in Qualtrics. Moreover, two collected datasets were incorrect (one data set was only zeros and another one had only one data point per minute) and could not be used in the analysis. This leaves ten Brainjam users that recorded their HRV and filled in the questionnaire in Qualtrics.

The manipulation has been found to be ineffective in Section 4.1, however, HRV data is more precise and the (in)effectiveness of the manipulation videos can be verified. Of the ten Brainjam users, five (two men) completed the debilitating version and five (three men) the enhancing version. Unfortunately, the timestamps of the data collected in Qualtrics and Brainjam did not match. Therefore, the manipulation check could not be verified.

A simple overview of the collected HRV data can be found in Table 4.5, for the debilitating manipulation, and in Table 4.6, for the enhancing version. Overall, each data set consists of more than 2000 data points per sample.

The average HRV of women in the debilitating experiment is 32.49, while for men it is 22.90. In the enhancing version of the experiment, the average HRV of women is 24.51, while for men the average HRV is 79.16. For curiosity, the HRV graphs from both experiments can be found in Section C.1.

Table 4.5: HRV from Debilitating Experiment.

Gender	Age	HRV min	Average HRV	HRV max
Male	38	15.91	19.84	23.04
Male	47	23.20	25.96	29.84
Female	41	18.27	21.77	25.98
Female	49	20.53	28.26	41.78
Female	40	40.42	47.45	54.82
Average	43	23.66	28.65	35.09

Table 4.6: HRV from Enhancing Experiment.

Gender	Age	HRV min	Average HRV	HRV max
Male	53	51.05	58.68	67.95
Female	42	21.81	29.12	36.11
Male	31	71.49	88.90	100.11
Female	32	17.25	19.91	24.47
Male	48	81.89	89.90	96.97
Average	41.20	48.70	57.30	65.12

Unfortunately, the data samples are too small to perform a parametric test. A non-parametric test, such as Spearman's rank correlation, can be found in Table 4.7 with no reported significant findings. Additionally, the mean values and standard deviations (SDs) can also be found in Table 4.7.

Table 4.7: Mean, Standard Deviation and Spearman's Correlations of Brainjam Data (N=10).

		Mean	SD	1	2	3
1	HRV Average	42.98	27.47	–		
2	Gender	1.50	0.53	-0.313	–	
3	Manipulation	0.00	0.53	0.522	-0.200	–

4.4. Life Satisfaction and Perceived Stress

As mentioned in Section 1.3, it has been established that perceived stress is a good predictor of life satisfaction (Hamarat et al., 2001; Extremera et al., 2009; Lee et al., 2016), which is also confirmed in the experiment conducted for this work. Figure 4.1 shows that the higher the reported stress, the lower the life satisfaction, linking the two dependent variables. This partially answers the main research question, "What role does stress play in the well-being of an individual, and is it impacted by gender?", showing that the well-being of an individual decreases with increased stress.

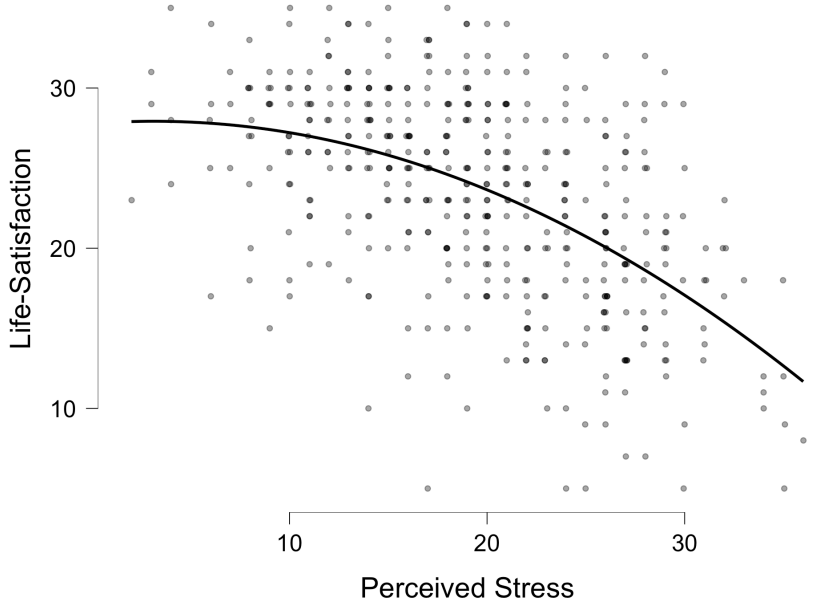

Figure 4.1: Reported Life Satisfaction and Stress.

4.5. Difference in Self-Reported Stress

The collected data has been analysed using linear regression. Participants of the study self-reported their perceived stress in the pre-test, after which they watched a manipulation video. As it has been established in Section 4.1, the manipulation did not work. The participants' stress was again measured in the post-test. The dependent variable of the linear regression analysis, that is reported in Table 4.8, is the difference between the post- and pre-PSS. The coefficient of determination has a value of $R^2 = 0.11$ with $F(20, 428) = 2.51$ and $p < 0.001$.

Table 4.8: Self-Reported Stress Results.

				95% Confidence Interval	
Variable	β	t	p	Lower	Upper
Constant	-5.153	-0.760	0.448	-18.484	8.178
BSCS	0.083	0.456	0.649	-0.274	0.439
Grit	-0.522	-0.270	0.787	-4.317	3.273
Kids	12.293	0.999	0.318	-11.882	36.469
Age	1.259	0.568	0.570	-3.098	5.615
Gender	0.362	1.211	0.227	-0.225	0.949
Student	2.993	0.373	0.709	-12.759	18.745
Duration	$5.334{\cdot}10^{-4}$	5.736	< .001	$3.506{\cdot}10^{-4}$	$7.161{\cdot}10^{-4}$
BSCS ⋆ Kids	-0.180	-0.555	0.579	-0.818	0.458
BSCS ⋆ Age	-0.014	-0.240	0.810	-0.130	0.101
BSCS ⋆ Student	0.080	0.396	0.692	-0.317	0.477
Grit ⋆ Kids	-0.127	-0.033	0.974	-7.795	7.540
Grit ⋆ Age	-0.048	-0.076	0.940	-1.284	1.189
Grit ⋆ Student	-1.165	-0.445	0.656	-6.311	3.980
Kids ⋆ Age	-2.935	-0.910	0.363	-9.274	3.404
Age ⋆ Student	-0.584	-0.208	0.835	-6.106	4.937
Gender ⋆ Duration	$-2.642{\cdot}10^{-4}$	-5.631	< .001	$-3.565{\cdot}10^{-4}$	$-1.720{\cdot}10^{-4}$

Table 4.8: Self-Reported Stress Results.

