Investigating the Effectiveness of Playing Digital Games for Relieving Psychological Stress

Siti Noorfatimah Safar

Doctor of Philosophy

University of York
Computer Science

September 2024

Abstract

Digital games are increasingly seen as a positive influence in people's lives. Evidence suggests digital games can alleviate psychological stressors. This thesis focuses specifically on daily or minor stressors such as such as missing a bus or spilling coffee on a clean shirt rather than major life stress events. Psychological stress is conceptualised as a dynamic interaction between individuals and their environment, where perceived demands exceed coping resources. Given the close relationship between stress and anxiety the thesis explores how gameplay might help regulate both. To address this, two surveys and four experimental studies were conducted.

The first survey examined whether gaming motivation relates to perceived stress, using the Video Game Pursuit (VGPu) scale and the Perceived Stress Scale (PSS). While individuals often played games when stressed, motivation alone did not strongly predict stress relief. A second survey explored gameplay experiences using the Challenge Originating from Recent Gameplay Interaction Scale (CORGIS) and Game User Experience Satisfaction Scale (GUESS-18), again finding only weak correlations with perceived stress.

Given the limited survey evidence, four experiments were conducted to measure whether playing games reduces acute stress more than non-game tasks, and whether immersion matters. Stress responses were measured using the State-Trait Anxiety Inventory (STAI) and Visual Analogue Scale (VAS) for stress. The four experiments looked at differences in stress and anxiety between playing a game and non-game activities as well as whether the level of immersion in the games also had an effect.

Overall, the results suggest that psychological engagement with gameplay, rather than immersion level alone, is key to reducing acute stress. While survey studies indicated small correlations between gaming motivations and stress, experimental findings provide evidence that playing games can significantly reduce acute stress when compared to non-gaming activities.

List of Contents

List of Tables

List of Figures

List of Appendix

Acknowledgement

To be on this PhD journey has been one of the most special experiences of my life. I was genuinely excited to begin this adventure, and I'm even more thrilled (and slightly stunned) to have made it to the finish line with minimal damage. There were highs and lows, moments of clarity and complete confusion, but I wouldn't trade the experience for anything. It has been a journey filled with growth, laughter, and more than a few "what have I done?" moments but above all, I'm grateful to have gone through it, and even more grateful to have completed it.

This would not have been possible without the collective support of many wonderful people. To my loving family (SBUC4005), especially my mom and dad, my brothers and sisters—and not forgetting my kiddies, thank you for your prayers, constant support, and encouragement. You have been my pillars of strength, and I am forever grateful for your unwavering belief in me. I truly believe that any success I have achieved is the result of my parents' heartfelt prayers and blessings.

My deepest and utmost gratitude goes to my supervisor, Paul Cairns, who, first and foremost, was willing to take me on as a student and then guided me throughout this journey. His invaluable guidance, mentorship, and expertise shaped my work in countless ways. I am especially grateful for the patience he showed during my struggles to become a researcher and helping me complete this thesis, making sure I stayed on track while still allowing me the space to explore and grow. I know I tested his patience many times, yet his support never wavered. I truly enjoyed our many supervision meetings, and especially our life chats before diving into the serious research discussions, where I spent most of the time going, "what?!" while he patiently explained things to me.

Before embarking on this journey, many told me that if I didn't cry during the PhD, then something was wrong. I didn't… well, at least not because of the PhD! In our very first supervision meeting, Paul promised me I would get a PhD, and that gave me the confidence I needed to stay the course. I am truly, truly blessed to have had him as my supervisor, may he be rewarded abundantly.

I would also like to thank Jo Iacovides and Joe Cutting, who served as my internal examiners at different stages of this thesis. Their feedback and support were invaluable to its completion. A special thank you to Joe Cutting for allowing me to use his games in my research.

To my friends in Brunei, thank you for your prayers, support, and encouragement. A special mention to those in the WhatsApp groups (please don't judge our group names): BBAFPDZ, Geng Gauk, Queen Bebeh, Savings TBC Expenses, Geng Bas Sekolah, Work Ops, Geeks, and Mystery. And to N and J, who were there quietly throughout the journey, your silent support was exactly what I needed. May Allah reward you all abundantly.

Heartfelt thanks go to my friends in York, especially Areesa and Cik Pnut, for your constant support and encouragement, thank you for dragging me into adventures, joining my escapades, entertaining my food obsessions, and feeding my snack addiction. To Azie and Adri, for always being there when I needed you, and to Mia, Keyon, Amira, Aliya, Gricel, Qurats, Sourour, Mahboubeh and many others too many to name, thank you for your friendship and companionship. You were all more than just friends; you were my family while I was away from home.

To my course mates, there were many, but especially Zainab, Najla, Basmah, Holly and Kong, seeing you all working hard in the office motivated me to... well, at least pretend to work too!

To my colleagues and friends at Universiti Teknologi Brunei, thank you for your encouragement and support, for checking in on me to make sure I was doing okay (and doing my work!).

Finally, I would also like to acknowledge the Government of Brunei Darussalam and Universiti Teknologi Brunei (UTB) for their generous support in terms of resources and opportunities. Their commitment to education and research has played a significant role in enabling this work.

Fa inna ma'al 'usri Yusra, indeed, with hardship comes ease. I truly believe the people I've mentioned above, and many others, were the ease sent to me along the way.

Declaration

I, Siti Noorfatimah Safar, declare that this thesis is a presentation of original work, and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

COVID-19 Impact Statement

Due to the COVID-19 pandemic, labs were closed, and in-person experiments were prohibited from the start of my PhD in October 2020 until they fully reopened in 2022. The rapidly changing measures and restrictions during this uncertain period made it difficult to determine the feasibility of conducting in-person experiments due to the closure of and restrictions on laboratories. This caused delay in collecting and analysing data, particularly experimental data,

As a result, we conducted online surveys (Chapter 3) instead of running experiments, resulting in two studies being completed during that time.
Once it was confirmed that in-person research could resume and restrictions were lifted, we were able to design and implement the experiments. Therefore, starting from Chapter 5, the thesis will focus on experimental research.

1. Introduction

Spacewar! Was the first computer game built in 1962 as a way to test a computer's abilities in a fun way[1]. The graphics were primitive, and the game was a simple two-player game with the main objective of hitting the other player before being hit. Since then, game design has developed tremendously. Now, digital games are one of the most successful forms of digital media, with approximately 3.32[2] billion people actively playing video games worldwide. This figure highlights the widespread appeal of playing games. Meta-analysis research conducted by Hamari & Keronen, (2017) on why people play games, showed that games are not only for enjoyment but also considered to be useful. Although the outcome of their analysis did not show a definitive reason why they considered playing games to be useful, it somehow indicates that there are other motivations as to why people play games.

In the previous years, the majority of research focused on the risks and negative impact of playing games (Demetrovics et al., 2011). Now, there is a growing interest in the positive effect of playing games on mental wellbeing (Bowman & Tamborini, 2015). Research indicates that playing digital games can enhance happiness (Huang et al., 2017; Pallavicini & Pepe, 2020; Shin et al., 2012) and improve mood (Khan & Peña, 2017; Russoniello et al., 2017). The literature also shows that games can support various aspects of mental wellbeing, such as:

- Post-work recovery (Collins & Cox, 2014; Reinecke, 2009)
- Coping with life's challenges (Iacovides & Mekler, 2019)
- Reducing intrusive memories of a traumatic event (Butler et al., 2020)
- Reducing anxiety (Fish et al., 2014; Sil et al., 2013)
- Recovering from daily hassles (Reinecke, 2009)
- Managing short-term or acute stress (A. Roy & Ferguson, 2016)
- Improving mood (Bowman & Tamborini, 2015; Khan & Peña, 2017)
- Managing unpleasant experiences (Tyack et al., 2020)
- Facilitating social connections that foster meaningful relationships (Bai et al., 2021)
- Alleviating depression (de Morais et al., 2020; Khan & Peña, 2017)
- Mitigating post-traumatic stress symptoms (Butler et al., 2020)

Another aspect of mental wellbeing is stress management and recovery. Although stress is not considered a diagnosable mental health issue in the way that conditions like depression or anxiety are, chronic stress or long-term exposure to stress can contribute to serious mental health conditions, such as generalised anxiety disorder, depression, or

[1] https://www.jesperjuul.net/thesis/2-historyofthecomputergame.html
[2] https://explodingtopics.com/blog/number-of-gamers

post-traumatic stress disorder (PTSD). Furthermore, stress is also attributed to exacerbating diseases such as diabetes, immune system suppression, asthma, gastrointestinal diseases, hypertension, chronic heart disease and several others (Salleh, 2008).

Research on games and mental wellbeing increasingly considers how games may support stress relief through underlying psychological mechanisms. One theoretical framework that addresses this is mood management theory (Zillmann & Bryant, 1985) which posits that media use, including digital games can regulate emotional states by decreasing negative affect and enhancing mood. From this perspective, games may contribute to stress relief by enabling temporary emotional escape and cognitive disengagement from stressors. Empirical studies support this view: for instance, Johnson et al. (2018) argue that immersive gameplay can act as a distraction, interrupting cycles of rumination and attentional focus on stress-inducing thoughts. While some studies (e.g., such as Kühn et al. (2014) have observed structural brain changes following gameplay such as increased grey matter volume in regions related to spatial navigation and strategic planning, these reflect long-term cognitive adaptations rather than immediate affective recovery. Therefore, the role of games in stress relief may be better understood as part of a broader coping process that includes mood regulation, distraction, and attentional redirection, rather than direct physiological stress recovery.

To understand how games support mental wellbeing, this thesis explores the various playing game experiences which include playing digital game motivation i.e. the pursuit of playing digital game, game challenges, game aesthetics, and playing immersion. Unlike user experience, playing game experiences go beyond the mere interaction between user and the system's usability. It also takes into consideration the layers of experience within the video games and the effects after playing the game (Nacke et al., 2010; Wiemeyer et al., 2016). There are various aspects of player experiences; some of them include immersions (Brown & Cairns, 2004) , interaction with game elements and other players (Schell, 2014), flow (Csikszentmihalyi, 2008), and challenge (Bostan & Öğüt, 2009).

While there is growing evidence to suggest that digital games can alleviate stress and anxiety, there is still a lack of comprehensive understanding of how digital games, particularly the experience of playing digital games such the motivation to play game (pursuit of playing game), game challenges, game aesthetics and immersion relates to stress. The lack of clarity led to the central question of how playing digital games may contribute to daily psychological stress reduction.

Stress is a complex topic with multiple definitions in the literature. For this thesis, the concept of stress proposed by Lazarus & Folkman (1984) is adopted, which defines stress a psychological response to a demand when the demand is perceived or appraised as threatening or overwhelming is adopted for this thesis. In addition to stress, this thesis also explores the concept of anxiety, which, compared to stress, is characterised by a more sustained emotional state involving persistent worry and fear about future uncertainties.

While stress typically arises as a direct response to immediate external pressures and often subsides once the stressor is removed, anxiety extends beyond the present moment and is marked by feelings of apprehension, tension, and uneasiness, even in the absence of clear or immediate threat (Abd-Alrazaq et al., 2022).

Therefore, this thesis aims to investigate the effectiveness of playing digital games in alleviating daily psychological stress and anxiety arising from short-term stressor, specifically the expectation of an anxiety-inducing events. This is done by exploring both the experiences of playing digital games and psychological impact of stress and anxiety.

1.1 Research Motivation

Mental health is a serious issue worldwide. Approximately 15.5% of the global population is affected by mental illnesses, and those numbers are rising each year. Although many require treatment, over 50% remain untreated (Spillers & Asimakopoulos, 2012). World Health Organisation (WHO) has classified Mental Health as a chronic disease alongside asthma, cancer, and diabetes. Common Mental Health Disorder (CMHD) includes depression, generalised anxiety disorder, panic disorder, obsessive-compulsive disorder, post-traumatic stress disorder, and social anxiety disorder. Worldwide, 272 million people suffer from anxiety disorders alone (Pham et al., 2016).

The WHO has also declared stress a serious issue, noting that stress causes the onsets of other mental health problems such as depression and anxiety when there is a prolonged exposure to stressful events (Lau et al., 2017). Events that cause stress—which is defined as a psychological response to a demand perceived or appraised as threatening or overwhelming—can lead to feelings of being burdened, overloaded, tense, worried, and anxious. Almost everyone experiences stress in daily life. When stress becomes overwhelming, people may feel fatigued, exhausted, and unable to cope with new stressors (Chen, 2021; Fink, 2016; Lazarus & Folkman, 1984; Monroe & Slavich, 2016) .

However, chronic mental health conditions are modifiable, which means that risk can be significantly reduced by changing human behaviour (Kinross, 2018). There are many ways people can recover from stress, such as sleeping (Sonnentag et al., 2008), exercising (Berger, 1994), and having a vacation (Sonnentag & Kruel, 2006). Stress can also be reduced by promoting positive thinking and improving moods (Bartels et al., 2019).

Although we can see a rising interest in this field of research, there is still more that we can do to understand how games work to alleviate stress, especially for daily and acute stress. The work on stress and games such as those that were conducted by Russoniello, et al. (2009) and Reinecke (2009) showed how casual games or computer games can support the reduction of and recuperation from stress by improving mood and providing recovery experiences such as relaxation, mastery and control. These mechanisms could help diverts attention from stressors, regulate negative emotions, and facilitate recovery, illustrating the ways games can actively contribute to stress relief. Given that stress could accumulate over time and daily stressors are more frequent and persistent, focusing on daily stress is particularly important because it has greater potential to contribute to long-term mental health issues. Furthermore, survey data from Collins & Cox (2014) suggest that digital games are generally more effective for managing daily stress. Still, there needs to be more evidence on how the experience of playing digital games contributes to stress reduction, as the psychological mechanisms involved—such as immersion, distraction, or emotional regulation—may differ between players and contexts. Therefore, the broad aim of this research is to understand the playing experiences of digital games in relation to day-to-day stress or minor stressors and rather than addressing chronic or trauma-induced forms of stress.

1.2 Research Questions

The overarching research question for this thesis is "Can playing digital games help with reducing stress and anxiety induced by stressful event, and if so, what aspects of playing digital games support this?".

To answer this, we must examine the experience of playing games and the effectiveness of digital games in alleviating stress. This is a broad and extensive topic; therefore, to narrow down the scope of this research, this thesis aims to answer these questions:

1. Is there a relationship between playing digital games and perceived stress?
2. What aspect of playing digital game experiences help with alleviating perceived stress?
3. To what extent does playing digital games affect psychological stress and anxiety-induced by stressful events?

1.3 Research Methodology

In order to demonstrate the relevant research methods, techniques, and theoretical approaches that have been applied, this section provides detailed descriptions of the studies and methodologies employed. This research focuses on the use of quantitative research as the main methodology to address the research questions. One of the tools commonly used to explore and measure the experience of playing digital games is questionnaires (Cairns & Power, 2018). Quantitative methods are also particularly strong at studying large groups of people and making generalisations from the sample being studied to broader groups beyond the sample (Swanson & Holton, 2005). Most researchers working in this area have utilised quantitative methods and have yielded important insights in wellbeing and games research as demonstrated in the research background. This supports our decision to use quantitative and statistical research, which we believe to be the most suitable method to understand if digital games can alleviate stress.

There are two main sections for this research. The first section is the surveys on the experiences of playing digital games and perceived stress. The purpose of the surveys is to find out if there is any correlation between playing digital games and the experiences of playing digital games. Two surveys studies were conducted, and this was done primarily using online using Qualtrics. We also conducted this research online due to the COVID-19 lockdown at the start of this research.

However, it is noted that there are limitations to using surveys only. One of the issues with using surveys is the lack of causality. Therefore, in addition to using questionnaires, experimental studies were also conducted. The advantages of running experiments are that it can be conducted in a controlled manner. Secondly, it allows the researcher to induce consistent and reliable psychological stress in most participants safely. To ensure generalisability of the results, the sample sizes collected in the studies were estimated based on related studies. Additionally, to provide the most realistic environmental setup for the experiment, the experiments described in this thesis, were conducted in Home Lab, in the Department of Computer Science. The specially designed laboratory space was created to provide ecological validity when collecting data, ensuring the environment closely mimics real-life settings. The experiments in this thesis necessitate that participants be in a natural environment of being at home but without the added distraction from other factors that could potentially create confounds.

To reduce the possibilities of confounding variables in the experiment, we also measured the trait anxiety, which is the baseline stress level of the participants. In addition, experiments were kept very focused by not measuring various aspects of gaming experience. Participants were randomised when assigned to an experimental condition, and each participant was only allowed to participate once for the experiment. The experiments were replicated to confirm findings and ensure that they were not the result of confounding variables. Using the same procedures and materials across experiments minimises confounds. Each of the experiments was piloted to identify possible confounds.

When conducting experiments, especially in understanding human behaviour, there will be elements of deception. This is commonly employed in the field of Psychology. Although, this could have ethical implications, procedures were put in place to ensure that no undue harm would be caused to the participants; details are in experimental design in Chapter 4 of this thesis.

In experiments 1 and 4, we also collected qualitative data using open-ended questions. This was to provide the researcher with additional information beyond what the survey could provide. A brief qualitative analysis was conducted, and the responses were tabulated to determine themes within the responses.

1.4 Research Contributions

The key contributions of this thesis are:

- Games can reduce stress, but they are not special; other activities also offer similar benefits. This suggests that the act of engaging in distraction helps individuals escape temporarily from stressors.
- The level of engagement (immersion) does not influence the reduction of stress.
- Additionally, this work demonstrates that the adaptation of the Trier Social Stress Test (TSST) provides a reliable and standardised method to induce anxiety or anticipatory stress in a controlled setting.

1.5 Ethical Considerations

Prior to each one of the surveys and experiments, ethics approval was first obtained. The ethics application was submitted to the University of York Ethics Committee, and approval was obtained before running the studies. Pilot studies were also conducted for all studies. Data collected were anonymised and kept confidential. In the experimental study, participants' personal information, such as their names, were removed and replaced with participants' IDs. File and data were only accessible to the researcher and the supervisor. All data were kept in a secure file with password-protected systems to prevent unauthorised access. Online surveys were designed and distributed using Qualtrics, which is an online survey tool that is equipped with password-enabled access. The data collected for the experiments were also collected using Qualtrics and were automatically managed and secured by the application.

All the research in this thesis was performed with due care for the participants who participated in the experiments and the impact of the research on the wider world. The research was performed according to the University of York's Code of Practice on Research Integrity. Each experiment was pre-screened by the Ethics Committee in the Department of Computer Science to ensure that it conformed to these guidelines. Participants were all at least 18 years old and did not belong to any vulnerable groups. In particular, care was taken to consider participant welfare, the anonymity and confidentiality of participants' data, and that they had given informed consent to participate in the experiment. These issues are described in more detail below.

Research conducted for this PhD is guided by the principles of ethical consideration, in line with the University of York's ethical guidelines. All the participant taking part in this research was fully briefed about their rights before taking part in any of the studies. All experimental studies described in this thesis followed the ethical principles of 'Do No Harm', 'Anonymity and Confidentiality', and 'Informed Consent'.

1.5.1 Do No Harm

No participants in any of the studies conducted during this research were put in any harmful situations. The experiments were designed so that participants would not be subjected to any physical harm. Although the research involves causing psychological distress, participants were informed via email before attending the experiment that they would be performing tasks that could be perceived as stressful in the Participant Information Sheet. Additionally, digital games that players engaged with did not contain violence, blood, or gore and were considered as casual, inviting, and friendly gameplay. Participants were also briefed before the experiment that they could stop and leave anytime without any repercussion. Their data would be destroyed upon request.

In the event of the panic attack during the experiment, the experiment was stopped immediately and the participant were asked to perform grounding exercise (advice from the wellbeing officer). This exercise is used to calm the participant down. The details of the exercise can be seen in Appendix A. If further help was needed, participants were directed to the wellbeing officer, or "Open door" which is the university practitioners working and available at the university.

1.5.2 Anonymity and Confidentiality

All studies were designed with due care and in accordance with the University's Code of Practice and Principles for Good Ethical Governance so that no participants were put in situations which might cause physical harm, mental discomfort, or distress unnecessarily. This includes harm to the welfare and interests of human participants (whether participating actively or through observation/use of their data) and harm to the welfare and interests of the wider community. The primary researcher has also undergone Ethical Research and Data Management Training before starting the study.

1.6 Data Management Plan

The data collected from all the studies were documented and stored throughout the project lifecycle while addressing the data protection and confidentiality issues. To ensure the data was managed properly, data collected and compiled from each study was recorded in the Data Management Plan provided by the university. To ensure the security of the data, depending on the data collected, digital data were stored in the university file store or the university's cloud storage, or otherwise in designated storage in the department, with two secure barriers, i.e., a locked cabinet in a locked room which is only accessible to the primary researcher and supervisor.

2. Research Background

The overarching research question of this thesis is: “Can playing digital games help with reducing stress, and if so, what aspects of playing digital games support stress reduction?”. To address this question, the literature will explore various concepts related to wellbeing, stress, anxiety, and gaming experiences. It begins by examining the implications of stress on wellbeing followed by a comprehensive discussion on the concept of stress, including its definition, causes (stressors), and the management of stress. Given the conceptual and biological overlap between stress and anxiety, and the ways in which they occur, this thesis also considers anxiety as a relevant construct. Understanding this overlap is important, especially in the context of experimental design and measurement.

To understand how digital games can support the reduction of stress and related anxiety, the thesis also discusses the various frameworks to explain how games work in alleviating these conditions. This is followed by the consideration of the motivations behind gaming and the overall gaming experience. The last part discusses methodologies adopted to select the right measures for stress and the protocol for conducting stress experiments. The review concludes by identifying the research focus and the methodologies suitable for this thesis.

2.1 Stress and Wellbeing

Stress can affect both mental and physical health (Slavich, 2016). Stress is a fundamental part of life (Monroe & Slavich, 2016), stress can cause disruptions to daily emotions and mental wellbeing (Spillers & Asimakopoulos, 2012). It has been associated with the onset of mental disorders such as anxiety and depression (Pascoe et al., 2017). Extensive research indicates that stress is linked to various major health conditions, including asthma, ovarian and breast cancer, rheumatoid arthritis, cardiovascular disease, chronic pain, and human immunodeficiency virus/AIDS (Slavich, 2016).

Physiologically, stress depletes energy levels, primarily due to sleep disturbances, this also reduces motivation to perform tasks (Brosschot et al., 2014). In the workplace, prolonged exposure to high stress levels can result in ‘burnout’, characterised by emotional exhaustion, depersonalisation and a diminished sense of personal accomplishment (Howard, 2008). Additionally, stress can lead to behavioural changes such as increased smoking, decreased in physical activities and poorer adherence to medical regimens, all of which could worsen major health conditions (Iwata et al., 2013; Montag et al., 2021).

Given these detrimental effects of stress, effective stress management is crucial. This process involves restoring emotional and mental states to normal levels (Howard, 2008).

Exploring effective methods for managing stress is essential for mitigating its long-term impacts. In the context of this thesis, the focus is on identifying effective interventions for stress, specifically through the use of digital games, by investigating how digital games can serve as a tool for managing daily stress and anxiety.

2.2 The Concept of Stress – Stress, Stressor and Strain.

Cohen et al. (1997) conceptualised stress into three perspectives: environmental, psychological, and biological. Environmental stress is conceptualised as stressful life events that could lead to various physical illnesses such as heart disease and skin disease. Psychological stress refers to an organism's perception and evaluation of the potential harm posed by environmental experiences. When the environmental demands are perceived to exceed their ability to cope, individuals label themselves as stressed and experience a concomitant negative emotional response. The biological perspective focuses on the activation of physiological systems that are responsive to physical and psychological demand. The prolonged exposures to these demands could lead to the development of a range of both physical and mental disorder. The two most common biological response to stress is the activation of the sympathetic-adrenal medullary system (SAM) and the hypothalamic-pituitary-adrenocortical axis (HPA) (Reisman, 2014; Sharma, 2018).

Several definitions of stress exist in the literature; this is not surprising, as it is not a new concept. It should be noted that we do not aim to redefine stress or introduce new definitions instead to adopt definitions that aligns with its focus on psychological stress and negative affect in response to everyday challenge, rather than physiological or endocrinological stress response.

People experience stress every now and then; while stress is associated with various emotions (Butler et al., 2020), it extends beyond a feeling. Some of the definitions of stress found in literature includes:

- An event external to the individual that places a demand on him/her (Kahn et al., 1964).
- A characteristic of the environment that poses a threat to the individual (Caplan et al., 1975).
- A state which results from a misfit between a person's skills and the demand placed upon him/her (French et al., 1974).
- Demands of a situation outweigh the individual's perceived psychological and physiological ability to cope with it effectively (Cohen et al., 1997).

From these definitions, two clear concepts emerge from this set: (1) stress is induced by external events, environments, states, or demands, and (2) there is a corresponding response or effect from these stressors. Eden (1982) distinguished stress as three main concepts: Stress, Stressor and Strain. Stress is a property of the environment as it is experienced by the person and represented in their consciousness, while strain is an individual's maladjustive psychological and physiological response to stress. Following Eden's concept of stress, the response here is known as strain, and the response are either psychological or physiological or both. Irrespective of the terms used, it is evident that stress is not a singular concept but rather a cause-and-effect phenomenon.

Similarly, Lazarus & Folkman (1984) emphasises the causal effect of cognitive appraisal and coping on stress. They developed the Transactional Model of Stress and Coping which explains that stress is a dynamic interaction between an individual and the demands of their environment. What distinguishes their definition from the others is that they further elaborate, when a demand is perceived as significant, the individual evaluates their resources for coping.

The concept that stress occurs when the demand is appraised as taxing or exceeding available resources, highlights that stress is a psychological effect that can lead to feelings of distress and negative emotions, which also triggers the body's physiological stress response (Cohen et al., 2007; Lazarus & Folkman, 1984). It also implies that the perception of stress is more critical than the actual cause. This idea is well captured by (Cohen et al. (1983), who assert that stress occurs only when an event is perceived as stressful, making stress an individualistic experience.

One of the earliest studies on stress was conducted by (Selye, 1976), which explored the relationship between stress and disease. In the experiments, rats were subjected to extreme temperatures, prolonged hunger, and forced exercise on a running wheel for extended periods. These extreme conditions triggered an internal reaction and caused physiological changes, such as stomach ulcerations, shrinkage of lymphoid tissue, and enlargement of the adrenal glands. These findings demonstrated that stress causes physiological response. Similarly, people also experience a physiological stress response, which could lead to illnesses. Selye's definition of stress is criticised because it only focuses on the biological aspect of stress

One significant effect of stress on human physiology is the activation of stress hormones such as adrenaline and cortisol (Bates et al., 2017). When a person is confronted with stressful events or stressors, the body reacts by entering a "fight-or-flight" mode, deciding whether to face or flee from the threat (Reisman, 2014). In response, adrenaline is released to increase heart rate, elevate blood pressure, and boost energy supplies needed to confront or escape the threat (Howard, 2008). Cortisol, on the other hand, is released to increase blood sugar levels, regulate metabolism, reduce inflammation, and enhance the availability of substances required for tissue repair. While the activation of these hormones is not inherently harmful, prolonged exposure and repeated activation can lead to cumulative wear and tear on the body (McEwen, 1998), as well as other health issues such as diabetes due to the constant release of cortisol (Lloyd et al., 2005). When a person is exposed to prolonged stress, the management of cortisol levels becomes challenging and can increase the risk of diabetes (Nicolson, 2008). It has also been shown that stress can alter or suppress the immune system and inflammatory pathways, making the body more susceptible to infections and chronic inflammatory conditions (Crosswell & Lockwood, 2020).

In summary, three key concepts of stress have been highlighted: stressors, are what caused stress, this is followed by the psychological effect, where the appraisal of stressors as significant can lead feelings of stress; and lastly, the physiological effects of stress, the causes chemical changes in the human body. Collectively, these elements contribute to our understanding of stress as a multifaceted phenomenon and the overlaps of these concept are what we know as stress.

In this thesis, we will adopt stress as a psychological concept by Lazarus & Folkman, (1984). We opted for this concept over the other for several reasons. Firstly, they conceptualise stress as the initial response that arises from an individual's perception of the environment which could eventually lead to feeling stressed. This early appraisal of stress is important, as not only it shows that stress could be mitigated before it becomes worse but also it allows the management of stress through various coping mechanisms.

Secondly, it fits our research area as we are looking at how games can be used as a way to alleviate stress, particularly regarding the experience of playing digital games on stress. Since, Lazarus and Folkman's model is based on how individuals perceive and cope with stress, it aligns with our goals to examine how gameplay affects stress level. By applying their model, we can assess how players' cognitive appraisal during gameplay influences their psychological responses to stress. Furthermore, playing digital games often involve cognitive engagement, such as problem solving, strategic thinking, and decision-making, which are presented as challenges in games (Bostan & Öğüt, 2009; Brandse & Tomimatsu, 2013; Cox et al., 2012; Denisova et al., 2020), which can influence how stress is managed. Given that both playing digital games and coping with stress require cognitive processes, Lazarus and Folkman's model allows us to explore how these processes interact. While this research adopts a psychological definition of stress, it uses induction methods like the Trier Social Stress Test (TSST), which are traditionally associated with physiological stress responses. However, the focus remains on subjective, self-reported stress and anxiety, rather than physiological or endocrinological measures. This distinction is important, as correlations between physiological indicators and self-report data are often weak, reinforcing the need to clearly define the scope of the study.

2.2.1 Differences between Psychological and Physiological Stress

In this section, we focus on the distinction between psychological and physiological stress. Although stress is often described as a singular experience, it actually comprises of two yet distinct interconnected components. Psychological stress refers to how a person perceives and appraises a stressor, whereas physiological stress describes how the body responds biologically to that stressor. In stress and stress-related research, both subjective measures (e.g. self-report questionnaires) and objective measures (e.g. cortisol levels) are often used to determine the level of stress.

A number of studies have examined both types of stress responses and found that psychological and physiological outcomes do not always correlate. For instance, discrepancies have been observed across various biomarkers, such as cardiovascular response (Porter & Goolkasian, 2019) and cortisol (Galantino et al., 2005). It is entirely possible for an individual to experience elevated physiological arousal without reporting subjective feelings of stress, especially in situations that involve excitement or challenge, such as competitive gameplay (Blascovich & Tomaka, 1996; Vedhara et al., 2003).

One commonly used biomarker for assessing physiological stress is the hormone cortisol, which is released during stressful situations as part of the “fight-or-flight” response (Hellhammer et al., 2009). However, as Hellhammer et al. (2009) point out, cortisol levels are highly sensitive to multiple biological and contextual variables. This introduces confounds that distorts the relationship between perceived stress and cortisol, particularly affects the correlation between perceived stress measured through self-reporting and cortisol level, which are often collected from saliva.

Additionally, Kudielka et al. (2009) noted that salivary cortisol regulation and response to stress challenges vary between individuals and can be influenced by several moderating factors such as smoking, caffeine consumption and oral contraceptive use, making it difficult to control for all these variables in each study. They further added that researchers need to account for factors that might influences cortisol levels when planning experiments, such as the time of day which could affect the circadian rhythms, or menstrual cycle phases in female participants, which could also affect the cortisol responses. It was also indicated that cortisol level could be affected by tasks (Dickerson & Margaret E. Kemeny, 2004). This could lead to the misalignment particularly studies involving gameplay, where heightened physiological arousal may occur without subjective stressor. This, however, does not mean that biomarkers should be avoided, Instead, it highlights the need to select stress measure that are conceptually aligned with the research aims.

Therefore, the decision in this study to focus solely on psychological stress is both deliberate and appropriate. A detailed discussion of the differences in how psychological and physiological stress are measured is presented later in Section 2.6.2.

2.2.2 Different Types of Stressors

Distinguishing between stressors is important as they may result in different outcomes which may require different measures and methodology for research (Epel et al., 2018; Payne, 1982). Stressors have been characterised in various ways. Holmes and Rahe (1967) characterised stressors by life events and it can be ranked by the degree of change it causes. We can find a number of studies in literature that focuses on life events: unemployment (Kasl & Cobb, 1980), bereavement (Stroebe et al., 2002) and financial problems (González & Vives, 2019). These events are considered severe stressors because they have greater impact but happen less frequently (De Aquino Lopes et al., 2014).

Contrary to life events, day-to-day stresses are hassles experienced that could happen frequently and have a relatively lower impact (DeLongis, Folkman, Lazarus, et al., 1988). Similarly, Crosswell & Lockwood (2020), also differentiates daily stress as interruptions or difficulties that happen frequently in daily life such as being late for appointment, arguments with one's spouse, and problems with one's car. Daily stress occurs more frequently but has a lower impact (DeLongis, Folkman, & Lazarus, 1988); however, long exposure to daily stress can build up over time to create a persistent frustration that aggravates illnesses (Bai et al., 2021). Additionally, certain daily stressors, such as microaggressions and experiences of racial or ethnic discrimination, contribute to chronic stress particularly in minority populations. For example, research shows that Latino individuals in the United States face higher rates of depressive symptoms compared to non-Latino Whites, a disparity linked to increased exposure to social stressors like discrimination (Torres & Taknint, 2015.). This underscores the significant long-term health effects that persistent and socially embedded daily stressors can have.

Stress is also characterised as acute or chronic. Acute stress is short-term, event-based exposures to threatening or challenging situations, such as giving a public speech (Bassett et al., 1987). According to Pratt & Barling (1988) chronic stress is defined as lasting a long time or recurring. They further characterised stress into four dimensions: specificity of time-onset, duration frequency or repetitiveness, and severity. Table 2.1 shows the categories and dimensions for each of the stressors. These dimensions vary and are independent of each other. Using this framework of stressors, they categorised stressors into mainly acute, chronic, daily hassles, and disasters.

Table 2.1
Categories of Stressors

	Specificity of time-onset	Duration frequency	Repetitiveness	Severity
Acute Stress	Specific	Short-term	Infrequent	High
Chronic Stress	Less defined	Long-term	Frequent	Constant
Daily Hassles	Specific	Short-term	Infrequent	Low
Disasters	Specific	Short or Long-term	Extremely Infrequent	Life threatening

Note: Reprinted from *Occupational Stress: Issues and Developments in Research* by Pratt & Barling (1988)

Others have termed acute stress or daily hassles as minor stressors such as being late for an appointment or problems with one's car (DeLongis, Folkman, & Lazarus, 1988) in comparison to chronic stress or life events such as the death of a loved one or being in a car crash (Tausig, 1982). McGonagle & Kessler (1990) further added that acute stress refers to events that cause stress that occurred within 12 months prior to the interview for the survey they conducted. Meanwhile Chronic Stress is defined as having occurred more than 12 months before the interview. They further provide the example of job loss and death of a loved one as acute stress.

Therefore, for the purpose of this research we will look into the effect of playing digital games on psychological stress and the potential of games to alleviate daily hassles or day-to-day stresses and acute stress, as these are both short-term and happen quite infrequently.

2.2.3 Strategies for Coping and Managing Stress

Individuals use different strategies to manage and cope with stress (Miller et al., 1988). Coping refers to the strategies that people use to manage and protect themselves from challenges and stresses in life (Pearlin & Schooler, 1978). Lazarus & Folkman (1984) defined coping as the ongoing cognitive and behavioural efforts to manage specific external and internal demands that are appraised as stressful. Their model suggests that, after the initial appraisal of the stressor, individual assess the resources available (both internally and externally) to cope with it. If the stressor is appraised as threatening, they then implement appropriate coping strategies.

Lazarus & Folkman (1984) also categorised coping strategies into two types: problem-focused and emotion-focused. Problem focus involves addressing the source of stress directly by confronting the threat and taking action to reduce stress. This may include proactively seeking information and problem-solving. Conversely, emotional coping focuses on regulating negative emotional responses, often through strategies like social support, cognitive reappraisal (reinterpreting the situation positively), distancing from stressors to create space between the person and the stressful situation. Escape-avoidance (avoiding the stressor or withdrawing from the situation either physically or psychologically by shifting g focus away from problem or engaging in behaviours that allow temporary relief) is also part of this strategy. Based on this framework, playing digital games could be viewed as an emotion-focused coping strategy, because it shifts the individual from the cause of stress by engaging activities within the digital game.

Similarly, Miller et al. (1988), also categorised coping styles into two types: 1) monitoring and 2) blunting. According to them, individual have different coping-styles preferences, some are high monitors and low blunters, while others are low monitors and high blunters. High monitors tend actively to seek out information about the threat, in order to stay informed and aware. In contrast, high blunters, cope well by cognitively distracting themselves and psychologically blunting or avoiding threat-relevant information.

Similarities can be drawn from both model of coping concepts. In both frameworks, coping involves managing the emotional and cognitive impact of stress. High monitors are akin to problem-focused coping in Lazarus & Folkman (1984), where individuals confront the source of stress by gathering information. On the other hand, high blunters, are similar to emotion-focused coping strategies like distancing or escape-avoidance.

Miedziun & Czabała, (2015) also discussed various techniques for managing stress. In the survey study they conducted, they identified three main categories of stress management techniques. The first category is physical activity, which includes activities like exercising and physical work. The second category is replacement gratification, which involves engaging in enjoyable activities such as listening to music, reading or any creative activities such as drawing or writing poems. The final category, distancing, where individuals emotionally or cognitively separate themselves from the stressor. Their study also found that the most common techniques for dealing with stress were listening to music, planning future activities, meeting with friends. These are various forms of replacement gratification which are considered as emotion-focused coping. They also highlighted that problem solving and reinterpreting and rationalising the stressful situation are techniques that are commonly used, which fall under for problem-focused coping style.

They further added that, during the periods of heightened stress, individuals often resorted to more passive coping mechanism, such as distancing and passivity as a way to cope with overwhelming emotions. Cognitive distancing, or distraction, is an attempt to avoid thinking about something distressing (Larsen & Christenfeld, 2011). Several studies have investigated the effects of distraction on blood pressure recovery from stress reactivity, finding that it can facilitate faster recovery. Following a stressful task, individuals who were provided with a distraction, demonstrated a faster recovery to baseline compared to those who were not. This is because the distraction prevents cognitive fixation on the stressors (Glynn et al., 2002).

This supports the idea that people have varying coping styles and that the strategies they use may shift depending on the level of stress they experience. As stress intensifies, individuals may transition from active coping to passive coping, showing the adaptive nature of coping mechanisms. This perspective is also supported by mood-management theory (Knobloch & Zillmann, 2002), which suggest that individuals actively select media such as music, films or games, to manage their affective sates. For instance, people in negative mood may seek our highly energetic of joyful media content to improve their mood. In this way, media consumption becomes a strategic mood-regulating behaviour. Applied to this context, playing digital games can serve as a deliberate, emotion-focused coping mechanism aimed at mood repair or stress relief.

While, the categorisation of coping and identification of coping styles are important, they are not the primary purpose of this thesis. These frameworks are useful for understanding how playing digital games fits within the coping mechanism. Based on various descriptions of the experience of playing games, which will be explored in the following sections. Playing digital games can be viewed as an emotion-focused coping strategy, also known as high blunters. Additionally, playing digital games can also be considered as passive coping mechanism by providing distance to the individual from the stressors.

However, to fully understand how individuals experience and respond to stress, it is also important to consider the role of anxiety. Stress and anxiety are conceptually and biologically intertwined, and many stress-inducing situations also provoke anxiety responses. Therefore, the next section will examine the relationship between stress and anxiety to further clarify their overlap and relevance to this research.

2.3 Stress and Anxiety

Another psychological condition that significantly impacts mental wellbeing and closely overlaps with stress is anxiety. According to Barnes & Prescott (2018) the number of adolescents suffering from anxiety disorder has increased by 70% since the mid-1980s. Like stress, anxiety is brought is a common response to challenging situations (Fish et al., 2014b). Stress and anxiety share considerable conceptual overlap, often making it difficult to distinguish between them. Both conditions arise from perceived threats or pressures and can trigger similar emotional and physiological reactions, such as increased heart rate, muscle tension, and heightened alertness. And similar to stress, when the feeling of anxiety becomes excessive or overwhelming, anxiety disorders can manifest, including impairments in cognitive, physiological, and behavioural states (Fish et al., 2014b). However, despite these similarities, stress and anxiety differ in their underlying mechanism and triggers.

As previously discussed, stress is typically a response to external pressures or immediate challenges, often subsiding once the stressor is removed. In contrast, anxiety extends beyond the present moment, characterised by persistent worry and fear about future uncertainties. Anxiety, like stress, is considered a normal response to life situations and is often marked by feelings of apprehension, tension, and uneasiness (Abd-Alrazaq et al., 2022). Some researchers define anxiety as a temporarily diffused emotional state triggered by a potentially harmful situation, even when the likelihood or certainty of harm is low (Goes et al., 2018). While both stress and anxiety can lead to behavioural disturbances, stress typically occurs as a direct reaction to present circumstances, whereas anxiety often involves anticipation of potential threats.

Stress and anxiety overlap because they share similar physiological and psychological responses, but they are distinct in their causes and how they manifest. Both stress and anxiety activate the sympathetic nervous systems, triggering the release of cortisol and adrenalins. This leads to fight-or-flight responses like increased demonstrated when one is feeling stressed.

Belzung & Griebel (2001) further characterized anxiety into two types: state anxiety and trait anxiety, depending on the duration of its effects. State anxiety is an acute response to a potential threat, while trait anxiety is chronic, manifesting as a persistent characteristic of an individual's personality (Endler & Kocovski, 2001; Spielberger, 1983). State anxiety is often triggered by acute stress and primarily functions to help individuals avoid dangerous situations (Roozendaal et al., 2009). In contrast, trait anxiety reflects an individual's predisposition to experience anxiety consistently, which can increase the likelihood of heightened state anxiety in potentially threatening situations (Endler & Kocovski, 2001).

In the event of physiological stress such as the loss of blood during an accident, physical changes occur in the body. Meanwhile perceived stress or psychological stress, include situations that are not just imminent but situation that could potentially happen (Daviu et al., 2019). This concept of anticipation is what sets stress and anxiety apart.

While stress and anxiety are distinct concepts, they often share overlapping features and can influence each other. For the purpose of this thesis, the primary focus will be on stress. The concept of anxiety on the other hand will be addressed explicitly in sections where its differentiation from stress is critical to the discussion.

2.4 Understanding Digital Games on Wellbeing

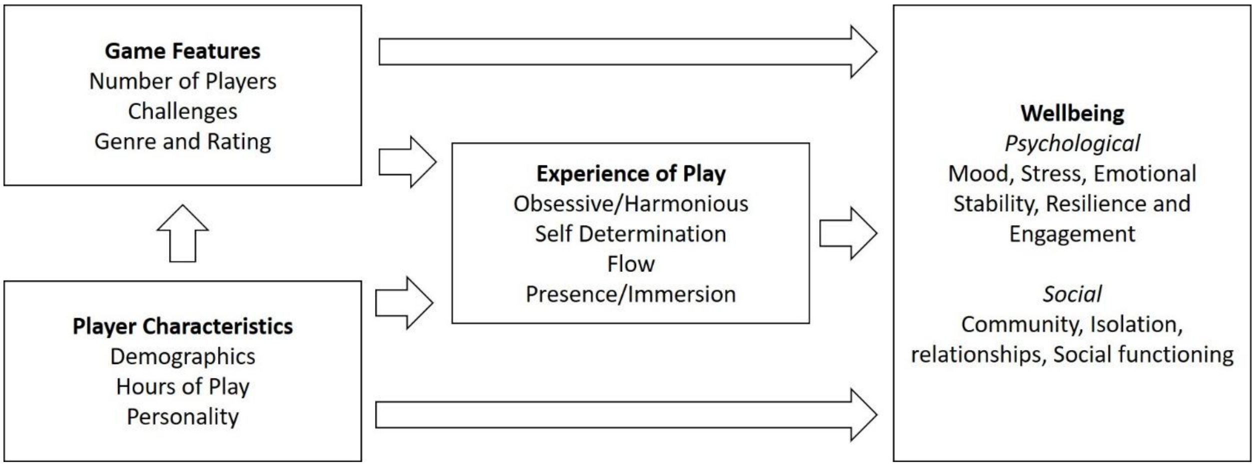
Digital games have proven to be an effective tool for managing stress and supporting psychological wellbeing (Bowman & Tamborini, 2012; Tyack et al., 2020). Several frameworks have been proposed to explain how games support wellbeing. De Aquino Lopes et al. (2014) presented four basic features of the recovery process: psychological detachment, relaxation, mastery experience and control during leisure time. Games are also said to provide the condition for psychological recovery by steering individuals away from negative thoughts (Collins et al., 2019). Both highlights the importance of psychological detachment for recovery.

One of the prevalent concepts is the Self-Determination Theory (SDT) by Deci & Ryan (1985, 2000). According to the SDT model, individuals have three basic psychological needs: autonomy, competence and relatedness. When these needs are fulfilled, individuals are more likely to be intrinsically motivated and experience positive outcomes. Within the SDT, autonomy is described as the feeling of freedom and choice while engaging in an activity, while, competence relates to the desire to feel effective and capable. Ryan et al. (2006) related autonomy and competence to the experience of user-friendly tools and intuitive controls (IC) in games. For example, their research with *Mario 64,* a simple platform game, showed that games with intuitive controls, could increase the experience of autonomy and competence, leading to a short-term positive effect on players. On the other hand, Lee & Chen (2022) found that a sense of control derived from playing digital games is associated with supporting intrinsic needs of autonomy for those who were experiencing stress due to unemployment. They also found increasing play time, positively linked with perceived wellbeing.

Relatedness is another key component of SDT, which focuses on the need for social connection and emotional support. This fosters a sense of belonging, and reduces the feeling of isolation, all of which are important factors in managing stress (Johnson et al., 2013). In digital games, relatedness facilitated through multiplayer modes or online communities, which allow players to connect and interact with others. Further, playing games creates positive emotions, engagement, relationships, meaning, and accomplishment (Bai et al., 2021). Because games are now connected, relationships can be built through Interactive online games that enable players to socialise and develop meaningful relationships without any space or time limits (Bai et al., 2021).

Building on SDT principles, the People-Game-Play Model of Videogames and Wellbeing Figure 2.1 by Johnson et al. (2013) illustrates how specific features of games player traits influence wellbeing. The model postulates that the experience of play on wellbeing is determined by game features and player characteristics, but wellbeing is not determined by experience of play alone. This is based on several studies they conducted, where they found that when personality (player characteristics) interacts with game features it could bring about a positive influence and consequently, improve wellbeing. Similarly, preference for and experience of playing games (game features) are key factors related to the level of need satisfaction and wellbeing experienced by players. They also found differing impact on enjoyment and wellbeing between, solo players, playing online with others and playing offline. This is in line with the SDT, which highlighted that social connectivity could support motivation and recovery.

Figure 2.1
The People-Game-Play Model of Videogames and Wellbeing



Note: reprinted from *the people-game-play model for understanding videogame's impact on wellbeing* by Johnson et al. (2013)

Previously, it was discussed that playing games can be seen as emotion-focused coping strategies. This approach mainly involves diverting attention from stressor to manage emotional response. This aligns well with the SDT, which also supports emotion-focused coping strategies. SDT emphasises the importance of fulfilling basic psychological needs to achieve psychological wellbeing. The people-game-play model, which integrates SDT principles, also supports the notion that games positively influence emotional wellbeing. This model not only confirms the benefits outlines by SDT but also highlights the contribution of playing experience to wellbeing, such as flow and immersion. The key difference is that SDT focuses on psychological needs in fostering positive emotion and overall wellbeing, whereas the People-Game-Model focusses on in-game experiences that are more specific to playing games.

Beyond the frameworks discussed above, additional game elements, such as game narrative, sound and visuals also contribute to the overall experience of playing games, and also support mental wellbeing (Birk et al., 2018). Narrative is the element in the game that enhances the emotional engagement of user via empathy and identification with in-game characters (Alexiou & Schippers, 2018). In the ongoing research conducted by Agrawal et al. (2018), they used narration in the game they developed called *Journey* to create a positive effect for those undergoing phases of anxiety and depression. The game consists of various scenarios that the players play to create the positive effects. Lau et al. (2017) attribute the positive impact of playing games to their visual and interactive design, as well as their immersive characteristics. They assert that these elements provide an alternative world that encourages learning and exploration, leading to meaningful, engaging, and challenging experiences. These experiences, in turn, may contribute to positive structural brain changes in regions associated with various mental health disorder as games offer a form of engagement that not only provides distraction due to their elements, but also allows for cognitive and emotional processing in a controlled environment.

There are different aspects of digital games that contribute to the overall well-being. The framework showed games could provide the psychological and emotional support needed in times difficulty. It also highlights the different experiences of playing games and how it supports wellbeing. Although this thesis does not directly apply any of the frameworks described above, it highlights the potential of playing digital games for well-being. The varied experience of playing digital games and their implications for wellbeing are explored further in the following section.

2.4.1 Coping with Stress using Digital Games

According to Demetrovics et al. (2011), individuals facing stressful situations often employ techniques such as cognitive disengagement from stressors or distancing to cope with stress. They also added that, one of the primary motivations for playing games was to forget daily problems, hassles and unpleasant feelings. Playing games provides the platform to escape from real life and reduce tension by creating pleasurable experiences. A study conducted by Kühn et al. (2014) found that playing games like Super Mario can induce positive structural brain changes in regions associated with mental health disorders, likely due to the cognitive and motor skill challenges that games present. Their study, which focused on cognitive function, aligns with Demetrovics et al. (2011) findings on the role of games to escape real-life stressors through a coping-escape mechanism.

Other researchers have provided evidence of gaming's role in stress management is from Reinecke (2009) and Collins et al. (2019). They demonstrated that both commercially available games and those designed specifically for wellbeing can support post-work recovery from stress and strain. Commercial games such as Lego: Marvel Superheroes have been shown to decrease stress levels over time, as indicated by reductions in self-reported stress and physiological markers like heart rate variability (Roy & Ferguson, 2016) and casual games like Bejeweled 2, Bookworm Adventures and Peggle are shown to aid relaxation and reduce physical stress, assessed through measures such as heart rate and cortisol levels (Russoniello et al., 2009). Moreover, games like Sushi Cat 2 showed greater engagement and affective restoration in response to stress (Rupp et al., 2017) compared to using guided relaxation, measured via self-report mood scales and behavioural engagement metrics (Rupp et al., 2017). Pesky gNATs, a purposely built game for recovery also showed success in supporting mental health interventions for adolescents, evaluated using psychological wellbeing questionnaires and clinical assessments (Coyle et al., 2017).

Specific studies highlight the benefits of different types of games. Fish et al. (2018) observed that casual video games such as Plant vs. Zombie, led to significant decrease in anxiety after one month of playing compared to the uptake of two types of medication in a severely depressed participant. In cases of extreme acute stress disorder, Horsch et al. (2017) found that playing a short session of Tetris diminishes acute stress disorder and the frequency of intrusive traumatic memories for participants who experience stress after emergency caesarean section. It provides a brief cognitive distortion from the traumatic event, though it did not affect general anxiety and depression.

Virtual reality (VR) games, as explored by Pallavicini & Pepe, (2020) have also shown to induce positive emotions and diminish negative emotions and state anxiety. Comparing exergames like Audioshield and casual video games, like Fruit Ninja VR. They found VR games is important in determining the increase positive emotions and decrease in negative and state anxiety. Conversely, Snodgrass et al. (2011) analysed if problematic online gaming is a response to life stress. Using World of Warcraft (WoW). They found that for highly stressed individual, their level of perceived stress magnifies rather than reducing their stress, while less stressed individuals find playing WoW to be enhance their lives.

In exergames, Huang et al. (2017) found playing Your Shape Fitness Evolved, reduces perceived stress and enhances vigour and happiness for 337 participants. Similarly, Singh et al. (2017) and Viana et al. (2021) that found the exergames Wii Sports Tennis and Wii Sport Bowling and Zumba Fitness resulted in a reduction in the anxiety and subscale after intervention for adults with physical disabilities. A single exergame session reduces state anxiety for women respectively.

Further evidence of gaming's role in stress management comes from Bouchard et al. (2012), who explored the efficacy of using visual and auditory biofeedback in games like Left 4 Dead for stress management among soldiers. Their results showed significant reduction in cortisol levels, indicating that such games can be effective in managing physiological stress response.

Collectively, these studies support the potential of digital games in managing stress through various mechanisms, including cognitive engagement, emotional distraction, and physical activity. However, the effectiveness of games can vary based on individual stress levels and the type of game, underscoring the need for further research to optimise their use in stress management and wellbeing; however, their effects can be complex and context dependent. It is important to note that many of these studies involve larger or acute stress events, such as trauma, clinical conditions, or work-related strain, whereas this thesis focuses specifically on daily hassles, frequent, lower-impact stressors. Given this difference in scope, some findings may not directly generalize to everyday stress experiences. Therefore, further research is needed to explore how commercial games support coping with daily stress by examining players' experiences rather than solely focusing on game content or physiological outcomes.

2.4.2 Coping with Anxiety using Digital Games

As discussed in the previous section, digital games serve as effective coping mechanisms for stress. Similarly, their potential for addressing anxiety has gained increasing attention, particularly due to the overlap between stress and anxiety in psychological research and in frameworks such as SDT and People-Game-Play-Model. Like stress, anxiety is a common emotional response to perceived threats, but it differs in that it often involves persistent anticipation of future harm rather than reaction to a present stressor. Given the conceptual and physiological overlap between stress and anxiety, it is not surprising that digital games have also been studied in the context of anxiety relief. Several researchers have examined how different types of games ranging from serious to therapeutic and commercial games can help alleviate anxiety symptoms, particularly, state anxiety.

For instance, Abd-Alrazaq et al. (2022) conducted a systematic review on the effectiveness of serious games in alleviating anxiety. Their findings suggest that exergames can be as effective as conventional exercises in alleviating anxiety, and that cognitive behavioural therapy (CBT)-based games are more beneficial than no intervention at all. Similarly, Barnes & Prescott (2018) reviewed therapeutic games designed for adolescents and found consistent evidence that such games help reduce anxiety symptoms. These studies highlight the therapeutic potential of games not only for stress management but also for anxiety treatment.

These studies demonstrate that playing games whether serious, therapeutic, or commercial can help alleviate anxiety. In the case of commercial video games, Kowal et al. (2021) found substantial evidence suggesting that such games could benefit individuals experiencing anxiety. One notable study by Fish et al. (2014) specifically examined the use of casual video games for anxiety reduction. They conducted an experiment using three popular casual video games; Bejeweled II, Peggle, and Bookworm Adventures to determine the impact of playing these games on anxiety. Participants were prescribed their chosen game for a one-month period, with a minimum playtime of 30 minutes per session, three times a week. The findings revealed that playing these games led to an immediate reduction in anxiety, particularly among individuals with depression. These benefits may be partially explained by how these games satisfy players' psychological needs such as autonomy and competence as proposed by the Self-Determination Theory, reinforcing intrinsic motivation and reducing negative affect.

In addition to individual experimental studies, recent meta-analytic work by Dondio et al. (2023) examined broader effectiveness of game-based interventions in reducing specific forms of anxiety, such as maths anxiety. These reviews suggest that while game-based interventions can be beneficial, their effectiveness often depends on the type of game and how it is implemented. Notably, non-digital games that encourage collaboration and social interaction tend to be more effective in reducing anxiety. In contrast, digital games particularly single-player ones with shorter durations appear less impactful. While the study reviewed outcomes across various game-based interventions, the observed differences in efficacy highlight the need to consider specific gameplay elements when seeking to understand how games may reduce anxiety.

Importantly, some scholars caution that the relationship between games, stress and anxiety is bidirectional and complex. Birk et al. (2015), for example, argue for an integrated approach, noting that while a game might be effective in reducing stress, its impact may vary depending on a player's baseline anxiety. This observation aligns with this thesis's interest in understanding how the psychological states of players, especially perceived stress interacts with their motivations to play and the kinds of games they choose.

In the context of this thesis, anxiety is not the central focus, but its close relationship to stress, particularly in anticipatory stress and trait anxiety is acknowledged. Therefore, this section supports the broader theoretical foundation by highlighting the dual roles that games can play in coping with both stress and anxiety. The inclusion of anxiety-focused studies strengthens the argument that digital games can serve as a multifaceted tool for emotional self-regulation and supports the investigation of how players' experiences and motivations are shaped by their psychological state. This reinforces the thesis's aim of exploring not only the types of games played but also the motivations behind their use in response to psychological stress.

2.5 The Experiences of Playing Digital Game

The previous section highlighted the significant potential of games for managing stress and anxiety. However, further consideration of the specific playing game experience is needed to understand how these elements can contribute to stress relief. Player experience is the process of player-game interaction specific to playing games (Nacke et al., 2010; Nacke & Drachen, 2011). It addresses the mechanism that describes the player's perception of the interaction with the game (Gerling et al., 2011; Wiemeyer et al., 2016). These experiences are conceptualised by differentiating them into specific dimensions like game flow, immersion, challenge, tension, competence, and emotions (Wiemeyer et al., 2016). They further added that player experience is a personal experience that elicit psychological responses that comprise of cognitive, perceptual and emotional experiences.

Building on the stress management strategies outlined in Section 2.2.2 and the relationship between games and wellbeing discussed in Section 2.3, emotion-focused stress coping strategies, such as replacement gratification is important for managing stress. This involves engaging in activities that people enjoy (Miedziun & Czabała, 2015). Hamari & Keronen (2017) assert that playing games is an enjoyable activity. However, it is unclear if people motivated to play games due to stress. McGonigal (2012) and Granic et al. (2014) considered gaming as an efficient and effective medium for managing emotion through positive experiences. Immersive technology used in games, has shown to be effective in managing stress. These is because it requires focus and mental effort, which can divert attention away from stressful thoughts and help to temporarily disconnect from stressors. One of the models used to understand stress recovery is from the Self-Determination Theory (SDT), where it proposes, that intrinsic motivation is related to autonomy, competence and relatedness. One model used to understand stress recovery is Self-Determination Theory (SDT), which proposes that intrinsic motivation is driven by the fulfilment of three basic psychological needs: autonomy, competence, and relatedness. When these needs are satisfied, individuals are more likely to experience psychological wellbeing and resilience, which supports recovery from stress. In the context of gaming, these needs can be met through engaging gameplay that offers choice and control (autonomy), challenges and skill development (competence), and social interaction or narrative connection (relatedness). Reinecke (2009), for instance, suggested that fulfilling these needs through media use, including games, contributes to recovery from daily stress, highlighting the relevance of SDT in explaining how and why digital games can aid stress management.

To measure player experience, Nacke et al. (2010) described various methods, including physical sensors to assess user reactions, eye tracking to monitor attention, behavioural logging of player actions, AI-driven player modelling, and qualitative interviews along with quantitative survey to assess players' perception of gaming experience. According to Cairns & Power (2018), player experiences are often measured by using questionnaires. In this thesis, we will primarily focus on the use of surveys to gauge individual perception of the playing experience. While a number of instruments exist, such as Positive and Negative Affect Schedule (PANAS), Game Experience Questionnaire (GEQ), the game engagement questionnaire (GEnQ) and the Core Elements of the Gaming Experience Questionnaire (CFGEQ), our focus will be on specific gaming experience such as immersion and challenge. Therefore, the following section will be on the playing experience relating to its potential for recovery, as previously discussed, which includes playing motivation, immersion, game challenges and digital game elements.

2.5.1 Playing Motivation

The literature on player motivation reveals a wide range of concepts for defining what playing motivation is. The concept within the Self-Determination Theory (SDT) on intrinsic motivation by Deci & Ryan (1985), which includes autonomy, competence, and relatedness, are key to understanding the intrinsic and extrinsic factors of motivation. We have also discussed how SDT contributes to the positive effect on wellbeing discussed in Section 2.3. A recent analysis to identify the different motivation concepts is the meta-ethnography of player motivation in digital games by McKechnie-Martin et al. (2024). They argue that players' motivation towards games has been classified in many motivational models. Thus, they conducted this analysis to provide a comprehensive list of factors influencing the motivation to play games. A total of 28 dimensions of play were obtained, which is still a considerable number. Hence, we do not attempt to discuss all the factors identified, only those that we feel could contribute in answering the research questions and the development of this thesis.

Autonomy and Competence. The dimensions identified include autonomy and competence, which are the core factors in the SDT. Autonomy is defined as the ability to direct one's own action free from influence, while competence involves engaging in tests of skill, overcoming technical challenges, and received feedback in-game performance. Similarly, Yee (2006) and Inchamnan & Wyeth (2013) also identified autonomy and competence as factors motivating players. Yee (2006) focuses on in-game behaviours and motivation, positing that people play games to seek mastery through competition and gaining power within the game, based on the survey study they conducted to determine the relationship between motivations and in-game behaviours for online games.

In contrast, Inchamnan & Wyeth (2013), analyses players experience in terms of cognitive processes, which they grouped into goals and challenges, action and interaction and interpreting feedback. They studied the effect of three puzzle games: *Portal 2, I-Fluid* and *Braid* by to understand the cognitive processes players engage in during gameplay and how these processes influence the feelings of competence, autonomy, control and presence. Using the Player Experience of Need Satisfaction (PENS) scale, designed based on SDT, they found that positive experiences are directly influenced by the game activity design, highlighting how motivation can be analysed through gameplay.

Similarly, Birk et al. (2016) related intrinsic motivation through the use of interactive application, particularly using Avatar Identification. They emphasised that interactivity increases engagement and in turn fosters motivation. Their research suggests that satisfaction is derived from completing tasks, especially in the use of interactive technology. This translates to more effort invested in the task and the more enjoyment they feel. In the study they conducted, customisation of Avatar increases identification with the character, which in turn enhances autonomy, immersion, invested efforts, enjoyment and positive effects. Despite the different approached, we can see that Inchamnan & Wyeth (2013) and Birk et al. (2016) explore how player engagement influences motivation, highlighting the importance of autonomy as well as competence in determining motivation.

Relatedness is the socialising aspect of motivation to play. While it is within the SDT, it is not present in the dimensions identified by McKechnie-Martin et al. (2024), we can draw parallels with other dimensions such as cooperation, fellowship and intimacy. These three dimensions are characterised as some form of connection with other players.

Escapism, fantasy, story for motivation to play also are part of the dimension identified by McKechnie-Martin et al. (2024). Escapism relates to distraction from real life responsibilities or problems, fantasy is the experience of being in a different world than reality through roleplaying and story is the interaction with characters and the lore of the game world. The key points from these are the motivation to play games it to be disassociated from the real-world and to create separation between the player and their reality. Escapism and fantasy are derived from the research conducted by Demetrovics et al. (2011). They conducted an online survey to identify components of motivation for playing online games. They identified seven dimensions of motivation including social, escape, coping, competition, coping, skill development, fantasy and recreation. In their research they highlighted coping as channelling distress and aggression through gaming that could improve mood. Form here, we can see that these factors relate to the distraction from real-life responsibilities or stress, in other words, disassociation from the real world either – escape from stress or being in a different world than the reality they live in. These factors were also identified in a number of studies, such as escapism by Lazzaro (2004) and De Grove et al. (2016), fantasy by Lazzaro (2004) and Yee (2006), story by Tychsen et al. (2008) and De Grove et al. (2016), and Khan & Peña (2017).

Enjoyment. In the meta-analysis conducted by Hamari & Keronen (2017) on why people play games, they identified enjoyment as a factor in motivation to play. Enjoyment is described as the effect of playing game that is entertaining and fun. Mekler et al. (2014) described enjoyment as the positive cognitive and affective appraisal of the game experience. It is frequently associated with fun and interest and it is the opposite of boredom.

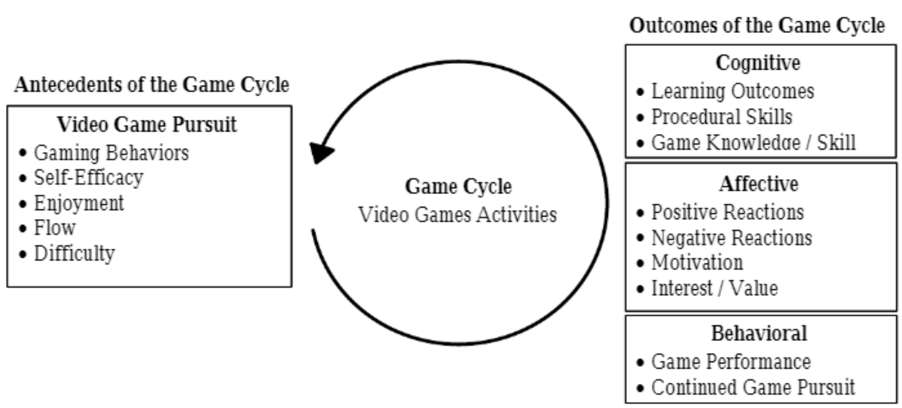
Measuring playing motivation. Various measures have been developed to assess game pursuit. For instance, two scales that were developed based on SDT are the Player Experience of Need Satisfaction (PENS) and Gaming Motivation Scale (GAMS). PENS was designed to assess the play experience in terms of competence, autonomy, relatedness, intuitive controls and presence/immersion. The scale has been statistically proven to predicting not only fun/enjoyment, but also game ratings, sales, developer loyalty, and sustained player interest (Rigby & Ryan, 2007). Vella et al. (2015) conducted an online survey of 446 participants to determine if playing alone or playing with other would improve their wellbeing. They discovered that people who play games on their own experience greater wellbeing. In the SDT, this is characterised as autonomy. They further discovered that social players experience better wellbeing when playing with strangers, which is characterised as relatedness in the SDT.

Gaming Motivation Scale (GAMS) that was developed by Lafrenière et al. (2012) was also designed in line with the SDT framework to investigate the reason behind playing game. The scale measures different aspects of gaming motivation: intrinsic motivation (desire to perform an activity for itself), integrated regulation (engagement of in an activity out of choice), identified regulation (engagement of behaviour based on meaning or personal goal), introjected regulation (engaging in activity out of internal pressure such as anxiety or guilt), external regulation (behaviour regulated through external means such as rewards), and amotivation (behaviour regulated through external means such as rewards).

Although both PENS and GAMS measure the motivation to play games, both scales measure the in-the-moment game experience. They assess motivation while playing game and being in the game cycle. Conversely Video Game Pursuit Scale (VGPu) was developed as model of game cycle that identifies the process of pursuing games or the antecedent of playing game. Therefore, we will explore the Video Game Pursuit (VGPu) scale by Sanchez & Langer (2020). Figure 2.2 shows the VGPu models that the gaming cycle is having a feedback loop between input, process output, whereby, the output generates positive cognitive, affective and behavioural experience. Compared to the other measure, VGPu, measures motivation to play going into the game.

VGPu is characterised by intentional pursuit of video game activities, confidence with game playing, an affinity towards video games, a tendency to experience flow with games, and a comfort with video games activities. The scale consists of 25 questions and uses a 5-point likert scale from "Strongly disagree" to "Strongly Agree". The VGPu measures the intention to play digital game or going into digital gameplay. Because of this, we adopted this measure for the first study. We are looking for measure the motivation to going into a gameplay, not the motivation to play a particular game. Furthermore, the VGPu focuses on the intentional pursuit of video games and practice, it does not concern the idea of playing a specific game in order to achieve a particular outcome; rather it reflects the general intention of playing digital game and the desire to play, which is more in line with the idea of general usage of games for the alleviation stress.

Figure 2.2
Game Cycle Model of the Video Game Pursuit – Antecedents and Outcomes



Note: Reprinted from *Video Game Pursuit (VGPu) Scale Development: Designing and Validating a Scale with Implications for Game-Based Learning and Assessment* by Sanchez & Langer (2020).

This not a comprehensive discussion of the diverse dimensions of motivation to play as shown by McKechnie-Martin et al. (2024). The discussion centres around the motivation that relates to what the thesis aims to achieve i.e., to determine which experience of playing games could support stress reduction. Therefore, by aligning with the coping strategies discussed in Section 2.2.2, particularly the techniques employed, such as replacement gratification and distancing, we focus only on the experiences that could support these techniques.

2.5.2 Playing Immersion

Immersion is a psychological state of being enveloped in an environment that presents a continuous stream of stimulating experiences. To achieve immersion, individuals must actively engage with these experiences to become absorbed and engrossed (Witmer & Singer, 1998). In a make-believe world, immersion, occurs when one is deeply engaged in the environment, feeling as if they are present there (Coomans & Timmermans, 1997). In videogames, Brown & Cairns (2004) noted that, apart from the feeling of being in the game, immersion can lead to a loss of awareness of time and the real world, giving a sense of being in the game environment. They added that the degree of involvement with the game is a gradual process. They categorised this process into engagement, engrossment and total immersion. They proposed three distinct stages of immersion: engagement, engrossment and total immersion.

Engagement involves overcoming the barriers of time, effort and attention investment. Once they do, they may experience engrossment, where they become emotionally affected by the game. Finally, total immersion happens when gamers lose track of time and become unaware of their surroundings, fully involved in the game. This state involves a psychological shift, where they connect deeply with the alternate world of the digital game they are playing. Immersion can be achieved through three components of gameplay: sensory, challenge and imagination (Ermi & Mäyrä, 2005). These components are represented through audiovisual synchronisation, impressive graphics, the players' depiction, use of mixed-reality technology, engaging activities, game challenges and story or narration. Silva Bastos et al. (2018) added that these components are needed in order to design an immersive game. narrows these components to mixed reality technologies, audio video synchronisation and player presentation, graphics and challenge in order to build immersive experiences in electronic game.

Immersion is an important element in games (Cheng & Cairns, 2005). Although the literature on immersion is extensive, there is limited research focusing on the experience of immersion related to wellbeing and stress. A number of research focuses on the use of Virtual Reality (VR), which is a technology that extends to which a person's cognitive and perceptual systems believe they are somewhere other than their physical location (Bermudez et al., 2019; Law et al., 2011) to understand the effect of immersive experience on wellbeing. For instance, in the systematic review conducted by Frost et al. (2022), they found significant evidence showing that replicating nature in the VR also could reduce negative effects. In video games research by Law et al. (2011), where they conducted an experiment on involving children on the cognitive processing of distraction task while experiencing pain. Pain was induced using the using the Cold Pressor Pain Protocol. They were testing if playing the game in the VR are able to distract them from the pain better than the passive distraction of watching a video of the game. They found that playing the game significantly improved tolerance and distract from the pain compared to passive distraction. Liszio & Masuch (2019), also compared the use of VR game to casual game. They found being immersed in virtual environment can increase relaxation and mood even in situations of stress, anxiety, or pain. This research exhibit that being totally immersed in a virtual environment supports wellbeing. Although VR is showing to be effective in supporting wellbeing, it is beyond the scope of this thesis. Furthermore, VR requires special device and software in order to operate it, this is not always ideal in a day-to-day situation.

Immersive quality can still be experienced in games that does not utilise VR. In the experiment by Cheng & Cairns (2005) that measures the effect of realism on game immersion, they found the game they created which has two different modalities, where one is more realistic than the other, is able to induce a level of immersion on the players. Participants were required play in both modalities to compare the effect of immersion. They found, that, participants could still be immersed even within a simple environment, such that changes went unnoticed by the players. They further elaborated that immersive state does not have to be at the level of presence described by Brown & Cairns (2004), even low-level immersion, engagement or engrossment is sufficient to overcome the incoherent modalities.

In **measuring immersion**, researchers have used both subjective and objective measure such as questionnaires and eye tracker (Choi et al., 2022). In their study, they measured the level of immersion while participants were watching a video. In game research, questionnaires are typically used to measure immersion, and a number of scales can be found in the literature. One such scale is the Presence Questionnaire developed by Witmer & Singer (1998), which measure presences in virtual environment. They defined presence as the subjective experience of being in one place, which is similar to the concept of being present in immersion (Brown & Cairns, 2004). Additionally, they also developed the Immersive Tendencies Questionnaire to measure differences in individuals' tendencies to experience presence. These scales specifically measure immersive experiences in virtual space.

To measure immersion in digital games, Jennett et al. (2008), developed the Immersive Experience Questionnaires (IEQ). Initially, the IEQ comprised of two questionnaires that measures the personal experience of the of playing the game. The first questionnaire was designed to measure the experience immersion before they were interrupted. The second questionnaire measures the experience of immersion at the end of the games. The first scales measure the experience of immersion in relation to completion of task. They hypothesised that if the person is immersed in a game, one might predict that it would be more difficult for them to switch from the game space to the task space. This will lead to impaired task performance, which is the measure of the time taken to complete the task. The second questionnaire measures how they feel after playing the game. Both scales consist of 5-likert scale, Strongly Disagree to Strongly Agres. In the final IEQ, the scale comprised of 31 items on a 5-point likert scale. The scale was developed to measure immersive state of the participants.

A short form non-disruptive measurement of immersion (IEQ-SF) was developed by Aung (2021). The scale was derived from the IEQ scale described above. The scale measures three factors of immersions: involvement, real-world disassociation (RWD) and challenge. It has 11-items and presented in a 5-point Likert scale, where 1 correspond to "Strongly Disagree" 5 being "Strongly Agree". Involvement is the degrees if involvement from cognitive and emotional facet, RWD, it's the engagement with the games and correspondingly, their disengagement from the real world. Challenge is the degree of difficulty experienced during gameplay. In the development of this scale, they found that the short-form scale is able to measure immediate in a short-time.

Based on the concept of immersion discussed in this chapter, we can draw similarities with the stress coping techniques discussed in Chapter 2.2.3 . According to Miedziun & Czabała (2015), distancing relates to disassociating oneself from the stressor. In the concept on immersion described above, immersion involves engaging into gameplay and being present within the environment. Both concepts relate to being separate from the world and, in the case of a stressful situation, from the stressors.

2.5.3 Digital Games Challenge

The concept of challenge in digital game is related to "contest", "trial", and "test' which are believed to be necessary constituents of games (Salen & Zimmerman, 2004). Game designers use challenge to maximize player enjoyment, aiming to create experiences that are engaging (Bostan & Öğüt, 2009). Players voluntarily and persistently engage in game challenges; Furze (2014) defined challenge by stating that playing digital games involves the player's voluntary and persistent engagement with a game's rule system and its challenge. Challenge can be described as the deliberate design elements that encourage players' engagements. The intentional pursuit challenge warrants the investigation of its implication on wellbeing. In the theory of psychological flow by Csikszentmihalyi (2008), the relationship between challenge and skill determines the engagement level of the player during the gameplay. At any given level of skill, lower than equal challenges results in boredom and detachment, while higher than equal challenge results in anxiety, stress and ultimately resignation. According to Sweetser & Wyeth (2005) computer games should provide challenge that match the player's skill.

Due to the importance of challenge it game design, several categories of challenge have been described in the literature. Feil & Scattergood, (2005) classified challenge is classifies into six groups: time, dexterity, endurance, memory/knowledge, logic and resource control challenges. Meanwhile, Brandse & Tomimatsu (2013) looked at challenge through how it is designed.

- Challenge should be solvable through the core game-play established by the game
- Challenge should not be marred through bad technical implementation
- The outcome of challenge should be determined through the actions of the players
- There should enough information for players to complete a challenge
- Players should be aware of the ramification of players' action on future challenges
- Challenge should not have an unfair advantage over the player

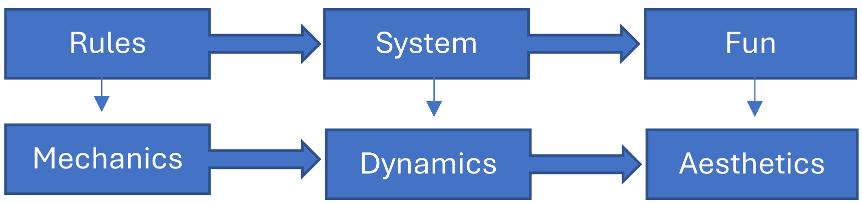
Cole et al. (2015) introduced a broader perspective on challenge. They said that game challenge does not have to be only about skill-based challenge, but it can also involve emotional challenges which could involve demanding cognitive effort to navigate complex narratives. This is observed from the accounts of playing avant-garde games. Where the satisfaction is derived from the resolution of tension within the narrative of the game, or the identification with characters. Game challenges are also attributed to causing the causing the experience of immersion. A player's perceived challenge is connected to many other experiences (Ermi & Mäyrä, 2005; Silva Bastos et al., 2018). In the research by Cox et al. (2012), they measured the effect of challenge on immersion and found that time challenge increases immersion. They argued that the level of challenge is an interaction between the level of expertise of the gamer and the cognitive challenge encompassed within the game.

Despite the significance of challenge in gaming, few established scales exist to measure it effectively. The Challenge Originating from recent Gameplay Interaction Scale (CORGIS) by Denisova et al. (2017) is one of the few validated tools that assess various dimensions of challenge: cognitive, emotional, performative and decision-making challenge. The scale measure in-game challenge and the degree of challenge that the digital game presents. The scale has undergone validation across three studies involving 1,390 players, demonstrating its validity and reliability in measuring the experience of challenge. The result shows questionnaire is a reliable and valid measure of challenge as player experience (Denisova et al., 2020). Another scale in the literature that measures challenge is the Videogame Challenge Inventory (CHA) by Vahlo & Karhulahti (2020), unlike CORGIS, the scale examines game preferences across different cultures, providing a broader context for understanding how players interact with challenges.

2.5.4 Digital Game Elements

People play digital games because it is fun, free and provide an escape from reality (Caillois, 2001). In the Mechanics, Dynamics, and Aesthetics (MDA) model of game design, shown in Figure *2.3*, Hunicke et al. (2004) relates fun to the aesthetics of the game, whereas rules and system to games mechanics and dynamics. This is particularly useful for game designer, guiding them to the right elements to enhance player experience.

Figure 2.3
Mechanics, Dynamics, Aesthetics Framework by Hunicke et al. (2004)



In addition to the game challenges discussed previously, game aesthetics, which includes the audiovisual quality and style of the game, are one of the central aspects of good digital games, and a good-looking graphics can make the game more appealing (Ermi & Mäyrä, 2005). Game aesthetics refers to the element in digital games that fosters interaction and engagement (Lau et al., 2017). According to Niedenthal (2009), game aesthetics also has to do with the senses, art and particular experiences. The experience refers to the sensory phenomena that the player encounters in the game, whether visual, aural, haptic or embodies. Secondly game aesthetics are an aspect of digital games that are shared with other art form, and lastly it is an expression of the game experienced through pleasure, emotion, sociability and form giving.

Lazzaro (2004), distinguishes fun into three categories: hard fun, easy fun, altered states. Hard fun involves meaningful challenges, that creates frustration and personal triumph. Whereas, easy fun can grab attention with ambiguity, incompleteness and detail, where the enjoyment is derived from experiencing the game activities. While altered states pertain to emotional changes that occur internally through thoughts, behaviours, and social interaction. These factors are what makes game enjoyable. Sweetser & Wyeth (2005) developed the GameFlow model derived from the theory on flow by Csíkszentmihályi (1990) to assert that in order for a game to be enjoyable, it needs to have these elements:

- **Clear Goals**: Players should understand what they need to achieve in the game.
- **Concentration:** The game should engage players' attention, allowing them to immerse themselves fully in the experience.

- **Challenge**: The game should present an appropriate level of challenge that matches the player's skill, promoting engagement without causing frustration.
- **Skill:** Players should have the opportunity to use their skills, and the game should provide feedback on their performance.
- **Control:** Players should feel a sense of control over their actions and the outcomes in the game.
- **Immediate Feedback:** The game should provide instant feedback on players' actions, helping them understand the effects of their choices.
- **Social Interaction:** Opportunities for social interaction can enhance the gaming experience, fostering connections between players.
- **Immersion:** Players should feel absorbed in the game world, losing awareness of the outside environment.

Although not many researchers have looked at this element as part of the gaming experience, it is however, an important aspect in game design as it facilitates and fosters engagement with gameplay that provides the intrinsic motivation for engagement with games (Alexiou & Schippers, 2018). The game visual provides the initial engagement to the rest of gaming experience, it creates the fun aspect of the game, that create an enjoyable experience for gamers.

We considered several scales to measure the games elements, such as the Gaming Experience Questionnaire (CFGEQ), The Game Engagement Questionnaire (GEnQ) and The Core Flow Gaming Experience Questionnaire (CFGEQ). The CFGEQ is designed to assess players' experiences during gameplay, evaluating dimensions such as immersion, flow, competence, and emotional responses, including both positive and negative effects. The GEnQ measures the level of engagement players experience while interacting with a game, focusing on cognitive involvement, emotional connection, and behavioural immersion. While, CFGEQ assess the flow state and overall gaming experience concentrating on flow, such as challenge, skill level, immersion, and enjoyment during gameplay. However, none of these questionnaires measure the aesthetic aspect of games.

The scale developed by Keebler et al. (2020) called the Game User Experience Satisfaction Scale (GUESS) measures constructs of Game User Satisfactions; Usability/Playability, Narratives, Enjoyment, Creative Freedom, Play Engrossment, Audio Aesthetics, Personal Gratification, Social Connectivity and Visual. The scale has been validated. The scale looked at different aspects of satisfaction, for instance, usability or playability asked the participant how they feel or rate the game navigation design. The scale also measures social connectivity, which is also characterised as relatedness in SDT. Another aspect that we are mostly interested in the design aspect of user satisfaction. The construct of visual aesthetic captures the players' satisfaction with the game. So, here we can see the scale is measing different aspects of the game satisfaction. The broad aspect of digital game satisfaction allows us to see possible relations with different aspects of digital game and for further consideration.

2.6 Methods for Stress Research

Although this section primarily focuses on methods used in stress research, it is important to recognise the close relationship between stress and anxiety (Daviu et al., 2019). Anxiety is often conceptualised as the anticipation of a future threat or stressor, and as such, many of the methods used to induce and measure stress also apply to anxiety. For instance, acute stressors can trigger both immediate stress responses and anxious anticipation (e.g., Brosschot et al., 2006). This overlap is particularly relevant in experimental studies where anticipation—such as before a task or evaluation—can evoke anxiety that is functionally indistinguishable from stress in terms of physiological and psychological response. Therefore, while the methods discussed in this section are framed as stress protocols and measures, they are equally applicable to the study of anxiety and anticipatory stress.

A number of research on stress and games can be found in the literature. Consequently, various measures have been developed to assess both stress responses and gameplay experiences, as demonstrated in the previous section. In stress research, experiments are commonly used alongside self-report survey, particularly for psychological effect of stress. Various protocols for conducting stress experiments exist in the literature, and the choice of protocol depends on the research objectives and methodologies employed. In this section, we examine the different protocols and measures used in stress research, with consideration of their relevance to anxiety and anticipatory responses as well.

2.6.1 Stress Protocols for Experiments

To measure the effect of stress, particularly in an experimental setup, it often involves stressing the subject to specific stressor. However, this needs to be in a controlled environment so that true effects of stress are measured. In order to be effective, the protocol should include elements of unpredictability (Ghoussoub et al., 2024), lack of control (McEwen & Sapolsky, 2010), representation of threat or damage (Tomaka et al., 1997) and in some cases social evaluation (Lupien et al., 2007). Researchers have designed various protocols to safely induce stress in participants within a safe and controlled setting. Common protocols are the Cold Pressor Task (CPT), Stroop Test, Sing-a-Song-Stress Test (SSST), Trier Social Stress Test (TSST) and the Maastricht Acute Stress Test (MAST).

The CPT is a diagnostic and experimental method used to evaluate cardiovascular function and pain response. It involves immersing a hand or foot into ice-cold water, typically around 0-4 degrees Celsius (32-39 degrees Fahrenheit), for a specified period, usually one to three minutes. The primary purpose of the test is to induce stress and observe physiological responses such as changes in heart rate, blood pressure, and pain threshold. The test was originally developed by Hines & Brown (1936). In their work, they explored the autonomic and cardiovascular responses to cold exposure, laying the groundwork for the cold pressor test as a tool for studying these systems. Over the years, the cold pressor test has been widely used in clinical and research settings to investigate various aspects of cardiovascular health, pain perception, and stress response mechanisms. However, this protocol primarily focuses on physiological responses rather than the psychological aspects of stress that this thesis aims to explore.