Variable	β	t	p	95% Confidence Interval	
				Lower	Upper
BSCS ⋆ Kids ⋆ Age	0.033	0.407	0.684	-0.128	0.194
BSCS ⋆ Age ⋆ Student	-0.067	-1.002	0.317	-0.200	0.065
Grit ⋆ Kids ⋆ Age	0.138	0.139	0.889	-1.817	2.094
Grit ⋆ Age ⋆ Student	0.822	0.876	0.381	-1.022	2.665

BSCS = Brief Self-Control Scale.
β = Unstandardised regression coefficient.

Majority of the results in Table 4.8 are not significant. *Duration* and *Gender* ⋆ *Duration* are the only two results that are significant. The main duration significant values are $\beta = 5.334 \cdot 10^{-4}$, $t = 5.736$ with $p < 0.001$. The *Duration* variable represents the observation that the longer the participant took to finish the experiment, the higher the self-reported stress.

Gender ⋆ *Duration* is a two-way linear interaction where gender is an independent variable, duration a moderator, and the stress difference is the dependent variable, with $\beta = -2.642 \cdot 10^{-4}$, $t = -5.631$, and $p < 0.001$. It can be observed, in Figure 4.2, that for short duration gender difference does not exist. On the other hand, a long duration of the experiment had a significant effect on gender.

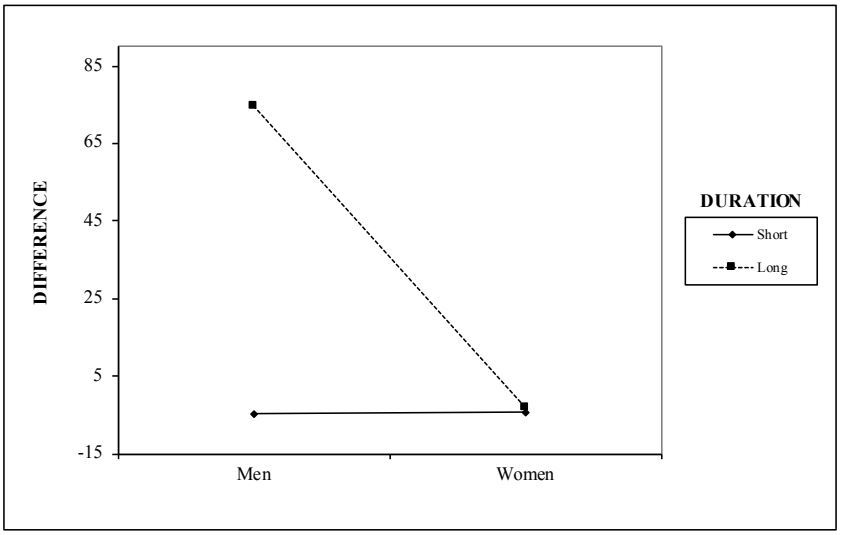

Figure 4.2: Two-Way Linear Interaction Between Duration, Stress Difference and Gender.

4.6. Satisfaction With Life

The scale that measure the self-reported satisfaction with life is used as a dependent variable in the linear regression. Table 4.9 shows the interaction between SWLS and the listed variables. The coefficient of determination is $R^2 = 0.16$, with $F(20, 428) = 3.98$ and $p < 0.001$. A total of four significant results can be found in Table 4.9. One main interaction, *Grit*, two two-way interactions, *BSCS* ⋆ *Student* and *Grit* ⋆ *Kids*, and one three-way interaction, *Grit* ⋆ *Kids* ⋆ *Age*.

Table 4.9: Self-Reported Satisfaction With Life.

Variable	β	t	p	95% Confidence Interval Lower	Upper
Constant	14.940	1.086	0.278	-12.098	41.978
BSCS	-0.470	-1.280	0.201	-1.193	0.252
Grit	8.524	2.176	0.030	0.826	16.221
Kids	12.421	0.498	0.619	-36.613	61.455
Age	-0.896	-0.199	0.842	-9.733	7.941
Student	-4.020	-0.247	0.805	-35.969	27.929
Duration	$-2.377 \cdot 10^{-5}$	-0.126	0.900	$-3.944 \cdot 10^{-4}$	$3.469 \cdot 10^{-4}$
Gender	-0.302	-0.497	0.619	-1.493	0.890
BSCS $\star$ Kids	1.262	1.917	0.056	-0.032	2.556
BSCS $\star$ Age	0.157	1.318	0.188	-0.077	0.391
BSCS $\star$ Student	0.898	2.190	0.029	0.092	1.704
Grit $\star$ Kids	-17.700	-2.237	0.026	-33.252	-2.148
Grit $\star$ Age	-1.684	-1.320	0.188	-4.192	0.824
Grit $\star$ Student	-10.201	-1.921	0.055	-20.637	0.235
Kids $\star$ Age	-3.952	-0.604	0.546	-16.809	8.904
Age $\star$ Student	2.288	0.402	0.688	-8.911	13.487
Duration $\star$ Gender	$2.946 \cdot 10^{-6}$	0.031	0.975	$-1.841 \cdot 10^{-4}$	$1.900 \cdot 10^{-4}$
BSCS $\star$ Kids $\star$ Age	-0.251	-1.514	0.131	-0.578	0.075
BSCS $\star$ Age $\star$ Student	-0.238	-1.744	0.082	-0.506	0.030
Grit $\star$ Kids $\star$ Age	3.996	1.980	0.048	0.030	7.963
Grit $\star$ Age $\star$ Student	2.294	1.206	0.229	-1.445	6.032

BSCS = Brief Self-Control Scale.

β = Unstandardised regression coefficient.

Grit is the only significant main effect, with $\beta = 8.524$, $t = 2.176$, and $p = 0.030$. This means that grit has an effect on the life satisfaction.

The first significant two-way interaction is between self-control (BSCS in Table 4.9) and student status, with $\beta = 0.898$, $t = 2.190$, and $p = 0.029$. Figure 4.3 shows the linear relationships. High self-control has a significant impact on satisfaction with life, as does the student status. Low self-control has a lower, but still significant impact on students/non-students.

The second significant two-way interaction is between grit and having children, with $\beta = -17.700$, $t = -2.237$, and $p = 0.026$. Figure 4.4 depicts the linear relationship between the two variables. Participants with high grit report higher satisfaction with life, with heavy dependence on children. Low grit, has a significantly smaller effect on children and life satisfaction.