The Stroop Test was designed by Ridley Stroop (1935) in his paper "Studies of interference in serial verbal reactions." The test is used to demonstrate the interference that automatic reading processes can have on the task of colour naming. It is often used as a psychological inducing stress protocol. In the test, participants are presented with a list of words, each of which is the name of a colour (e.g., "red," "blue," "green"). The words are printed in colours that may or may not match the colour names. The task is to name the colour of the ink rather than the word itself. For example, if the word "red" is printed in blue ink, the correct response is "blue". Stroop test focuses on the cognitive function rather than acute stress inducing, which may produce subtle stress response.

One protocol that employs both physical and psychological effects to induce stress on participants is the Maastricht Acute Stress Test (MAST) designed by Smeets et al. (2012). The MAST is widely used in research to study the effects of acute stress on physiological responses, such as cortisol levels, heart rate, and subjective stress ratings. The MAST is valuable for its ability to induce a significant and measurable stress response, making it useful for investigating the mechanisms underlying stress and for testing interventions aimed at reducing it.

The test combines physical, psychological, and social stressors to elicit a robust stress response, allowing researchers to measure various physiological and psychological stress markers. The MAST includes elements such as exposure to cold water, mental arithmetic tasks, and social evaluative threat components, making it a multifaceted stress-induction procedure. The protocol consists of several components:

- Physical Stressor where participants are required to immerse their hand in ice-cold water for a specified period, typically around 1-3 minutes.
- Cognitive Task, During the cold-water immersion, participants perform mental arithmetic tasks under time pressure, such as serial subtraction.
- Social-Evaluative Component where participants are informed that their performance is being evaluated, adding a social stressor to the experience.

In contrast, the Sing-a-Song Test (SSST), designed by Brouwer & Hogervorst (2014), aims to create a standardised method for inducing social-evaluative stress in laboratory settings. The SSST offers a simpler and more accessible alternative. The SSST is part of a broader category of stress-inducing tasks used in psychophysiological research to understand how people react to stress and to identify potential interventions for stress-related disorders. While the SSST is a psychological stress test that involves participants singing a song in front of an audience. The test is designed to elicit a stress response through the social and performance anxiety typically associated with public singing. This test aims to measure physiological and psychological stress indicators, such as heart rate, blood pressure, and self-reported stress levels. SSST triggers cognitive responses associated with performance anxiety which includes social judgement, fear of negative evaluation.

Because this thesis focuses on the psychological aspects of stress rather than physical stressors, the Maastricht Acute Stress Test (MAST) was not adopted for this research. While the MAST effectively induces acute stress through physical challenges, such as cold-water immersion, our objective is to explore stress responses that arise from psychological and cognitive factors in a more relatable context.

Additionally, the Sing-a-Song Stress Test (SSST) was also not adopted due to its potential to induce embarrassment in participants. This protocol requires individuals to sing in front of an audience, which can elicit significant performance anxiety and feelings of self-consciousness. Such social evaluative stressors might lead some participants to withdraw from the study or provide biased responses influenced by their discomfort. This concern aligns with our goal of maintaining a supportive environment that encourages honest and meaningful participation.

The Trier Social Stress Test (TSST) is one of the most used and reliable protocols for inducing psychological and acute stress (Crosswell & Lockwood, 2020). The TSST was designed to induce moderate psychological stress in a laboratory setting (Kirschbaum et al., 1993) by performing several tasks useful and appropriate standardized method for stress studies, allowing for the derivation of physiological, psychological, and endocrine responses (Birkett, 2011). The protocol that has been shown to be a valid and reliable method for inducing acute stress under controlled conditions (Allen et al., 2017; Roy et al., 2001).

The test involves participants delivering an assessed presentation and solving mathematical problems under time pressure. Stress levels are measured using a validated scale administered to participants before the task briefing and after the intervention, i.e., playing games. Following the presentation, participants undergo a surprise mental arithmetic test in front of judges who observe them without providing feedback or displaying facial responses or encouragement. TSST has been demonstrated to be a useful and appropriate standardised protocol for stress studies (Birkett, 2011).

In using the TSST, the effect of stress is measured using psychological and physiological measure. Often, both measures are used due the inherent issues with measuring only with physiological measure. Although, there are instances where researchers only measure the subjective effect of stress as in the case of Fish et al. (2018), Horsch et al. (2017), Huang et al. (2017), Pallavicini & Pepe (2020), and Rupp et al., (2017).

In this thesis, TSST adopted due to several factors: firstly, it induces acute psychological stress. Secondly, it does not induce physical pain as in the case of the CPT and MAST as this research is not interested in physical stress. and lastly, amongst all the protocol discussed, TSST is more used, and validated protocol shown to be the most effective in inducing psychological stress (Birkett, 2011). The TSST is adopted in the experiments conducted. The experimental designed is discussed in detail in Chapter 4 and the adopted in experiments detailed in Chapter 5 – 8.

2.6.2 Stress Measurement

The concept of stress discussed in sections 2.2 and 2.2.1 highlights that stressors elicit two different stress responses: physiological and psychological. These differences introduce complexity and barriers such as the lack of consistency (Epel et al., 2018). Particularly comparing the results between the two different stress responses. In this section we will discuss the measures for physiological and psychological stress responses.

Physiological responses refer to the biological changes experienced in the body. To measure these effects, various physiological measures are used, including heart rate (Taelman et al., 2008), cortisol levels (Bassett et al., 1987) and skin temperature (Liapis et al., 2015). Heart rate is often measured using specialised devices such as electrodes placed on the body (Taelman et al., 2008) or an electrodiagram (ECG) to measure the heart rate variability and rhythms (Forte et al., 2022). In addition to heart rate, urine and saliva samples are also collected to measure the cortisol and adrenaline levels (Bassett et al., 1987). Another physiological measure is skin conductance, which is measured using a sensor placed on the middle and ring finger of the participants' hands (Liapis et al., 2015). These measures require physical contact and can be quite intrusive for some participants.

The use of physiological measures for stress provides a tangible assessment of stress. However, these measures do not always accurately reflect the participants the participants' stress states (Lazarus & Folkman, 1984). Physiological signals can also be affected by other emotions such as happiness (Fredrickson, 1998). Stress measurement can be improved by using multiple methods. For example, interviews and surveys can be used concurrently to support the physiological results. There are also other issues, associated with the use of physiological data to measure stress reactivity, according to Blascovich & Tomaka (1996), an increase in the heart rate can reflect either challenge or threat appraisals unless HPA axis indicators such as blood pressure are also measured to provide a more comprehensive understanding of the body's stress response.

Although physiological are often used to assess stress level, it is often accompanied by self-report instrument. This is because increases in physiological arousal does not always indicate an increase in stress arousal (Csikszentmihalyi, 2008). They could be affected by other events such as excitement (Pfaff et al., 2007). For example, increased heart rate may reflect either a challenge or threat appraisal (Blascovich & Tomaka, 1996). Research on stress has also shown that using physiological measure with psychological measures for stress is inconsistent. This underscores the complexity of assessing stress. For instance, several studies found no significant correlation between physiological indicators and self-report for stress (Galantino et al., 2005; Pallavicini et al., 2021).

The issue with physiological measure was also discussed by Lazarus & Folkman (1984). According to them, encountering a stressor does not always activate a physiological stress response, and the activation of a stress response is dependent on cognitive appraisal. This means that stress is only stressful if the person perceived the event as stressful. Therefore, self-report measures are sufficient in determining the stress level of the individual.

On the other hand, psychological stress response is the appraisal of stressors, and this involve cognitive assessment. To measure the psychological effect of stress often, self-report such as interviews (Ewart et al., 2002) and answering a set of questionnaires (Cohen, 1994) are used. These are considered to be the simplest form of psychological measure (Crosswell & Lockwood, 2020). In the study by DeLongis, Folkman, & Lazarus (1988) where they examined the daily stress processes among 75 married couple across 20 assessments during a 6-month period, participants were interviewed once monthly for a 6-monhts period concerning social support, self-esteems, beliefs values and commitments, life stresses, health and psychological wellbeing. The participants were also asked to write any symptoms or discomforts they had that day on a chart provided. Correlation analysis was done to determine if there was a significant relationship between daily stress and the occurrence health problems. Their findings revealed that there is a tendency towards decline in health such as such as flu, sore throat, headaches and backaches with the increase in daily hassles. Although, their research showed a correlation between stress and illnesses, it does not account that mood is almost always affected by illnesses (Stockwell et al., 2019). Therefore, the mood result is a reflection of the illnesses experienced by the participants rather than an appraisal of daily stress.

Survey is one of the most commonly used methods to measure stress. While self-reports often show weak correlations with physiological indicators, they remain valuable for capturing subjective experiences of stress that may not be reflected in physiological data as previously discussed. A widely used psychological instrument to measure the perception of stress is the Perceived Stress Scale (PSS) by Cohen et al. (1983) which is considered to be effective at measuring global stress. The PSS measures the degree to which the situations in one's life are appraised as stressful. It has been validated by several researchers (de Witte et al., 2021; Lee, 2012) and translated to other languages such as Korean (Lee, 2012), Arabic (Almadi et al., 2012), and Spanish (Baik et al., 2019) . Although the PSS seems like a simplistic measure for stress, but it is established as an acceptable measure for Perceived Stress with a consistent reliability and validity score

(Baik et al., 2019; Ezzati et al., 2014; Lee, 2012). Furthermore, the scale is also accessible for any non-profit related researcher, which make it a popular measure of perceived stress.

The Life Events and Difficulties Schedule (LEDS) by (Brown & Harris, 1978) is another psychological measure of stress. It is considered as the standard psychological stressor exposure. LEDS used structured interview protocol for assessing exposure to stress across someone's lifetime. It is a well-established scale and has been used extensively in the medical field. It provides both comprehensive assessment of stressor exposures across the lifespan and determine the severity of the experiences. However, for this measure is not suitable for this study, as it requires a trained interview to conduct the study, in which the researcher does not have the necessary background.

There are also instances where both physiological and psychological measures were used. Vedhara et al. (2003) examined the relationship between self-reported emotional distress and change in cortisol levels. Fifty-four women attending a diagnostic breast clinic completed scales measuring stress, anxiety and depression and provided five saliva samples over the course of a single day for the measurement of cortisol. No significant relationships were evident between absolute cortisol levels and the distress measures. Analysis of the change in cortisol levels revealed a non-linear interaction effect between stress and anxiety and time of day.

For this thesis, we adopt an experimental design to measure the immediate psychological effects of stress induction and the use of digital games as a potential stress-relief intervention. This approach allows for the systematic manipulation of stress-inducing conditions and the structured timing of the intervention. This enables the observation of short-term, within-subject changes in perceived stress, which is the primary focus of this thesis. Controlled stress manipulation provides a consistent framework to observe how gameplay influences stress perception in real time, thereby capturing its immediate psychological impact.

Stress, as defined in this thesis, refers to a subjective psychological state resulting from perceived pressure or demands that exceed an individual's coping resources. Given this definition, this thesis is primarily concerned with the psychological dimension of stress, specifically, the perception of stress. Hence, it is essential to employ measures that directly reflect participants' internal experiences. Therefore, this thesis relies on subjective self-report instruments to capture individuals' immediate appraisals of stress. These experiences are inherently personal, and not always detectable through physiological indicators. While physiological measures may offer complementary insights, they do not necessarily align with individuals' perceived experience of stress as discussed in the previous section.

However, it is important to note that the number and variety of stress measures in the literature can be overwhelming. This necessitates careful selection to ensure that the chosen instruments are relevant, valid, and reliable for the aims of this research.

Crosswell & Lockwood (2020) developed a guideline or best practices for researcher across disciplines on how to measure stress. They guidelines summarises the process for selecting the right measures which includes determining the type of stress, the timescale of the stressor exposure, the stress response that the researchers wish to adopt, the stress life stage, measurement window and the characteristics of stress being measured and the validity of the scale. Having guidelines such as these help researchers to determine the right measures particularly for complex concept such as stress. Therefore, we adopted this guideline for our studies and explained further in the next section.

2.6.3 Selecting the Right Measure

We can find a number of stress measures in the literature. Due to the extensive research on stress, there is a significant number of scales to measure different aspects of stress such as acute stress, strain, stress reactivity. As previously discussed, the use of stress questionnaires is dependent on the type of stress, stressors or stress response. Measuring traumatic life events is not similar to measuring acute stress. Therefore, understanding and choosing the right scale for the study is important. By using systematic approach and the guidelines for selecting the psychological stress measures developed by Crosswell & Lockwood (2020), we were able to narrow down the options to three main scales that we adopted for our studies.

This process aligns closely with Lazarus and Folkman's transactional model of stress, which highlights the subjective appraisal of stressors and available coping resources. For example, determining the type of stress and the stress response to assess reflects the primary and secondary appraisal processes central to their theory, ensuring the selected measures capture the personal and situational nature of stress as defined in this thesis. Primary appraisal involves evaluating whether a situation is perceived as stressful, while secondary appraisal considers one's perceived coping resources. By aligning measurement selection with these appraisals, the chosen scales capture the personal and situational nature of stress as defined in this thesis.

Crosswell & Lockwood (2020) summarised the process of selecting the scales to seven steps.

I. Determine the type of stress that you intend to measure.
II. The timescale of the stressor exposure.
III. Identify which types of stress responses to assess.
IV. Determine the life stage in which the stressor occurs.
V. Identify additional characteristics of the stressor such as severity.
VI. Consider the measurement assessment window
VII. Finally, to choose a well validated scale.

In order to systematically identify relevant stress measurement scales and related research, a comprehensive search strategy was developed. Firstly, key terms and relevant vocabulary and synonyms were identified such as 'digital games', 'game-based', 'computer-assisted therapy', 'game design', 'mental-health', 'stress', 'acute stress', 'depression' and 'anxiety', 'games', 'stress', 'mental health', 'well-being', 'acute stress', 'stress scale', 'casual game', 'serious game', 'digital games mechanics', 'digital intervention', 'recovery', 'mood', 'positive affect' and, 'emotion'.

These terms generated search strings to be used in research databases with the addition of Boolean operators OR and AND to return a more inclusive and focused result. The resulting search string includes: (Digital Games OR Games OR Serious Games OR Serious Digital Games OR Casual Games OR Digital Games Mechanics OR Gaming) AND (Stress OR Acute Stress OR Mental Health OR Recovery OR Mood OR Positive Affect).

The next step we selected relevant databases to apply the search string such as Journal of Medical Internet Research, PubMed Central, ACM Digital Library, Google Scholar, IEEE Xplore Digital Library, Science Direct, Springer Library and Wiley. Additional databases include EMBASE (Elsevier, PsycINFO (EBSCOhost), Cochrane Library (Wiley) and NIMH (National Institute for Mental Health).

Manual search was also conducted through these publications and through reference lists of related systematic reviews. Throughout the study selection, the reference lists of included studies were further reviewed to identify relevant citations.

From the search, we found over forty scales that measures different aspect of mental health issues which includes anxiety, depression, post-traumatic syndrome and also other mental health related issues such as stress and low mood. These scales were then filtered down against Croswell and Lockwood's guideline.

The first steps immediately eliminate scales that measures other aspects of mental health and related issues aside from stress for instance the Post-traumatic Diagnostic Scale (PDS) by Foa et al. (2016) that assesses post-traumatic symptoms severity and Hospital Anxiety and Depression Scale (HADS) created by Zigmond & Snaith (1983) that was designed to assess anxiety and depression symptoms in medical patients.

The second step is to select scales based on the timescale of the stress exposure. For this research, we are interested in day-to-day stress and short-term or acute stress. This eliminated scales that measures chronic stress, or long-term stress exposure such that measured by The Life Events and Difficulties Schedule (LEDS) by Brown & Harris (1978). LEDS employs semi structured interview that covers life domains and designed to stimulate recall of past experiences.

The third and fourth criteria are to determine the type of stress response and the life stage in which the stressor occurs. For this research we are interested in the psychological response, therefore, instrument that measures physiological response such as the cortisol level, heartrate is eliminated. Furthermore, scales that are designed for children are also eliminated. Only scales that are designed for young adults of the age 18 and above are retained.

The sixth stage is to consider the measurement assessment window. Because acute stress is short-term and then the subject may return to their baseline state not long after being stressed (Vallarino et al., 2012), we are interested in scales that are able to capture immediate response.

However, we included scales the Perceived Stress Scale by Cohen et al. (1983) as it measures the general stress disposition and measures the degree to which situation in one's life are appraised as stressful is over the period of four weeks are eliminated.

And lastly, selecting scales that are well-validated and are able to measure the intended aspects. We also added a few criteria to fit our research objectives and considering the lack of resources when conducting the experiments.

Scales that require expert observation and judgement such as the use of visual cues or that involves interviewing by experts such as the Life Events and Difficulties Schedule (LEDS) by Brown & Harris (1978). Additionally, because we wanted to measure the change in stress, we needed a scale that can be distributed at several time points. Furthermore, we also considered a potential confound, such as the Trait or predisposition of being stressed.

Using these guidelines, we narrowed down the options to four main scales that we used for our studies.

- Perceived Stress Scale (PSS) by Cohen et al. (1983)
- State and Trait Anxiety Scale (STAI) by Spielberger (1983)
- Acute Stress Appraisal (ASA) by Mendes et al. (2007)
- Visual Analogue Scale (VAS) by Barré et al. (2017)

Perceived Stress Scale (PSS)

Cohen et al. (1983) designed the Perceived Stress Scale (PSS) to measure the degree to which situations in one's life are appraised as stressful based four week or one month period. The scale measure perception of stress that occurs over the period of four weeks by asking the participants experiences stress. It was tested from two sets of college students; Sample 1 comprises of 332 students, and the second sample comprises of 114 students. The study showed that the PSS has adequate internal and test-retest reliability. It is also a useful and economical tool for assessing chronic stress level.

PSS has been validated by several researchers and has been translated to other languages such as Korean (Lee, 2012), Arabic (Almadi et al., 2012), and Spanish (Baik et al., 2019). The scores are obtained by summing across all 10 items. Question 4, 5, 6,7 and 8 are scored in reverse. The sum of scores between 0 – 13 shows low level of perceived stress, 14 – 26; Moderate level of perceived stress and 27 – 40; show highly perceived stress.

Originally designed with 14-items (PSS-14), it was later reduced to 10-item scale (PSS-10) after removing the lowest factor loadings (item 4,5,12, and 13) from the original scale. The scores are obtained by summing across all 10 items. If the total score is between 0 – 13; low stress, 14 – 26; Moderate stress and 27 – 40; highly stressed.

State and trait anxiety inventory (STAI)

The State-Trait Anxiety Inventory was first introduced by Spielberger (1983) to measure the anxiety level in the respondents. It differentiates between the temporary condition of state anxiety and trait anxiety. State anxiety is a temporary state that one experiences at that moment (current situation) and trait anxiety is a general propensity to be anxious where the respondent notes how he/she feels overall. The scale consists of a 40-item self-completed questionnaire that aims to assess separately state anxiety and trait anxiety, each bearing 20 questions each. The STAI consists of two forms: Form X-1 to assess the state of stress currently and Form X-2 to measure the enduring states of anxiety and stress. STAI has been validated in several anxiety and stress research and has shown to be sensitive to various context (Gaudry et al., 1975).

A number of studies in games and stress has adopted STAI, for example Butler et al. (2020) used STAI to investigate the use of Tetris game as a preventative intervention to reduce intrusive memories of a traumatic event in patients with existing posttraumatic stress who are from the German Federal Armed Forces. They were interested in measuring the enduring state of anxiety of the patients and administered Form X-2 to both the control (participants underwent EMDR therapy) and intervention (Tetris play) group. The patients from the Intervention group spent 60 minutes per day for two sessions per week, for six week playing Tetris. A total of 40 participants participated in the experiment. Their psychological analysis found that only the Tetris group showed a significant reduction in anxiety symptoms.

Fish et al. (2014), also conducted an experiment where they prescribed casual videogame play regimen to investigate if the intervention could reduce the anxiety symptoms severity. Fifty-nine participants aged 30 years and older were recruited. Two conditions of the experiments are the intervention group where the participants need to play a minimum of

30 minutes per session, 3 times a week for one month. Both groups were administered with the STAI Form Y-1 and Form Y-2. Their analysis shows the group with the prescribed regimen of casual video games play significantly reduced state and trait anxiety symptoms severity.

Acute Stress Appraisal (ASA)

Mendes et al. (2007) developed the Acute Stress Appraisal (ASA) using the components of demands and resources that was theorised by Lazarus & Folkman (1984). The theory posits that stress is identified by two distinct elements: perceived situational and personal demands and personal resources. Stress is perceived as a challenge when the resources exceed the demands and as a threat when the demand exceeds the resource. Demands are the pressure that stressors impose on the individuals, while resource refer to the individual's ability to meet those demand. Based on this concept, Mendes et al. (2007) developed the ASA to measure the effect of the demand by creating two sets of questionnaires; one is pre-task and the other post-task.

The pre-task questionnaire captures appraisal of the stressor after participants are informed about the task demands but prior to their performance of the task. The post-task questionnaire assesses the individuals' perceptions of the demands and resources after the task. The pre-task questionnaire has twelve items, while post-task questionnaire has seven. The scales use a 7-point liker scale. The items represent either demand or resources. To obtain the score, which is the Threat score, is obtained by dividing the demands by resources.

Visual Analogue Scale (VAS)

The Visual Analogue Scale (VAS), or graphic ratings scale, is a widely used measurement instrument designed to assess characteristics or attitudes that are believed to range across a continuum of values. This scale provides a simple and effective way to capture subjective experiences. The VAS typically consists of a horizontal line, usually 10 centimetres in length, with word descriptors at each end that represent the extremes of the variable being measured. For example, in the context of stress, one end might be labelled "No Stress" while the other is labelled "Maximal Stress." Participants respond by marking on the scale their level of stress at that moment. Originally introduced by Hayes & Patterson (1921), the VAS was developed as a subjective measure specifically for assessing acute and chronic pain. Over the years, it has been adapted for use in various fields, including psychology, medicine, and healthcare, to evaluate not only pain but also other emotional and psychological states (Dutheil et al., 2017). Its flexibility makes it suitable for measuring a range of feelings, including anxiety, mood, and, as noted, stress.

In the context of stress measurement, the VAS has undergone several adaptations to enhance its applicability. For instance, Barré et al. (2017) utilised the scale to create a 10-point ruler format, where respondents can indicate their stress level on a continuum ranging from "No Stress" to "Maximal Stress." One of the primary advantages of the VAS is its simplicity and ease of use, both for researchers and participants. It requires minimal explanation and can be quickly administered, making it ideal for studies where time is a factor. Moreover, the VAS captures the subjective experience of stress in a straightforward manner, providing a visual reference that can often resonate more with respondents than traditional numerical scales. In this thesis, the VAS that we adopted is the VAS for stress.

2.7 Chapter Summary

The research background explores the multifaceted relationship between stress, coping mechanisms, and digital games. Guided by Lazarus & Folkman (1984) psychological concept of stress, stress is not just a reaction to external events but involves a cognitive appraisal process where individuals assess the significance of stressors and their coping capabilities. Stressors can vary widely, from daily hassles to major life events, and can trigger different stress responses. In this research, we focus on acute stress rather than chronic stress, aiming to understand its effects on day-to-day experiences.

Coping strategies are crucial in managing stress and can be broadly categorised into problem-focused and emotion-focused approaches. Problem-focused coping addresses the root cause of stress, while emotion-focused coping aims to alleviate the emotional impact of stress. It is argued that games can be considered a form of emotion-focused coping. This is because games allow players to distance themselves from stressors, disassociate, and engage in replacement gratification. The role of digital games in well-being is a growing area of interest. Research suggests that playing games can have both positive and negative effects on stress levels. On one hand, games might offer a distraction, foster relaxation, or provide a sense of achievement, potentially mitigating stress. On the other hand, excessive gaming or exposure to stressful game scenarios could exacerbate stress.

The experience of playing games is also multifaceted, we can also see that the gaming experience concept are intertwined. For instance, immersion is a factor in challenge and also game elements. Hence, when we relate this experience to coping techniques for stress, we can focus on how certain aspects facilitate psychological distancing and personal gratification. Key elements such as immersion, challenge, and various game mechanics allow players to escape into a make-believe world. This experience helps them manage their emotions and restore themselves. Understanding how these game design elements and player interactions contribute to the stress experience is essential. Exploring these dynamics aids in assessing how digital games can be effectively used as a tool for stress management.

To conduct stress research particularly for experimental studies, stress protocol is needed to reliably and safely induce stress. The selection of protocol is dependent on the type and level of stress. Additionally, selecting the right measure is also crucial. Crosswell & Lockwood (2020) outlines the steps for selecting stress measures. From over 40 scales, the selection narrowed down to four scales. Each of the four selected scales have distinct focuses when assessing stress. PSS assess the general perception of stress over the period of four weeks, making is suitable for measuring general perception of stress in day-to-day life. On the other hand, STAI distinguishes between state and trait anxiety, it differentiates between the temporary and current feeling and the trait measures general propensity to be anxious. This makes STAI suitable to measure not only immediate effect of stress but also, how the participant generally feels. Therefore, the trait measure can be used at the baseline comparison. Meanwhile ASA evaluates stress based on demands and resources and VAS provides a visual measure of subjective experiences. Which means, the scales measure stress in relation to the demand of the task or the stressor present. Lastly, VAS for stress provides an easy representation of scale. Like STAI, it measures the immediate effect of stress but using visual representation.

3. Surveys of the Experiences of Playing Digital Games and Perceived Stress

There are many factors that influence why people play games. In the motivation to play discussed in Chapter 2.5.1, we explored multiple aspects of why people play digital games, which include autonomy, competence, relatedness, escapism, story. We related these factors to strategies to cope with stress. According to Demetrovics et al. (2011), when a person is faced with a stressful event, they use various coping techniques, such as cognitive disengagement from stressors or distancing. They added that one of the primary motivations for playing games is to forget daily problems, hassle, and unpleasant feelings by escaping real life and reducing tension through pleasurable experiences. Chapter 2.4.1 and 2.4.2 presented a number of evidence to support the positive effect of playing games on general wellbeing, stress and anxiety. However, there is still more that we need to understand about whether the experience of playing games could help in stress and anxiety reduction in a day-to-day context, particularly the motivation to play is related to their stress level.

Therefore, to begin answering the outlined research question, one of the tools commonly used to explore and measure the experience of playing digital games is questionnaires (Cairns & Power, 2018). There are numerous questionnaires used to measure various aspects playing digital game experiences. Similarly, surveys are also commonly used in research on stress, particularly to measure psychological aspect of stress, this was discussed extensively in the research background in Chapter 2.

This chapter focuses on addressing the two research questions of this thesis. Firstly, to examine the motivation of playing digital games and if the relation with their levels of perceived stress. This is elaborated in Survey 1 section of this chapter. The second research question to explore the relationship between the experiences of playing digital games including which is discussed in Survey 2. Overall, the main objective of this section is to determine if there is a correlation between game experiences and perceived stress.

3.1 Survey 1: Game Pursuit and Perceived Stress

This study aims to understand the motivation for playing digital games among individuals experiencing stress. This is an exploratory study conducted using an online survey through the Qualtrics platform. The study investigates the relationship between participants perceived stress and motivation to play. We also examined participants' game preferences to determine if there is a relationship with their perceived stress. The study attempts to answer the following research questions.

RQ 1: Is there a relationship between perceived stress and motivation to play?
RQ 2: Is there a relationship between perceived stress and games people play?

3.1.1 Methodology

Design

This is a survey study which was conducted using an online survey platform, Qualtrics, which allowed participants to complete the survey remotely via a link. The survey consisted of three main sections, which uses two main scales: Perceived Stress Scale (PSS) and the Video Game Pursuit (VGPu). Gaming behaviour was also collected, where participants were asked to list the games that they have played the most in the last month as well as the frequency of playing that game. Additionally, demographics were also collected. Overall, the survey consisted of 40 questions.

The first section measured the level of daily stress using the Perceived Stress Scale (PSS). The scale assesses the psychological response of stress, which is the degree to which the situations appeared to be unpredictable, uncontrollable, overloaded in their life (Cohen et al., 1983). The scale measures this perceived stress during the last four weeks. The selection of this measure was based on the guidelines that was described in Section 2.6.3 on stress measure, we adopted the Perceived Stress Scale (PSS) because the objective of this study is see if there is a relationship in their motivation to play and perceived stress on a daily basis. Since, the PSS measures perceived stress over the period of four weeks, this also allows to determine if a particular game stands out in their pursuit of game.

The second section measures the motivation to play games using the Video Game Pursuit Scale (VGPu) developed by Sanchez & Langer (2020). This scale measures the motivation to play games, specifically focusing on the positive experiences associated with gameplay. These experiences are characterised by the continued play of the game, the confidence in skills and confidence in playing the game, the positive experience that the game elicits and the experience of immersion, once the player is in flow. Another factor included in the scale is the intimidation with game, unlike the other subscales, this reflects a negative experience. While it is included in the overall positive experience of gameplay captured by the VGPu scale, it represents a distinct but related dimension. It is related to negative attitudes with games, which could inhibit people from the gaming cycle. However, it can improve the prediction of game reaction and performance. Although there are other scales that measure motivation to play such as Gaming Motivation Scale (GAMS) which measures motivation of playing while in-game, we want to find out if people are motivated to start playing game. Since the VGPu measures the antecedent to entering into the gaming cycle, this scale is adopted for this study.

The last section collected information on gaming behaviour where the participants listed the most played game in the last four weeks and how often they played the game. This is to determine if there is a relation between perceived stress and game preferences, that is if there is a particular game that people play when they are feeling stressed. Additionally, demographics information was also collected.

Measuring Daily Stress

For the Perceived Stress Scale (PSS), participants indicated their feeling and thoughts by selecting one of the options to reflect on how often they felt or thought a certain way. The survey consists of a 5-point likert scale ranging from “Never” to “Very Often”. Scores were obtained by summing the responses across all 10 items, with questions 4, 5, 6,7 and 8 being reversed scored. The total score ranges from 0–40, where scores between 0 – 13 indicate low perceived stress, 14 – 26 indicate moderate perceived stress, and 27 – 40 indicate high perceived stress. The Perceived Stress Scale (PSS) is provided in Appendix B.

Measuring Motivation to Play Games

The Video Game Pursuit (VGPu) measures the motivation to play in relation to four characteristics shown in Table 3.1. All items on the scale were evaluated on a 5-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”. The scores are obtained by finding the mean for each subscale. To avoid any bias items in the survey were randomised.

Table 3.1 shows the factors within the VGPu questionnaire. Appendix E presents the complete questionnaire.

Table 3.1
Video Game Pursuit Constructs

Construct	Code	VGPu Characterisation
Intentional Game Play	IGP	Intentional actions and behaviours taken for continued video gaming playing
Generalised Self-Efficacy	GSE	Confidence in abilities and skills at video game playing
Enjoyment of Game	EOG	Positive experience with video games
Prone to Game Immersion	PGI	A tendency to become immersed and experience flow with video game
Intimidation with Game	IWG	Comfort with video game

Games Preferences and Frequency of Playing Games

Participants were also asked to list the games they had played most frequently in the last four weeks. Allowing participants to provide their own list of games ensures a more robust dataset that is not constrained by a predefined list. This approach gives a more comprehensive and accurate picture of what the participants play and current trends in games. The questions can be found in Appendix C.

Participants

The surveys were distributed through different platforms, Instagram, Facebook, emails and universities different communication channels and to personal acquaintances. As a fulfilment of the scholarship, this first study was conducted for participants in Brunei Darussalam. The survey was distributed to the local universities and higher education institutions in the country. It was open for a total of two weeks and received a total of 298 responses. Twenty-five percent (N=43) were discarded, including those who did not give their consent and those who were aged 18 or younger. Participants who did not complete more than 30% of the questions were also discarded. The final dataset consisted of 224 responses (113 male, 98 female 98, and 13 who preferred not to say). The sample's age ranges from 18 to 44 years of age. More than 75% were students while the rest are either unemployed full-time employed, part-time employed, or others. The demographic distributions are shown in Table *3.2*, Demographic questions can be seen Appendix D.

Table 3.2
Demographic Analysis of the Research Sample

		n	%
Age	18 - 24	173	77
	25 - 34	47	21
	35 – 44	3	1
	45 – 55	1	0
	56 – 60	0	0
Gender	Male	113	50
	Female	98	44
	Non-binary	0	0
	Prefer not to say	13	6
Employment	Unemployed	14	6
	Student	172	77
	Full-time employment	26	12
	Part-time Employment	5	2
	Other	7	3
Highest Qualification	N/A	1	0
	Primary Education	0	0
	Secondary Education	14	6
	Sixth Form Colleges	56	25
	Vocational and Technical Education	62	28

	Bachelor's Degree	85	38
	Master's Degree	6	3
	Doctoral Degrees	0	0

3.1.2 Results

Perceived Stress

The total stress score is tabulated below. The scores show that 25 participants scored low perceived stress, 167 scored moderate stress and 32 scored High stress. From the survey, 75% were moderately stressed and 14% scored high in perceived stress (Table 3.3).

Table 3.3
Perceived Stress Score

Stress Score Range	Stress Level	n	%
0-13	Low Stress	25	11
14-26	Moderate Stress	167	75
27-40	High Perceived Stress	32	14

Perceived Stress and Motivation to Play Games

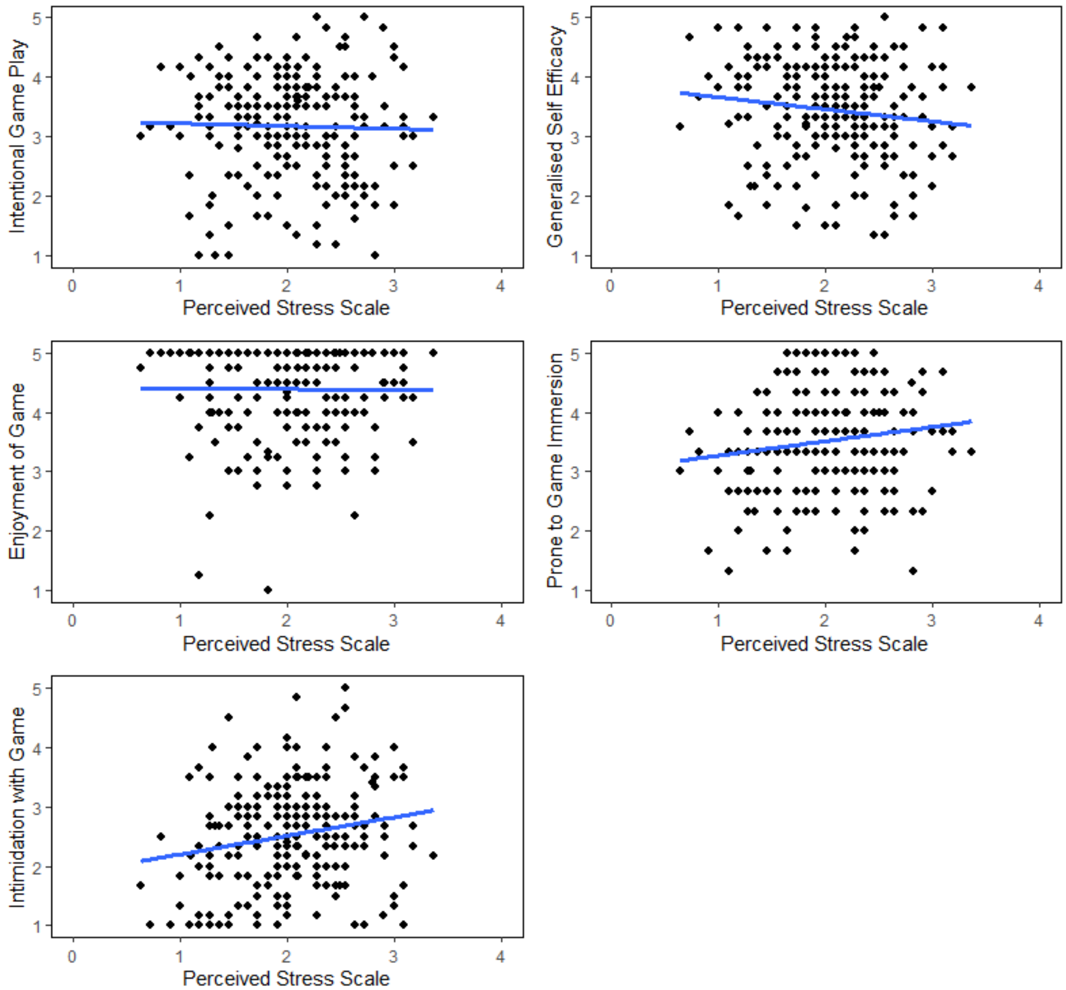
To answer RQ1, the correlation between perceived stress and each of the game pursuit constructs were calculated. The results show there is a weak negative correlation between PSS with GSE and weak positive correlation between PSS with PGI and IWG. Overall, there is a small effect size between the variables as shown in Table 3.4 and Figure 3.1.

Table 3.4
Pearson Correlation Coefficients Matrix of Perceived Stress and Video Game Pursuit.

	PSS	IGP	GSE	EOG	PGI	IWG
PSS	-	0.001	0.018	0.000	0.155	0.196
IGP	-0.030	-	0.576	0.388	0.062	0.176
GSE	**-0.133**	**0.759**	-	0.386	0.046	0.296
EOG	-0.003	**0.623**	**0.621**	-	0.057	0.152
PGI	**0.155**	**0.248**	**0.214**	**0.238**	-	0.001
IWG	**0.196**	**-0.412**	**-0.544**	**-0.386**	0.030	-

Note: *Left values are the r score, right values are the r^2 score. Values in bold are significant, $p<0.05$.*

Figure 3.1
Scatterplots of Perceived Stress and Video Games Pursuit (VGPu)



Perceived Stress and Games Preferences

To answer RQ2, regarding the relationship between Perceived Stress and Games Preferences, the listed games were first checked and cleaned for spelling errors and variations in names of the same title. The frequency of each title was counted and summarised. A total of 70 game titles were listed and tabulated in Table 3.5. Six games were listed at least 10 times by the participants, and each game was plotted to determine if there is a correlation with Perceived Stress. Overall, there is no difference across the median (Figure 3.2) of the most played games with perceived stress. Top games played were also plotted against VGPu (Figure 3.3).