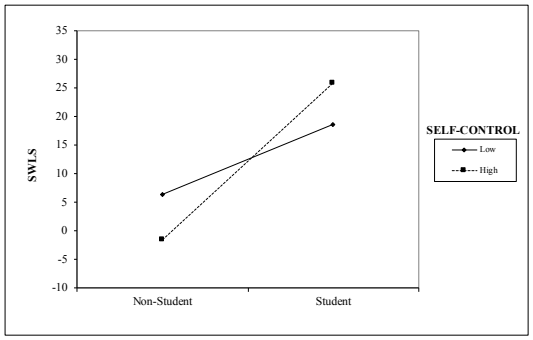

Figure 4.3: Two-Way Linear Interaction Between SWLS, BSCS and Students.

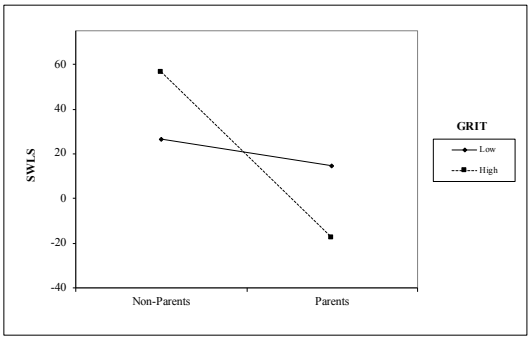

Figure 4.4: Two-Way Linear Interaction Between SWLS, Grit and Kids.

Finally, as mentioned above, one three-way interaction has been found to be significant with $\beta = 3.996$, $t = 1.980$, $p = 0.048$, and can be found plotted in Figure 4.5. Satisfaction with life in younger participants, with high grit is influenced by having children or not. The same can be observed in older participants. Almost no difference is observed in older participants with lower grit and the effect of children. A small variation can be found in young, low grit participants, and the effect of children on their life satisfaction.

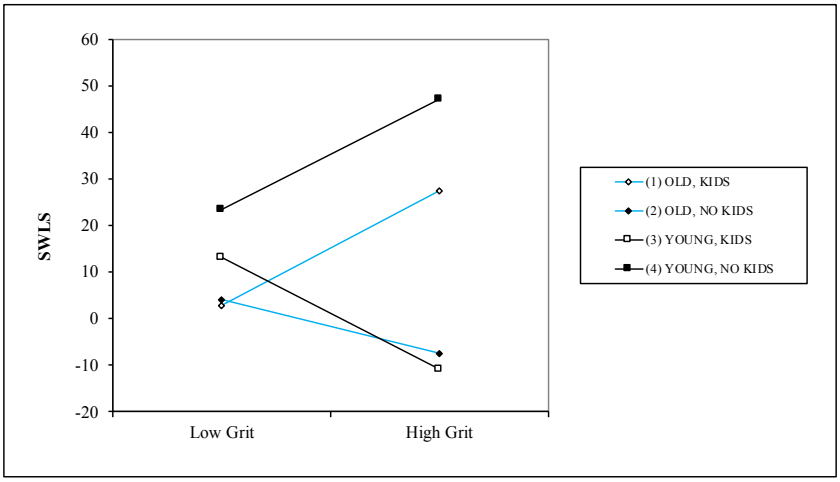

Figure 4.5: Three-Way Linear Interaction Between SWLS, Grit, Kids and Age.

4.7. Summary

Throughout this chapter, the results of the conducted experiment have been presented. The manipulation videos have been found to be ineffective. HRV data sets collected via Brainjam were presented, but could not be linked to the questionnaire as the time stamps did not match. Nevertheless, important correlations have been identified, and the dependent variables of stress response and life satisfaction were compared to other variables such as gender and age using linear regressions. Gender and the time required to complete the experiment have been found to play a role in the perceived stress. Life satisfaction had more significant results, however, none of them were gender significant.

5
Discussion

The purpose of this thesis is to better understand the role gender plays in stress. The videos created by Crum et al. were developed to change a person's mindset towards stress (Crum et al., 2017a). In this experiment, the videos were used to manipulate the respondents' stress. However, they were found to not change the perceived stress significantly. Therefore, the manipulation was excluded from the linear regressions used to analyse the collected data.

The main dependent variables that were investigated are the difference between post-PSS and pre-PSS, and the satisfaction with life. The results found a strong relation between stress and the duration of the experiment as well as between life satisfaction, self-control, and other covariates.

All the scales that were chosen in the *Gender & Stress* experiment were gender neutral (Pavot et al., 1991; Cohen et al., 1983; Duckworth, 2021), with the exception of BSCS. The gender difference in the BSCS has not been researched. The scales were chosen consciously for their gender neutrality as the manipulation videos were meant to cause differences. Unfortunately, the manipulation did not work.

This chapter discuses the results that were found in Chapter 4. First, the scientific relevance of the results is discussed (see Section 5.1), followed by the practical relevance in Section 5.2. Future research is discussed in Section 5.4 and the chapter is summarised in Section 5.5.

5.1. Scientific Relevance

Two dependent variables have been investigated in this experiment. First is the perceived stress difference, which is discussed in Section 5.1.1. Second is the life satisfaction, which is compared to grit and other variables in Section 5.1.2.

5.1.1. Stress Differences

The Perceived Stress Scale (PSS) is used to measure the stress level of participants. The results imply that the duration of the experiment is directly connected with stress. This is confirmed by literature that claims that stress affects speed (Hockey, 2013). When observing duration and stress from the gender perspective, it can be observed, in Figure 5.1, that men with increased stress difference took longer to complete the experiment. Women were significantly more consistent in their self-reported stress, and the variation in stress difference in women is negligible. Literature states that stressed men speed-up their decision making, whereas stressed women take longer to decide (Lighthall et al., 2012).

The main research questions of this thesis is *"What role does stress play in the well-being of an individual, and is it impacted by gender?"* and can be partially answered with the information presented above. Task completion speed is clearly affected by stress and the speed of response varies more for men, depending on their stress. Women are less affected by stress difference in their completion speed.

SQ 1 is meant to answer if grit and self-control are connected to stress. As can be observed in Table 4.8, no significant results were found connected to grit and BSCS. Therefore, the answer to SQ 1 is that grit and self-control are not connected with stress difference. Same is true for children (SQ 3), age (SQ 4) and student status (SQ 5).

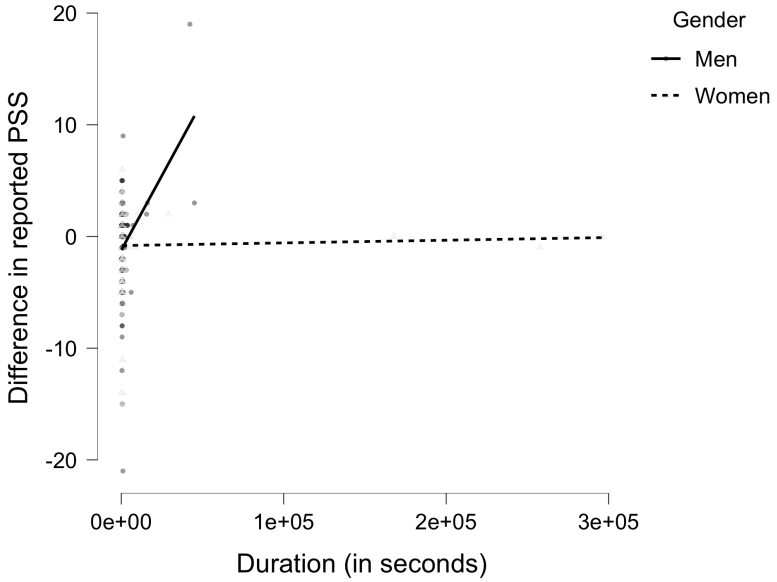

Figure 5.1: Duration, Perceived Stress and Gender.

5.1.2. Life Satisfaction

Life satisfaction and perceived stress were found to be connected by literature (Lee et al., 2016) as well as in this thesis (Figure 4.1). Therefore, the life-satisfaction results discussed in this section can be connected to stress.

Grit scale and well being have been found to be connected. This is confirmed by Duckworth (2016), who found that emotionally healthy people are more gritty. Ain et al. (2021) used the grit and satisfaction with life scales in their study, and like the results in this thesis, Ain et al. found significant Pearson's correlation between grit and SWLS, as did Khan & Khan (2017). When the two scales from this experiment are plotted against each other, in Figure 5.3, and compared to a plot found by Duckworth (2016), in Figure 5.2, a similar trend can be observed. This answers a part of SQ 2. Satisfaction with life is positively influenced by grit. The other part of SQ 2 asks if life-satisfaction is influenced by self-control. No significant results have been found in this experiment.

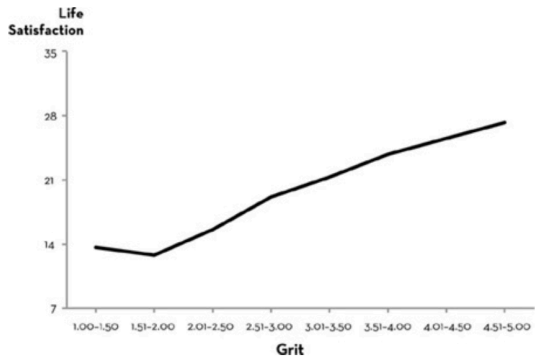

Figure 5.2: Life Satisfaction and Grit by Duckworth (2016).

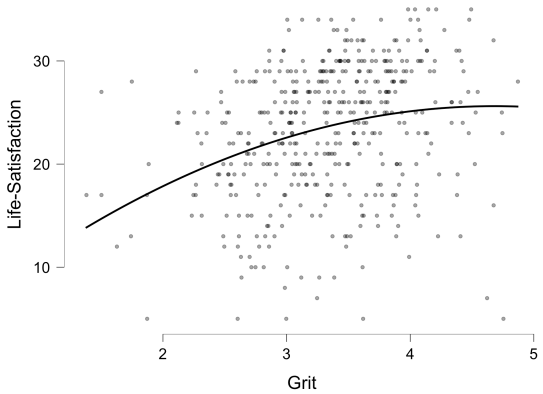

Figure 5.3: Reported Life Satisfaction and Grit.

Several studies have found children to have a positive influence on life satisfaction (Angeles, 2010; Pollmann-Schult, 2014). The collected data confirms this finding, and is graphically presented in Figure 5.4. Therefore, gritty people with children are happier in life than those without children or with lower grit. People with low grit and children were found to be the unhappiest. Children make life more

complex and create more worries, however, they make the parents more happy and satisfied with their life which answers SQ 3 as well.

Self-control and life-satisfaction seem to go hand in hand as well, as confirmed by literature (Wiese et al., 2018). However, the main effect found between the two is insignificant ($p < 0.201$). When another variable is introduced, (non-)students, a clear pattern can be observed. Students are less satisfied with their life as opposed to non-students. As life-satisfaction increases, the self-control of an individual increases too, both in students and in non-students, as is shown in Figure 5.5. The data has been collected during the COVID-19 pandemic, which has affected everyone's life, irrespective of their gender, age, or country of residence. The scale investigates subjective well-being with only five questions. Due to the pandemic, many university students have experienced delay in their studies and had to switch to online education which made students more anxious and depressed (Fawaz & Samaha, 2021), and the pandemic, in general, negatively affected their mental health (Debowska et al., 2020; Savage et al., 2020; Rogowska et al., 2020). One of the many reasons can be found to be the reverse relationship between parents and young adults. Young adults found themselves to be a potential danger to their older relatives, like parents, who in the past they viewed as their protectors (Schimmenti et al., 2020). A study by Rogowska et al. (2020) found that the pandemic had a negative effect on students' life satisfaction. This answers the second part of SQ 5, "Are stress and satisfaction with life affected by student status?". Yes, life satisfaction is affected by student status which has a negative effect on the overall well-being.

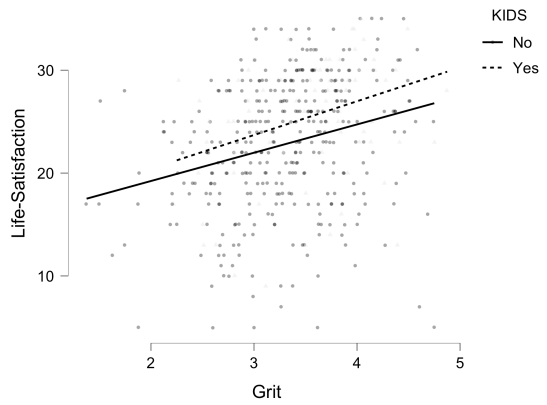

Figure 5.4: Grit, Life-Satisfaction and Children.