Table 3.5
List of Top Games Played

Game Title	n	%
PlayerUnknown's Battleground (PUBG)	24	11
Genshin Impact	23	10
League of Legends: Wild Rift (LOL)	16	7
Among Us	14	6
Mobile Legends: Bang Bang	11	5
Counter Strike: Global Offensive	10	4

Figure 3.2
Boxplot of Perceived Stress and Top Games Played

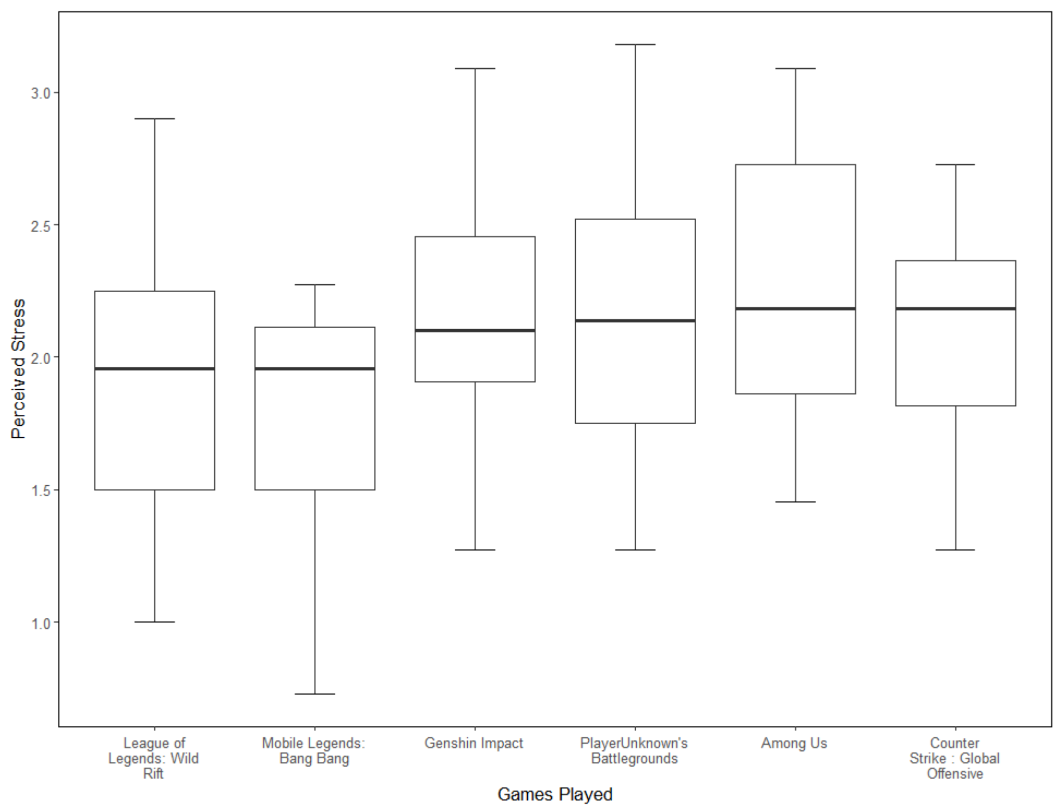


Figure 3.3
Box Plots of Video Game Pursuit (VGPu) and Top Games Played

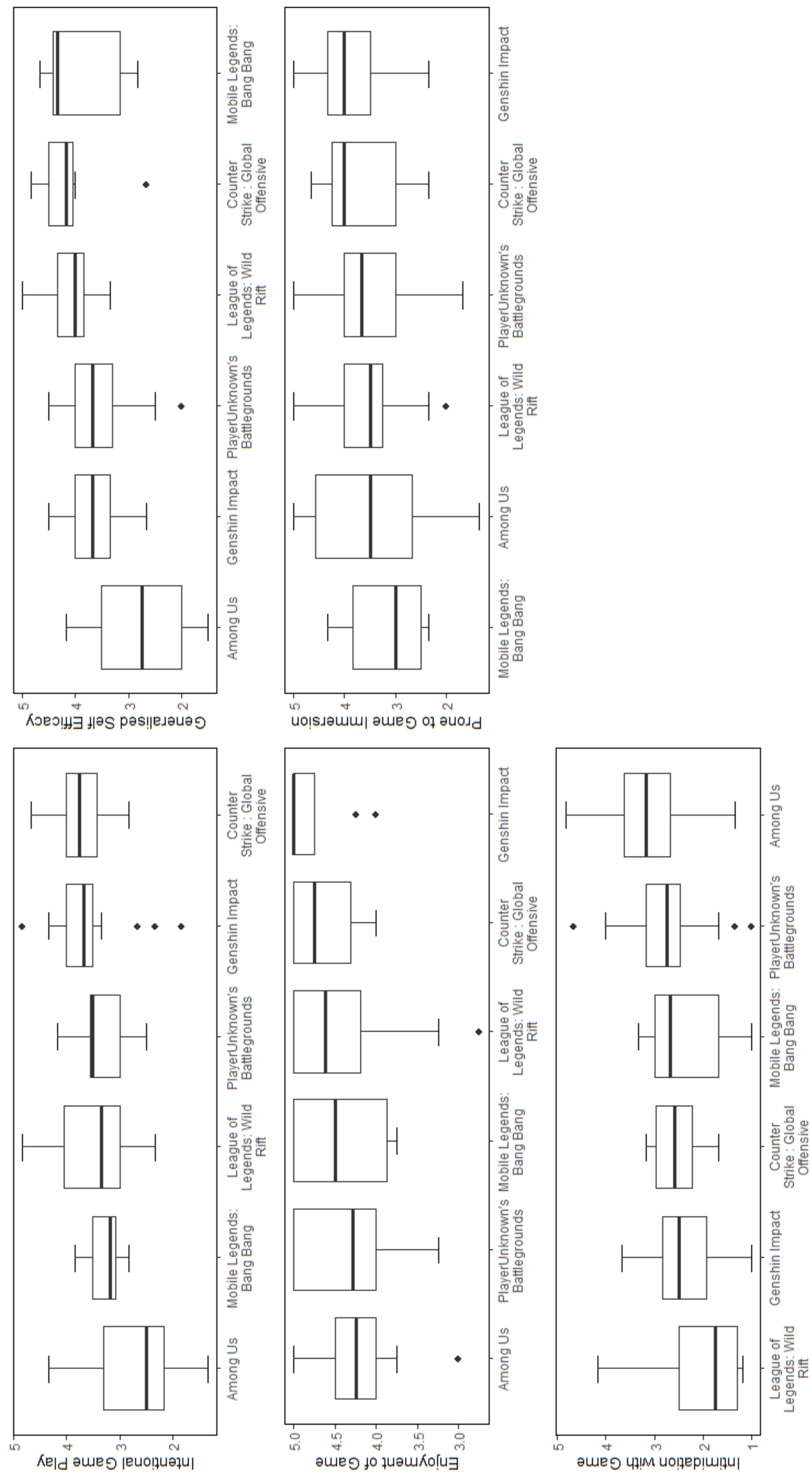


Table 3.6
Mean and Standard Deviation (SD) for Top Games Played

Top Games Played	PSS	IGP	GSE	EOG	PGI	IWG
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
PlayerUnknown's Battleground (PUBG)	2.12 (0.48)	3.38 (0.45)	3.58 (0.62)	4.37 (0.57)	3.49 (0.75)	2.78 (0.85)
Genshin impact	2.21 (0.47)	3.56 (0.69)	3.69 (0.48)	4.87 (0.26)	3.40 (0.76)	2.43 (0.73)
League of Legends: Wild Rift (LOL)	1.87 (0.56)	3.51 (0.69)	4.09 (0.50)	4.41 (0.68)	3.58 (0.79)	1.93 (0.81)
Among Us	2.28 (0.51)	2.65 (0.83)	2.83 (0.92)	4.21 (0.53)	3.50 (1.10)	3.11 (0.88)
Mobile Legends: Bang Bang	1.72 (0.46)	3.26 (0.31)	3.86 (0.73)	4.41 (0.56)	3.15 (0.75)	2.35 (0.83)
Counter Strike: Global Offensive	1.99 (0.42)	3.72 (0.55)	4.02 (0.75)	4.65 (0.39)	3.67 (0.85)	2.52 (0.56)

Table 3.7
One-Way ANOVA for Perceived Stress and Video Game Pursuit (VGPu) for Top Games Played

Factors	Result
PSS	$F(5,92) = 2.447, p=0.04$
IGP	$F(5,92) = 5.081, p<0.01$
GSE	$F(5,92) = 6.803, p<0.01$
EOG	$F(5,92) = 3.955, p<0.01$
PGI	$F(5,92) = 1.389, p=0.24$
IWG	$F(5,92) = 3.927, p<0.01$

A one-way ANOVA was performed to compare the effect of top games played on perceived stress and the VGPu's five constructs. The results revealed that there was a statistically significant difference in the perceived stress and the top games played $F(5,92) = 2.447$, $p=0.04$. The test also revealed that with an exception of the Prone to Immersion construct, there are significant differences in the intention to play, games self-efficacy, enjoyment of game and intimidation with games constructs against the games played as shown in Table *3.7*.

However, the post-test using Tukey's HSD for multiple comparisons found that there is no statistically significant difference in the Perceived Stress mean between any pair of games as demonstrated in Table 3.8. The post test for each of the subscale for motivation to play games for the top games played was also calculated. The compact letter display of the Tukey's HSD result can be seen from Table 3.8 – 3.13. Full details of the Tukey's HSD result can be seen in Appendix F.

Table 3.8

Tukey's Pairwise Comparisons for Perceived Stress and Top Games Played Compact Letter Display

Among Us	a
Genshin Impact	a
PlayerUnknown's Battlegrounds	a
Counter Strike: Global Offensive	a
League of Legends: Wild Rift	a
Mobile Legends: Bang Bang	a

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.9

Tukey's Pairwise Comparisons for Intention to Game Play and Top Games Played Compact Letter

Genshin Impact	a	
PlayerUnknown's Battlegrounds	a	
Counter Strike: Global Offensive	a	
League of Legends: Wild Rift	a	
Mobile Legends: Bang Bang	a	b
Among Us		b

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.10

Tukey's Pairwise Comparisons for Games Self-Efficacy and Top Games Played Compact Letter Display

Genshin Impact	a	
PlayerUnknown's Battlegrounds	a	
Counter Strike: Global Offensive	a	
League of Legends: Wild Rift	a	
Mobile Legends: Bang Bang	a	
Among Us		b

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.11
Tukey’s Pairwise Comparisons for Enjoyment of Games and Top Games Played Compact Letter Display

Genshin Impact	a		
Counter Strike: Global Offensive	a	b	
League of Legends: Wild Rift	a	b	
Mobile Legends: Bang Bang	a	b	
Among Us		b	
PlayerUnknown's Battlegrounds		b	

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.12
Tukey’s Pairwise Comparisons for Prone to Game Immersion and Top Games Played Compact Letter Display

Genshin Impact	a
Counter Strike: Global Offensive	a
League of Legends: Wild Rift	a
Among Us	a
PlayerUnknown's Battlegrounds	a
Mobile Legends: Bang Bang	a

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.13
Tukey’s Pairwise Comparisons for Intimidation with Games and Games Played Compact Letter Display

Among Us	a		
PlayerUnknown's Battlegrounds	a		
Counter Strike: Global Offensive	a	b	
Mobile Legends: Bang Bang	a	b	
League of Legends: Wild Rift		b	
Genshin Impact	a		c

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

PUBG and Genshin Impact

Although a total of 70 game titles were collected, only PlayerUnknown's Battlegrounds (PUBG) and Genshin Impact had sample sizes exceeding 20. Therefore, to better understand the relationship between the motivation to play and perceived stress, these two games were analysed in more detail. The limited sample sizes for other games were insufficient for robust statistical analysis. This analysis aims to explore whether there is a correlation between the motivation to play and perceived stress specifically for PUBG and Genshin Impact. Unlike the overall analysis, which showed only a weak correlation and minimal effect between the Perceived Stress Scale (PSS) scores and both gameplay intention and enjoyment, this focused analysis seeks to provide a more detailed understanding of these relationships for the two games with the larger sample sizes. Table 3.14 shows the correlations and Figure 3.4 - Figure *3.8* shows the scatterplots between top games played with PSS and factors within VGPu.

Table 3.14

Pearson Correlation Coefficients Matrix for Perceived Stress and Video Game Pursuit for PlayerUnknown's Battleground (PUBG) and Genshin Impact.

PUBG	**PSS**	**IGP**	**GSE**	**EOG**	**PGI**	**IWG**
PSS	-	0.205	0.219	0.100	0.045	0.106
IGP	**-0.453**	-	0.453	0.377	0.008	0.185
GSE	**-0.468**	**0.673**	-	0.475	0.035	0.373
EOG	-0.316	**0.614**	**0.689**	-	0.114	0.196
PGI	0.212	-0.091	0.186	0.338	-	0.008
IWG	0.325	**-0.430**	**-0.611**	**-0.443**	-0.091	-
Genshin Impact	**PSS**	**IGP**	**GSE**	**EOG**	**PGI**	**IWG**
PSS	-	0.036	0.047	0.004	0.065	0.000
IGP	0.191	-	0.441	5.570	0.114	0.071
GSE	-0.217	**0.664**	-	0.013	0.154	0.026
EOG	0.061	0.236	0.116	-	0.015	0.076
PGI	0.255	0.337	0.392	0.123	-	0.048
IWG	0.010	-0.266	-0.162	-0.276	0.220	-

Note: Left values show the r score, and the right values are the r^2 score. Significant vales are in bold, $p<0.05$.

Figure 3.4

Scatterplots of Perceived Stress and Intentional Game Play Between PUBG and Genshin Impact

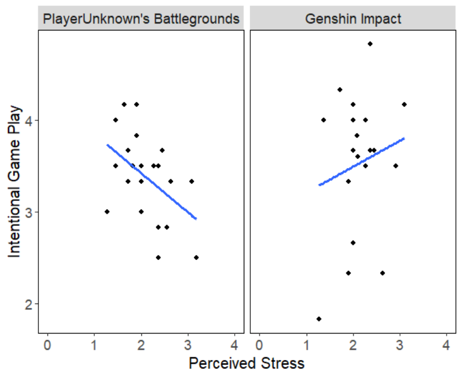


Figure 3.5

Scatterplots of Perceived Stress and Game Self-Efficacy Between PUBG and Genshin Impact

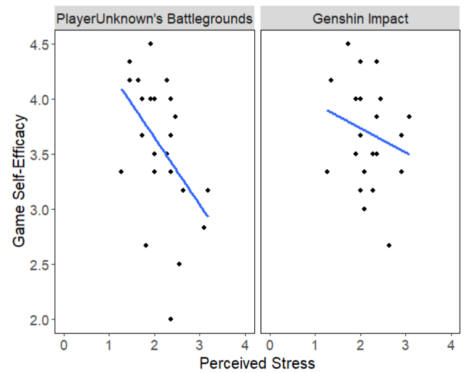


Figure 3.6

Scatterplots of Perceived Stress and Enjoyment of Game Between PUBG and Genshin Impact

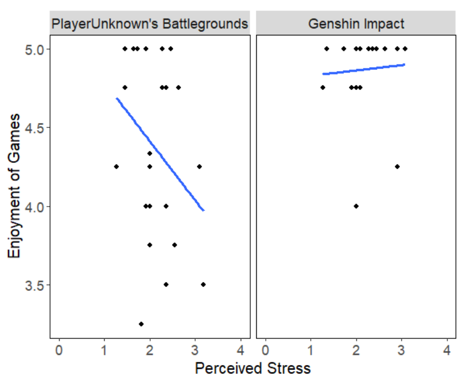


Figure 3.7

Scatterplots Perceived Stress and Prone to Game Immersion Between PUBG and Genshin Impact

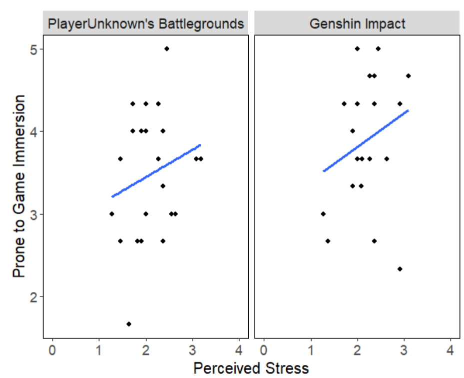
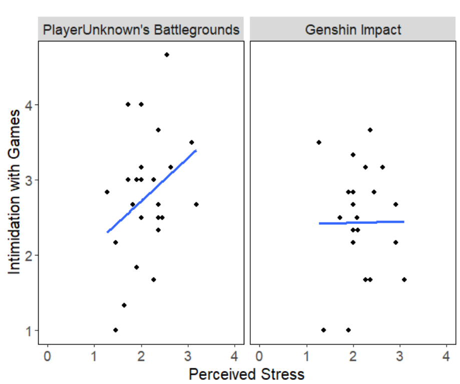


Figure 3.8

Scatterplots of Perceived Stress and Intimidation with Games Between PUBG and Genshin Impact



To determine whether there is significant difference between the means between Perceived Stress and the sub-scales for the video game pursuit, a t-test was conducted. Table 3.15 summarises the result.

Table 3.15
The t-tests for PUBG and Genshin Impact Against Video Games Pursuit

	PUBG		Genshin Impact		df	t	p	d
	M	SD	M	SD				
PSS	2.12	0.48	2.21	0.47	44.99	0.70	0.49	0.20
IGP	3.38	0.45	3.56	0.69	37.62	1.05	0.30	0.31
GSE	3.58	0.63	3.69	0.48	42.90	0.69	0.49	0.20
EOG	4.37	0.57	4.87	0.26	32.44	3.91	0.00	1.12
PGI	3.49	0.75	3.90	0.76	44.88	1.88	0.07	0.55
IWG	2.78	0.85	2.43	0.73	44.53	-1.51	0.14	-0.44

3.1.3 Discussion

There are two main aims of this study: 1) to examine if there is a relationship between perceived stress and motivation to play and, 2) to see the relationship between perceived stress and the games people play. To address both research aims, we first assessed the level of stress among participants. The Perceived Stress Scale (PSS) results showed about 89% of the participants are reported experiencing moderate to high level of perceived stress, which highlights that the sample is affected by stress. This highlights also highlights that people experience stress on a day-to-day basis. The high level of stress may also affect the overall results in this study as it may cause ceiling and floor effects. Also, the sensitivity may be reduced, making it difficult to detect relationships with other variables.

Perceived Stress and Motivation to Play Games

The first aim of the study was to investigate the relationship between people's perceived stress and their motivation to play as measured across the five subscales of the VGPu. Despite the high prevalence of stress, the analysis did not show any significant correlation between perceived stress and the intentional pursuit of games. Similarly, no correlation was found between perceived stress and enjoyment of games. On the other hand, the results show, there is a weak negative correlation between perceived stress and game self-efficacy, which seemed to indicate that as the level of stress increases their confidence with game play decreases. On the other hand, the positive correlations between perceived stress and prone to game immersion indicate that as the level of stress increases so in the tendency to be immersed with the game.

Interestingly, the result also showed there is a positive correlation between perceived stress and intimidation with gameplay, suggesting that participants find games more difficult as their level of stress increases. This finding suggests that, although perceived stress was not directly linked to the pursuit of games, it indicates that motivation to play may be influenced by other experiences of gameplay, in this case, immersion. Additionally, it suggests that as the level of stress increases, the confidence in playing games decreases and the games seemed more difficult.

This study also highlights potential limitations in the use of the VGPu and Perceived Stress scales to fully capture the complex relationship between stress and gaming motivation. The VGPu measures the motivation of play in a gaming cycle but not motivation to play while in a stressed state. The VGPu, although effective in measuring general gaming motivation, may not be sensitive enough to detect motivations associated with stress level. Secondly, the PSS, albeit a well-validated scale, measures the stress perception over the period of four weeks. The measure may not capture the stress state of the participants immediately or for measuring day-to-day stress. Given these finding, it is evident that an alternative measurement tool is needed to asses specific intentions or motivations to play games as a method of stress relied. immediate perceived state and their intention to play a game to overcome stress. Given these findings, it is evident, that an alternative measurement tool is needed to assess specific intention or motivation to play video games as a method of stress relief.

Perceived Stress and Game Preferences

The second objective of the study was to examine the relationship between perceived stress and game preferences. Game preferences refer to the games participants played most frequently in the past. Due to the extensive list of games reported, the list was filtered to include only games that were listed at least ten times. The list was reduced to only six game titles as shown in

Table *3.5* . PlayerUnknown's Battleground (PUBG) had the highest number followed closely by Genshin Impact. The medians of the perceived stress levels for the top games played showed little difference across the different games, suggesting a lack of clear relationship between game preferences and perceived stress. Despite this, the one-way ANOVA test Table *3.7* (Table 3.7) showed a significant difference between perceived stress and games played where, p = 0.04. However, the Tukey's HSD post-hoc test (Table 3.8) found no significant differences in the pairwise comparisons between groups. This is likely due to random variation rather than any meaningful effect, making the interpretation of these findings more challenging.

Hence, to get more information, an analysis of the motivation to play for different games was also performed. The one-way ANOVA results, as shown in Table 3.7, indicated that, with the exception of prone to game immersion (PGI), there is a significant difference across the four VGPu constructs; IGP, GSE, EOG and IWG. Tukey's HSD was also conducted, the results for intentional gameplay indicated that Among Us showed significant difference from other games, except for Mobile Legends: Bang Bang. In game self-efficacy, Among Us showed significant difference from all the other games. In the enjoyment of games, Among Us is significantly different from Genshin Impact only. In the intimidation with games, Among Us is different from League of Legends: Wild Rift, while Genshin Impact is significantly different to League of Legends: Wild Rift.

The four results show the differences amongst the games, mainly for Among Us. Perhaps one of the contributing factors observed in these differences is the design of the game. Among Us is described as having a round-bodies astronaut-like creatures wearing spacesuits in different colours and lack of arms with short leg [3]. It is a party and social deduction game that is centred on a group of crewmates trying to complete a task. On the other hand, CSGO and PUBG design focuses on realistic depiction of human soldiers. Leagues of Legend: Wild Rift and Genshin Impact uses element of human-like characters with fantasy and anime-inspired aesthetics. These differences in design and visual style could play a role in determining the motivation to play. Aesthetics refers to the graphics of the game (Keebler et al., 2020). While Hunicke et al., (2004b) characterise it as something fun, Niedenthal, (2009) terms it as the experience that effects the sensory in the form of visual, aural, haptic or embodied. It is the aspects of digital games that are shared with other art form and it an expression of the games that translates to pleasure, emotion and sociability. We can see that aesthetics as visual cues that could lead to expression emotion and satisfaction.

The significant differences in the game efficacy also suggest that players' confidence in their gaming skills varies notably when playing Among Us compared to the other titles. This variation might be attributed to differences in game complexity or player skill requirements. This is due to the distinctions between the gameplays. Among Us, which is considered to be a casual game, may not require high level of skills compared to the other games (Kultima, 2009). The dedication and investment of time between the games also differ. Casual games are "touch and go" while complex games require dedication and investment of time to fully enjoy the overall gameplay. CSGO[4] and PUBG[5] are both shooting games, which are considered to be competitive games. These games compared to Among Us require a lot of practice and investment of time in order to develop the skills to be good at it.

Individual Game Analysis – PUBG and Genshin Impact

Due to a lack of clear relationship between perceived stress and the game played, individual games analysis was performed. The two top games are PUBG and Genshin

---

[3] https://among-us.fandom.com/wiki/Characters
[4] https://en.wikipedia.org/wiki/Counter-Strike:_Global_Offensive
[5] https://en.wikipedia.org/wiki/PUBG:_Battlegrounds

Impact. Overall, only PUBG shows moderate significant correlations between Intentional Game Play, where $r = -0.45$ and Generalised Game Self-Efficacy, where $r = -0.47$ with Perceived Stress. These results imply that the increase in the intention to play and game efficacy decreases perceived stress. PUBG as previously noted, requires time investment to be proficient at playing it. The long gameplay and the level of skills required reflects the challenges the game poses. This suggests challenges in games could be the motivational factor for playing those games.

However, there is no relationship between perceived stress and game preferences. By breaking the analysis down to the popular games, we were able to see a correlation between the intention to play and game self-efficacy within PUBG. And this correlation shows that it could be worthwhile to investigate the games or similar games for their effects on stress.

Overall Discussion

The findings of this study highlight the complexities in the relationship between perceived stress and the various aspects of gaming motivation and preferences. While perceived stress did not significantly correlate with the pursuit of games, it did affect game immersion, self-efficacy and perceived difficulty of the game. The significant variations observed across the different games, particularly the contrast between the popular games and their gameplay, highlight the importance of game design elements in determining player experience. Game elements particularly, game aesthetics could further inform the effect of playing experiences in relation to stress.

3.2 Survey 2: Games Experiences and Perceived Stress

The complex yet interesting relationship between perceived stress and gaming behaviour seen in Survey 1 opens up opportunities for further exploration. The analysis from Survey 1 showed that while perceived stress did not display a significant correlation between pursuit of specific games, it did influence several other gaming experiences, including the efficacy in gameplay and immersion. The result from the previous study also highlighted the variations in the game's design elements, such as the aesthetics and the challenge levels across the top games played.

Playing games is all about overcoming challenges (Brandse & Tomimatsu, 2013) but in game design, challenge have been used as a component to maximize enjoyment of playing games (Bostan & Öğüt, 2009). The outcome from challenges presented is largely dependent on the players abilities (Brandse & Tomimatsu, 2013). In the previous study, we saw a negative correlation between perceived stress and abilities in playing video games. Building on these findings, this study aims to explore the relationship between the level of challenges presented by games and players' perceived stress. To measure challenges in games, Challenge Originating from Recent Gameplay Interaction Scale (CORGIS) is used. It measures four aspects of challenge: Cognitive Challenge, Emotional Challenge, Performative Challenge, Decision Making Challenge which measures challenges that are present in the game (Denisova et al., 2020a).

In addition to challenges, the analysis from the first survey also showed a positive relationship between perceived stress and immersion. Furthermore, we highlighted that game design particularly, the visual presentation or the aesthetics of the game may have an influence on the motivation to play and perceived stress. Although, it is difficult to determine what aspect of the visual design that could contribute to this. To get a general idea if the aesthetics can contribute stress alleviation, rather than focusing on specific aspect of game design such as colour, we want to measure the general satisfaction with design. Hence, we adopted the Game User Experience Satisfaction Scale (GUESS-18) for this survey. The scale measures satisfaction on several factors, not only on visual and audio aesthetics, but also other experience of playing game of play engrossment, usability and playability, games narrative, enjoyment, creative freedom, personal gratification and social connectivity. It is due to the comprehensiveness of this scale that it was adopted for this study.

Therefore, this study aims to answer the following research questions.
RQ 1: Is there a relationship between perceived stress and the game challenges?
RQ 2: Is there a relationship between perceived stress and various aspects of game user satisfaction including usability/playability, narrative, play engrossment, enjoyment, creative freedom, audio and visual aesthetics, personal gratification, and social connectivity?

3.2.1 Methodology

Design

Similar to Survey 1, this study was conducted as an online survey using Qualtrics as the main data collection platform. The survey link was distributed across various platforms to reach participants. The survey included three well-validated scales: the Perceived Stress Scale (PSS), Challenge Originating from Recent Gameplay Interaction Scale (CORGIS) and the Game User Experience Satisfaction Scale (GUESS-18). As in the first survey, participants' gaming behaviour and demographic information were also collected.

Overall, the survey consisted of four parts and included 50 questions. Perceived Stress Scale (PSS) was used to measure participants' stress level. The second part measured game challenges using Challenges Originating from Recent Gameplay Interaction (CORGIS), which assesses challenges related to cognitive, emotional, performative, and decision-making aspects. We also adopted the Game User Experience Satisfaction Scale (GUESS-18), which measures satisfaction in nine areas, including play engrossment and aesthetics. Although play engrossment does not exactly describe immersion, we found that the questions or statements are closely related to how immersion is defined. The questions include: "I enjoy the fantasy or story provided by the game," "I feel detached from the outside world while playing the game," and "I do not care to check events that are happening in the real world during the game." Additionally, the scale measures usability/playability, narratives, enjoyment, creative freedom, personal gratification, and social connectivity. These factors provide further insights into the gaming experience. The selection of this scale is based on its comprehensive measurement of various aspects of gameplay, including the two factors we want to examine: immersion and aesthetics. Furthermore, using this single scale rather than multiple scales reduces the number of items for participants to answer, which we hope will decrease fatigue and dropout rates in completing the survey (Backor et al., 2007; Ghafourifard, 2024).

In Survey 1, in the discussion of PUBG and Genshin Impact, we argued that, although both PUBG and Genshin Impact involve multiplayer gameplay and combat[6], they have contrasting looks and designs. Genshin Impact features an anime style design[7], whereas, PUBG[8] uses realistic visual design. We want to measure the general perception of the aesthetics; therefore, we adopted the GUESS-18, as it measures the satisfaction level of the game based on general aspect of the design.

[6] https://news.codashop.com/kh/difference-between-pubg-and-pubg-mobile/
[7] https://www.xp-pen.com/blog/genshin-impact-art-style.html
[8] https://news.codashop.com/kh/difference-between-pubg-and-pubg-mobile/

The next section is the user satisfaction scale (GUESS-18). The questionnaire measures satisfaction based on nine digital game characteristics. This scale was selected based on the various aspects of games it measures, including narratives, audio and visual aesthetics.

In this survey, gaming behaviours were also collected. Participants were asked to list the games that they have played the most in the last four weeks along with how often they played the games or the frequency of play and time of play. The demographics section for the participants includes their age, gender, level of study, and employment. If the participants are not yet at the age of 18, they were not allowed to participate in the survey.

Measuring Daily Stress

Following Survey 1, Perceived Stress Scale (PSS) was adopted to measures the degree to which the situations in one's life are appraised as stressful.

Measuring Game Challenges

Game challenges were measured using Challenge Originating from Recent Gameplay Interaction Scale (CORGIS). It measures the participants' perception of challenge, the scale comprises of 30 questions distributed among four subscales: Cognitive Challenge, Emotional Challenge, Performative Challenge, Decision Making Challenge. All items on the scale were evaluated on a 7-point scale from 1= Strongly Disagree to 7=Strongly agree. The items presented were also randomised for each participant. The scale was designed to be used directly after playing a game, for this study the participants were asked to relate their answer they played the most in last four weeks instead. This is to ensure that the results can be connected with the PSS. Table *3.16* shows the factors withing the scale and the characteristics of each factor. The scale can be found in Appendix G.

Table 3.16
Challenge Originating from Recent Gameplay Interaction (CORGIS) Constructs

Construct	Code	CORGIS Characterisation
Cognitive Challenge	CC	Arising from the need for preparation, planning ahead, memorisation, effort and multi-tasking.
Emotional Challenge	EC	Arising from the emotion evoked in the player which might also have implications for things they thought about outside of the game.
Performative Challenge	PC	Arising from the game requiring rapid and accurate action from the player.
Decision-Making Challenge	DM	Arising from having to make choices that were difficult or could lead to regrettable outcomes.

Measuring Game User Experience Satisfaction

GUESS-18 is a short Version of the original 55-item Game User Experience Satisfaction Scale (GUESS). It has been validated and demonstrated as an excellent fit to give a comprehensive measure of the participants video game satisfaction. Participants rate the experience of using the videogame based on nine dimensions including usability/playability, narratives, enjoyment of game, narratives, creative freedom, audio and visual aesthetics satisfaction, social connectivity, personal gratification. All items on the scale were evaluated on a 7-point scale from 1= Strongly Disagree to 7=Strongly agree. The items presented were also randomised for each participant. Just as CORGIS, participants are required to answer the questions in relation to the most played game in the last four weeks. Table 3.17 shows the factor within GUESS-18 and the characteristics of each factor. The scale can be found in Appendix H.

Table 3.17

Game Users Experience Satisfaction Scale (GUESS-18) Constructs

Construct	Code	GUESS-18 Characterisation
Usability/Playability	UP	Ease of game with minimal cognitive interferences from interfaces and controls.
Narratives	NR	Story aspect of the game that are able to hold player's attention and shape player's emotions.
Play Engrossment	PE	Degree to which the game can hold player's attention and interest.
Enjoyment	EJ	Amount of pleasure and delight derived from playing the game.
Creative Freedom	CF	Extent of the game is able to foster creativity and curiosity and freely express individuality.
Audio Aesthetics	AA	Auditory aspect to enrich gaming experience.
Personal Gratification	PG	Motivational aspect to promote sense of accomplishment and desire to succeed and continue playing.
Social Connectivity	SC	Degree to which the game is able to facilitate social connection with other players.
Visual Aesthetics	VA	Attractiveness of the game graphics.

Games Preferences and Frequency of Play.

As in the previous study, gaming behaviours were also collected. Participants were asked to list the games that they have played the most in the last four weeks and the duration and frequency of playing the game. Both GUESS-18 and CORGIS were designed to be used immediately after they have played the game so that it will be fresh in their minds. However, to measure if there is a specific game that people play in the while being stressed daily, the game needs to be played as often as four weeks, which is also the duration for the measure of perceived stress. Therefore, additional instructions were included, asking participants to respond to the survey concerning the games they have played in the last four weeks as presented below.

“Please answer the next part of the survey in relation with the game that you have played the most in the LAST 4 WEEKS, which listed in the previous question.”

Additionally, the survey also asked participants to indicate the duration and frequency of playing the stated game. Additionally, the higher frequency and duration of playing the stated game may indicate their extensive knowledge of the game they played.

Participants

The surveys were distributed through different media platforms, game forums, Discord Channels and Reddit pages. The forums were chosen from the list of games obtained from Survey 1 and others are channels that are associated with the listed forums. A total of 110 requests to post the survey were submitted and only 30 granted permissions to post the survey in the channels. The rest indicated that it was against their channel rules, while others did not respond.

The surveys were open for a total of three weeks and received a total of 1,338 responses. After the data cleaning process, a combined total of 665 respondents were received. Reponses were removed if they did not give consent, were under the age of 18, answered incorrectly for the attention check questions and also if they did not provide any game title or answered “none” or “nil”. Participants who did not complete more than 30% of the questions were also discarded. The game titles were also checked and corrected for spelling mistakes or any typographical errors. A total of 204 games titles were obtained from the survey. Table *3.18* shows the demographic distributions of the participants.

Table 3.18
Demographic Analysis of the Research Sample

		n	%
Age	18 - 24	332	50
	25 - 34	242	36
	35 – 44	72	11
	45 – 55	15	2
	56 – 60	3	0
	Above 60	1	0
Gender	Male	424	64
	Female	208	31
	Non-binary	23	3
	Prefer not to say	10	2
Employment	Unemployed	93	14
	Student	232	35
	Full-time employment	262	39
	Part-time Employment	56	8
	Other	22	3

3.2.2 Results

Perceived Stress

Table 3.19 shows the stress score for 665 participants. The scores show that 151 participants scored low perceived stress, 405 scored moderate perceived stress, and 109 scored high perceived stress. 61% were moderately stressed and 16% scored high in perceived stress.

Table 3.19
Perceived Stress Score

Stress Score Range	Stress Level	n	%
0-13	Low Stress	151	23
14-26	Moderate Stress	405	61
27-40	High Perceived Stress	109	16

Games Preferences

A total of 217 games titles were collected in this study. To manage our analysis and also following Survey 1, we filtered the games list to only include games which were listed at least 10 times, except for PUBG and Genshin Impact as listed in Table 3.20. PUBG was included in the list because these games were analysed in Survey 1. Therefore, to be consistent these games were also analysed. Twenty-five respondents for Genshin Impact were received. However, only nine for PUBG. Hence, even though PUBG did not make part of the Top games played with ten and more respondents, PUBG is included in the data analyses. One of the factors that led to the limited number of PUBG respondents is attributed to the restrictions set by the game forum pages. Table 3.20 shows the top games played in the last four weeks.

SuperStar Series has the highest number of respondents, followed by Fate/Grand Order. Both games have more than forty respondents. SuperStar Series is a compilation of SuperStar JYPNation, SuperStar SMTown and SuperStar YG. These are rhythm games with similar gameplay, due to the similarities, all the responses from these games are compiled called as SuperStar Series. The only difference is the songs that each of these games have.

Table 3.20
List of Top Games Played

Game Title	n	%
SuperStar Series	64	29
Fate/Grand Order	56	26
Fire Emblem Heroes	35	16
Pokémon GO	34	16
Genshin Impact	29	13
League of Legends: Wild Rift	28	13
Idle Heroes	16	7
Mobile Legends: Bang Bang	16	7
Valorant	13	6
Noita	11	5
Pokémon Legends: Arceus	11	5
Final Fantasy XIV	9	4
PlayerUnknown's Battlegrounds	9	4

Perceived Stress and Game Preferences

Perceived stress is then analysed against the top games played. The boxplots in Figure 3.9 shows the medians for perceived stress across the top games played while Table 3.21 shows the mean and standard deviation of perceived stress for the top games played. SuperStar Series showed the highest perceived stress median which is followed by Genshin Impact.

Figure 3.9

Box Plot of Top Games Played and Perceived Stress

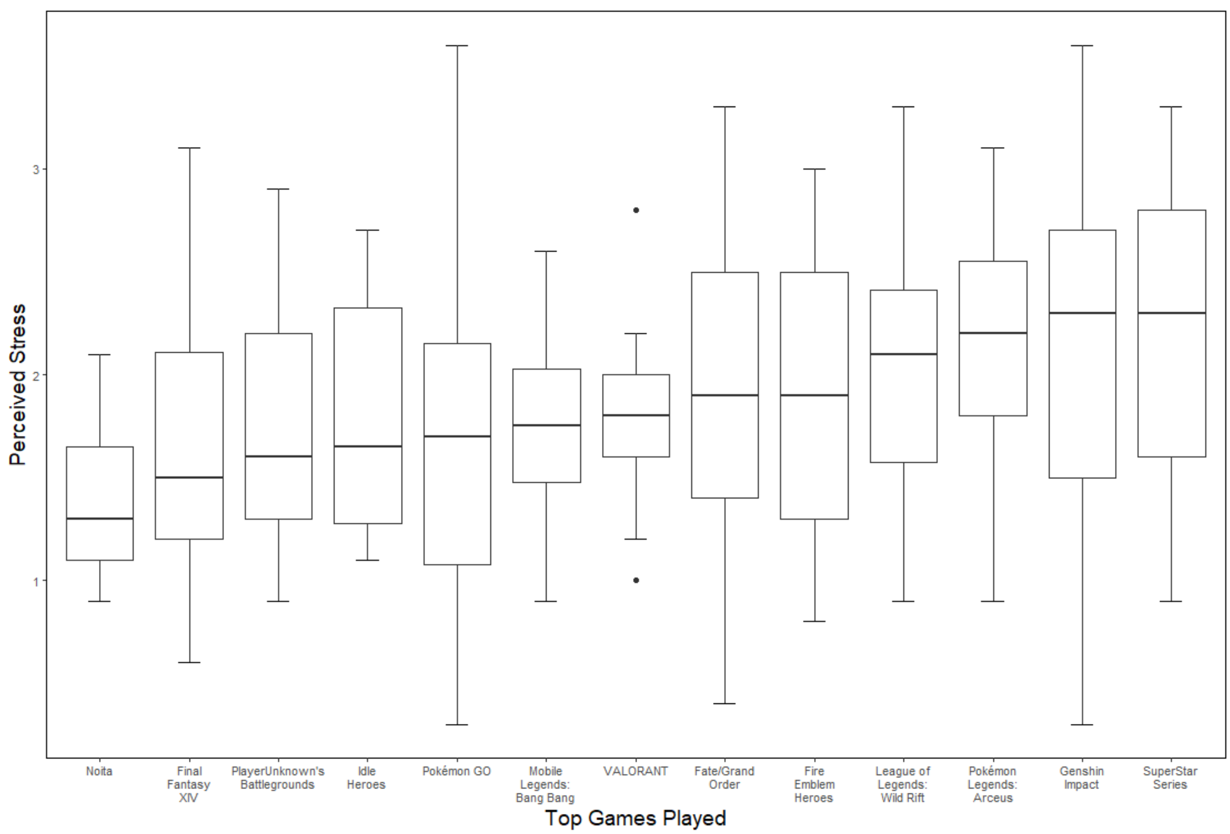


Table 3.21
Mean and Standard Deviation of Perceived Stress for Top Games Played

Top Games Played	Mean	Standard Deviation
SuperStar Series	4.61	1.11
Fate/Grand Order	1.87	0.69
Fire Emblem Heroes	1.87	0.66
Pokémon GO	1.67	0.80
Genshin Impact	2.21	0.81
League of Legends: Wild Rift	2.04	0.64
Idle Heroes	1.79	0.57
Mobile Legends: Bang Bang	1.72	0.51
Valorant	1.81	0.46
Noita	1.38	0.39
Pokémon Legends: Arceus	2.15	0.63
Final Fantasy XIV	1.78	0.85
PlayerUnknown's Battlegrounds	1.78	0.69

A one-way ANOVA was conducted to compare the effect of perceived stress amongst the top games played. The result revealed a statistically significant difference for perceived stress and the games played, where $F(12,318) = 2.826$, $p<0.001$. Therefore, post-hoc test was conducted by performing pairwise Tukey's HSD test on the Top Games played. The Tukey's HSD showed perceived stress was significantly different for SuperStar Series with Pokémon GO ($p = 0.01$) and SuperStar Series and Noita ($p = 0.01$) and Noita and Genshin Impact ($p = 0.04$). The compact result is shown in Table 3.22. Detailed information can be seen in Appendix I.

Table 3.22

Tukey's Pairwise Comparisons for Perceived Stress and Top Games Played Compact Letter Display

SuperStar Series	a		
Genshin Impact	a	b	
Fate/Grand Order	a	b	c
Fire Emblem Heroes	a	b	c
League of Legends: Wild Rift	a	b	c
Idle Heroes	a	b	c
Mobile Legends: Bang Bang	a	b	c
VALORANT	a	b	c
Pokémon Legends: Arceus	a	b	c
Final Fantasy XIV	a	b	c
PlayerUnknown's Battlegrounds	a	b	c
Pokémon GO		b	c
Noita			c

Note: Means that do not share a letter are significantly different. 95% Confidence Level.

Perceived Stress and Game Challenges

To answer **RQ1**, the correlation between game challenges and perceived stress was calculated. The results show a weak positive correlation between perceived stress and emotional, performative and decision-making challenge as shown in Table 3.23. Figure 3.10 shows the scatterplots for perceived stress and game challenges.

Table 3.23

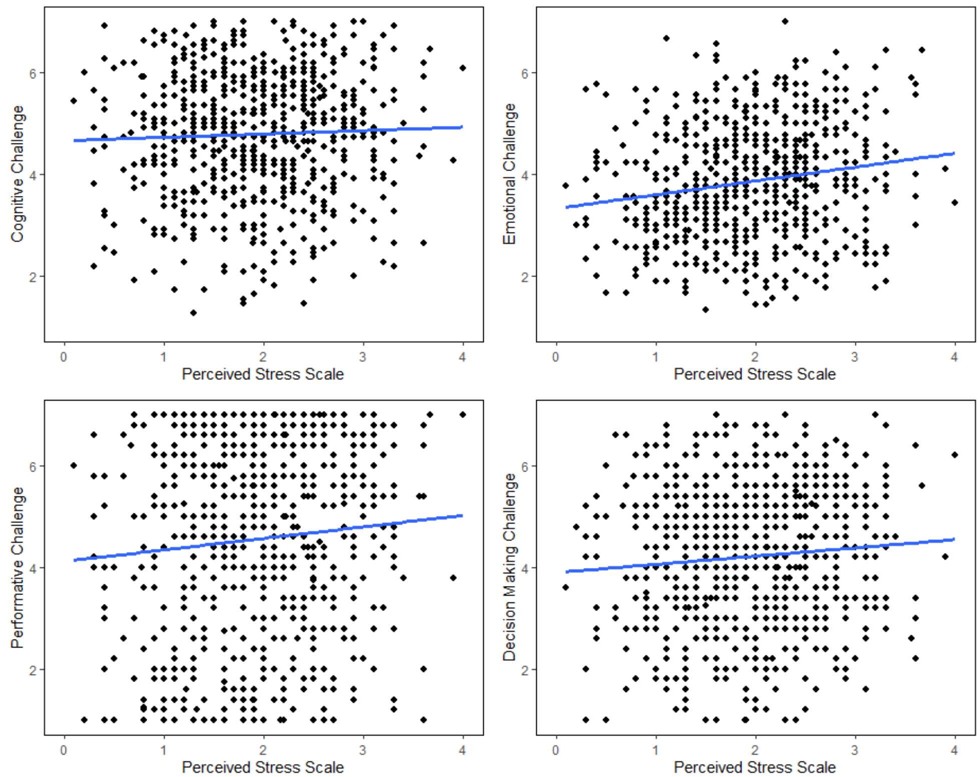
Pearson Correlation Coefficients Perceived Stress and Challenge Originating from Recent Gameplay Interaction (CORGIS)

	PSS	**CC**	**EC**	**PC**	**DC**
PSS	-	0.002	0.031	0.007	0.007
CC	0.039	-	0.238	0.356	0.472
EC	**0.175**	**0.488**	-	0.051	0.319
PC	**0.086**	**0.597**	**0.226**	-	0.132
DC	**0.083**	**0.687**	**0.565**	**0.363**	-

Note: Left values show the r score, and the right shows r^2 score. Significant values are in bold, $p< 0.05$.

Figure 3.10

Scatterplots of Perceived Stress and Challenge Originating from Recent Gameplay Interaction (CORGIS)



Perceived Stress and Game Challenges for Top Games Played

Following the significant correlation between perceived stress and emotional, performative and decision-making challenge analysed earlier, further investigation into the relations between perceived stress and game challenges for the top games played was also conducted. Figure *3.11* shows the medians for top games played against the games challenges subscales. This is followed by the mean and the standard deviation for all the games shown in Table 3.24.