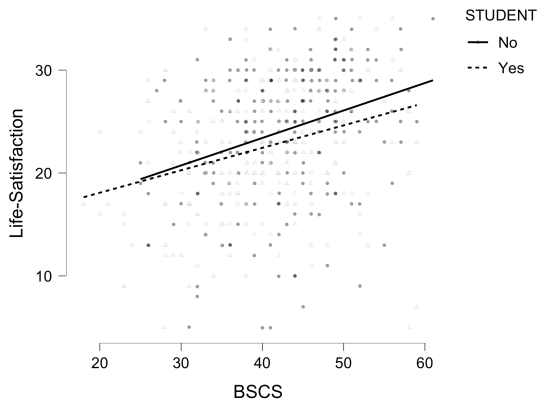

Figure 5.5: Self-Control, Life-Satisfaction and Students.

One three-way interaction has been observed in the data. In addition to the results presented in Figure 4.4 and Figure 5.4, age is added as a variable. Figure 5.6 is divided into participants who are childless and those with at least one child. The interaction between life-satisfaction, grit, and children has already been explained above.

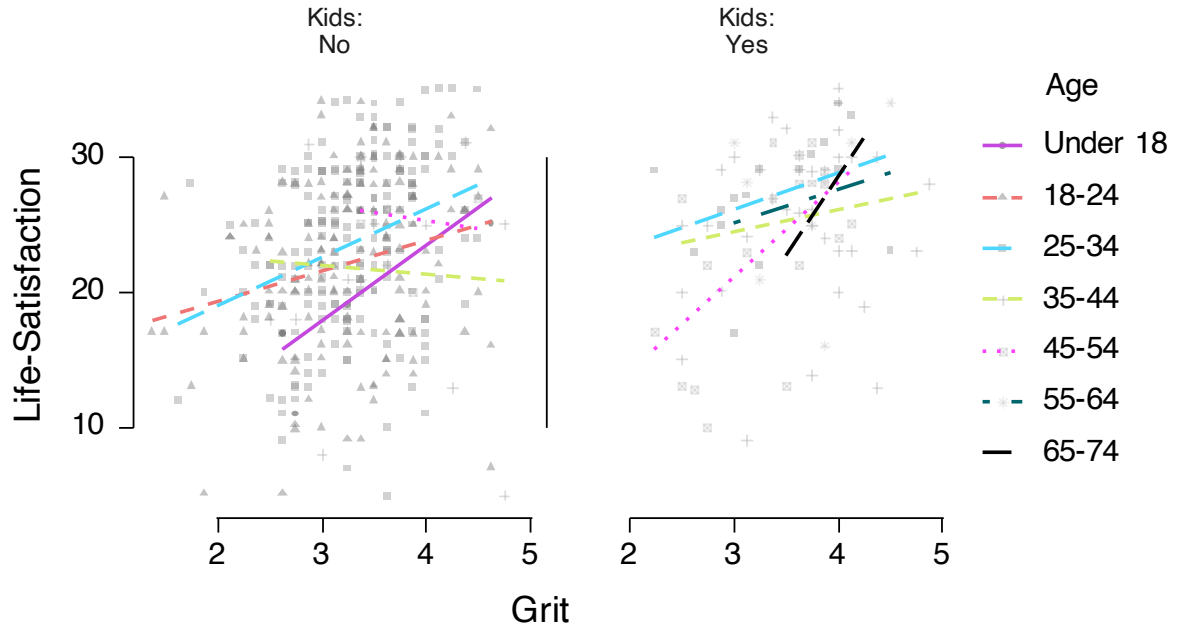

Figure 5.6: Grit, Life-Satisfaction, Children and Age.

Life satisfaction and grit have been found to increase with age (Baird et al., 2010; Duckworth, 2016), and can vary depending on the country, health, and vocation (Pavot & Diener, 1993). This phenomenon is not fully observed in the childless respondents. Participants who reported to be in the age groups of under 18, 18-24, and 25-34 have a very similar life-satisfaction. However, 35-44 year old participants are less satisfied with their life than the ones aged 45-54, and have the opposite trend to other age groups. People with ages between 45-54 are less satisfied with their life as their grit increases. It is possible the results are skewed as there is a significant difference in the number of childless respondents, depending on age group. This can be observed in Table 5.1. This difference can explain the inconsistency with literature as the age groups under 18, 35-44, and 45-54 are significantly underrepresented compared to the age groups of 18-24 and 25-34. Therefore, age groups 35-44 and 45-54 follow the findings of (Baird et al., 2010), the older individuals are, the more satisfied with life they are. The same age groups are, however, the only ones who have the opposite trend with life-satisfaction and grit. The only other variation are children. The subjects might be less satisfied with their life due to the fact that they are not parents.

Table 5.1: Frequency of Children.

Age	Children	Frequency
Under 18	No	5
	Yes	0
18 - 24	No	148
	Yes	0
25 - 34	No	192
	Yes	16
35 - 44	No	15
	Yes	36
45 - 54	No	4
	Yes	19
55 - 64	No	1
	Yes	8

Table 5.1: Frequency of Children.

Age	Children	Frequency
65 - 74	No	1
	Yes	4

SQ 4 asks "How does age affect well-being?". In Section 4.5, no significant findings were found between stress and age. The only statistically significant finding is between life-satisfaction, age, grit, and children. Making it more complex to answer SQ 4.

Examining Figure 5.6 from the perspective of parents, brings similar results. As has been observed earlier, parents are more satisfied with their life compared to childless respondents. No significant variation can be observed between life-satisfaction and age. Age group 45-54 has the highest life-satisfaction variation. However, the overall trend is very similar between all age groups.

Baird et al. (2010) also found that life-satisfaction sharply decreases after the age of 70. The exact age has not been reported in this study and it is therefore possible that the age group 65-74 is comprised of people under 70. Baird et al. reported that people above 70 are less satisfied with their life due to the increase in health-issues. Therefore, another explanation could be that the four respondents in this age group are all healthy individuals. Of course, a combination of under 70 and healthy 70+ individuals is also a possibility.

5.2. Implications

The presented results show that stressed individuals are slower in completing tasks. Many individuals expect themselves to be as effective in their work, studies, or care regardless of their stress-level. For example, many people experienced or are experiencing burnout during the worldwide pandemic (Beheshti, 2021). People expected they can juggle working from home as effectively as when being in the office and feel bad when that is not the case. However, the pandemic has created an extra stress factor that affects everyone in their daily life. It is important to acknowledge that as stress increases, individuals are slower in completing their tasks and employers should not expect the same standard of work.

Students are less satisfied with their life than non-students. As discussed previously, this could be due to the COVID-19 pandemic. Students have been cut out from their support circle of friends, could not socialise, do sports, work, or even visit their families. In some cases, their studies have been put on hold. However, when online education started, new challenges arose. Online exams became the norm in higher-education, with many students experiencing complications and higher stress, resulting in poor results (de Bruijn, 2020). Universities need to acknowledge these problems and provide students with adequate support systems such as psychologists.

5.3. Limitations

The most important limitation of this research is the failure of the manipulation. The stress mindset manipulation videos, created by (Crum et al., 2017a), caused a statistically insignificant difference in the perceived stress of the respondents. Crum et al. (2017a) performed their experiment in a controlled environment, unlike the present experiment. Huebschmann & Sheets (2020) investigated the impact of the stress mindset on perceived stress and its effect on mental health. The study found that the respondents' mindset correlated with the perceived stress and its effect on mental health (Huebschmann & Sheets, 2020). Therefore, in the present research, a statistically significant effect should have been observed between the manipulation videos, meant to affect the stress mindset of respondents, and the perceived stress.

The results in this study are not differentiated based on the country of residence. A great difference can be observed between students and vocations in different countries (Pavot & Diener, 1993). It is possible some variations of this study could be explained if the residence country was accounted for. For instance, respondents from New Zealand have not been affected by the pandemic as much as the

respondents from France.

During the experiment, participants had to select which age group they are part of. However, it would be more practical if the exact age of the participants was known. A steep decline in life-satisfaction should be observed after 70 years of age. Due to the nature of reported results, the participants reported to be in the age group of 65-74 making it impossible to know if a decrease in life-satisfaction should have been observable or not.

A better sample distribution would provide higher quality insights. The biggest number of participants were above 18 and under the age of 35 (79%). Only 18% of the participants reported to have children. Yet, age and children have been found to be significant results.

The study asked the respondents to identify as male, female, or non-binary. Three individuals identified as non-binary and, due to the large representation of binary genders, the non-binary were excluded from this study. In order to ensure a good representation of the general population, it is important to include people from all walks of life (e.g. minorities, old, and young).

Similarly, one question has been missing from the experiment. LGBTQ minorities experience higher stress (Kelleher, 2009). In some countries it is still illegal to not identify as a heterosexual. This experiment has been filled in by people from all around the world and it would, therefore, be useful to know if some of the participants are subjected to additional stress than others.

Many psychologists, psychology students, and other individuals are familiar with the scales that have been used in this experiment. It is possible some of the respondents were familiar with the scales and even knew that the videos are supposed to manipulate them. Participants with such knowledge should have been excluded from the final data set. However, no question was formulated to identify this group of respondents.

Finally, two last limitations of the study are that it is a self-reported study and that the environment was not controlled. Self-reported studies suffer from social desirability bias (Gonyea, 2005). Respondents might want to appear more desirable or they might not want to report what they truly think (Gonyea, 2005).

Respondents participated in the study in various environments. It is possible some of them were distracted (e.g. loud noises, watching TV, crying children), while others fully focused on the experiment. This could change the outcome of the manipulation effect. It is possible that, if all the participants were in a controlled environment, the outcome of the manipulation videos would be different.

5.4. Future Research

The impact of children on life-satisfaction should be investigated from several more perspectives. First, it should be established if the child still lives with their parents. Several studies found that once children *leave the nest*, parents become more satisfied with their marriage (Gilbert, 2009), and married parents have been found to be more satisfied with their life when compared to unmarried parents (Angeles, 2010). Angeles also observed that married parents' happiness increases with the number of children. Contrary to Angeles, studies by Blanchflower (2009) and Gilbert (2009) found that children decrease the life satisfaction of individuals. Angeles study was performed in the United Kingdom whereas the research of Blanchflower and Gilbert was performed in the United States. Therefore, future research needs to investigate if marital status and the number of children differ in their effects on life satisfaction depending on the culture the participants live in.

Due to the current times, it would be prudent to investigate the effect of COVID-19. How did the pandemic affect individuals' stress? The effects of home-based working and home-schooling should be investigated. Higher perceived parental stress has been associated with COVID-19 related stressors (Brown et al., 2020). Spinelli et al. (2020) found that the quarantine during the pandemic in Italy had a negative effect on the well-being of both parents and children. Future research should differentiate results between pandemic afflicted countries (e.g. Italy, India) and less impacted countries (e.g. New Zealand).

5.5. Summary

In this chapter, the experiment results relevant to this thesis have been discussed in detail. As expected, the perceived stress has been found to be a good predictor of life-satisfaction. The biggest limitation of this experiment is the ineffectiveness of the manipulation videos. The future research needs to investigate the effect of COVID-19 on the respondents.

6
Conclusion

The aim of this thesis was to investigate the effect of gender on stress. This was done in order to decrease the gender data gap rather than to exacerbate it.

Literature confirms that men and women have different causes of stress, react to it differently, and use different coping methods when dealing with stress. Therefore, an experiment was created to better understand the effect of gender, given the same manipulation. Two manipulation videos, developed by Crum et al., were used in the experiment. The respondents filled in a pre-test, where their stress level was established, followed by a manipulation video that was either debilitating or enhancing in nature. After the respondents watched one of the videos, they filled in the post-test. In the post-test, their self-reported stress has been measured again, together with their grit, self-control, and satisfaction with life. Furthermore, general demographics data such as age, gender, number of children, and country of residence were collected. A manipulation check was also performed.

A difference between pre-PSS and post-PSS should have been observable. However, the difference was not statistically significant. As a result, the manipulation was deemed ineffective, and had to be removed from further analysis.

In total, 457 individuals participated in the experiment. Eight respondents were removed from the data set as their English comprehension level was not adequate or due to their nature as outliers. This resulted in 449 participants as the final number. Every scale used in the experiment has been found to have a good internal reliability.

Ten Brainjam users participated in the experiment and recorded their HRV. Women were found to have a higher HRV in the debilitating version compared to men, with the opposite being true for the enhancing version. However, no significant findings were found when a non-parametric test (Spearman's Correlation) were performed. The timestamps collected via Qualtrics did not match with timestamps collected in Brainjam. Therefore, the effect of the manipulation on HRV could not be established.

Two dependent variables, difference in self-reported stress and life-satisfaction, have been compared to other variables using linear regression. Several significant results were found.

Self-reported stress difference had two statistically significant results. Duration of the experiment has been found to be directly connected with stress. This was heavily dependent on the gender. Men were found to have a greater stress variation as the duration of the experiment increased.

Life-satisfaction resulted in more significant results. Grit has been found to have the main effect on the dependent variable. The higher the grit, the higher the life-satisfaction, Duckworth came to the same conclusion in all her studies. Respondents with children reported higher life satisfaction compared to childless participants as their grit increased. When another variable is added to the mix, namely age, a new trend can be observed. Life satisfaction increases with age, with the happiest individuals being above the age of 65. Life-satisfaction has been found to increase with the increase in self-control, with students/non-students as a variable. Students were found to be less happy with their life compared to the respondents who are not students.