Figure 3.11

Box Plots of Top Games Played and Challenge Originating from Recent Gameplay Interaction (CORGIS)

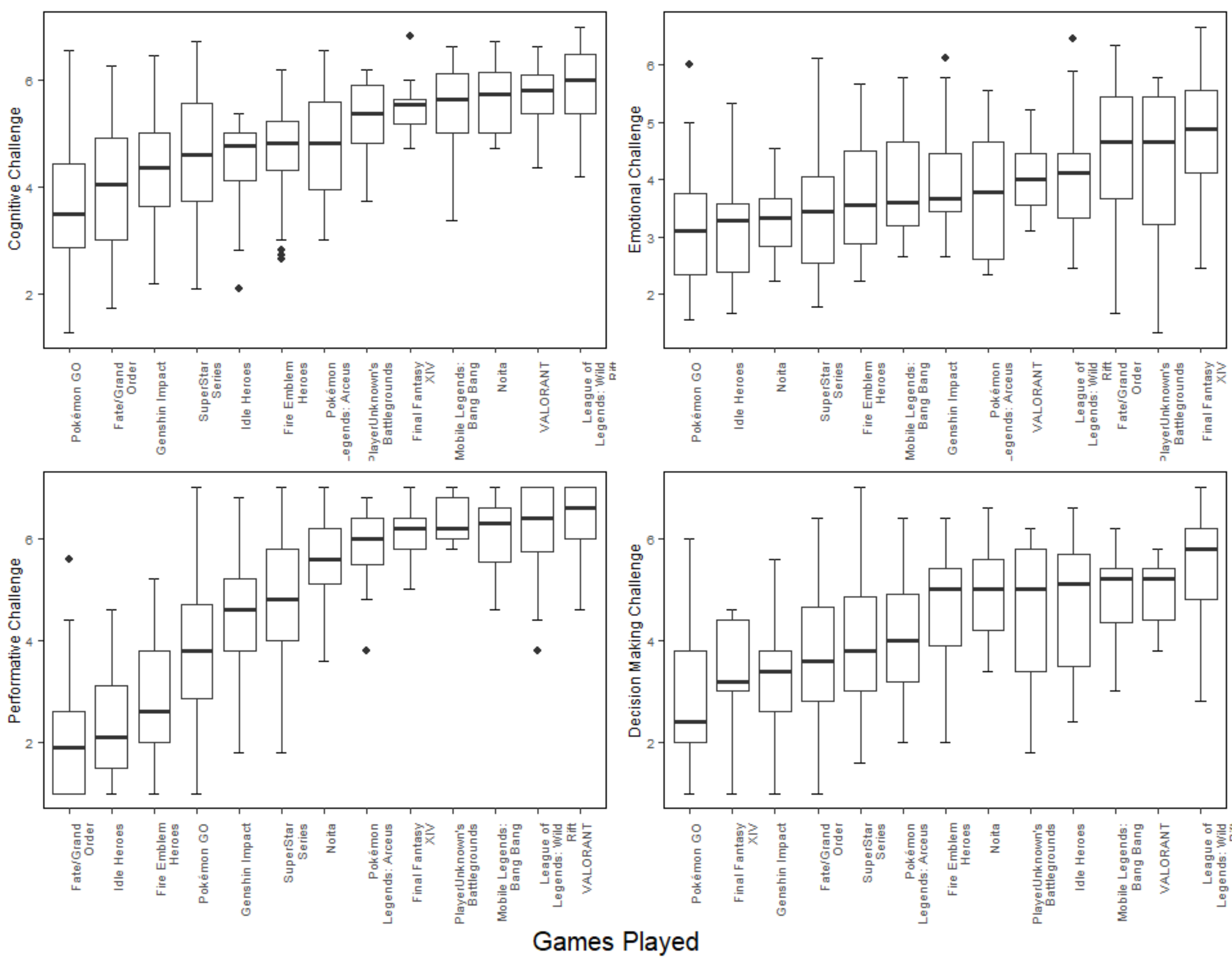


Table 3.24
Mean and Standard Deviation (SD) of Challenge Originating from Recent Gameplay Interaction (CORGIS) for Top Games Played

Top Games Played	CC	EC	PC	DC
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
SuperStar Series	4.61(1.11)	3.47(0.99)	4.88(1.31)	3.91(1.24)
Fate/Grand Order	3.97(1.18)	4.55(1.10)	2.06(1.10	3.72(1.33)
Fire Emblem Heroes	4.75(0.91)	3.70(0.93)	2.84(1.23)	4.60(1.12)
Pokémon GO	3.63(1.21)	3.13(1.05)	3.72(1.56)	2.85(1.44)
Genshin Impact	4.28(1.03)	3.96(0.89)	4.59(1.12)	3.25(1.10)
League of Legends: Wild Rift	5.90(0.83)	4.03(0.95)	6.14(0.94)	5.49(1.05)
Idle Heroes	4.40(0.96)	3.15(0.92)	2.29(1.11)	4.66(1.41)
Mobile Legends: Bang Bang	5.49(0.97)	3.93(0.94)	6.11(0.70)	4.88(0.99)
Valorant	5.61(0.77)	4.06(0.62)	6.34(0.71)	4.97(0.60)
Noita	5.64(0.70)	3.36(0.71)	5.60(0.93)	4.87(1.01)
Pokémon Legends: Arceus	4.77(1.16)	3.73(1.20)	5.85(0.92)	4.04(1.35)
Final Fantasy XIV	5.27(0.89)	4.16(1.63)	6.38(0.47)	4.64(1.56)
PlayerUnknown's Battlegrounds	5.55(0.61)	4.64(1.33)	6.07(0.70)	3.24(1.16)

The analysis is followed by a one-way ANOVA to compare the effect of perceived stress and game challenges for the top games played. The overall results are shown in Table *3.25*. The results show there are significant differences between all the top games played. Tukey's HSD post-hoc test was conducted for each of the game challenge subscale. Table 3.26, Table 3.27, Table 3.28, Table 3.29, and Table 3.30 shows the compact letter display of the pairwise comparison between the game challenge subscales. Detailed information can be seen in Appendix I. The result shows that the top game played have varying difference between them in each of the challenge subscales.

Table 3.25
One-Way ANOVA of Perceived Stress and Challenge Originating from Recent Gameplay Interaction (CORGIS) for Top Games Played.

PSS and CORGIS	Result
Perceived Stress	$F\ (12, 318) = 2.83, p<0.001$
Cognitive Challenge	$F\ (12, 318) = 12.06, p<0.001$
Emotional Challenge	$F\ (12, 318) = 6.02, p<0.001$
Performative Challenge	$F\ (12, 318) = 48.64, p<0.001$
Decision Making Challenge	$F\ (12, 318) = 10.41, p<0.001$

Table 3.26
Tukey's Pairwise Comparisons for Perceived Stress and Top Games Played Compact Letter Display.

SuperStar Series	a			
Genshin Impact	a	b		
League of Legends: Wild Rift	a	b	c	
Final Fantasy XIV	a	b	c	
VALORANT	a	b	c	
PlayerUnknown's Battlegrounds	a	b	c	
Pokémon Legends: Arceus	a	b	c	
Fire Emblem Heroes	a	b	c	
Idle Heroes	a	b	c	
Fate/Grand Order	a	b	c	
Mobile Legends: Bang Bang		b	c	
Pokémon GO		b	c	
Noita			c	

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.27
Tukey's Pairwise Comparisons for Cognitive Challenge and Top Games Played Compact Letter Display

League of Legends: Wild Rift	a			
Noita	a	b		
VALORANT	a	b		
Final Fantasy XIV	a	b	c	
Mobile Legends: Bang Bang	a	b		
PlayerUnknown's Battlegrounds	a	b	c	
Pokémon Legends: Arceus	a	b	c	d
Fire Emblem Heroes		b	c	
SuperStar Series		b	c	
Idle Heroes		b	c	d
Genshin Impact			c	d
Fate/Grand Order				d
Pokémon GO				d

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.28
Tukey's Pairwise Comparisons for Emotional Challenge and Top Games Played Compact Letter Display

Fate/Grand Order	a			
Final Fantasy XIV	a	b		
League of Legends: Wild Rift	a	b	c	
Genshin Impact	a	b	c	d
Mobile Legends: Bang Bang	a	b	c	d
PlayerUnknown's Battlegrounds	a	b	c	d
Pokémon Legends: Arceus	a	b	c	d
VALORANT	a	b	c	d
Fire Emblem Heroes		b	c	d
Noita		b	c	d
SuperStar Series		b	c	d
Idle Heroes			c	d
Pokémon GO				d

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.29
Tukey's Pairwise Comparisons for Performative Challenge and Top Games Played Compact Letter Display

League of Legends: Wild Rift	a					
Mobile Legends: Bang Bang	a					
PlayerUnknown's Battlegrounds	a					
VALORANT	a					
Final Fantasy XIV	a	b				
Noita	a	b	c			
Pokémon Legends: Arceus	a	b	c			
SuperStar Series		b	c			
Genshin Impact			c	d		
Pokémon GO				d	e	
Fire Emblem Heroes					e	f
Fate/Grand Order						f
Idle Heroes						f

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.30

Tukey's Pairwise Comparisons for Decision-Making Challenge and Top Games Played Compact Letter Display

League of Legends: Wild Rift	a				
Fire Emblem Heroes	a	b			
Mobile Legends: Bang Bang	a	b	c		
VALORANT	a	b	c		
Idle Heroes	a	b	c		
Noita	a	b	c		
PlayerUnknown's Battlegrounds	a	b	c	d	
Pokémon Legends: Arceus	a	b	c	d	e
Final Fantasy XIV		b	c	d	e
SuperStar Series		b	c	d	
Fate/Grand Order			c	d	e
Genshin Impact				d	e
Pokémon GO					e

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Perceived Stress and Games User Experience Satisfaction

To answer **RQ2**, the correlation between perceived stress and game user satisfaction was also calculated. The results show there is a weak positive correlation between perceived stress and personal engrossment, and a weak negative correlation between perceived stress and enjoyment, as shown in Table 3.31.

Table 3.31

Pearson Correlation Coefficients for Perceived Stress Scale (PSS) and Game User Experience Satisfaction Scale (GUESS-18)

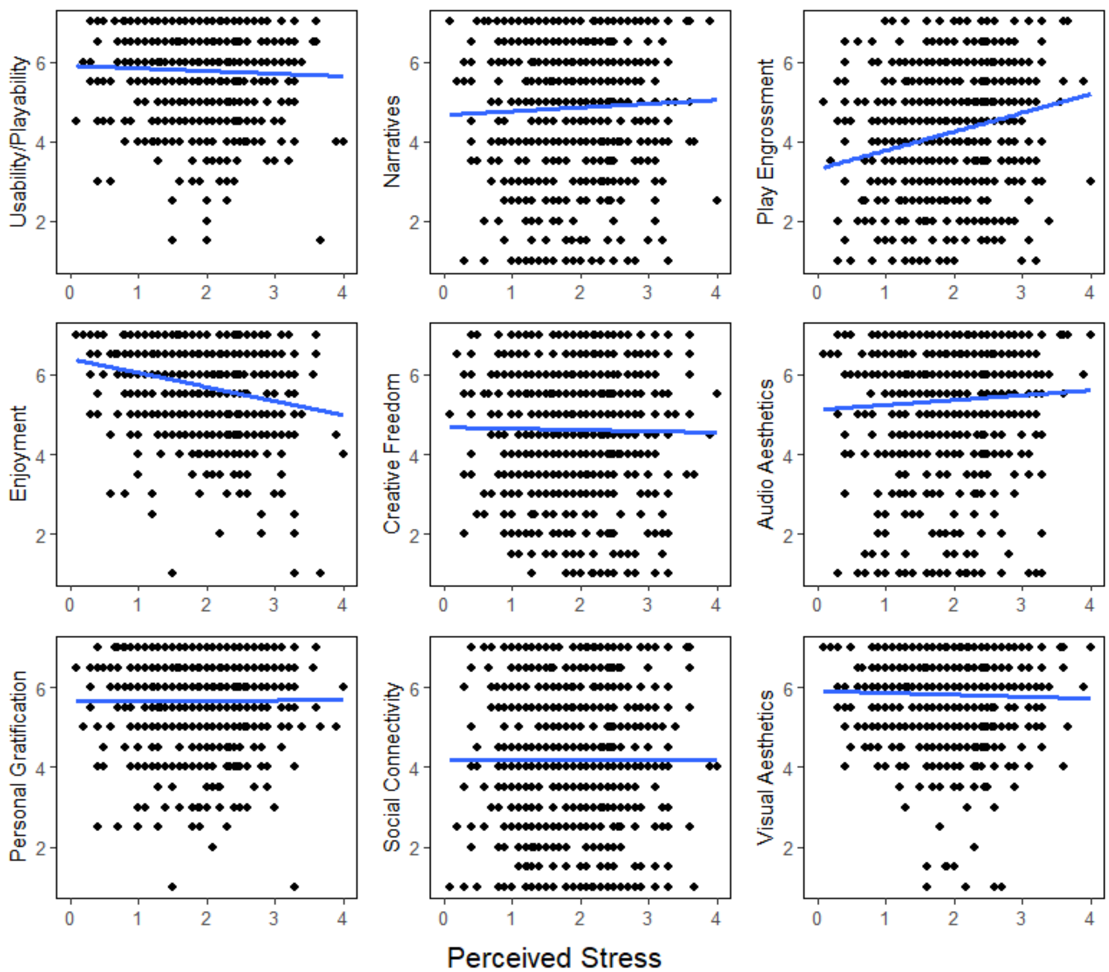
	Perceived Stress	Usability/ Playability	Narrative	Personal Engrossment	Enjoyment	Creative Freedom	Audio Aesthetic	Personal Gratification	Social Connectivity	Visual Aesthetics
Perceived Stress	-	0.002	0.002	0.048	0.053	0.000	0.003	0.000	0.000	0.001
Usability/ Playability	-0.046	-	0.016	0.001	0.068	0.011	0.014	0.033	0.000	0.075
Narrative	0.042	**0.128**	-	0.033	0.076	0.236	0.194	0.003	0.001	0.130
Personal Engrossment	**0.218**	0.027	**0.183**	-	0.008	0.044	0.067	0.075	0.002	0.020
Enjoyment	**-0.230**	**0.260**	**0.275**	**0.088**	-	0.097	0.105	0.089	0.002	0.091
Creative Freedom	-0.015	**0.105**	**0.486**	**0.210**	**0.311**	-	0.112	0.036	0.048	0.106
Audio Aesthetic	0.053	**0.119**	**0.440**	**0.258**	**0.324**	**0.335**	-	0.084	0.028	0.148

Personal Gratification	0.002	**0.181**	0.059	**0.273**	**0.299**	**0.191**	**0.290**	-	0.046	0.059
Social Connectivity	-0.001	0.016	0.037	0.039	0.039	**0.219**	**0.167**	**0.214**	-	0.003
Visual Aesthetics	-0.030	**0.274**	**0.360**	**0.142**	**0.301**	**0.325**	**0.385**	**0.243**	0.058	-

Note: Values on the left are the r scores, and the right values the r^2 scores. Values in bold are significant, $p<0.05$.

Figure 3.12

Scatterplots of Perceived Stress and Game User Experience Satisfaction Scale (GUESS-18).

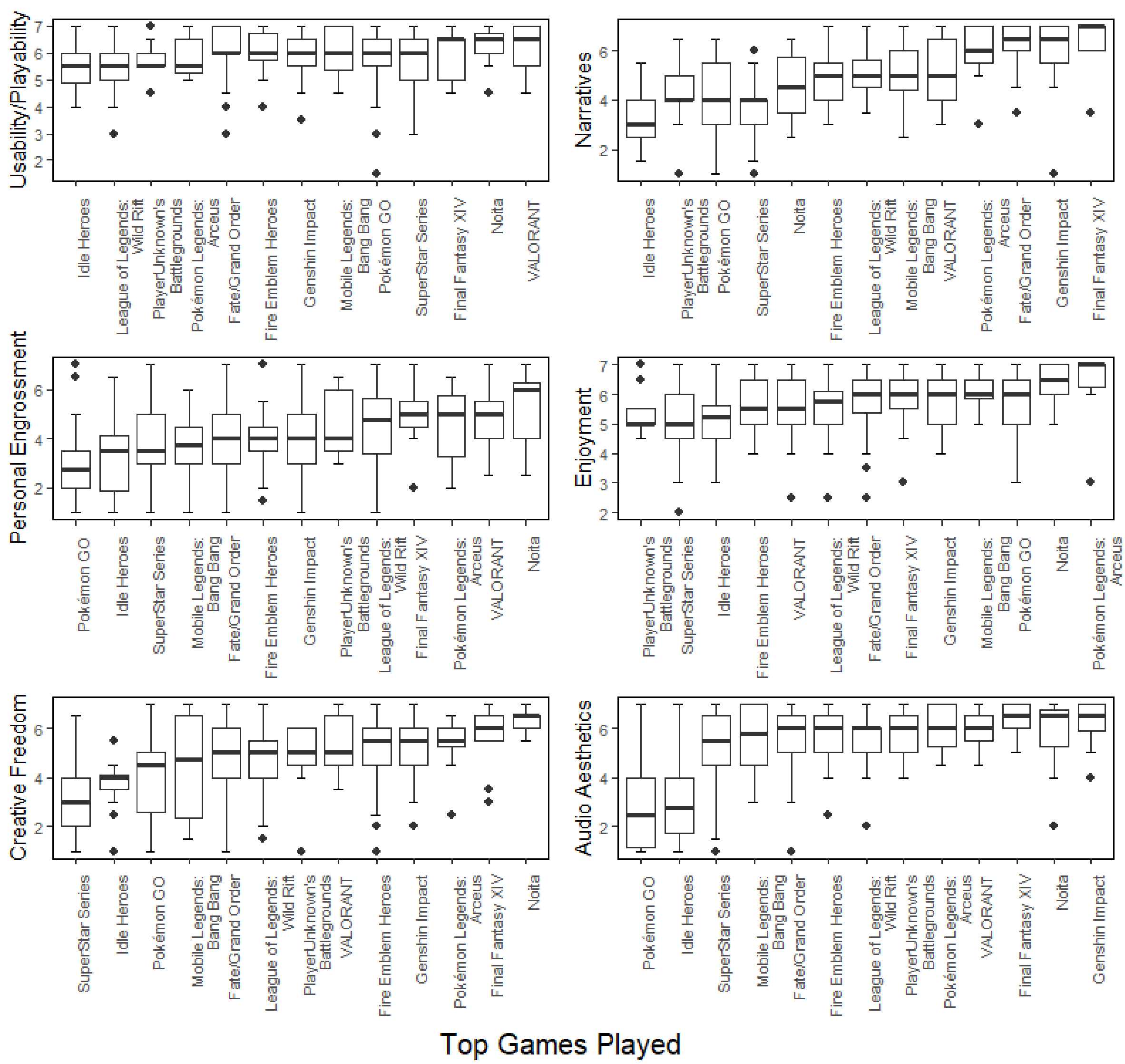


Games User Satisfaction for Top Games Played

Similarly, we also analysed game user satisfaction for the top games played. The initial analysis revealed a significant correlation between perceived stress with play engrossment and enjoyment. Therefore, further investigation on the relations between perceived stress and game use satisfaction were conducted. Figure 3.13 displays the medians for top games played against games use satisfaction subscales. This is followed by the mean and the standard deviation for all the games, as shown in Table 3.32.

Figure 3.13

Box Plots of Game User Experience Satisfaction Scale (GUESS-18) for Top Games Played



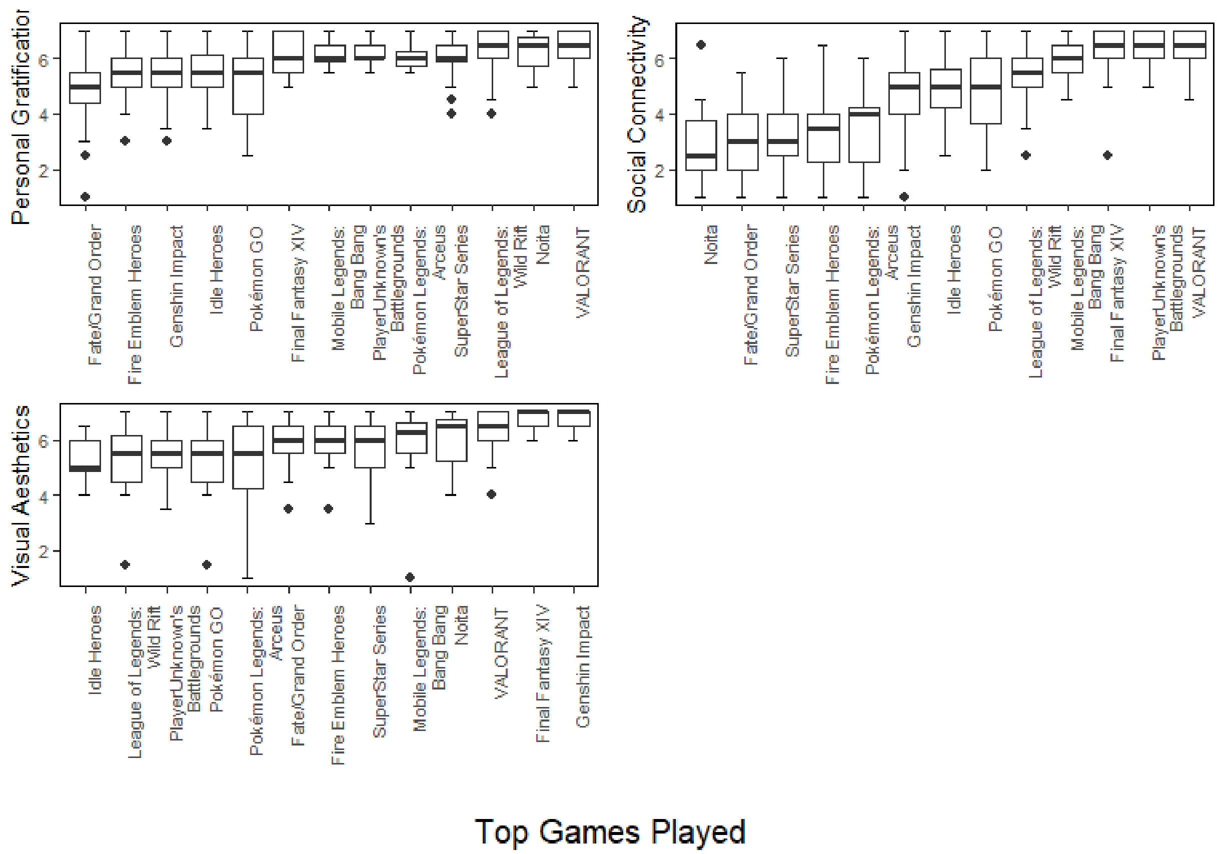


Table 3.32

Mean and Standard Deviation (SD) of Game User Experience Satisfaction Scale (GUESS-18) for Top Games Played

Top Games Played	UP Mean (SD)	NR Mean (SD)	PE Mean (SD)	EJ Mean (SD)	CF Mean (SD)	AA Mean (SD)	PG Mean (SD)	SC Mean (SD)	VA Mean (SD)
SuperStar Series	5.70 (1.00)	3.60 (1.14)	3.87 (1.50)	5.17 (1.21)	2.98 (1.37)	5.17 (1.62)	6.13 (0.76)	3.18 (1.19)	5.71 (0.89)
Fate/Grand Order	6.07 (0.89)	6.32 (0.82)	4.04 (1.49)	5.82 (1.03)	4.68 (1.50)	5.71 (1.28)	4.95 (1.22)	3.10 (1.31)	5.96 (0.88)
Fire Emblem Heroes	6.09 (0.74)	4.90 (0.90)	3.99 (1.27)	5.60 (0.98)	5.09 (1.35)	5.64 (1.13)	5.51 (1.03)	3.31 (1.33)	5.97 (0.83)
Pokémon GO	5.76 (1.14)	3.97 (1.71)	2.97 (1.51)	5.62 (1.14)	4.00 (1.78)	2.78 (1.69)	5.10 (1.39)	4.87 (1.34)	5.16 (1.43)
Genshin Impact	6.00 (0.83)	6.03 (1.22)	4.00 (1.60)	5.67 (0.95)	5.17 (1.34)	6.23 (0.92)	5.52 (1.04)	4.62 (1.50)	6.71 (0.37)
League of Legends: Wild Rift	5.54 (1.04)	5.07 (0.94)	4.50 (1.67)	5.57 (1.07)	4.79 (1.17)	5.59 (1.16)	6.16 (0.87)	5.39 (1.08)	5.38 (1.28)

Idle Heroes	5.53 (0.90)	3.31 (1.12)	3.34 (1.67)	5.22 (1.03)	3.72 (1.00)	2.94 (1.65)	5.56 (0.96)	4.84 (1.40)	5.22 (0.82)
Mobile Legends: Bang Bang	6.03 (0.85)	5.09 (1.28)	3.72 (1.28)	6.09 (0.58)	4.47 (2.00)	5.63 (1.32)	6.19 (0.54)	5.97 (0.74)	5.88 (1.47)
Valorant	6.12 (0.85)	5.19 (1.44)	4.85 (1.21)	5.58 (1.30)	5.50 (1.27)	6.12 (0.74)	6.42 (0.70)	6.31 (0.80)	6.27 (0.90)
Noita	6.27 (0.75)	4.55 (1.35)	5.18 (1.59)	6.41 (0.63)	6.36 (0.45)	5.68 (1.55)	6.27 (0.68)	3.05 (1.59)	5.95 (1.11)
Pokémon Legends: Arceus	5.86 (0.78)	5.95 (1.25)	4.55 (1.59)	6.41 (1.20)	5.41 (1.14)	6.00 (1.00)	6.05 (0.47)	3.41 (1.58)	5.05 (1.86)
Final Fantasy XIV	6.00 (0.94)	6.33 (1.15)	4.83 (1.39)	5.67 (1.22)	5.56 (1.38)	6.33 (0.83)	6.17 (0.75)	6.06 (1.49)	6.72 (0.36)
PlayerUnknown's Battlegrounds	5.78 (0.71)	4.28 (1.64)	4.56 (1.29)	5.39 (0.82)	4.72 (1.56)	5.67 (0.97)	6.22 (0.51)	6.39 (0.74)	5.44 (1.21)

The analysis is followed with a one-way ANOVA to compare the game user satisfaction among the top games played. The results of the analysis show difference between most of the game use satisfaction subscales with the exception of usability/playability, as shown in Table 3.33. A Tukey's HSD post-hoc test was conducted for each of the game user satisfaction subscales, displayed in Table 3.34 – 3.42, which shows the compact letter display of the pairwise comparison between the Game User Satisfaction subscales. Detailed information can be seen in Appendix I. The top game played exhibits varying differences among them in each of the game user satisfaction subscales.

Table 3.33
One-Way ANOVA of Game User Experience Satisfaction Scale (GUESS-18)

GUESS-18	Results
Usability/Playability	F (12,318) = 1.47, p=0.150
Narratives	**F (12,318) = 21.89, p<0.001**
Play Engrossment	**F (12,318) = 3.37, p<0.001**
Enjoyment	**F (12,318) = 2.63, p<0.001**
Creative Freedom	**F (12,318) = 11.03, p<0.001**
Audio Aesthetic	**F (12,318) = 17.18, p<0.001**
Personal Gratification	**F (12,318) = 7.25, p<0.001**
Social Connectivity	**F (12,318) = 22.22, p<0.001**
Visual Aesthetics	**F (12,318) = 5.36, p=0.001**

Table 3.34

Tukey's Pairwise Comparisons for Usability/Playability and Top Games Played Compact Letter Display

Noita	a
VALORANT	a
Fire Emblem Heroes	a
Fate/Grand Order	a
Mobile Legends: Bang Bang	a
Final Fantasy XIV	a
Genshin Impact	a
Pokémon Legends: Arceus	a
PlayerUnknown's Battlegrounds	a
Pokémon GO	a
SuperStar Series	a
League of Legends: Wild Rift	a
Idle Heroes	a

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.35

Tukey's Pairwise Comparisons for Narratives and Top Games Played Compact Letter Display

Fate/Grand Order	a					
Final Fantasy XIV	a	b	c			
Genshin Impact	a	b				
Pokémon Legends: Arceus	a	b	c	d		
VALORANT	a	b	c	d	e	
Mobile Legends: Bang Bang		b	c	d	e	
League of Legends: Wild Rift		b	c	d		
Fire Emblem Heroes			c	d	e	
Noita				d	e	f
PlayerUnknown's Battlegrounds				d	e	f
Pokémon GO					e	f
SuperStar Series						f
Idle Heroes						f

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.36
Tukey's Pairwise Comparisons for Play Engrossment and Top Games Played Compact Letter Display

Noita	a	
VALORANT	a	
Final Fantasy XIV	a	
League of Legends: Wild Rift	a	
SuperStar Series	a	b
Idle Heroes	a	b
Fate/Grand Order	a	b
Genshin Impact	a	b
Pokémon Legends: Arceus	a	b
Mobile Legends: Bang Bang	a	b
Fire Emblem Heroes	a	b
PlayerUnknown's Battlegrounds	a	b
Pokémon GO		b

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.37
Tukey's Pairwise Comparisons for Enjoyment and Top Games Played Compact Letter

Pokémon Legends: Arceus	a	
Noita	a	
Fate/Grand Order	a	
Idle Heroes	a	b
Genshin Impact	a	b
Mobile Legends: Bang Bang	a	b
Fire Emblem Heroes	a	b
PlayerUnknown's Battlegrounds	a	b
Pokémon GO	a	b
VALORANT	a	b
Final Fantasy XIV	a	b
League of Legends: Wild Rift	a	b
SuperStar Series		b

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.38

Tukey's Pairwise Comparisons for Creative Freedom and Top Games Played Compact Letter Display

Noita	a			
VALORANT	a	b		
Final Fantasy XIV	a	b	c	
Pokémon Legends: Arceus	a	b	c	
Genshin Impact	a	b	c	
Fire Emblem Heroes	a	b	c	
League of Legends: Wild Rift	a	b	c	
PlayerUnknown's Battlegrounds	a	b	c	
Fate/Grand Order		b	c	
Mobile Legends: Bang Bang		b	c	
Pokémon GO		b	c	
Idle Heroes			c	d
SuperStar Series				d

Note: Means that do not share a letter are significantly different.

Table 3.39

Tukey's Pairwise Comparisons for Audio Aesthetics and Top Games Played Compact Letter Display

Genshin Impact	a		
Final Fantasy XIV	a	b	
VALORANT	a	b	
Pokémon Legends: Arceus	a	b	
Fate/Grand Order	a	b	
Noita	a	b	
PlayerUnknown's Battlegrounds	a	b	
Fire Emblem Heroes	a	b	
Mobile Legends: Bang Bang	a	b	
League of Legends: Wild Rift	a	b	
SuperStar Series		b	
Idle Heroes			c
Pokémon GO			c

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.40

Tukey's Pairwise Comparisons for Personal Gratification and Top Games Played Compact Letter Display

VALORANT	a		
Noita	a		
SuperStar Series	a		
Mobile Legends: Bang Bang	a		
League of Legends: Wild Rift	a		
PlayerUnknown's Battlegrounds	a	b	
Pokémon Legends: Arceus	a	b	
Final Fantasy XIV	a	b	
Idle Heroes	a	b	c
Genshin Impact	a	b	c
Fire Emblem Heroes	a	b	c
Pokémon GO		b	c
Fate/Grand Order			c

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.41

Tukey's Pairwise Comparisons for Social Connectivity and Top Games Played Compact Letter Display

VALORANT	a				
Mobile Legends: Bang Bang	a	b			
PlayerUnknown's Battlegrounds	a	b			
League of Legends: Wild Rift	a	b	c		
Final Fantasy XIV	a	b	c		
Idle Heroes	a	b	c	d	
Pokémon GO		b	c	d	
Genshin Impact			c	d	
Pokémon Legends: Arceus				d	e
Noita					e
SuperStar Series					e
Fire Emblem Heroes					e
Fate/Grand Order					e

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

Table 3.42
Tukey's Pairwise Comparisons for Visual Aesthetics and Top Games Played Compact Letter Display

Genshin Impact	a			
Final Fantasy XIV	a	b		
Fate/Grand Order	a	b	c	
VALORANT	a	b	c	d
Noita	a	b	c	d
Mobile Legends: Bang Bang	a	b	c	d
Fire Emblem Heroes	a	b	c	d
PlayerUnknown's Battlegrounds	a	b	c	d
SuperStar Series		b	c	d
League of Legends: Wild Rift			c	d
Pokémon Legends: Arceus			c	d
Idle Heroes			c	d
Pokémon GO				d

Note: Means that do not share a letter are significantly different. At 95% Confidence Level.

PUBG and Genshin Impact

In Survey 1, PlayerUnknown's Battlegrounds (PUBG) and Genshin Impact the most listed games in the survey, so these games were analysed to understand the relationships between perceived stress and the motivation to play. Following this, these two games were also analysed. However, the number of participants playing PUBG is small in this survey, compared to Survey 1, only nine respondents listed PUBG in Survey 2, this may affect the overall results. However, for the purpose of consistency we still analyse these two games. We will begin by analysing relations between PUBG and Genshin Impact with perceived stress and the game challenges and then followed by game use satisfaction.

Table 3.43 and Figure 3.14 – 3.18 shows the correlation between perceived stress and game challenges for PUBG and Genshin Impact. The findings indicate that there are no significant correlations between perceived stress across the game challenge subscales for PUBG. In contrast, Genshin Impact, a positive moderate correlation was found specifically with the Decision-Making Challenge subscale.

Table 3.43
Pearson Correlation Coefficients of Perceived Stress and Challenge Originating from Recent Gameplay Interaction (CORGIS) for Player Unknown's Battle (PUBG) and Genshin Impact.

PUBG	**PSS**	**CC**	**EC**	**PC**	**DC**
PSS	-	0.088	0.004	0.096	0.132
CC	-0.297	-	0.347	0.013	0.527
EC	-0.064	0.589	-	0.309	0.766
PC	-0.310	0.113	0.556	-	0.227
DC	-0.364	**0.726**	**0.875**	0.476	-
Genshin Impact	**PSS**	**CC**	**EC**	**PC**	**DC**
PSS	-	0.048	0.080	0.003	0.154
CC	0.218	-	0.397	0.397	0.508
EC	0.283	**0.630**	-	0.196	0.375
PC	-0.059	**0.630**	**0.443**	-	0.053
DC	**0.392**	**0.713**	**0.612**	0.230	-

Note: Values in the left are the r scores and on the left are shows r^2 scores. Values in bold are significant, $p<0.05$.

Figure 3.14
Scatterplots of Perceived Stress and Cognitive Challenge Between PUBG And Genshin Impact

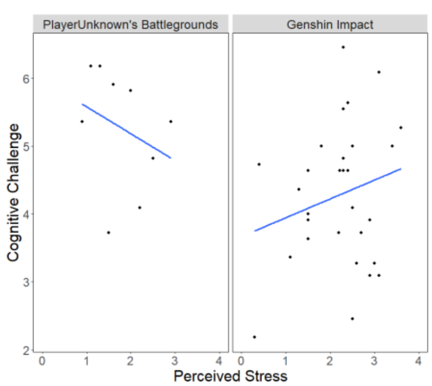


Figure 3.15
Scatterplots of Perceived Stress and Emotional Challenge Between PUBG And Genshin Impact

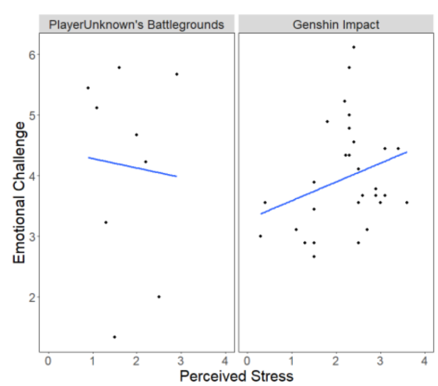


Figure 3.16
Scatterplots of Perceived Stress and Performative Challenge Between PUBG And Genshin Impact

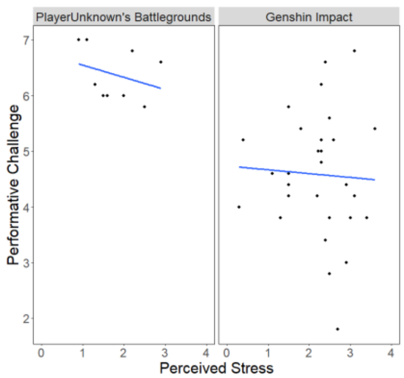
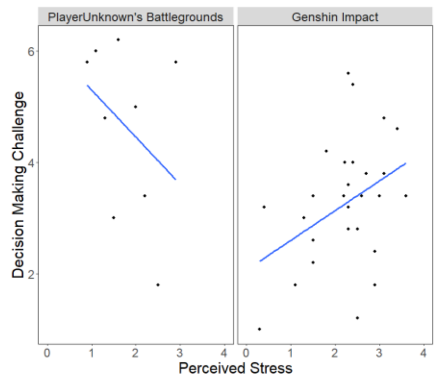


Figure 3.17
Scatterplots Perceived Stress and Decision-Making Challenge Between PUBG And Genshin Impact



A t-test was conducted to compare the differences between PUBG and Genshin Impact in relation to perceived stress and game challenges. Table 3.44 presents the overall comparison between PUBG and Genshin Impact in terms of perceived stress and game challenge. The analysis reveals that there is no significant difference in perceived stress between PUBG and Genshin Impact. On the other hand, we can see difference between the two games in relation to the cognitive, performative and decision-making challenge, indicating that players may experience these aspects differently in each game.

Table 3.44
The t-test on Challenge Originating from Recent Gameplay Interaction (CORGIS) Between PlayerUnknown's Battlegrounds (PUBG) and Genshin Impact using Welch Test

	PUBG		GENSHIN IMPACT					
	M	SD	M	SD	df	t	p	Cohen's d
PSS	1.78	0.67	2.21	0.81	16.03	1.61	0.13	0.55
CC	5.27	0.89	4.28	1.03	15.28	-2.80	**0.01**	-0.99
EC	4.16	1.63	3.96	0.89	9.51	-0.35	0.73	-0.81
PC	6.38	0.47	4.59	1.12	32.17	-6.87	**<0.00**	-1.77
DC	4.64	1.56	3.25	1.1	10.61	-2.50	**0.03**	-1.15

Note: Significant values are in bold, where p<0.05.

Next, we compared the results between PUBG and Genshin Impact concerning perceived stress and game use satisfaction. Table 3.45 and Figure 3.18 – 3.26 shows the overall results for the two games. The analysis showed only Audio Aesthetics is significantly correlated with perceived stress, showing a negative strong correlation in PUBG. Conversely, Genshin Impact showed a weak to moderate significant correlations across the game use satisfaction subscales, with exception to enjoyment and personal gratification.

Table 3.45

Pearson Correlation Coefficients of Perceived Stress and Game User Experience Scale (GUESS-18) for Player Unknown's Battle (PUBG) and Genshin Impact

PUBG	PSS	UP	NR	PE	EJ	CF	AA	PG	SC	VA
PSS	-	0.062	0.163	0.031	0.399	0.176	0.516	0.413	0.359	0.138
UP	-0.248	-	0.090	0.002	0.013	0.075	0.423	0.078	0.060	0.612
NR	-0.404	0.300	-	0.494	0.020	0.874	0.629	0.055	0.011	0.607
PE	0.176	0.049	**0.703**	-	0.084	0.359	0.101	0.001	0.015	0.296
EJ	-0.632	0.113	0.142	-0.29	-	0.005	0.211	0.371	0.151	0.008
CF	-0.419	0.274	**0.935**	0.599	0.070	-	0.605	0.001	0.003	0.588
AA	**-0.72**	0.650	**0.793**	0.318	0.459	**0.778**	-	0.282	0.143	0.790
PG	0.643	-0.279	-0.234	0.027	-0.609	-0.031	-0.531	-	0.709	0.080
SC	-0.599	0.244	0.106	-0.12	0.388	-0.057	0.378	**-0.842**	-	0.028
VA	-0.372	**0.782**	**0.779**	0.544	0.087	**0.767**	**0.889**	-0.283	0.167	-
Genshin Impact	**PSS**	**UP**	**NR**	**PE**	**EJ**	**CF**	**AA**	**PG**	**SC**	**VA**
PSS	-	0.023	0.297	0.106	0.000	0.235	0.188	0.008	0.107	0.04
UP	**0.152**	-	0.011	0.379	0.147	0.008	0.012	0.205	0.000	0.001
NR	**0.545**	**-0.11**	-	0.114	0.000	0.305	0.098	0.004	0.481	0.011
PE	**0.326**	**0.616**	**0.338**	-	0.142	0.090	0.100	0.051	0.087	0.004
EJ	-0.006	**0.384**	**0.018**	**0.377**	-	0.004	0.021	0.029	0.004	0.000
CF	**0.485**	0.088	**0.552**	**0.301**	-0.059	-	0.120	0.018	0.243	0.002
AA	**0.434**	**0.111**	**0.314**	**0.316**	**0.144**	**0.347**	-	0.004	0.100	0.073
PG	0.092	**0.453**	0.063	**0.226**	**0.169**	**0.133**	0.062	-	0.017	0.024
SC	**0.328**	-0.007	**0.694**	**0.295**	-0.059	**0.493**	**0.315**	**0.131**	-	0.001
VA	**0.202**	-0.029	**0.103**	0.061	-0.004	-0.039	**0.271**	**0.154**	-0.031	-

Note: Values in the left are the r scores and on the left are shows r^2 scores. Significant values are in bold, where $p<0.05$.