It is important to acknowledge the negative effect the COVID-19 pandemic has on stress levels of the general population and the students' satisfaction with life. One of the limitations of this research is that the results are not stratified based on country. Some countries were more heavily affected by the pandemic, which could have had an affect on the reported perceived stress as well as life satisfaction. Future research should investigate the effect of the pandemic.

Two limitations arose from the experiment due to it being self-reported. The first limitation is that

participants might have wanted to appear more desirable, leading to them answering untruthfully. The second limitation is that the study was performed in an uncontrolled environment. It is possible some participants focused fully on the experiment, whereas others were multitasking, for example. Therefore, future research should be performed in a controlled environment to limit the external factors on the study participants.

The duration of the experiment was the only variable affected by gender. Therefore, the answer to the main research question *"What role does stress play in the well-being of an individual, and is it impacted by gender?"* is that stress plays a significant role in how quickly men finished the experiment of this thesis. No significant findings were found between gender and life satisfaction.

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A

Newsletter

The newsletter sent to Brainjam users can be found in Figure A.1. Half the users received enhancing version of the experiment and the other half received the debilitating version. Three reminders were sent in total.

Reageren mannen en vrouwen verschillend op stress?

Daniela Hallak, Masters student aan de TU Delft, onderzoekt dit momenteel. En jij kan haar en ons enorm helpen door mee te doen aan een kort experimentje. Het is supermakkelijk en duurt nog geen 15 minuten.

Dus doe mee en laten we samen onderzoeken of mannen en vrouwen verschillend reageren op stress! De resultaten delen we natuurlijk met jullie in een van de volgende nieuwsbrieven.

Hey Brainjammers,

Stress is part of our life whether we like it or not. It is a part of our life that we try to eliminate or utilise. Brainjam helps us command our stress and make us more efficient human beings. But does it help all of us equally?

My name is Daniela Hallak and I am a Masters student at TU Delft. I am investigating how men and women respond to stress. Research says that men and women have different causes of stress, react to stress differently, and cope with stress differently. But when we design solutions to help us with our stress we do not consider these differences.

I have designed an experiment that will help observe if mHealth apps like Brainjam would benefit from tailoring their apps based on gender. The experiment takes about **15 minutes**. You will need your heart rate belt and your phone.

Please join the experiment and help us help everyone. The experiment is open till the 25th of April. Click the button below to start the experiment.

Thank you,
Daniela

Start het experiment!

Figure A.1: Newsletter Distributed by Jamzone.

B

Pre-Test & Post-Test Questions

This appendix lists all the questions participants of the test need to answer. Section B.1 contains questions related to the pre-test. After watching the manipulation video, participants answer the questions in Section B.2 as well as for their perceived stress (same as in the pre-test).

B.1. Pre-Test

The following questions are a part of Perceived Stress Scale (Cohen, 1988). For each question participants choose one of the alternatives: never, almost never, sometimes, fairly often, very often.

1. In the last month, how often have you been upset because of something that happened unexpectedly?
2. In the last month, how often have you felt that you were unable to control the important things in your life?
3. In the last month, how often have you felt nervous and stressed?
4. In the last month, how often have you felt confident about your ability to handle your personal problems?
5. In the last month, how often have you felt that things were going your way?
6. In the last month, how often have you found that you could not cope with all the things that you had to do?
7. In the last month, how often have you been able to control irritations in your life?
8. In the last month, how often have you felt that you were on top of things?
9. In the last month, how often have you been angered because of things that happened that were outside of your control?
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

B.2. Post-Test

The questions of the post-test are listed bellow. In addition, to the questions bellow the questions of pre-test are also part of the post-test (they are not listed bellow).

1. What was the name of the video you watched?
   (a) Stress is enhancing
   (b) Stress is deteriorating
2. The video showed me that I should:
   (a) Utilise my stress
   (b) Learn to manage my stress

3. Gender
   (a) Male
   (b) Female
   (c) Non-binary / Third Gender
4. Age
   (a) Under 18
   (b) 18 - 24
   (c) 25 - 34
   (d) 35 - 44
   (e) 45 - 54
   (f) 55 - 64
   (g) 65 - 74
   (h) 75 - 84
   (i) over 85
5. Was your English level sufficient for this experiment (questionnaire & video)?
   (a) Yes
   (b) No
6. How many children do you have?
   (a) 1
   (b) 2
   (c) 3
   (d) 4+
   (e) I have no children
7. Are you a student?
   (a) Bachelor
   (b) Masters
   (c) No
8. In which country do you currently reside?
   → Drop down list of all the countries.

The following questions are part of a Satisfaction With Life Scale (Diener et al., 1985). For each question participants choose one of the alternatives: strongly disagree, disagree, slightly disagree, neither agree nor disagree, slightly agree, agree, strongly agree.

8. In most ways my life is close to my ideal.
9. The conditions of my life are excellent
10. I am satisfied with my life.
11. So far I have gotten the important things I want in life.
12. If I could live my life over, I would change almost nothing.

The following ten questions are used to investigate grit, scale created by Duckworth & Quinn (2009). For each question participants choose one of the alternatives: not at all like me, not much like me, somewhat like me, mostly like me, very much like me.

13. New ideas and projects sometimes distract me from previous ones.
14. Setbacks don't discourage me.
15. I often set a goal but later choose to pursue a different one.
16. I am a hard worker
17. I have difficulty maintaining my focus on projects that take more than a few months to complete.
18. I finish whatever I begin.
19. I am diligent.
20. I have been obsessed with a certain idea or project for a short time but later lost interest.

The following 13 questions are used to investigate self-control (Tangney et al., 2004). For each question participants choose one of the alternatives: not at all like me, not much like me, somewhat like me, mostly like me, very much like me.

21. I am good at resisting temptation.
22. I have a hard time breaking bad habits.
23. I am lazy.
24. I say inappropriate things.
25. I do certain things that are bad for me, if they are fun.
26. I refuse things that are bad for me.
27. I wish I had more self-discipline.
28. People would say that I have iron self- discipline.
29. Pleasure and fun sometimes keep me from getting work done.
30. I have trouble concentrating.
31. I am able to work effectively toward long-term goals.
32. Sometimes I can't stop myself from doing something, even if I know it is wrong.
33. I often act without thinking through all the alternatives.

C
Data

HRV plots collected via Brainjam can be found in Section C.1. The geographical distribution of all participants can be found in Section C.2.