Figure 3.18

Scatterplots of Perceived Stress and Usability/Playability Between PUBG And Genshin Impact

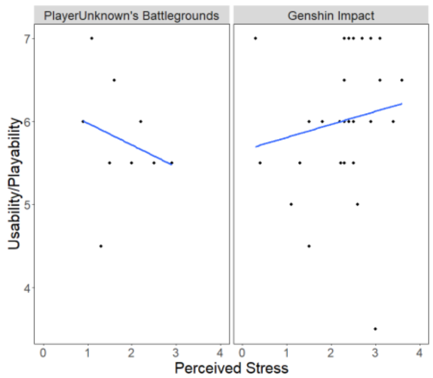


Figure 3.19

Scatterplots of Perceived Stress and Narratives Between PUBG And Genshin Impact

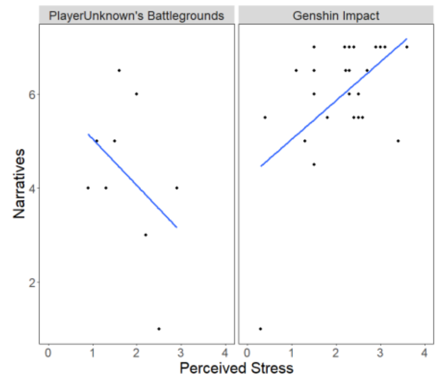


Figure 3.20

Scatterplots of Perceived Stress and Play Engrossment Between PUBG And Genshin Impact

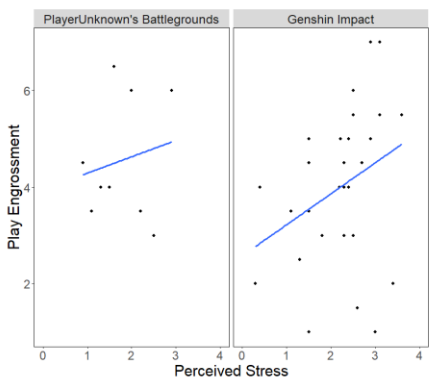


Figure 3.21

Scatterplots of Perceived Stress and Enjoyment Between PUBG And Genshin Impact

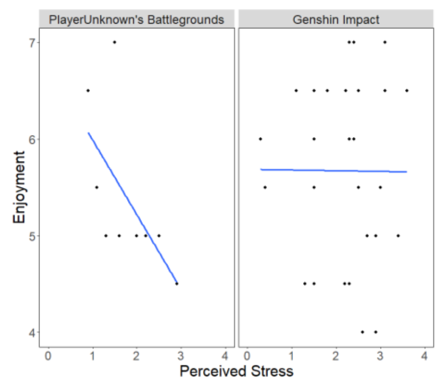


Figure 3.22

Scatterplots of Perceived Stress and Creative Freedom Between PUBG And Genshin Impact

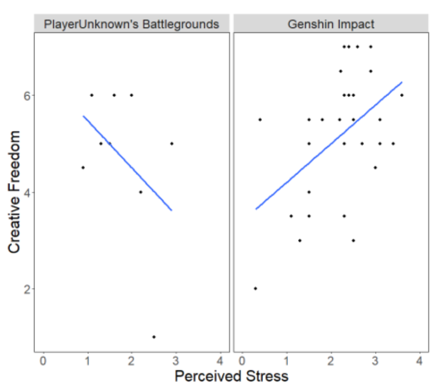


Figure 3.23

Scatterplots of Perceived Stress and Audio Aesthetics Between PUBG And Genshin Impact

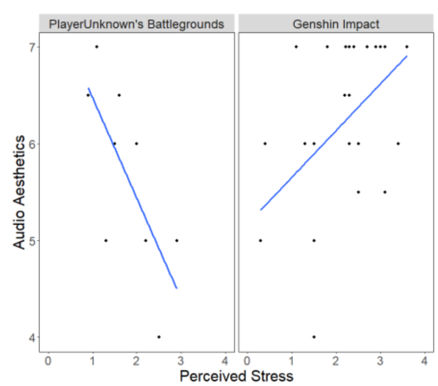


Figure 3.24

Scatterplots of Perceived Stress and Personal Gratification Between PUBG And Genshin Impact

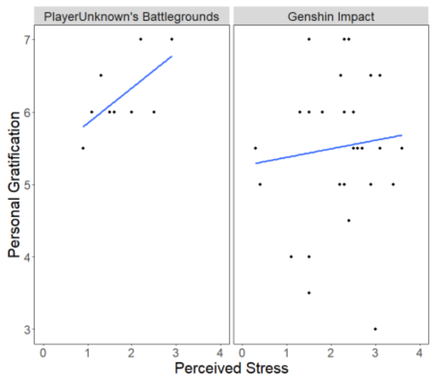


Figure 3.25

Scatterplots of Perceived Stress and Social Connectivity Between PUBG And Genshin Impact

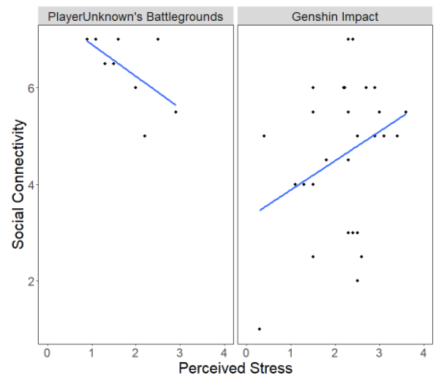
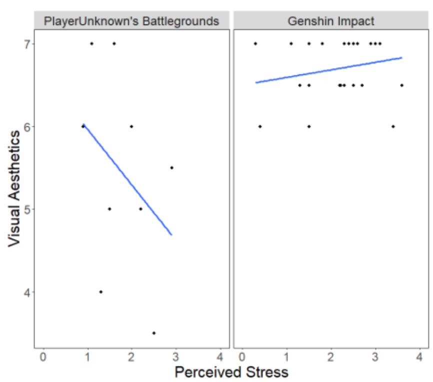


Figure 3.26

Scatterplots of Perceived Stress and Visual Aesthetics Between PUBG And Genshin Impact



The t-Test conducted to compare PUBG and Genshin Impact in relation to game use satisfaction is presented in Table 3.46. The results indicate significant differences between the two games in the following areas: narrative, personal gratification, social connectivity and visual aesthetics. These finding suggests that player experience and satisfaction derived from these elements vary notably between the two games.

Table 3.46
t-Test on Game User Experience Satisfaction (GUESS-18) Between PlayerUnknown's Battlegrounds (PUBG) and Genshin Impact

	PUBG		Genshin Impact					
	M	SD	M	SD	df	t	p	d
UP	5.78	0.71	6.00	0.83	15.47	0.78	0.45	0.27
NR	4.28	1.22	6.03	1.22	10.91	2.96	**0.01**	1.32
PE	4.56	1.29	4.00	1.60	16.43	-1.07	0.30	-0.36
EJ	5.39	0.82	5.67	0.95	15.24	0/87	0.40	0.31
CF	4.72	1.56	5.17	1.34	11.88	0.78	0.45	0.32
AA	5.67	0.97	6.23	0.92	12.97	1.54	0.15	0.61
PG	6.22	0.51	5.52	1.04	28.59	-2.75	**0.01**	-0.75
SC	6.39	0.74	4.62	1.50	28.21	-4.75	**<0.00**	-1.29
VA	5.44	1.21	6.71	0.37	8.46	3.09	**0.01**	1.93

Note: Using Welch t-Test

SuperStar Series and Fate/Grand Order

In this Survey, SuperStar Series has the highest number of respondents, followed by Fate/Grand Order. Both games have more than forty respondents. Similar to PUBG and Genshin Impact, this section will compare SuperStar Series and Fate/Grand Order. Table 3.47 and Figure 3.27 – 3.30 illustrate the overall correlations for these games in relation to perceived stress and the games challenge subscales. The results indicate that there are no significant correlations for either game in relation to perceived stress and the games challenges.

Table 3.47
Pearson Correlation Coefficients of Perceived Stress and Challenge Originating from Recent Gameplay Interaction (CORGIS) for SuperStar Series and Fate/Grand Order

SuperStar Series	PSS	CC	EC	PC	DC
PSS	-	0.000	0.014	0.001	0.036
CC	0.001	-	0.658	0.226	0.391
EC	0.119	**0.811**	-	0.113	0.557
PC	-0.024	**0.475**	**0.336**	-	0.062
DC	0.191	**0.625**	**0.746**	**0.249**	-
Fate/Grand Order	**PSS**	**CC**	**EC**	**PC**	**DC**
PSS	-	0.658	0.226	0.391	0.113
CC	0.137	-	0.326	0.500	0.506
EC	0.211	**0.811**	-	0.200	0.334
PC	0.186	**0.475**	**0.447**	-	0.276
DC	0.108	**0.625**	**0.578**	**0.524**	-

Note: Values in the left are the r scores and on the left are shows r2 scores. Significant values are in bold, where p<0.05.

Figure 3.27
Scatterplots of Perceived Stress and Cognitive Challenge Between SuperStar Series and Fate/Grand Order

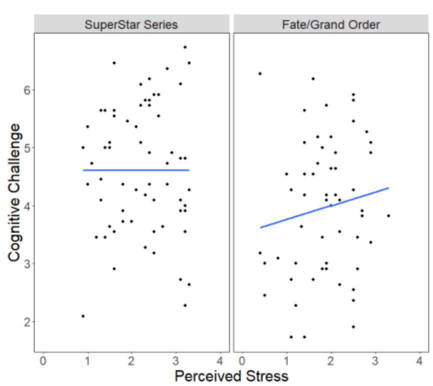


Figure 3.28
Scatterplots of Perceived Stress and Emotional Challenge Between SuperStar Series and Fate/Grand Order

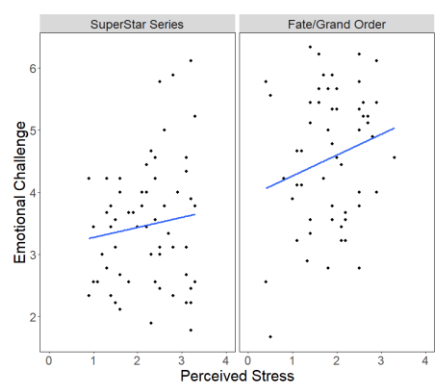


Figure 3.29
Scatterplots of Perceived Stress and Performative Challenge Between SuperStar Series and Fate/Grand Order

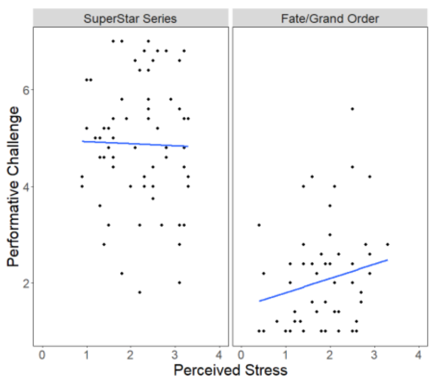
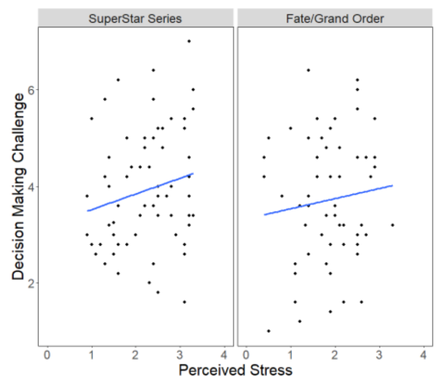


Figure 3.30
Scatterplots Perceived Stress and Decision-Making Challenge Between SuperStar Series and Fate/Grand Order



Although there was no significant correlation observed, the t-test showed there is a significant difference between SuperStar Series and Fate/Grand Order in relation to perceived stress and across the game challenge subscales. Table 3.48 shows the t-test results for perceived stress and game challenge for SSS and Fate/Grand Order.

Table 3.48
The t-test on Challenge Originating from Recent Gameplay Interaction (CORGIS) Between SuperStar Series and Fate/Grand Order

	SuperStar Series		Fate/Grand Order					
	M	**SD**	**M**	**SD**	***df***	**t**	***p***	**Cohen's *d***
PSS	2.22	0.73	1.87	0.69	117.13	-2.69	0.01	-0.49
CC	4.61	1.11	3.97	1.18	113.86	-3.06	0.00	-0.56
EC	3.47	0.99	4.55	1.10	111.66	5.65	<0.00	-0.56
PC	4.88	1.31	2.06	1.10	117.82	-12.83	<0.00	-2.32)
DC	3.92	1.24	3.72	1.33	10.61	-2.5	0.03	-0.15

Note: Using Welch t-Test

Next, we compared the results between SuperStar Series (SS) and Fate/Grand Order (FGO) in relation to perceived stress and game use satisfaction. Table 3.45 shows the overall correlations for both games. Figure 3.31 – 3.39 illustrates the scatterplot of these results. The analysis revealed that SuperStar Series showed no significant correlations between perceived stress and any of the game user satisfaction subscale. In contrast Fate/Grand Order exhibit a positive moderate correlation specifically for Personal Engrossment.

Table 3.49

Pearson Correlation Coefficients of Perceived Stress and Game User Experience Satisfaction Scale (GUESS-18) for SuperStar Series and Fate/Grand Order

SS	PSS	UP	NR	PE	EJ	CF	AA	PG	SC	VA
PSS	-	0.000	0.000	0.050	0.050	0.000	0.000	0.000	0.000	0.000
UP	-0.094	-	0.020	0.000	0.070	0.010	0.010	0.030	0.000	0.070
NR	0.152	-0.189	-	0.030	0.080	0.240	0.190	0.000	0.130	0.130
PE	0.223	0.000	0.167	-	0.010	0.040	0.070	0.070	0.000	0.020
EJ	-0.18	0.079	0.096	-0.083	-	0.100	0.100	0.090	0.000	0.090
CF	-0.169	0.018	**0.304**	-0.034	**0.264**	-	0.120	0.040	0.050	0.110
AA	0.194	-0.184	0.171	0.057	**0.377**	**0.261**	-	0.080	0.030	0.150
PG	0.053	**0.271**	-0.199	**0.256**	0.193	-0.047	0.134	-	0.030	0.060
SC	-0.087	0.062	0.127	-0.124	-0.005	**0.247**	0.198	-0.047	-	0.000
VA	-0.125	0.129	0.189	0.213	**0.256**	**0.364**	**0.284**	0.219	0.117	-
FGO	**PSS**	**UP**	**NR**	**PE**	**EJ**	**CF**	**AA**	**PG**	**SC**	**VA**
PSS	-	0.029	0.003	0.188	0.012	0.006	0.000	0.002	0.013	0.007
UP	0.171	-	0.000	0.005	0.057	0.009	0.001	0.001	0.008	0.046
NR	0.056	0.018	-	0.011	0.095	0.015	0.143	0.012	0.007	0.200
PE	**0.434**	0.074	0.103	-	0.001	0.069	0.017	0.145	0.017	0.001
EJ	-0.109	0.239	**0.307**	0.025	-	0.06	0.092	0.077	0.005	0.116
CF	0.08	0.096	0.123	0.263	0.245	-	0.077	0.152	0.18	0.015
AA	-0.014	0.035	**0.378**	0.132	**0.304**	**0.277**	-	0.141	0.05	0.062
PG	0.045	0.037	0.108	**0.381**	**0.278**	**0.39**	**0.375**	-	0.058	0.021
SC	0.115	0.092	0.084	0.131	0.074	**0.424**	0.223	0.241	-	0.003
VA	-0.084	0.214	**0.447**	-0.023	**0.34**	0.122	0.249	0.146	0.054	-

Note: Values in the left are the r scores and on the left are shows r^2 scores. Significant values are in bold, $p<0.05$.

Figure 3.31
Scatterplots of Perceived Stress and Usability/Playability Between SuperStar Series and Fate/Grand Order

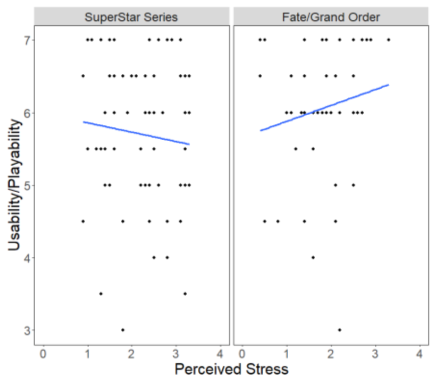


Figure 3.32
Scatterplots of Perceived Stress and Narratives Between SuperStar Series and Fate/Grand Order

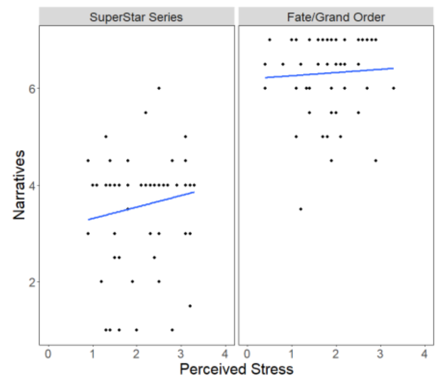


Figure 3.33
Scatterplots of Perceived Stress and Play Engrossment Between SuperStar Series and Fate/Grand Order

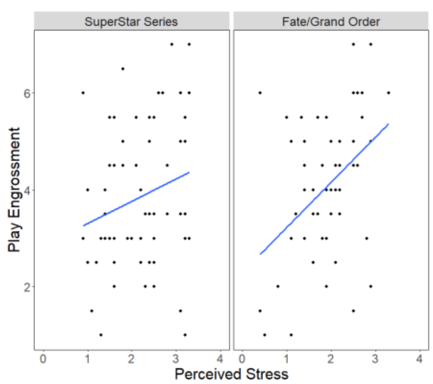


Figure 3.34
Scatterplots Perceived Stress and Enjoyment Between SuperStar Series and Fate/Grand Order

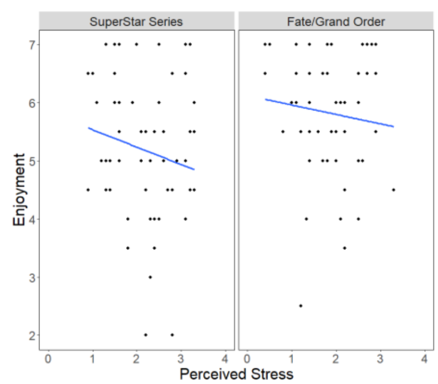


Figure 3.35
Scatterplots of Perceived Stress and Creative Freedom Between SuperStar Series and Fate/Grand Order

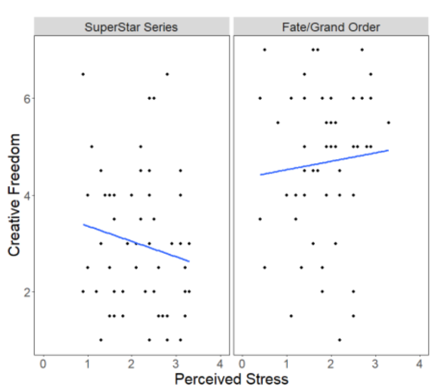


Figure 3.36
Scatterplots Perceived Stress and Audio Aesthetics Between SuperStar Series and Fate/Grand Order

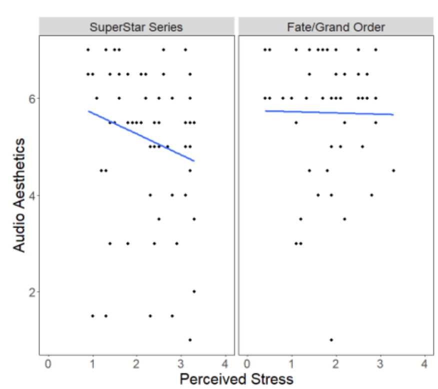


Figure 3.37
Scatterplots of Perceived Stress and Personal Gratification Between SuperStar Series and Fate/Grand Order

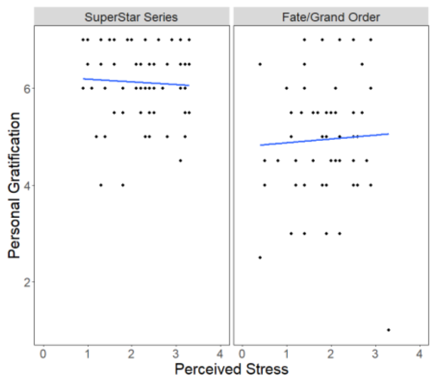


Figure 3.38
Scatterplots Perceived Stress and Social Connectivity Between SuperStar Series and Fate/Grand Order

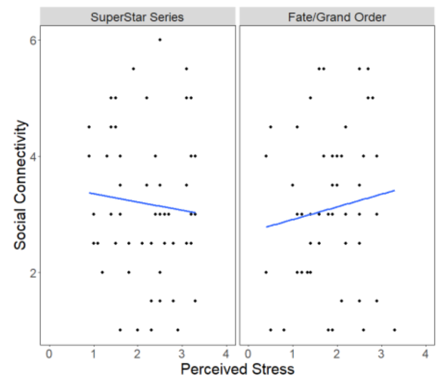
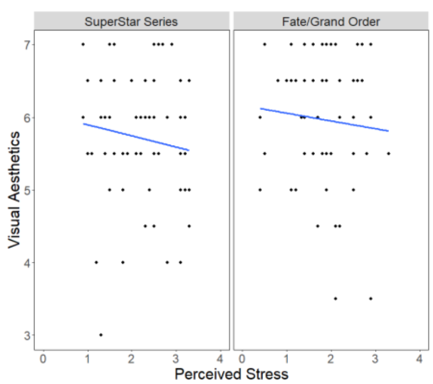


Figure 3.39
Scatterplots of Perceived Stress and Visual Aesthetics Between SuperStar Series and Fate/Grand Order



The t-test shown in Table 3.50 for SuperStar Series (SS) and Fate/Grand Order (FGO) on Game User Experience showed significant difference across the game user satisfaction subscales with the exception of personal engrossment.

Table 3.50
The t-test on Game User Experience (GUESS-18) Between SuperStar Series and Fate/Grand Order

	SS		FGO					
	M	SD	M	SD	*df*	t	*p*	Cohen's d
UP	5.70	1.00	6.07	0.89	117.97	2.14	**0.03**	0.39
NR	3.60	1.14	6.32	0.82	113.72	15.14	**<0.00**	1.32
PE	3.87	1.50	4.04	1.49	116.21	0.62	0.54	0.11
EJ	5.17	1.21	5.82	1.03	117.92	3.18	**0.00**	0.57
CF	2.98	1.37	4.68	1.50	112.34	6.47	**<0.00**	1.91
AA	5.17	1.62	5.71	1.28	116.86	2.01	**0.05**	0.36
PG	6.12	0.76	4.95	1.22	89.19	-6.24	**<0.00**	-1.18
SC	3.18	1.19	3.10	1.31	111.99	-0.35	0.72	-0.07
VA	5.71	0.89	5.96	0.88	116.42	1.56	0.12	0.29

Note: Using Welch t-Test

3.2.3 Discussion

The study had two primary aims: 1) to investigate the relationship between perceived stress and game challenges and, 2) to explore the relationship between perceived stress and game user satisfaction. To address both aims, we first assessed the level of stress among participants. The survey revealed that 76% of the respondents reported being moderately stressed or highly stressed, which highlights that the sample is affected by stress. This underscores the importance and the relevance of this research. However, the high level of stress might influence the results in unforeseen ways, as was evident in Survey 1. Additionally, it could be challenging to analyse the variations related to game factors due to potential ceiling and floor effects. Sensitivity may also reduce, making it more difficult to detect relationships with other variables.

Game Preferences

Before addressing the two main research questions and setting up the discussion, we first examined game preferences and its relation to perceived stress. Initially, the list consisted of 217 but were narrowed down to the top games played. The final list consists of 13 games. The median for the top games played showed SuperStar Series having the highest perceived stress median compared to Noita, which has the lowest median. This indicates that participants that play SuperStar Series are generally more stressed than participants playing Noita. However, it is important to note discrepancies in the number of participants for these games. SuperStar Series has 64 participants, while Noita only 11 responses. Despite this, the variance analysis indicated a significant difference in the perceived stress among the top games played. Post-test comparisons revealed SuperStar Series is significantly different from Pokémon Go and Noita, while Noita is also significantly different from Genshin Impact.

The previous study suggested that game design might influence stress experience. These games varied widely in gameplay and visual style: SuperStar Series, is a rhythm-based game that is played by tapping descending-coloured buttons to align them with a bar at the bottom of the screen in order to progress to the next song. Pokémon GO uses augmented reality to blend to real-world exploration with game-world. The goal of the game is to catch Pokémon by flicking Poké Balls on their screens towards the Pokémon. Noita uses procedurally generated pixel world design. The player controls the witch to navigates through eight biomes to battle with enemies and collect spells complete the game's main path. Genshin Impact offers an open-world action RPG experience where players use characters with elemental powers to complete quests and challenges. While both SuperStar Series and Genshin Impact involve combat, they differ significantly in gameplay: SuperStar Series focuses on rhythm, whereas Genshin Impact combines combat with expansive exploration.

Perceived Stress and Games Challenges.

To begin answering the first research question, we conducted a correlation analysis to examine the relationship between perceived stress and game challenges. The initial results showed a positive but weak correlation with emotional, performative and decision-making challenge. Despite this weak correlation, the large sample size suggests that these findings could still be meaningful. The results suggest that as the level of challenge in the game increases so does the stress level. It could also indicate that people that experiences stress choose games that are more challenging or seek games that provide the right level of challenge, gravitating toward challenging games when they are stressed.

Further analysis on perceived stress and game challenges among top games played showed that the median for Pokémon Go tend to be lower compared to the other games like League of Legends: Wild Rift, Final Fantasy XIV or VALORANT, showing the later games have higher challenge levels. Demonstrating the different levels of challenge between those games. The variance analysis showed there is significant difference in the perceived stress and game challenges across all the challenge subscale for the top games played. Further post-test was also conducted to see if there is a significant difference between perceived stress and for factors of game challenges across the top games.

The post-test results showed differences among the games in perceived stress and across the challenge subscale. The differences are quite significant in some game compared to others, for instance, the level of perceived stress in SuperStar Series is significantly different to Mobile Legends: Bang Bang as well as Pokémon Go and Noita. This signify that these games offer different levels of challenges and the perception of stress experienced while playing these games are also different. However, it is difficult to determine which aspects of game challenge are most strongly associated with perceived stress. Although, differences can be observed between these games in terms of game play and the challenges they present, for instance, SuperStar Series and Mobile Legends: Bang Bang are different in terms of gameplay and challenges but statistically, these differences are not evident.

The differences are also observed in the other game challenges factors. The post-test showed each of the top games played have different challenge levels for each of the game challenge factors. For instance, the cognitive challenge in League of Legends: Wild Rift differs from games like SuperStar Series and Pokémon Go. Perhaps, in League of Legends: Wild Rift, players are required to engage in complex strategic thinking and real-time decision-making, which contrasts with the more straightforward cognitive demands of SuperStar Series and the gameplay of Pokémon Go. Similarly, the emotional challenge for Fate/Grand Order differs significantly from games like SuperStar Series. Fate/Grand Order involves narratives and character interactions that may demand emotional investment, unlike the more straightforward nature of the SuperStar Series.

When it comes to performative challenges, League of Legends: Wild Rift, Mobile Legends: Bang Bang, and PlayerUnknown's Battlegrounds are significantly are different from SuperStar Series, Genshin Impact, and Pokémon Go. The former set of games can be characterised as highly competitive play, requiring players to have high level of skills. In contrast, the latter games offer a more relaxed or narrative-driven experience where the focus is less on competitive performance and more on exploration or casual gameplay. For decision-making challenge, League of Legends: Wild Rift is markedly different from that in SuperStar Series, Genshin Impact, and Pokémon Go. The level of decision-making processes between these games are different likely due to decision making in SuperStar Series are perhaps needed less compared to the other games. Again, demonstrating the differences between these games, making it difficult to interpret.

Perceived Stress and Game User Satisfaction

To answer the second research question, we explored user satisfaction on games and the effect on perceived stress. The Pearson correlation found a weak positive correlation between perceived stress and play engrossment, which suggest that as stress level increase, so is the tendency for game engrossment. In Survey 1, we observed similar result for perceived stress and game immersion. Sanchez & Langer (2020) characterised prone to game immersion as the tendency to become immersed in a flow state when playing game. The GUESS-18 scale relates engrossment to holding player’s attention and interest. Although, there is a difference in both concepts, where flow is experienced while being in the game, and engrossment is the pre-cursor to flow. However, this could indicate that, even though, there is no intention for game pursuit, playing game in a high stressed level, could hold the players’ attention. The result in Survey 1 also showed a negative correlation between perceived stress and the immersion. Play engrossment is similar to immersion, in the immersion definition by Brown & Cairns (2004), engaging to a gameplay can lead to immersion. The positive correlation suggests that as the perceived stress increases, so is the attention and interest towards the game.

Regarding the enjoyment scale, the results indicated a negative correlation between perceived stress and enjoyment, suggesting that as the level of enjoyment increases, the stress level decreases. However, this contrary to what we found in the first survey. Using the VGPu scale we found enjoyment to be positively correlated with stress. Indicating, that as the level of stress increases, the more they enjoy the game. According to the coping strategies by Miedziun & Czabała, (2015) one of the techniques people use to cope with stress is replacement gratification. This involves doing activities that they enjoy. This conflicting result is interesting, because not only, it suggests that people can still enjoy playing game even when stressed, but it could also suggest that when people are stressed, they do not enjoy playing game. Which implies some there might be differences in the perception of enjoyment and the type of replacement gratification people seek. In other words, there are preferences in the coping techniques that people adopt.

Further analysis showed varying levels of result for the median score on the game user satisfaction across the top games played. While usability and playability showed minimal variation, with median scores remaining consistent, narratives scores reveal a stark contrast. Genshin Impact, a game which is known for its elaborate backstory, stands out compared to SuperStar Series, which has a simpler gameplay, and lacks story and narration. Noita ranks the highest, in terms of players' engrossment, suggesting that Noita is highly engaging. This is in contrast to SuperStar Series and Pokémon GO. This is somewhat surprising, given that Pokémon GO includes an optional augmented reality feature, which is a technology that is often reported as having an immersive-related feelings such as engagement (Marto & Gonçalves, 2022). However, the limited use of AR suggests that technology alone does not indicate stress relief.

Most games generally receive high marks for enjoyment. However, SuperStar Series scored low in fostering creativity and curiosity, which is in contrast to Noita, likely due to the simpler gameplay of a rhythm game. In terms of audio aesthetic, Pokémon Go and Idle Heroes have low score, while other games generally high score of other games. For visual aesthetics, Genshin Impact scored the highest, other games also scored relatively high with minimal variations amongst them. Social connectivity scores are notably low for Noita, which is expected given its single-player nature, and the highest for VALORANT.

In the analysis of variance on the game satisfaction, with the exception of usability and playability, other factors of satisfaction are significantly different across the top games played. This indicates there is a varying level of satisfaction for the top games played. The Tukey's pairwise comparison provided some insights into the differences between these games in relation to players' satisfaction. Just as the post-test result observed for game challenges, the post-test for game satisfaction also showed significant difference between the games played for all the satisfaction factors except for usability, highlighting the different levels of satisfaction derived from each of the games people play. There are many factors contributing to this result; however, this is not evident in these results.

We can see variations in terms of game challenges and user satisfaction of games in each of the top games played. To some extent, this is expected because of the apparent differences between the games such as design, mechanics and the gameplay that each of those games offers. Overall, the players select games that provide the challenges they seek and so whilst they do vary in the aesthetics, mechanics or design, they do not vary in the perceived challenges.

Individual Game Analysis – Player's Unknown Battle (PUBG) and Genshin Impact

We also looked at the relationship between perceived stress and the specific games people play. In the first survey, we analysed PUBG and Genshin Impact, as these games were the most listed games; therefore, we also included these games' analysis for consistency and to see if the outcome from this study aligns with our discussion. The other two games, we analysed are SuperStar Series and Fate/Grand Order. These are the most listed games in this study.

In the correlation analysis of PUBG and Genshin Impact, the result did not show any significant findings, although the correlation in PUBG indicated a weak but negative correlation for all the game challenges. This suggests that the level of stress decreases as the challenges increase. However, the result did not show significant findings, and if there is a correlation it might be weak likely due to the small number of participants and also the difference in the number of participants between PUBG (n=9) and Genshin Impact (n=29).

Similarly, Genshin Impact also demonstrated a weak correlation between perceived stress and game challenges, except for decision-making challenge. However, the results are positive correlation but not significant. This implies that the task of making decisions increases, the level of stress also increases. The post-test using the t-test for both games showed there is no significant difference in perceived stress between PUBG and Genshin Impact, but there is a difference in cognitive, performative and decision-making challenge, demonstrating the difference in challenges these games present.

The lack of significant results observed for the perceived stress are likely due to how the scales were designed. Firstly, the scale was designed to measure challenge and not challenges in relation to perceived stress. Secondly, the scale was designed to measure challenge after a gameplay. However, this study was designed to measure the relations between perceived stress in daily life and the challenges in games, which means we are measuring games that the participants played the most in the recent month.

In game user satisfaction, we found a strong negative correlation between audio aesthetics and perceived stress for PUBG. For Genshin Impact, perceived stress is positively correlated with usability, narrative, play engrossment, creative freedom, audio aesthetics, social connectivity and visual aesthetics. This suggests that these factors are positively correlated with stress levels. However, the t-test showed only narrative, social connectivity and visual aesthetics to be significantly different between PUBG and Genshin Impact, showing PUBG and Genshin Impact are different in on the level of satisfaction for these factors.

Individual Game Analysis – SuperStar Series and Fate/Grand Order

We also performed, analysis on SuperStar Series and Fate/Grand Order which are the two top games played in this survey. The result showed there is a small and positive correlation between cognitive, emotional and decision-making challenge for PUBG. However, these results are not significant. In FGO, the analysis also revealed a small and positive correlation between perceived stress and all the factors in game challenges. Similar to PUBG, these results are not significant. The post-test, however, showed that there is significant difference between PUBG and FGO in their level of stress and challenges.

The analysis on user satisfaction for SuperStar Series and Fate/Grand Order only showed a weak correlation between perceived stress and all of the GUESS-18 constructs. In SuperStar Series, usability, enjoyment, social connectivity and visual aesthetics show negative correlation. And in Fate/Grand Orde, enjoyment, audio aesthetics and visual aesthetics showed negative correlation. However, except for personal engrossment in Fate/Frand Order, none of the other correlations are not significant in both SuperStar Serios and Fate/Grand Order. The result on personal engrossment for Fate/Grand Order suggests that as the perceived level increases so is the personal engrossment. The post test conducted showed there is a significant difference between SuperStar Series and Fate/Grand Order in usability, narration, enjoyment, creative freedom, audio aesthetic and personal gratification.

Analysis of Game Aesthetics

In survey 1, it was proposed that game aesthetics might have an effect on the motivation to play and the potential effect on perceived stress. However, the result from this survey, showed there is no significant relationship between perceived stress and visual aesthetics. Although, the there is a negative correlation, but the value is too weak to be meaningful. In top games and the individual analysis of games. There is a significant difference in the visual aesthetics between these games, this is expected as these are different games with different game design and gameplay. In the individual game analysis, PUBG, SuperStar Series and Fate/Grand Order also did not show any significant correlation, although they are all positively correlated. Only Genshin Impact, showed a positive and significant correlation.

Overall discussion

Overall, some factors suggest that there might be a relationship between game challenges and perceived stress, although the exact nature of this influence varies and is not straightforward. The weak correlations indicate a general trend without strong evidence of specific relationships, while the significant t-test results suggest that game challenges do not uniformly impact stress. This variability highlights the complexity of how different game challenges operate.

Similarly, factors related to game satisfaction also showed some correlation particularly, between perceived stress and personal engrossment as well as enjoyment. The results showed there is a consistent positive correlation between perceived stress and play engrossment across all the analysis. Which indicate that, there is a tendency for immersion to increase as stress levels rise. This implies that there is a positive correlation between stress levels and game engrossment, suggesting they may be related, but the direction of this relationship cannot be determined. Conversely, enjoyment exhibited negative correlations throughout the analysis, suggesting that as enjoyment increases, stress levels decrease. Implying that people who enjoys playing game tend to have lower stress. Other factors in the satisfaction scales including aesthetics produced inconsistent results through the analysis, making it difficult discern which aspect of gaming experience could help with overcoming stress. Given the outcome from both survey 1 and survey 2, the thesis will move from survey to conducting experiment. This is to determine the causal effect of playing games on psychological stress.

4. Experimental Design

One of the limitations identified in the surveys that we conducted was the inability to establish a direct, causal relationship between the games played and stress level. Therefore, to address these limitations, we conducted a series of experiments that will allow us to directly measure the causal effect of gaming on psychological stress and while isolating potential confounding variables such as environmental effects. Conversely, running an experiment also poses other issues, i.e. ecological validity which may arises from the experiment. In this context, we drew on the study conducted by Henze et al. (2017), who demonstrated that the Trier Social Test (TSST) produces stress responses with real-life exam test, they found that the Cortisol as well as the subjective stress responses are significantly associated with acute stress responses in real-life situations. Therefore, we need to put participants under stress and measures the effect the effect of playing games on alleviating psychological stress.

Importantly, in designing our experiments, we focused on two distinct concepts: stress and anxiety, as discussed in Section 2.3 of the background chapter. While stress is often defined as a response to specific external threat, anxiety is more aligned with the anticipation of potential threat or failure. In Experiments 2,3, and 4, we adapted the TSST to not induce full-blown stress, but rather to evoke of state of anticipatory anxiety. In these experiments, participants were told they would undergo job interview and arithmetic test, which is central to the TSST, but the experiment concluded shortly after collecting the second state anxiety data – before the participants actually performed the tasks. Thus experiment 2 - 4 primarily assessed the psychological effect of anticipatory anxiety, while Experiment 1 focused on acute stress induction through the full TSST procedure.

There are two primary considerations when designing the experiment. Firstly, since the experiment involves stressing participants, therefore, it needs to be in a controlled and safe environment. This requires careful consideration when selecting the right protocol for inducing stress and anxiety. There are various protocols that can be found in the literature, this has been discussed extensively in Chapter 2. From our research, we considered the Trier Social Stress Test as the most suitable for our research objective. The TSST can induce consistent psychological stress (Allen et al., 2017). It was designed by Kirschbaum et al. (1993) and has been validated and widely used in many stress research and has shown to be safe and fit for use in experiments.

The TSST was designed to measure the effect of stress using subjective and objective measures, that is, stress can be measured by collecting self-report and/or and collecting biological data such as heartrate and cortisol. Given our focus on the psychological aspect of stress, we opted to rely solely on self-report to measure the differences in stress after playing the game. The validity and the use surveys are well documented, and this has been discussed extensively in Chapter 2.

Furthermore, we were concerned with the implication of using objective measures such as the result affected by the health conditions, the time of the experiment conducted, emotions and a few others. Emotion can affect the physiological results by influencing heart rate, blood pressure, and cortisol levels (Lazarus & Delongis, 1983). The second consideration in our experimental design was the selection of scales to measure stress reactivity. We conducted a systematic analysis, detailed in Chapter 2 for the selection of the appropriate stress scale and further explained in each of the experimental chapters.

We opted to use the State-Trait Anxiety Inventory (STAI) as the primary measure of stress reactivity, as anxiety is closely related to stress, particularly in how individuals perceive and respond to stressors. The STAI includes two components: trait anxiety, which reflects a person's general tendency to experience anxiety across situations, and state anxiety, which reflects temporary feelings of anxiety in response to specific situations. Prior research has shown that high trait anxiety can make individuals more reactive to stressors, often resulting in elevated state anxiety during stressful events (Spielberger, 1983). By comparing these two components, we can better understand both baseline vulnerability to stress and how individuals react to stress-inducing tasks over time

In addition to the STAI Scale, we also incorporated secondary scales to measure stress, such as the Acute Stress Appraisal (ASA) and the Visual Analogue Scale (VAS). Detailed descriptions of the use of these scales and their application in each experiment are provided in Chapter 6.

The integration of stress and anxiety concepts in the experimental design allowed us to explore not only whether digital games can reduce psychological stress but also anxiety caused but also acute stressors.

4.1 Methodology

In total, we conducted four experiments to address the main research questions outlined in this thesis:

Experiment 1: Commercial Game for Acute Stress.
Experiment 2: Self-paced Casual Games for Acute Stress
Experiment 3: Comparisons between Digital Games with Non-Game Activity
Experiment 4: Comparisons of Digital Game, Non-Game Activity and Waiting.

Each of these experiments is described in detail in Chapters 5 through 8. While all four experiments were built around the Trier Social Stress Test (TSST) protocol, they differed in how the stress was induced. In Experiment 1, participants underwent the full TSST procedure, including the preparation, public speaking (job interview), and mental arithmetic tasks. However, in Experiments 2, 3, and 4, we used adaptation of the TSST to evoke anticipatory of state stress without exposing participants to the full stress-inducing procedure. Specifically, participants in these experiments were informed that they would complete the job interview and math test, but the experiment concluded shortly after collecting their state stress data, before the stress task was actually carried out. These modifications were intended to elicit the anxiety or psychological anticipation of stress, rather than the full physiological stress response. The rationale and methodological details of these variations are discussed in the respective methodology sections of each chapter.

4.1.1 Ethical Consideration

Applications were submitted to the University Ethics Committee for each experiment conducted. All studies were designed with due care in accordance with the University's Code of Practice and principles for ethical governance, as discussed in Section 1.3.

To safeguard participants, data collected were anonymised and kept confidential. Participant's personal information, such as their names, were removed and replaced with participant IDs. No personal information was stored and filed, and data were accessible only to the researcher and supervisor. All data are kept in a secure file with password-protected systems from unauthorised access. Data were collected using Qualtrics, a survey tool that is equipped with password-enabled access. The University of York has license with Qualtrics; therefore, it follows, fulfils the university ethical requirements. The primary researcher has also undergone Ethic Research and Data Management Training before starting the research.

Given that the experiments involved inducing stress in participants, the experimenter consulted well-being officers on how to respond in the event of panic attacks. Strategies included relocating the individual to a different room, engaging in breathing exercises, asking simple questions to redirect focus, and employing grounding techniques to foster a sense of presence and stability such as asking about things they can hear, see, touch or feel, taste, and smell. Additionally, the university provided access to "Open door" practitioners, as well as support from Security. There is also the option of contacting NHS for a non-emergency health advice by visiting 111.nhs.uk or phoning 111 if needed.