C.1. HRV Data

The HRV data for debilitating and enhancing experiment can be found plotted in Figure C.1 and Figure C.2, respectively.

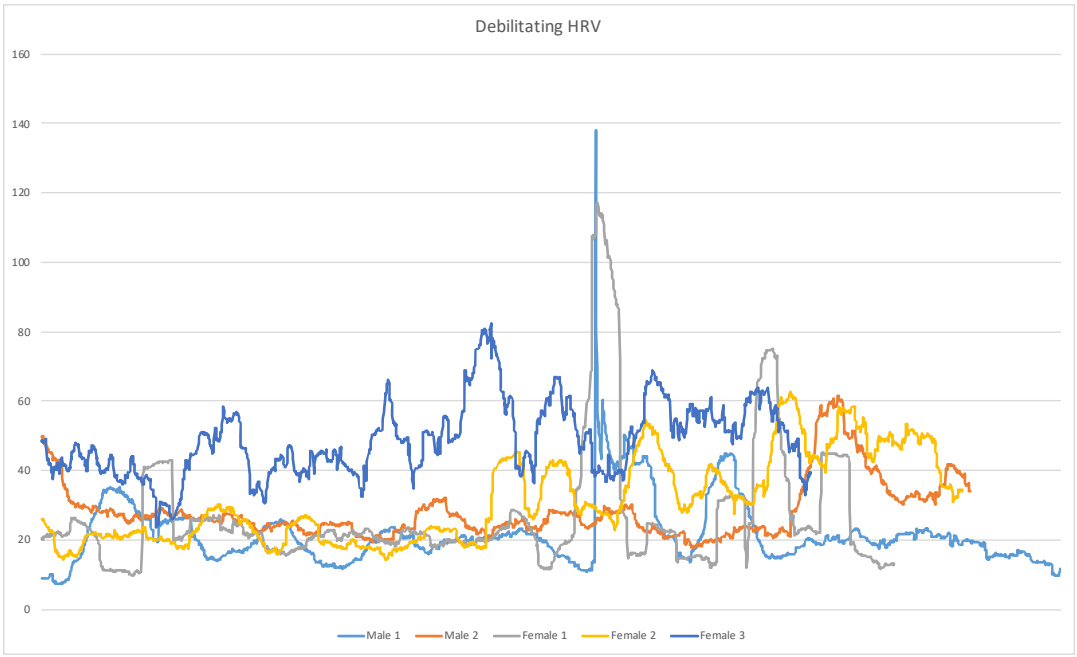

Figure C.1: Debilitating Manipulation HRV Plot.

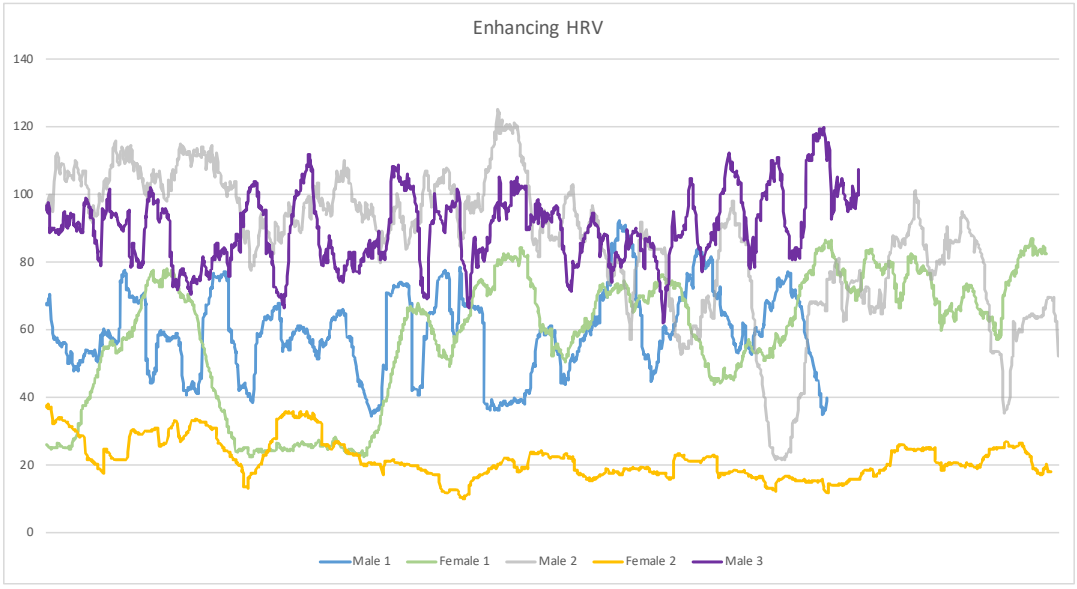

Figure C.2: Enhancing Manipulation HRV Plot.

C.2. Geographical Data

The geographical distribution of the experiment participants can be found Figure C.3, in the form of a pie chart. The frequency of participants per country is listed in Table C.1.

Figure C.3: Geographical Distribution.

Table C.1: Frequencies per Country.

Country	Frequency	Percent	Cumulative Percent
Albania	1	0.219	0.219
Antigua and Barbuda	1	0.219	0.438
Australia	6	1.313	1.751
Austria	2	0.438	2.188
Belgium	11	2.407	4.595
Brazil	1	0.219	4.814
Bulgaria	1	0.219	5.033
Canada	5	1.094	6.127
Czech Republic	19	4.158	10.284
Denmark	7	1.532	11.816
Finland	1	0.219	12.035
France	2	0.438	12.473
Germany	28	6.127	18.600
Greece	1	0.219	18.818
Hungary	1	0.219	19.037
Iceland	1	0.219	19.256
India	5	1.094	20.350
Ireland	9	1.969	22.319
Italy	10	2.188	24.508
Kenya	3	0.656	25.164
Lebanon	1	0.219	25.383
Luxembourg	2	0.438	25.821
Malaysia	1	0.219	26.039
Mexico	1	0.219	26.258
Morocco	1	0.219	26.477
Netherlands	226	49.453	75.930
New Zealand	6	1.313	77.243
Norway	2	0.438	77.681
Philippines	1	0.219	77.899
Portugal	8	1.751	79.650
Romania	4	0.875	80.525
Russia	4	0.875	81.400
Singapore	3	0.656	82.057
Slovakia	2	0.438	82.495
Slovenia	1	0.219	82.713
South Korean	1	0.219	82.932
Spain	3	0.656	83.589
Sweden	4	0.875	84.464
Switzerland	3	0.656	85.120
Turkey	1	0.219	85.339
United Kingdom	40	8.753	94.092
United States of America	27	5.908	100.000
Total	457	100.000	