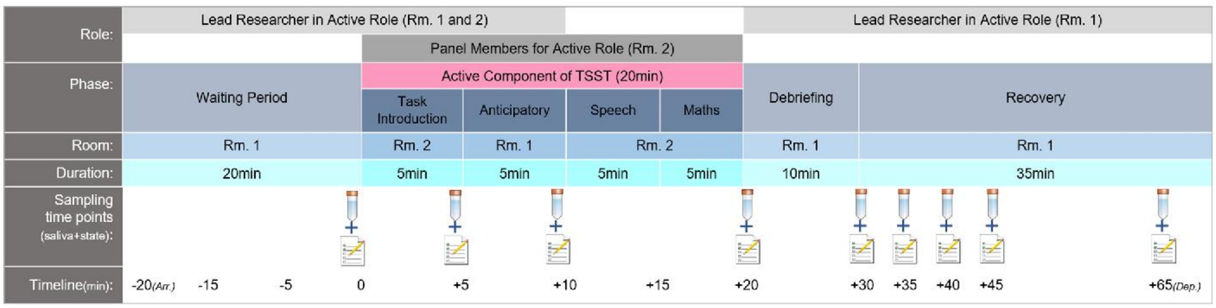
4.2 Experimental Design

Although the original developer for the TSST did not provide detailed procedures, consequently, many researchers developed their own manuals and interpretation of the protocol procedure. The TSST has been adapted to fit the researchers' research objectives. In this thesis, the design for the experiments was adapted from Labuschagne et al. (2019) guide for Trier Social Stress Test protocol and the procedures follow closely with the Introductory Manual in Appendix J.

Figure 4.1 shows the various stages of the TSST described in the guide by Labuschagne et al. (2019). The protocol includes pre-TSST period, the TSST period and post-TSST periods. The TSST period involve the tasks' introduction or briefing, preparation, and the presentation stage.

Figure 4.1

Illustration of the Various Phases of a Standardised Trier Social Stress Test (TSST) Protocol



Note: Reprinted from an introductory guide to conducting the Trier Social Stress Test by Labuschagne et al. (2019)

Figure 4.2 illustrates the adapted protocol to align with our research objective. Daviu et al. (2019) indicated that state anxiety can also be triggered by the acute stress, which can be experienced from the TSST.

According to Birkett (2011), stress levels begin to rise from the moment participants are briefed about the upcoming tasks, peaking during the actual performance phase—specifically the speech and math tasks—and then declining immediately after task completion. This pattern of stress reactivity is shown in Figure 4.3.

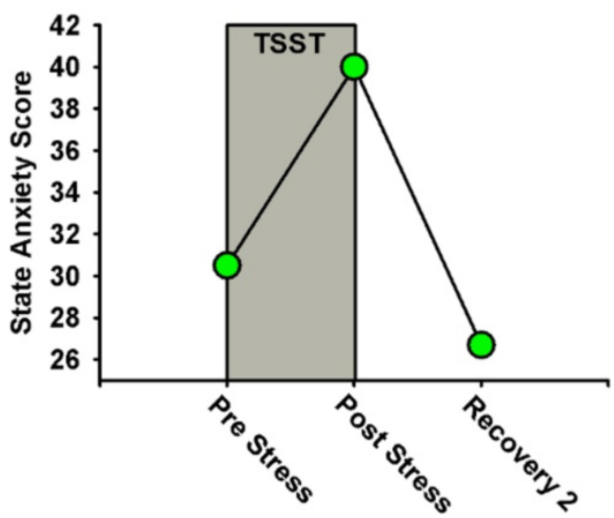
In our study, we introduced the intervention period prior to this peak, during the anticipatory phase. This period of rising stress is what Daviu et al. (2019) and Pulopulos et al. (2020) refer to as anxiety or anticipatory stress or anticipatory anxiety, which are a psychological and physiological response triggered not by the task itself, but by the expectation of a potentially stressful situation.

Therefore, it is important to note that in Experiments 2, 3, and 4, the stress response we aimed to capture was not the full stress reaction evoked by completing the TSST tasks, but rather the anticipatory psychological stress or anxiety that arises in anticipation of them. In these experiments, participants were informed they would undergo a job interview and mental arithmetic task, but the procedure concluded shortly after we collected their state anxiety data, that is before any actual performance occurred. This design isolates the psychological experience of anticipation, a key component of anxiety, allowing us to investigate how digital games might help alleviate such pre-task stress in a controlled setting.

Figure 4.2
Adaptation of the Trier Social Stress Test (TSST) protocol (no cortisol measures taken).

	Pre-TSST	TSST for Anxiety					Post-TSST	
Phase	Waiting Period	Task Introduction	Task Preparation	Intervention	Speech	Maths	Recovery Period	Debriefing
Room	1	2	2	2	3	3	1	1
Duration	5 mins	5 mins	5 mins	5 mins	5 mins	5 mins	5 mins	5 mins
Main Measures	STAI Trait		STAI State 1	STAI State 2				

Figure 4.3
Graphs of STATE Anxiety Score by (Birkett, 2011a) in the research they conducted.



4.3 Experiment Procedures

4.3.1 Recruitment

The experiments were advertised through physical and digital posters across various social channels accessible to individuals within the campus community. Participation was limited to individuals aged 18 and above. While we also accepted participants from outside the university, the majority of participants were from within the university community due to the distribution of posters primarily around campus. The posters contained general information about the study and included QR codes linking to the registration form. Participants were able to select their preferred date and time for attending the experiment through the online booking system linked to the registration form.

Once we received the application for the experiment, a confirmation email was sent along with the Participant Information Sheet. This provide the participants more information of the experiment and what is expected of them but without giving too much details concerning the tasks that they will perform. Each participant took part in the experiment individually, following their scheduled appointment.

4.3.2 Procedures

Figure 4.4 outlines the procedures of the experiment. Detailed procedures are shown in Appendix J. The experiments were conducted in the Human-Computer Interaction Lab at the University of York. Three rooms were prepared for the experiment. This is suggested in the handbooks[9] that we followed, as well as the feedback from the participants in the Pilot studies we conducted. They felt that the move from one room to another built up anticipation. Prior to the experiment, participants were emailed the participant information sheet (Appendix K). Only those who are 18 of age and without existing mental health condition were allowed to participate in the experiment. If they fulfilled the criteria and agreed to participate, they were sent an invitation to the university lab.

Upon arrival, they were asked to enter Room 1, where they were asked to read the Participant Information Sheet again and sign the Consent form (Appendix N) if they agreed to participate. To avoid being identified by name, they were given a participant ID, which was used for completing the survey. Once the participant signed the consent form, they were then asked to complete the demographic profile and the STAI-Trait scale (tT), this measured any existing mental health conditions they may have, which we used as their stress reactivity baseline and statistical control. Once this is completed, we moved the participants to Room 2. They were briefed with the tasks (Appendix L). The tasks involved performing a 5-minute presentation for a pretend job interview in front of the judge. They were informed that they will be recorded while performing the presentation and that the video will be judged after the end of the experiment. They were also informed that there will be a 5-minute arithmetic mental math test after the presentation. The mental test is counting backwards in step 13, starting from 1035. If they got the counting wrong, it would be repeated from the beginning. The details of the arithmetic test were withheld and not relayed to the participants until after the have completed presentation. Participants were given five minutes to prepare for the task. Pen and paper were provided. Once the time was up, the pen and paper were then taken away. This is followed by completing the Pre-task and Pre-intervention scale(s).

After the preparation time is up, they were asked to complete the second scale. This measures the stress level experienced after the briefing (t1). And then followed by the intervention session for 5-minutes. The activity was dependent on the Condition they were

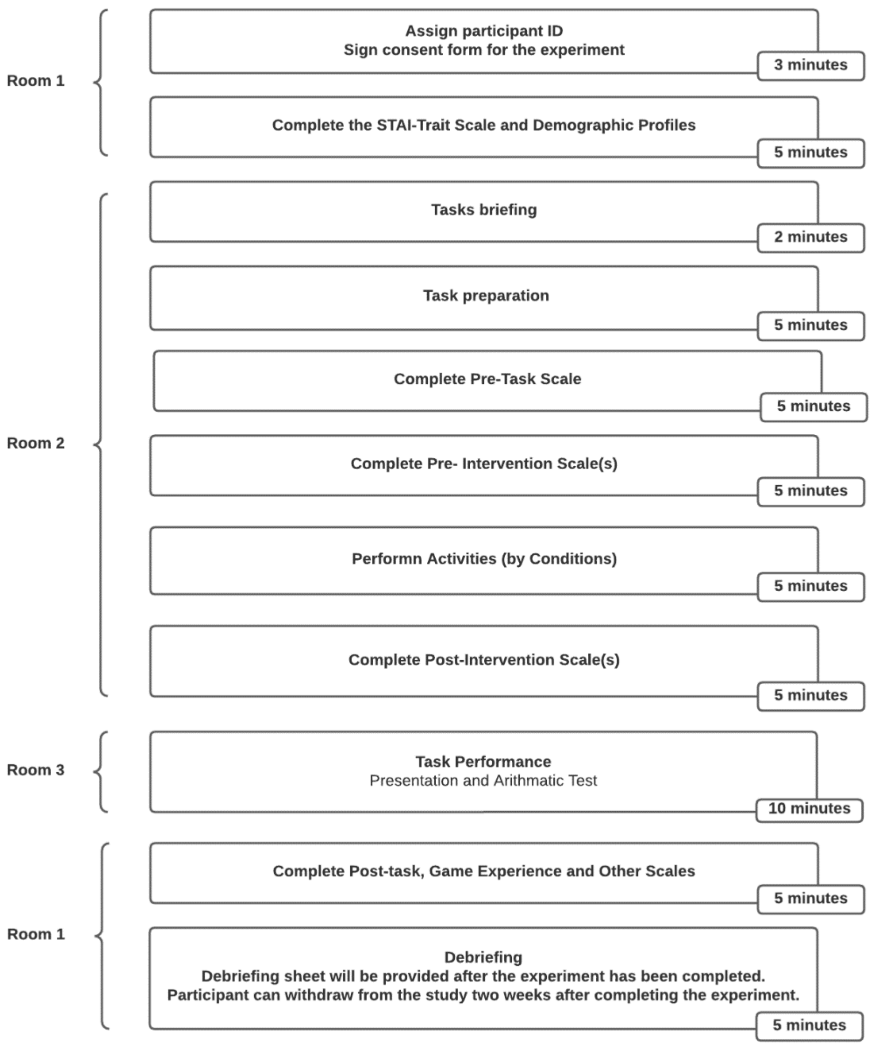
[9] Handbook of Clinical Neurology, 2022, https://www.sciencedirect.com/topics/psychology/trait-anxiety

assigned. After that, they complete the second STAI State scale (t2), to measures the effect of stress after the intervention. They then perform the tasks given.

In Experiment 1, Participants were asked to perform the activities depending on the conditions they were allocated, either the Waiting or Gaming intervention group. They were also given five minutes to perform the activities. Participants in the intervention group were given a game to play meanwhile participants in the control group did non-game related activities. Once they have completed the 5-minutes, they proceeded to complete the post-intervention survey(s).

In Experiments 2 – 4, we modified the experiment, where participants were under the impression that they will be performing the tasks, however, they experiment will stop before they completed the tasks. This is further explained in Experiment 2.
The presentation and the arithmetic were performed In Room 3; The tasks took 20 minutes to complete overall. After completing the tasks, we asked participants to return to Room 1 where they completed the post-task scale and game experience scales such as GUESS-18 and Immersion. And lastly, the experiment ends with a debriefing Appendix M.

Figure 4.4
Experimental Procedures



4.3.3 Measures

We used several scales throughout the experiment to measure stress reactivity and game experiences. To measure stress reactivity, we used the State-Trait Anxiety Inventory (STAI), Acute Stress Appraisal (ASA) and VAS (Visual Analogues Scale) for stress.

The main measure we used for stress reactivity is the State-Trait Anxiety Inventory (STAI), which comprises two components: the Trait scale (measuring general anxiety predisposition) and the State scale (measuring current anxiety levels). The STAI was administered across Experiments 1 to 4 (Appendix O), before and after each intervention. While the STAI primarily measures anxiety, it is commonly used in stress research due to the close relationship between anxiety and stress responses (Spielberger, 1983). However, as a self-reported measure, the STAI may be influenced by participants' subjective perceptions and may not fully capture physiological aspects of stress. This limitation should be considered when interpreting changes in stress reactivity based solely on STAI scores.

On the other hand, the ASA measure if the tasks are able to induce acute stress. By collecting the ASA score pre and post task, we were able to determine the effect of tasks are able to induce stress as expected.

The second scale is the ASA (Appendix P). The scale results will show the effect of the tasks on the Acute Stress level. The scales items can be found in the Appendix. ASA was used in Experiment 1 because ASA measure participants appraisal of resource and demands of the tasks, which means the scale is measuring the participants appraisal of tasks and not their general perception. ASA as previously mentioned measures what the participants perceive as threat and challenge.

The third scale that we adopted was the VAS (Appendix R). The VAS uses images to rate of stressfulness. The scale uses visual cues to measure the effect of stress, which is often considered to be more effective and simpler for measuring stress (Dutheil et al., 2017). It measures the intensity of the stress from 1 to 5. The scale as adopted in Experiment 3 and 4. It is used to supplement the result obtained from STAI and compare the result between the two scales. To measure Player Experiences, we used Short-Form Immersion Experience Questionnaire (SF-IEQs) (Appendix Q) to measure Immersion, GUESS-18 to measure Game Satisfaction and a short answer question to measure Immersion and Involvement. The use of these scales was dependent on what we want to measure in each experiment. The use of which scales are explained in detail in each study section. Table 4.1 summarises the use of measures for each experiment.

Because we wanted to measure the change in their stress level after the intervention, the scales were distributed at two main time points: pre-intervention (t1), i.e. after the task briefing and task preparation and post-intervention (t2). The difference between the two sets of data (t2-t1) is the Change in stress level (tD).

Table 4.1
Main Stress Reactivity Scale and Game Experience Measures for Each Experiments.

Experiment	Stress Reactivity	Game Experiences
1	STAI, ASA	Games User Experience Satisfaction Scale (GUESS-18)
2	STAI	Short Form Immersive Experience Questionnaire (IEQ-SF)
3	STAI, VAS	Rate of Immersion
4	STAI, VAS	Rate of Immersion and Involvement

4.3.4 Apparatus

To ensure consistency, the following apparatus were maintained throughout the experiments, although not all items were used in every experiment:

I. Laptops and computers were utilised to collect survey data, providing information on stress traits and state scores.
II. Mobile phones and iPads served as the gaming medium, allowing participants to engage in gameplay sessions during the experiment.
III. Digital camcorders, along with tripods, were used to videotape presentations and mental math tests.
IV. A microphone was used to capture audio during the experiment.
V. Clipped folders were used to organize any necessary documents or materials related to the experiment.
VI. Pens and paper were provided for participant to do preparation.
VII. A timer was used to track the duration of presentations and math tests, facilitating time management and ensuring consistency across sessions.

4.3.5 Game Selection

In Experiment 1, the game was based on the results of the Survey 2. Although it does not precisely match the games listed, we opted for similar game, a rhythm game. The top game listed in the previous study was based on a popular Korean group with limited song selections, which might not resonate with local participants. Hence, BeatStar, a rhythm game was used in this experiment. For Experiments 2, 3, and 4. the 2 Dots was used. The games consist of two variants: low-immersion and high immersion. The extracted games are devoid of other gameplay such as collecting awards and coins. This reduces noises that may come from the game. This game was developed by Joe Cutting and was used in the experiments to measure attention and immersive experience (Cutting et al., 2020; Cutting & Cairns, 2022). We used the same game across experiments seemed appropriate. Detailed explanations of the gameplay for each game can be found in Chapter 6.

5. Experiment 1: Commercial Game for Acute Stress

The overarching research question for this thesis is “Can playing digital games help with reducing stress and anxiety induced by stressful event, and if so, what aspects of playing digital games support this?”.

In survey 1 and 2, we explored the experiences of playing games in relation to motivation, game challenges and user satisfaction. Two key concepts that stood out from the results are the experiences of immersion and enjoyment. In both survey studies, the result consistently showed that there is a positive correlation between immersion and perceived stress, which indicated that as the perceived level increases so is the tendency to be immersed in game. According to the strategy of coping from stress by Miedziun & Czabała (2015), one of the techniques for management stress is through replacement gratification and distancing. Replacement gratification is doing things that you enjoy. While distancing is the act of emotionally or cognitively separating themselves from the stressor.

In the experience playing game, immersion is often described as being in the game (Brown & Cairns, 2004; Jennett et al., 2008). Games are also said to facilitate the escape from reality (Demetrovics et al., 2011). Therefore, the experimental section of this thesis will be focusing on measuring the effect of playing games on psychological stress and the experience of immersion effect stress. While literature suggests that games can support mental well-being, further exploration is needed to comprehend their efficacy in managing short-term stress, known as acute stress. Acute stress arises from events perceived to exceed one's coping resources, potentially leading to short-term effects like impaired cognitive function and increased heart rate, among others. The neglect of managing short-term stress may result in long-term consequences.

Therefore, to answer the main research question, we designed an experiment to assess the impact of playing games on stress levels based on the TSST guideline detailed in Chapter 2 and Chapter 4, as well as the guideline on selecting scales detailed in Chapter 2. Chapter 4 of the Experimental Setup. Before we can measure the effect of immersion, we first, measure the effect of playing games as a stress reliever from acute stress. This is also to determine there is effect that can be observed. Secondly, the first experiment is to determine if the experimental design can produce any result before conducting further experiments.

Hence, the aim of the first experiment, is to measure the effect of playing digital games as on acute stress. This experiment contrasts gaming against the absence of gaming to gauge its influence on acute stress levels. The experimental hypothesis is that participants in the Gaming condition will experience a stress reduction compared to participants in the Waiting condition.

5.1 Methodology

5.1.1 Design, Procedures, and Materials.

The design and procedures for this experiment are adapted from the experimental design discussed in Chapter 4, where detail description can be found. In this experiment, we employed two conditions: Waiting and Gaming conditions. Participants were randomly assigned to one of the conditions. In the Waiting condition, participants were asked to sit quietly and wait until they were called to do the interview and arithmetic test. No tasks were given at all. Meanwhile participants in the Gaming condition were given a rhythm game to play. Each condition lasted for five minutes.

The study followed a 2 x 2 mixed-measures ANOVA experimental design. The independent variables were the conditions, and the dependent variables were the stress scores measured at two time points: pre-intervention (t1) and post-intervention (t2). Additionally, the change in stress scores (delta = t2 − t1) was calculated and analysed to directly assess the effect of the intervention.

5.1.2 Measures

To measure the effect of playing BeatStar, a rhythm game, on acute stress, participants were assigned to the gaming condition where they played the game for five minutes. We used the State-Trait Anxiety Inventory Scale (STAI) and Acute Stress Appraisal Scale (ASA). Additionally, we also asked a few game experience questions such as the frequency of playing digital games (Appendix H). The STAI scales consisting of the Trait scale and State scale. The Trait score is collected at the start of the experiment before participants are informed of the tasks for the experiment. The State scores were collected at two time points: after the tasks briefing, where participants were briefed about the presentation and the arithmetic test that they needed to perform while being recorded and observed, which we called t1, and after the intervention stage, which is after participants perform the activity that they were allocated to, we called this time-point as t2.

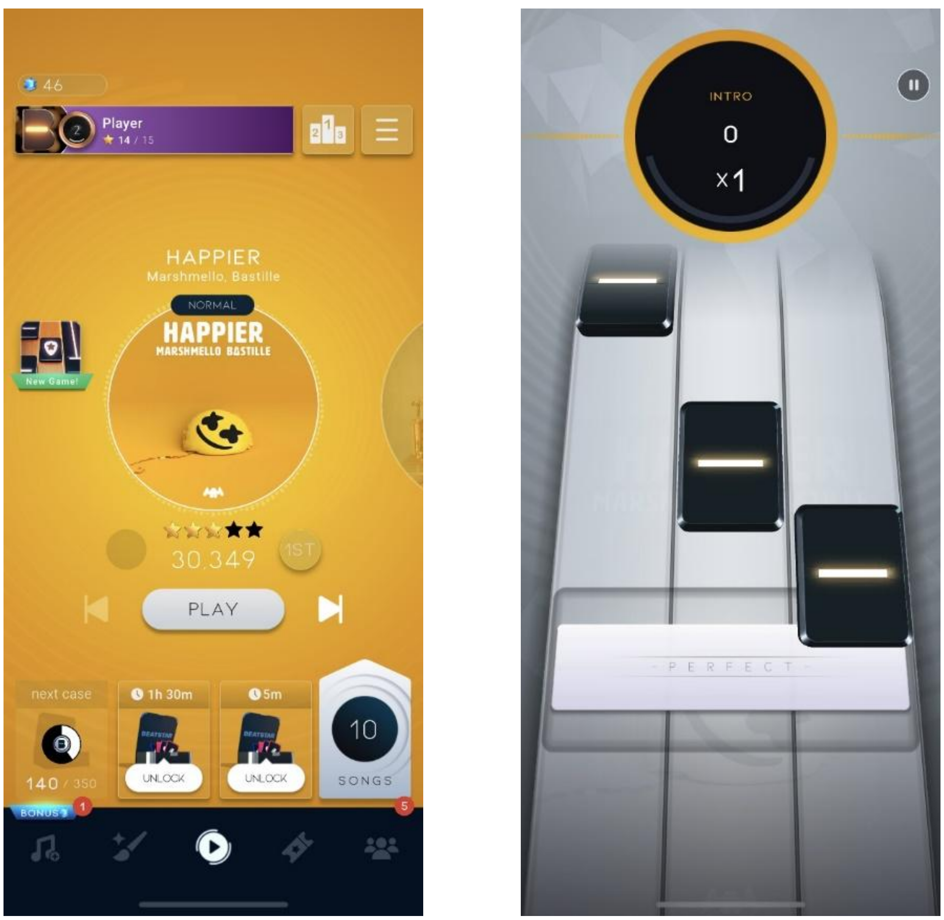
The ASA consist of pre-task and post-task scales. Pre-task score (PT1) will be collected after the task briefing and the post-task score (PT2) will be collected after they have performed the task. We also included demographics and questions regarding participants' game experience, including the game they played in the last four weeks, the frequency of playing the game and the time of playing the game.

5.1.3 Games Selection

In this experiment, participants in the Gaming condition were provided with BeatStar, a rhythm game, to play. This decision was based on the findings of the second survey study in Chapter 3., which revealed that the most frequently played game was SuperStar Series, another rhythm game centred around Korean pop idols. However, due to the game's niche appeal in a specific region and group, we opted to select a rhythm game with similar features but a broader song selection and audience.

BeatStar's gameplay involves tapping and swiping along to the instruments, vocals, and beats of popular and contemporary songs. As the song plays, players must tap, swipe, or hold their finger on a series of inputs at the right time to match the song's beat or sound effects. Figure 5.1 (a) shows the main screen of the game and Figure 5.1 (b) shows the gameplay view of the game.

Figure 5.1
(a) Main Screen of BeatStar (b)Gameplay View of BeatStar



(a) **(b)**

5.1.4 Participants

Overall, there were 62 participants; however, 2 withdrew after the task briefing because they felt uncomfortable and nervous about performing the presentation. The final number considered for analysis is 60 participants.

The participants were 42% Male, 55% Female, and 3% Non-binary. Most were aged between 18 and 24 (57%), while 37% were between 25 and 34 years old (25 Males, 33 Females, and 2 Non-binary). The overall age range was 18 to 55 years, with a mean age of 25.5 years (SD = 6.15).

All participants were staff and students from the University of York. Participants were recruited by convenience sampling. They responded to posters across campus and social media posts: the study was advertised on Discord, Facebook and Reddit. Participants were randomly allocated to either the Waiting Group or the Gaming Group, with 30 participants in each condition. The study was open to individuals aged 18 and above and with no existing mental health conditions. Each participant received a £10 Amazon voucher. Table 5.1 summarises the demographic profiles by conditions.

Pilot studies were also conducted for each of the conditions, each involving two participants. The purpose of these pilot studies was to test the flow of the experiments and ensure that all materials were functioning properly.

Table 5.1
Demographic Analysis of the Research Sample

		Waiting		Gaming		All	
		n	%	n	%	n	%
Age	18 - 24	14	23	20	33	34	57
	25 - 34	14	23	8	13	22	37
	35 – 44	1	2	2	3	3	5
	45 – 55	1	2	0	0	1	2
Gender	Male	11	18	14	23	25	42
	Female	19	32	14	23	33	55
	Non-binary	0	0	2	3	2	3
Employment	Student	24	40	27	45	51	85
	Full-time employment	5	8	1	2	6	10
	Part-time Employment	0	0	1	2	1	2
	Others	1	2	1	2	2	3

5.2 Results

We hypothesised that there would be a reduction in stress for participants playing the game compared to participants who were waiting and doing nothing at all. To see if there is any effect of playing the game on stress, we first calculated the STAI State scores followed by calculating the ASA scores.

5.2.1 State-Trait Anxiety Inventory Scale (STAI)

STAI State

STAI State Change

To see the change in stress after the intervention between the two conditions, the mean score and standard deviation were calculated for STAI State before (t1) and after the intervention (t2). The change in score (tD) is the difference between t2 and t1. The results are shown in Table *5.2*, while Figure 5.2 shows the boxplot for the STAI State scores t1 and t2. Figure 5.3 shows the change in the STAI State score (tD). We can see from the result and boxplot that there is a small reduction in stress for both the Waiting and Gaming Conditions.

STAI State Induction Validation

In order to ensure that the induction process have worked, a one-sample t-test was conducted on the post-induction STAI State scores to determine whether they were significantly higher than expected non-stressed values. Given that the STAI State uses a 4-point Likert scale, a mean item score of approximately 2 (i.e. “Somewhat”) was used a conservative estimate of non-anxious populations. This value served as a benchmark to test whether participants’ reported anxiety was significantly elevated after the induction.

The sample mean STAI state score was 2.26 ($SD = 0.56$). The t-test revealed a significant elevation in state anxiety, $t\,(59) = 3.61$, $p < 0.001$. This suggests that the stress induction effectively elevated anxiety in the experiment.

Table 5.2

Mean and Standard Deviation (SD) for State Trait Anxiety Inventory (STAI) State t1, t2 and tD by Conditions

Conditions	STAI State t1		STAI State t2		STAI State Difference tD	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Waiting	2.29	0.61	2.18	0.6	-0.11	0.33
Gaming	2.24	0.53	1.92	0.49	-0.32	0.32

Figure 5.2

The Box Plot of State Trait Anxiety Inventory (STAI) State Scores by Conditions.

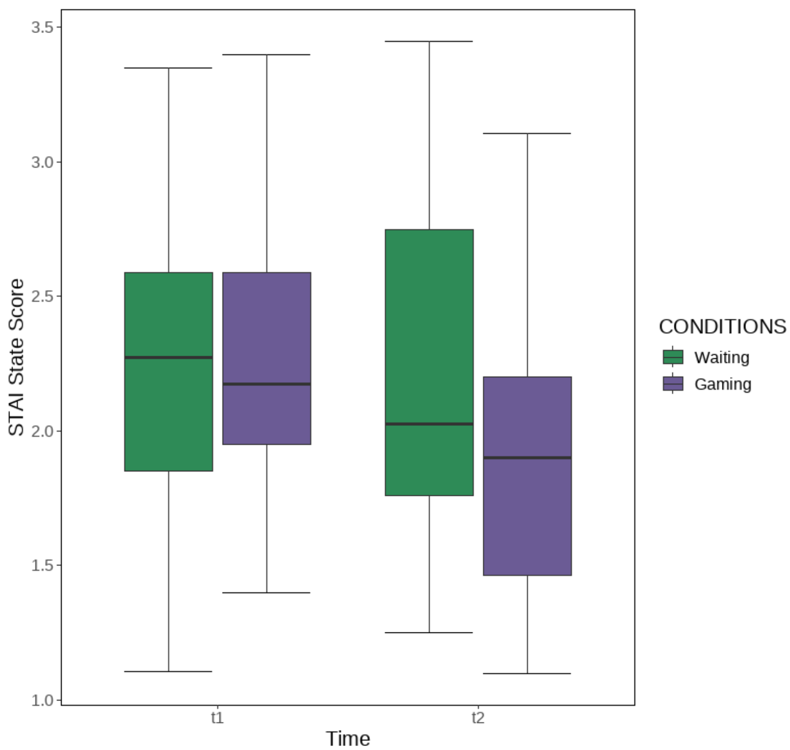
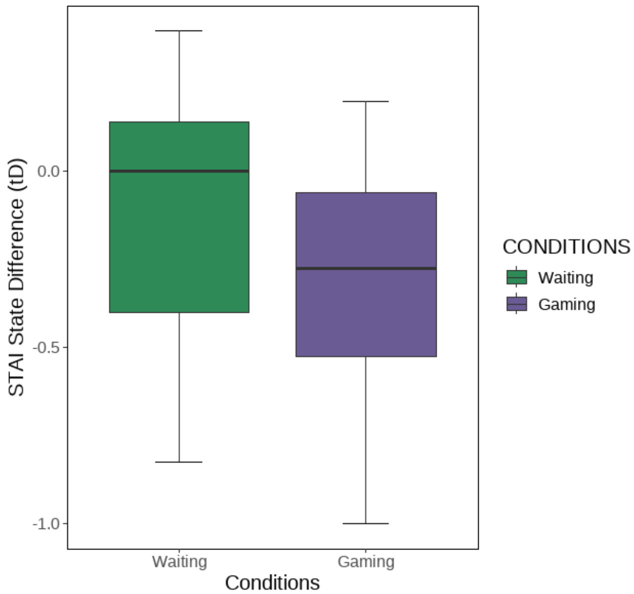


Figure 5.3

The Boxplot for the Change in the State Trait Anxiety Inventory (STAI) State Scores by Conditions.



Using a 2 x 2 mixed-measure ANOVA on the STAI State scores to calculate across the two conditions, we found a significant effect for Time is [F (1, 58) = 25.31, p <0.001] and the interaction between Conditions with Time [F (1, 58) = 6.38, p < 0.001]. However, there is no significant effect for Conditions [F (1, 58) = 1.35, p < 0.25], as shown in Table 5.3.

Table 5.3

Between-Group Comparisons for State Trait Anxiety Inventory (STAI) Score and Conditions

Interactions	F (1,58)	Sig (p-value)	Effect size (ges)
Conditions	1.35	0.25	0.021
Time	25.31	**< 0.001***	0.036
Conditions X Time	6.38	**< 0.001***	0.009

A paired samples t-test (Table 5.4) conducted on t1 and t2 revealed a significant difference for the Gaming condition, with t (29) = 1.75, p < 0.001*, while there was no significant difference significant difference for Waiting condition.

Table 5.4
The t-test for Waiting and Gaming Conditions

Conditions	n	df	t(29)	p
Waiting	30	29	5.40	0.090
Gaming	30	29	1.75	**< 0.001***

Note: Using Bonferroni Test.

STAI Scale Correlations

We also performed a correlation analysis between the STAI Trait scale and the STAI State scale using the Pearson Correlation Coefficient. Table 5.5 and Figure 5.4 present the results, illustrating the varying correlations among the STAI scales in both conditions. Following Cohen et al. (2013) labels for correlation; values less than four are weak, between 0.4 and 0.6 as moderate and above 0.7 as strong correlation. Based on this, the STAI Trait scores weak correlations with the other STAI State scales (t1 and t2) as well as the STAI State Difference (tD). However, there was a strong correlation between STAI State t1 and t2 in both the waiting and gaming conditions: $r = 0.851$ and $r = 0.801$, respectively. Additionally, we observed weak to moderate correlations between t1 and tD, and between t2 and tD.

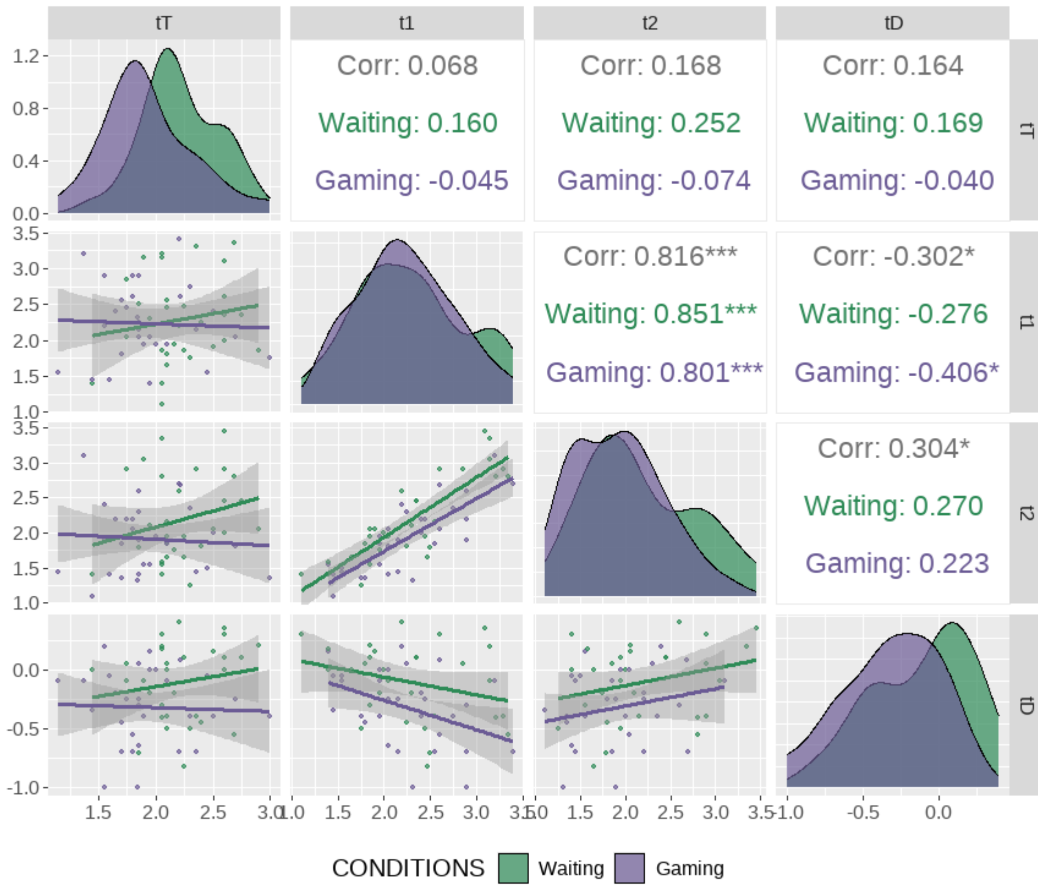
Table 5.5
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI) Scales.

Waiting	tT	t1	t2	tD
tT	-	0.026	0.064	0.029
t1	0.160	-	0.724	0.076
t2	0.252	**0.851**	-	0.073
tD	0.169	-0.276	0.270	-
Gaming	tT	t1	t2	tD
tT	-	0.002	0.005	0.003
t1	-0.045	-	0.642	0.165
t2	-0.074	**0.801**	-	0.050
tD	-0.040	**-0.406**	0.223	-

Note: Values on the left is the r score and the right is the r^2.
Values in bold are significant, $p<0.05$

Figure 5.4

The Scatterplot Matrix for State Trait Anxiety Inventory (STAI) Scales by Conditions.



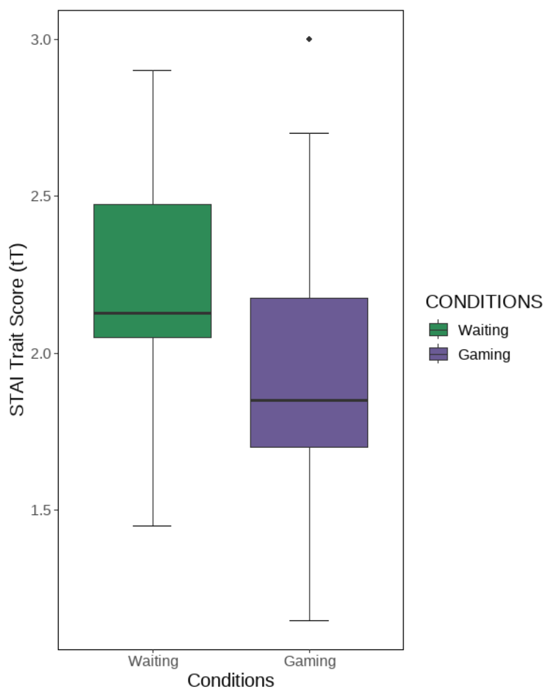
STAI Trait

When we designed the experiment, one of the confounding factors that we considered was the trait anxiety which refers to an individual's tendency to experience anxiety, which differs from state anxiety that arises at a specific moment or pre-existing stress conditions. Therefore, we also collected the trait score using the STAI Trait scale before we began the experiment. The mean score and the standard deviation for the STAI Trait (tT) are shown in Table 5.6. The mean score for the Waiting condition is slightly higher compared to the Gaming condition. Figure 5.5 shows the boxplot for trait anxiety.

Table 5.6
STAI Trait Mean and Standard Deviation (SD) by Conditions.

	Mean	Standard Deviation
Waiting	2.215	0.333
Gaming	1.931	0.401

Figure 5.5
The Box Plot for State Trait Anxiety Inventory (STAI) Trait Scores by Conditions



To see if there is a systematic difference in tT between the two conditions, we used an independent two-sample t-test. Table 5.4 shows the result of the analysis. There is a significant difference in tT across the Waiting Condition (M = 2.21, SD = 0.33) and Gaming Condition (M = 1.93, SD = 0.40), where t (60) = 2.99, p = 0.004. The effect size for the difference is measured by Cohen's d, which is reported as -0.77, indicating a large effect size.

Table 5.7

The t-test for State Trait Anxiety Inventory (STAI) Trait Scores by Conditions

	Waiting		Gaming					
	M	(SD)	M	(SD)	*df*	t	*p*	Cohen's *d*
STAI Trait	2.215	0.33	1.931	0.40	56.113	-2.99	0.004	-0.77

Note: Using Welch test

The covariate STAI Trait was tested further to investigate if tT has a significant effect on conditions. Using a Linear Regression model to the results is shown in Table 5.8 which revealed that the covariate, Trait Anxiety, was not significantly related to the participant's STAI State score.

Table 5.8

Linear Regression Result for State Trait Anxiety Inventory (STAI) Trait and State Scores

Independent Variable	Estimate	t-Value	p-value
Trait	0.05	0.42	0.67
Conditions	0.20	2.18	0.03*

5.2.2 Acute Stress Appraisal (ASA)

We performed the same analysis for Acute Stress Appraisal (ASA). The mean Threat score for ASA1 and ASA2 score and the standard deviation for both conditions were calculated as shown in Table 5.9. The ASA Difference (ptD) shows the change in the ASA score after the conditions. The result shows an increase in the overall ASA score for both Waiting and Gaming conditions. However, we can see that the mean score for participants in the Waiting condition (Mean = 1.55, SD = 1.53) is higher compared to participants in the Gaming condition (Mean = 0.51, SD = 1.46). Figure 5.6 is the boxplot for the difference between ASA PT1 and PT2 scores for both conditions, while Figure 5.7 shows the change in ASA score (ptD).

Table 5.9
Mean and Standard Deviation (SD) of Acute Stress Appraisal (ASA) Scores

CONDITIONS	ASA PRE TASK PT1		ASA POST TASK PT2		ASA Threat ptD	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Waiting	-0.26	1.65	1.29	1.86	1.55	1.54
Gaming	-0.34	1.90	0.17	1.81	0.51	1.46

Figure 5.6
The Boxplot for Acute Stress Appraisal (ASA) Threat Score for Pre-Task (PT1) and Post-Task (PT2) with Threat Score Difference (ptD) by Conditions.

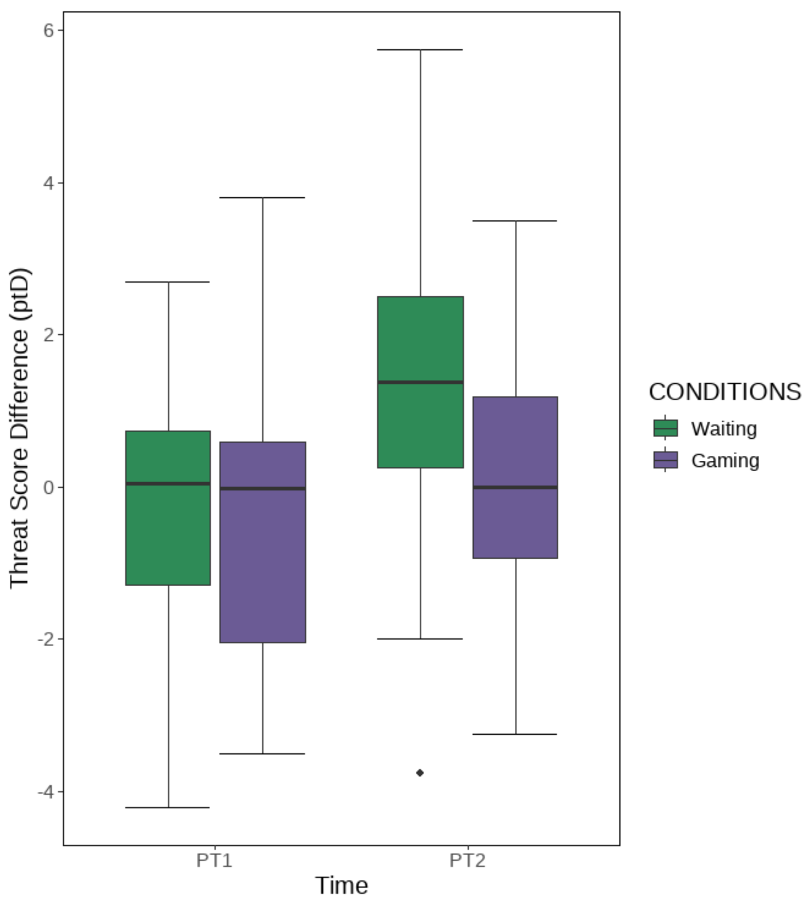
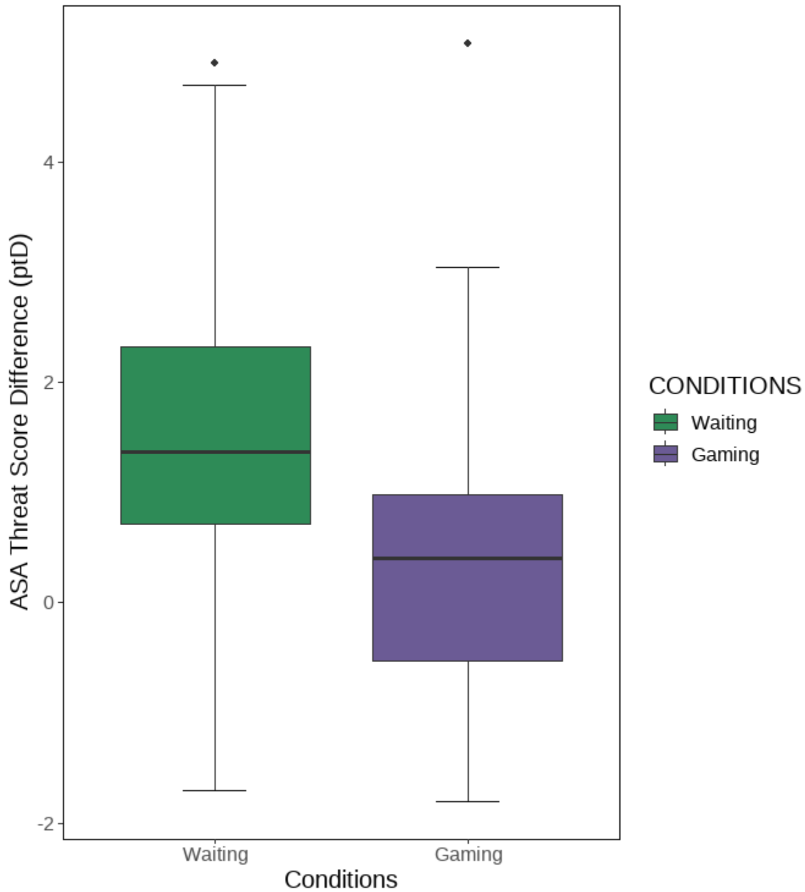


Figure 5.7

The Box Plot of Acute Stress Appraisal (ASA) Threat Difference (ptD) by Conditions.



Using a 2 x 2 ANOVA on the ASA Scores across the two conditions, we found a significant effect for Time [F (1, 58) = 36.32, p < 0.001] and Conditions and Time [F (1, 58) = 7.212, p = 0.009]. However, there is no significant effect for Conditions [F (1, 58) = 2.014, p = 0.028]. The results are shown in Table 5.10.

Table 5.10

Between-Group Comparisons for Acute Stress Appraisal (ASA) Threat Scores.

Interactions	F (1,58)	Sig (p-value)	Effect size (ges)
Conditions	2.014	0.161	0.028
Time	28.434	**< 0.001***	0.078
Conditions X Time	7.212	**0.009***	0.021

A paired samples t-test conducted on PT1 and PT2 of the Acute Stress Appraisal (ASA) scale revealed a significant difference for the Gaming condition, with t (29) = 1.75, p <

0.001*, while there was no significant difference significant difference for Waiting condition (Table 5.11).

Table 5.11
The t-test for Waiting and Gaming Conditions.

Conditions	n	df	t(29)	p
Waiting	30	29	-5.55	0.065
Gaming	30	29	-1.92	**< 0.001***

Note: Using Welch test.

ASA Scale Correlations

We also performed a correlation analysis for ASA scale using the Pearson Correlation Coefficient. We also conducted a correlation test to determine any significance correlation. Following Cohen et al. (2013) labels for correlation; values less than 0.4 are weak, between 0.4 and 0.6 as moderate and above 0.7 as strong correlation.

Based on this, the STAI Trait scores shows a weak correlation with the other ASA scales (PT1 and PT2) as well as the ASA Threat score (ptD). In contrast, there was a moderate and significant correlation between PT1 and PT2 in both the waiting and gaming conditions: r = 0.387 and r = 0.473, respectively. Additionally, we observed weak to moderate correlations between PT1 and ptD, and between PT2 and ptD. Table *5.12* and Figure 5.8 present the results, illustrating the varying correlations among the ASA scales in both conditions.

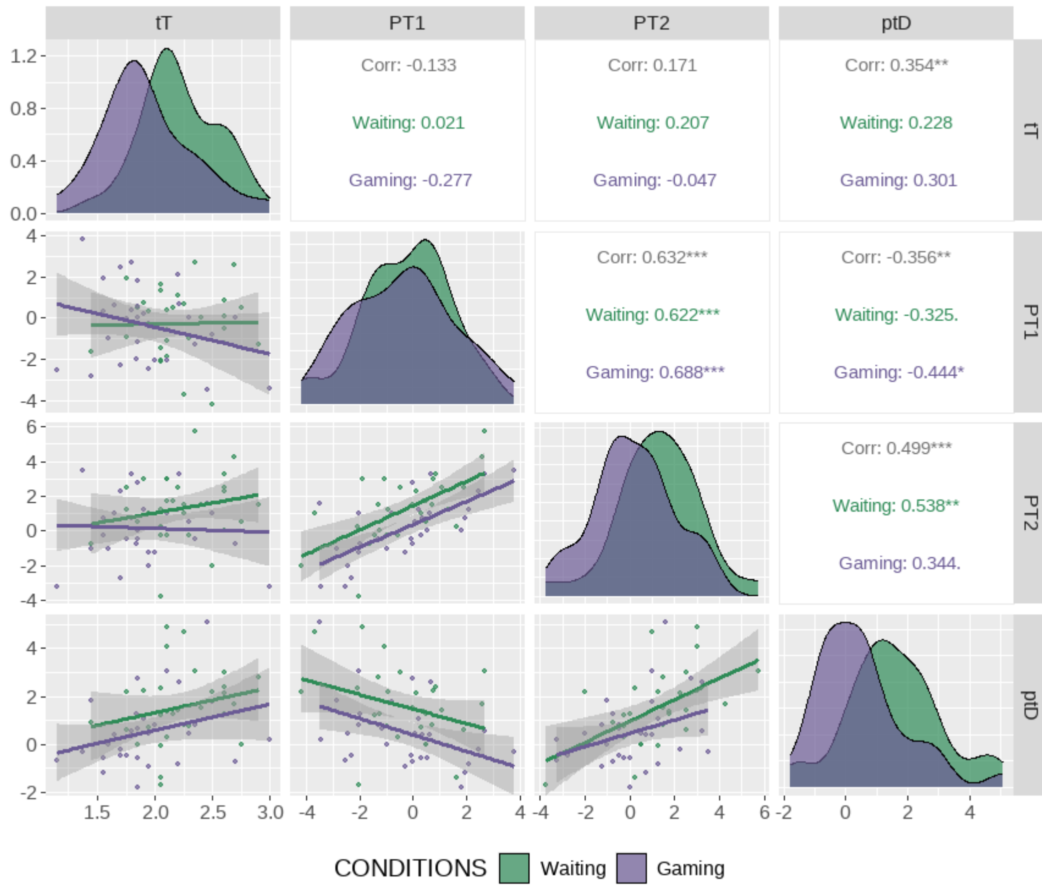
Table 5.12
Pearson Correlation Coefficients Matrix for Acute Stress Appraisal (ASA) Scale.

Waiting	tT	PT1	PT2	ptD
tT	-	0.040	0.042	0.052
PT1	0.021	-	0.387	0.105
PT2	0.207	**0.622**	-	0.289
ptD	0.228	-0.324	**0.538**	-
Gaming	**tT**	**PT1**	**PT2**	**ptD**
tT	-	0.077	0.002	0.091
PT1	-0.277	-	0.473	0.197
PT2	-0.047	**0.688**	-	0.118
ptD	0.301	**-0.444**	0.344	-

Notes: Values on the left is the r score and the right is the r^2.
Values in bold significant, p<0.05

Figure 5.8

Scatterplot Matrix for State Trait Anxiety Inventory (STAI) and Acute Stress Appraisal (ASA) Scores by Conditions



STAI Trait and Acute Stress Appraisal

Using Linear Regression, we also analysed the effect of STAI Trait (tT) on ASA Difference (ptD). Table 5.13 shows the overall results. We found there is a significant effect for tT on the ptD [F (1, 57) = 2.075, p = 0.043].

Table 5.13

Linear Regression Result for State Trait Anxiety Inventory (STAI) Trait Score and Acute Stress Appraisal (ASA) Scores

Independent Variable	Estimate	t-Value	p-value
Trait	1.078	2.075	0.043
Conditions	0.734	1.813	0.075

Using the Pearson Correlation Coefficient, we computed the correlations between the STAI Trait and ASA scales. Table 5.14 illustrates the varying correlations among the STAI scales in both conditions.

The STAI Trait scale exhibited weak correlations with any of the ASA scales. However, there was a strong correlation between ASA PT1 and PT2 in both the Waiting and Gaming conditions: r = 0.622 and r = 0.688, respectively. Figure 5.9 shows the scatterplot matrix for both Waiting and Gaming conditions.

STAI Scale and ASA Scales Correlation

Using the Pearson Correlation Coefficient, we computed the correlations between the STAI and ASA scales. Table 5.14 and Figure 5.9 present the results, illustrating the varying correlations among the STAI scales in both conditions. The STAI Trait scale (tT) exhibited weak correlations with any of the STAI State scales (t1 and t2) as well as the ASA scales (PT1 and PT2). As expected, t1 and t2 showed strong correlation with each other in both conditions. This is also observed for PT1 and PT2 across conditions.

Table 5.14

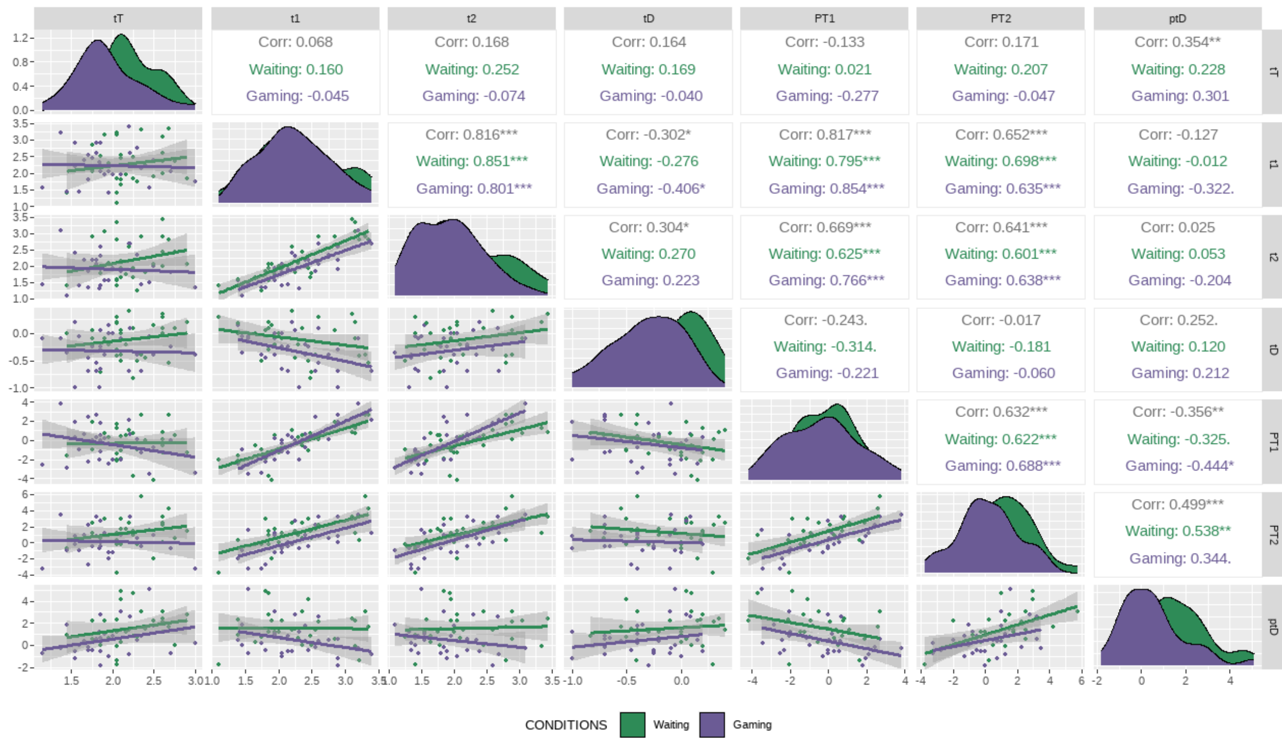
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI) Scale and Acute Stress Appraisal (ASA) Scale

Waiting	tT	t1	t2	tD	PT1	PT2	ptD
tT	-	0.026	0.064	0.029	0.000	0.043	0.052
t1	0.160	-	0.724	0.076	0.632	0.487	0.000
t2	0.252	**0.851**	-	0.073	0.391	0.361	0.003
tD	0.169	-0.276	0.27	-	0.099	0.033	0.014
PT1	0.021	0.795	0.625	-0.314	-	0.387	0.106
PT2	0.207	0.698	0.601	-0.181	**0.622**	-	0.289
ptD	0.228	-0.012	0.053	0.12	-0.325	**0.538**	-
Gaming	**tT**	**t1**	**t2**	**tD**	**PT1**	**PT2**	**ptD**
tT	-	0.002	0.005	0.002	0.077	0.002	0.091
t1	-0.045	-	0.642	0.165	0.729	0.403	0.104
t2	-0.074	**0.801**	-	0.050	0.587	0.407	0.042
tD	-0.04	**-0.406**	0.223	-	0.049	0.004	0.045
PT1	-0.277	0.854	0.766	-0.221	-	0.473	0.197
PT2	-0.047	0.635	0.638	-0.06	**0.688**	-	0.118
ptD	0.301	-0.322	-0.204	0.212	**-0.444**	0.344	-

Note: Values on the left is the r score and the right is the $r^{2.}$ Bold values shows are significant, $p<0.05$

Figure 5.9

Scatterplot Matrix for State Trait Anxiety Inventory (STAI) Scale and Acute Stress Appraisal (ASA) Scale by Conditions



5.2.3 Feedback on Playing Digital Games (Qualitative Questions)

We also collected information on gaming experiences. Participants were asked to list the games they have played in the last four weeks and the frequency of playing those games. Additionally, we also asked their general opinion of playing games before performing the task. Out of 61 participants, two participants from the Waiting condition did not respond to the questions, resulting in 59 responses. In total, eighteen participants in the Waiting condition indicated that playing games would help them before performing the task, while eighteen participants in the Gaming condition felt the same. Several participants reported they do not play game generally. Specifically, eight participants from the Waiting condition and five participants from the Gaming condition stated that they do not play games generally. Three participants from the Waiting condition felt that playing game would not helpful, two did not provide any answer and three said that playing game would help. While two participants in the Gaming condition felt that the game helped and the others did not feel it helped at all. However, please note, the experimental data are still included as it did not affect the result. Complete result can be seen from Appendix U.

Nineteen participants answered "No" for question on "Do you think playing games in general is helpful to play before the task?" with 8 participants from each condition. A simple thematic analysis was conducted following (Braun & Clarke, 2006) approach, which involves identifying, analysing, and reporting pattern (themes) within qualitative data was conducted from the responses received. The general sentiments are that playing games are viewed as positive and negative. This is summarised in Table 5.15.

Some of these sentiments are described using the same words or terms such as distraction. The word distraction was used to describe distraction from performing the task, that is they were not able to prepare and concentrate on the task (interview) that they were about to perform. On the other hand, distraction was also used to describe being distracted from the task, that is task is causing them stress. This distraction is viewed as positive as it takes their mind from the negative thought or emotion they are feeling.

Table 5.15
Views on Playing Games Before Performing the Task.

Positive	Negative
Relaxing, calming and manage Stress, tension, anxiety, nerve and overthinking	Distressing and increased stress
Confidence	Nervous
Fun	No added value
Distraction from negative thoughts	Distraction from the task
Forget away task	Forget the task
Focus away from task	Focus on task
Concentrating from events	Concentrating on events

Based on the feedback provided, several themes emerged:

Games and Stress Reduction:

Many participants reported that playing games helped them manage stress by offering a distraction from their worries. For some, games provided a temporary escape from stressful thoughts, allowing them to focus on the game rather than their upcoming task. This was particularly noted when individuals described feeling calmer and more focused after engaging with a game. Games appear to offer a form of mental relaxation, helping to ease tension and provide a sense of calm before high-pressure situations.

Games as a Distraction:

While some found that games helped them stay calm, others noted that this distraction could have mixed effects. Games were reported to help participants clear their minds and relieve stress, but they also sometimes caused individuals to forget important points they had planned to discuss. This suggests that while games can be beneficial for reducing immediate stress, they may also divert attention away from preparation tasks, potentially leading to a loss of focus.

Game Type and Enjoyment:

The effectiveness of games in managing stress seemed to be influenced by personal preferences and the nature of the game. Participants who enjoyed the game or its music reported feeling more relaxed and less anxious. Conversely, those who disliked the game or found it stressful experienced less benefit. For example, music elements within games were mentioned as particularly soothing when participants liked the songs, but not when they did not.

Game-Based Preparation:

There was also feedback indicating that specific types of games, such as math-based games, might be more beneficial for mental preparation. Participants suggested that such games could help "warm up" their brains or practice problem-solving skills relevant to tasks like interviews. However, some participants remained unsure about the overall impact of games on task performance and preparation.

Impact on Performance:

Despite the stress relief noted by many, some participants experienced difficulties with remembering their preparation and felt that the game might have negatively impacted their ability to focus on the task. This suggests a potential trade-off between stress relief and task preparation, where the distraction provided by games might interfere with mental rehearsal and focus on task-specific details.

5.3 Discussion

The purpose of this study is to measure the effect of digital games on acute stress levels and determine whether games can have a differential effect on stress relief when performing a stressful task. The tasks involve performing a presentation for a mock job interview followed by a mental arithmetic test. We hypothesised that participants who played the game (Gaming condition) would experience stress relief compared to participants who were not doing anything at all (Waiting condition). The result analysis supported our hypothesis. We observed a reduction in stress for both conditions, but it was higher in the gaming conditions, however, further analysis indicated that the decrease in stress for participants who played games is significant compared to those who just waited. This seems to imply that playing games may alleviate stress, but it could also indicate that the waiting condition had a less positive or even negative effect on stress levels.

We also observed that the Trait score for participants in the Waiting condition was slightly higher compared to participants in the Gaming condition. Therefore, we measured the effect of STAI Trait as potential confound on the change of stress. The t-test test showed a significant difference in trait scores between the two conditions. Correlation analysis also showed only a small correlation between trait score and the change in stress, and further analysis using simple linear regression showed that there was no significant effect of Trait on the change in stress.

Conversely, the analysis on the second stress scale, ASA showed, an increase in the stress appraisal. Notably, participants in the Gaming condition displayed a lowered Threat appraisal compared to the Waiting participants. Further analysis showed there is a significant decrease in stress over time, which supports the finding with STAI. Similar to the STAI, we also analysed the effect of trait on the threat score, and we found traits have a significant effect on Threat. This is contrary to what we found between Trait and State scores found in STAI.

Several key points to highlight are firstly, the ASA scale is the measure of the participant' reflected perception of the stressfulness about the tasks itself rather than the immediate perception of stress. Secondly, the post-task measure with ASA was taken after the completion of the task, unlike the second STAI measure which was taken immediately before the task. These factors suggest that the post-task ASA is not a measure of immediate stress but rather a reflection of the task itself as a stressor. Given that the ASA scores increased from before to after the task, it suggests that participants may have been underestimating the stressfulness of the task to how they experienced it. Alternatively, they might have been under-reporting ahead of the task as a coping mechanism to manage their apprehension about performing the task. Nonetheless, the fact that the post-task appraisal of stress is higher provides further support that the task is indeed an effective stressor.

The pre-task ASA, however, does serve as a reliable measure of acute stress in anticipation of the task. It is reassuring to observe that it correlates with the STAI pre-task scores. This correlation provides confidence that both scales, despite their differences, accurately capture the acute stress experienced by participants.

In some interpretations, the ASA post-task is considered a trait response to stress (Mendes et al., 2007). However, since it does not correlate with STAI trait stress, this interpretation does not seem to be supported. Instead, because the ASA post-task correlates with both STAI state measures (t1, t2), it suggests that the ASA post-task is also a measure of acute stress. This disparity in interpretation may stem from differences in the contexts of previous work, such as variations in study design and whether participants had longer-term stress-related issues.

Furthermore, the STAI trait measure did not correlate with any of the acute stress measures (STAI pre, STAI post, or ASA pre). This suggests that trait stress was not a significant influence on how people responded to the task as a stressor. As a result, it reduces the risk that trait stress of participants is a confound for this experimental design.

Overall, the results suggest that playing a game may help reduce stress compared to simply waiting, but it is also possible that the waiting condition contributed to maintaining or increasing stress levels. Therefore, these findings suggest a potential benefit of games for managing everyday stress, but the results have some limitations.

This experiment also provides important considerations for using this experimental protocol in further studies. Firstly, we found that STAI State and ASA effectively capture pre-task stress, but the post-test results were more intricate and nuanced. Secondly, the task was successful in achieving the desired effect of manipulating stress levels. It is important to note that Trait does not pose as a potential confound in this experiment.

From the qualitative analysis, we also gleaned into their sentiments on playing games. Generally, participants viewed playing games before performing a task as either negative or positive. Those who viewed playing game as positive feels that games help them to relax and take their minds from negative thoughts. On the other hand, those who viewed them as negative, said that playing game take from away from preparing for the task. The outcome of this analysis is interesting because first, it highlights the different perceptions of games, secondly, the different ways people cope under stressful conditions, thirdly, the how each person confronts stressful situations. In one view, playing game takes their mind away from the stressor and give them the time to recuperate, whereas some wishes to confront the stressors, by focusing on in and in this instance by thinking and preparing for it.

There are several limitations to the study that we aim to address for other experiments to enhance their validity. Firstly, the gaming experience was occasionally interrupted by advertisements. While this scenario reflects the reality of many commercial off-the-shelf games and players' experiences, it poses a challenge when using such games in experimental studies. One potential improvement would be to exercise tighter experimental control over the game used. However, this approach carries the risk of compromising the high production qualities that players typically enjoy. Balancing these factors will be crucial in designing future experiments to ensure both experimental rigour and participant engagement.

Secondly, people who were in the Waiting condition could amuse themselves with other things to do such as walking around the room they were in and looking out of the window. These might have been stress-reducing strategies for some of the participants. However, the opposite is also true, some participants might have experienced the waiting time as boring and were unable to relax, which could have affected the results accordingly.

Therefore, there is a need for a more controlled environment without any distractions such as having them wait in an empty or windowless room.

To address this, another approach would be to have participants in the control condition play a game-like task that requires their attention but lacks the key gameplay features that may contribute to stress relief, such as immersion or engagement. This would help control for the effects of general task engagement or distraction, isolating the specific impact of the game's therapeutic elements. An example of this is the simple button-clicking task used in Jennett et al. (2008).

The TSST (Trier Social Stress Test) was selected as the task for this study from a range of known stressful tasks. While the TSST is specifically designed to induce stress that includes physiological responses such as cortisol release, this study focuses solely on subjective psychological stress measures. As discussed in Section 2.6.2, psychological and physiological stress are related but distinct components of the stress experience. Psychological stress refers to how individuals perceive and appraise stressors, whereas physiological stress involves biological responses that may not always correlate with subjective reports. Given the complexity and potential confounds involved in measuring physiological stress (e.g., cortisol variability influenced by biological and contextual factors), focusing on subjective stress measures aligns directly with the research aims. The observed increase in stress levels, as indicated by STAI and ASA scores, supports the effectiveness of the TSST in inducing psychological stress. Furthermore, the TSST represents a stressor somewhat reflective of real-world tasks, providing useful insights into stress responses in everyday-like situations.

One issue that needs to be addressed is the lack of consistency between the two measures, the STAI and ASA scales. The STAI measures the affective response to stress, capturing general feelings or emotions induced by stress. Participants rate descriptions of how they are feeling at a given moment, such as "I feel calm", "I feel secure", and "I feel jittery". In contrast, the ASA scales focus more on the cognitive response to stress, assessing participants' perceptions of the task itself. Questions on the ASA scale pertains to the task's demands and uncertainties about performance, such as "The task is very demanding" or "I am uncertain about how I will perform during the upcoming task".

This lack of consistency stems from the inherent complexity of the stress concept, as previously discussed. It may be beneficial to consider the aspect of stress being measured when selecting stress measures, whether it is cognitive, affective, or behavioural in nature. This approach could help ensure a more comprehensive understanding of participants' stress responses in future studies.

Despite the identified weaknesses, we obtained results that align with previous research findings, indicating that games can indeed be beneficial for alleviating day-to-day stress.

6. Experiment 2: Self-paced Casual Game for Acute Stress

There is evidence in the literature, as well as the result from the first experiment suggesting that playing digital games may help alleviate stress and anxiety. We found a significant reduction in stress for participants playing the game compared to participants who were doing nothing.

This reduction is consistent with research such as Russoniello et al. (2009), which reported that casual games are effective at improving mood and decreasing stress. While both their findings and ours indicate the potential for games to support mental wellbeing, but they do not explain the mechanism behind this effect. Several researchers have proposed explanations for how games may support well-being, for instance, Tyack et al. (2020) post-experiment interviews indicate that video games are seen to support competence relative to perceived skills, based on the Self-Determination Theory.

Several researchers have investigated other aspects of game experiences to support wellbeing. For example, in the literature, we discussed how Fish et al. (2018) compared the use of Casual Video Games and Medication to reduce anxiety symptoms, in particular, looking at flow. They found playing games reduces anxiety immediately and when the anxiety that the player experiences move to flow, especially when the level of skill matches with the skill required to play the game. Additionally, the survey studies described in Chapter 3, showed that there is a positive correlation between perceived stress and the immersion.

Building on these, we designed the current experiment to measure the effect of immersion on anxiety induced by stressful events. Immersion refers to the degree to which players are deeply engages, absorbed, and focused during a gameplay (Jennett et al., 2008). This was further elaborated as the degree to which players are involved in different aspects of the game that causes their attention, awareness, and thoughts to move from the real world around to events occurring within the game (Cairns et al., 2016). Using the experimental design described in in Chapter 4 i.e. the adapted TSST, and due to the significant effect observed in Experiment 1, we aimed to investigate the effect of immersion on alleviating anticipatory stress or anxiety.

It is important to note that throughout this thesis, stress is treated as the overarching construct, and we use state anxiety as a validated measure of short-term psychological stress. While the stressor in this experiment involves anticipation rather than actual task performance, this paradigm reliably elicits elevated state anxiety, which reflects participants' stress response.

The main objective of this experiment was to explore the effect of immersion on stress. The experiment will compare the changes in state anxiety after playing low-immersion or high-immersion games. We hypothesise that participants in the High-Immersion group will experience a significant reduction in state anxiety compared to those in the Low-Immersion group.

6.1 Methodology

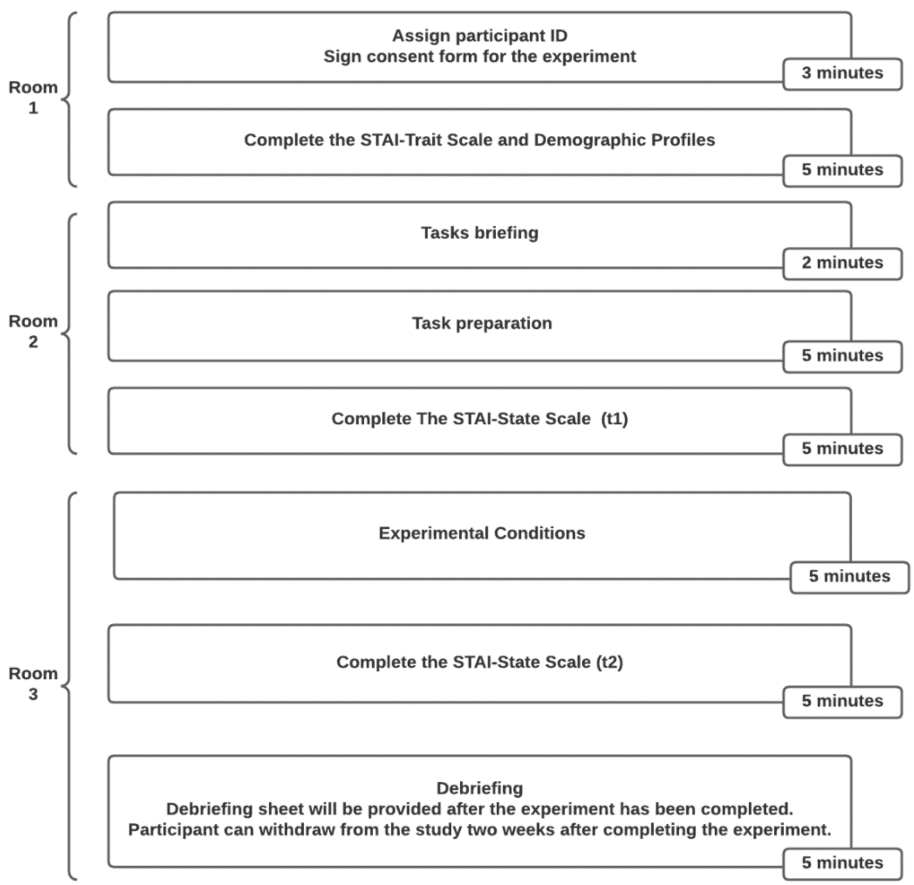
6.1.1 Design, Procedures and Materials

The design and procedures of this experiment adhere to the protocol outlined in Chapter 4 which is the adaptation of the Trier Social Stress Test (TSST). The adaptation of the TSST induces anticipatory stress or anxiety. Based on the findings of the first experiment, it was observed that the protocol effectively induces psychological stress responses or anxiety as early as the briefing stage, even before the actual task performance. In particular, there was a significant change in stress over time during this anticipatory stress, which aligns with Pulopulos et al. (2020) description of anticipatory stress – a kind of anxiety triggered by the expectation of a potential stressful event.

The procedure involves removing the actual tasks performance. Instead, participants were led to believe that they would be performing the job interview and mental arithmetic tasks. The experiment ended after they had completed the post-intervention surveys, without any tasks being carried out. This design isolates the anticipatory phase of the stress response, allowing us to focus on the anxiety elicited by the anticipation of stressful event. The total time to complete this experiment was shorter compared to the full protocol used in Experiment 1. The adapted protocol is depicted in Figure 6.1.

In this experiment, there are two conditions: Low Immersion and High Immersion conditions. Participants were randomly assigned to one of the two conditions. In the Low Immersion condition, participants played a simplified version of the game used in this experiment, while participants in the High Immersion group will play the same game but designed to be highly immersive compared to the low immersion game. The study followed a 2 x 2 mixed-measure ANOVA experimental design. The independent variables were the experimental conditions and the time points at which stress was measured, and the dependent variable was the STAI scores as a measure of stress.

Figure 6.1
Adapted Trier Social Stress Test (TSST) Protocol to Measure Anxiety Induced by Stressful Event



6.1.2 Measures

In this study, we employed three scales: The State-Trait Anxiety Inventory (STAI), the Immersive Experience Questionnaire - Short Form (SF-IEQ), and the Game User Experience Satisfaction Scale (GUESS-18). Similar to Experiment 1, we used the STAI scales to assess both anxiety trait and state anxiety scores. However, we chose not to include the ASA scale, as it primarily measures stress related to specific tasks performed during the experiment. Since our study does not focus on measuring tasks or the experimental protocol.

To gauge participants' levels of immersion in the games they played and to determine if the games they played could induce the level of immersion for each of the games that were designed, we employed the Immersive Experience Questionnaire - Short Form (IEQ-SF).

The IEQ-SF is a short questionnaire designed to measure player experience following a game play session that can be completed in approximately a minute. The scale is based on a 5-point Likert scale system of response. IEQ-SF consists of 11 items from the original IEQ, where 1 corresponds to “Strongly Disagree”, and 5 is “Strongly Agree”. The questionnaire structure is split into 3 factors: Involvement, Real World Dissociation, and Challenge. Involvement is the degree of involvement from cognitive and emotional facets during gameplay.

Additionally, the Game User Experience Satisfaction Scale (GUESS-18) was adopted to evaluate other aspects of the experience of playing digital games The Game User Experience Satisfaction Scale (GUESS-18) is a tool used to measure user satisfaction with video games. It assesses various aspects of the gaming experience, including usability, enjoyment, immersion, and overall satisfaction. The scale consists of 18 items, hence the name "GUESS-18," and respondents rate each item on a Likert scale, typically ranging from 1 to 7 or 1 to 5, depending on the version used. The Game User Experience Satisfaction Scale (Guess-18) was previously used in the second study. A detailed description of the scale can be found in Chapter 3.

6.1.3 Games Selection

For this experiment, we used a cloned version of the game called Two Dots, which is a simple, self-paced casual game. Two Dots is a simple self-paced puzzle game. The game is played by connecting dots to complete a pattern.

This game is adapted from research on video games and attention (Cutting et al., 2020; Cutting & Cairns, 2022). They developed the game to investigate if players could recall game features when they are highly immersed in a game. They developed two variations of the game to measure the effect against the low immersion game. The cloned version has been stripped of additional features that are typically found in commercial games. This allows greater control over the participants' experiences during gameplay which was one of the issues we encountered in the first experiment. It was challenging to ensure that participants played only the assigned song, and control the presence of other artefacts, such as advertisements. One important aspect of using the cloned game is whether it is able to induce the desired immersive effect. Cutting & Cairns, 2020 found the games they built were able to induce the intended levels of immersion. Therefore, with their permission, it made sense for us to use the already-built game in this experiment.

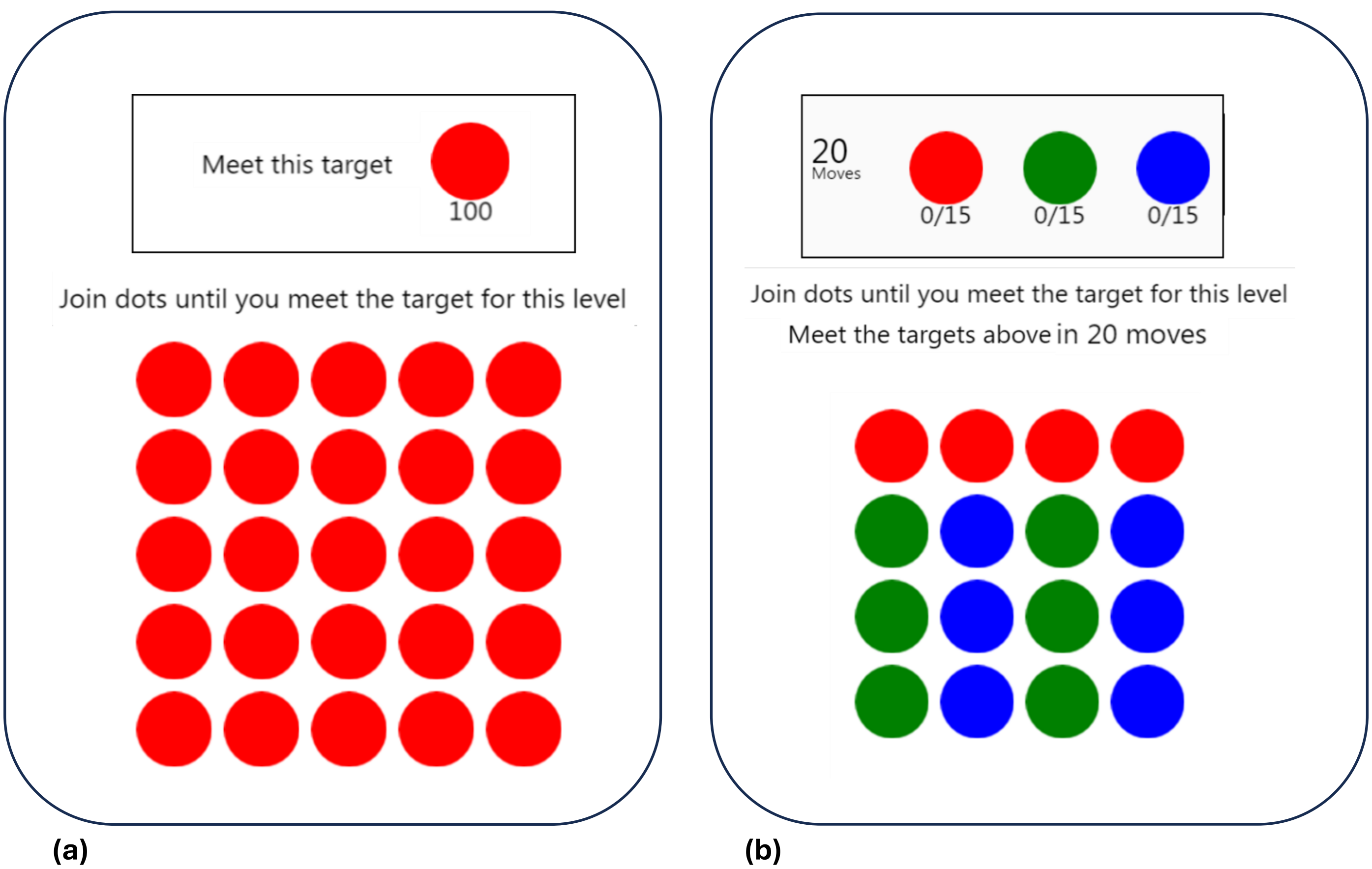
In the High Immersion game, players were required to connect more complex dots, with three different colours. Dots of the same colour had to be matched to complete a target, and a new set of dots appeared once the target was achieved. The difficulty level increased as the stages progressed, and these highly immersive games were engaging and included multiple colours and achievement targets. The games also include a one-minute practice round before commencing with the actual round.

Figure 6.2(a) shows the screen for the Low Immersion game. Players simply need to connect the dots in a single motion until they reach the target, which is normally 25 dots per page. Initially, participants had an overall target of 100 dots to complete. Once they reached this target, a new set of 25 dots appeared, maintaining the same target amount for each subsequent iteration. This process continued iteratively for five minutes. The time was hidden from the player to avoid unnecessary tension or creating any challenge in the game. This game was designed with no levels, the dots are all single-coloured, and no additional challenges.

The High Immersion game also has the same objective, which is to connect the same-coloured dots until they reach the target. However, there are more than one colours, and the number of movements are limited. Figure *6.2*(b) shows the screen for High immersion game. Similarly, this game also runs for five minutes but the timer was hidden from players to avoid additional challenges to the game.

Figure 6.2

Two Dots Game (a) Low Immersion Variant (b) High Immersion Variant



6.1.4 Participants

All participants were staff and students from the University of York. They were convenience samples recruited through posters distributed across campus and social media postings. Recruitment efforts encompassed both physical advertisements on campus and digital promotions via social media channels such as Discord, Facebook, and Reddit. The posters and flyers used for recruitment contained pertinent research details along with a link to the online booking system. This system facilitated the creation of individual appointment slots and provided information regarding the experiment's location. Each participant was given £10 Amazon voucher for their participation. Inclusion criteria comprised of individuals who were (1) aged 18 and above, (2) free from mental health issues, and (3) had not participated in Experiment 1. Each participant received a £10 Amazon voucher as compensation. Random allocation was employed to assign participants to either the Low Immersion or High Immersion Group.

The experiments were piloted for each condition. Overall, there were 62 participants; however, only 61 participants were included in the analysis. One participant withdrew after the task briefing was given citing fear of doing presentation. The participants were 33 females, 25 males, and two who identified as non-binary. Among them, 57% were between the ages of 18 and 24, and 37% were between 25 and 34. The age of the participants ranged from 18 to 44, with an average (M) of 23.42 years and a standard deviation (SD) of 4.60 years. The complete demographic profile is shown in Table *6.1*.

Table 6.1
Demographic Analysis of the Research Sample

		Low Immersion		**High Immersion**		**All**	
		n	**%**	**n**	**%**	**n**	**%**
Age	18 - 24	24	39	22	36	46	75
	25 - 34	7	11	6	10	13	21
	35 – 44	0	0	2	3	2	3
Gender	Male	19	31	17	28	36	59
	Female	12	20	12	20	24	39
	Non-binary	0	0	1	2	1	2
Employment	Unemployed	2	1	0	0	2	3.28
	Student	25	41	28	46	53	86.89
	Full-time employment	3	5	2	3	5	8.2
	Part-time Employment	1	2	0	0	1	1.64

6.2 Results

The main hypothesis of the experiment was that participants in High Immersion conditions will experience a significant reduction of state anxiety compared to participants in Low Immersion condition. To assess the impact of playing digital games on state anxiety, we analysed the STAI scores, followed by the levels of immersion and the game user satisfaction experience.

6.2.1 State-Trait Anxiety Inventory Scale (STAI)

STAI State

STAI State Change

The mean and standard deviation for the STAI State for both conditions were calculated, as well as the STAI State Difference (tD), as shown in Table 6.2. Figure 6.3 displays the boxplot of the STAI State scores for both conditions. The results indicate a decrease in the anxiety score across conditions, with participants in both conditions experiencing a small reduction in stress. Figure 6.4 illustrates the change in STAI State in both conditions.

STAI State Induction Validation

Similar to Experiment 1, a one-sample t-test was conducted on the post-induction STAI State scores to determine whether they were significantly higher than expected non-anxiety values which is approximately 2 (i.e. "Somewhat"). The sample mean STAI state score was 2.28 (SD = 0.52). The t-test revealed a significant elevation in state anxiety, $t(60) = 4.10$, $p < 0.001$. This suggests that the stress induction effectively elevated anxiety in the experiment.

Table 6.2
State-Trait Anxiety Inventory Scale (STAI) State Scores t1, t2 and tD Mean and Standard Deviation (SD) by Conditions.

Conditions	STAI State t1		STAI State t2		STAI State Difference tD	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Low Immersion	2.21	0.49	1.91	0.37	-0.30	-0.12
High Immersion	2.34	0.56	1.99	0.45	-0.35	-0.11

Figure 6.3

The Box Plot of State Trait Anxiety Inventory (STAI) State Scores by Conditions.

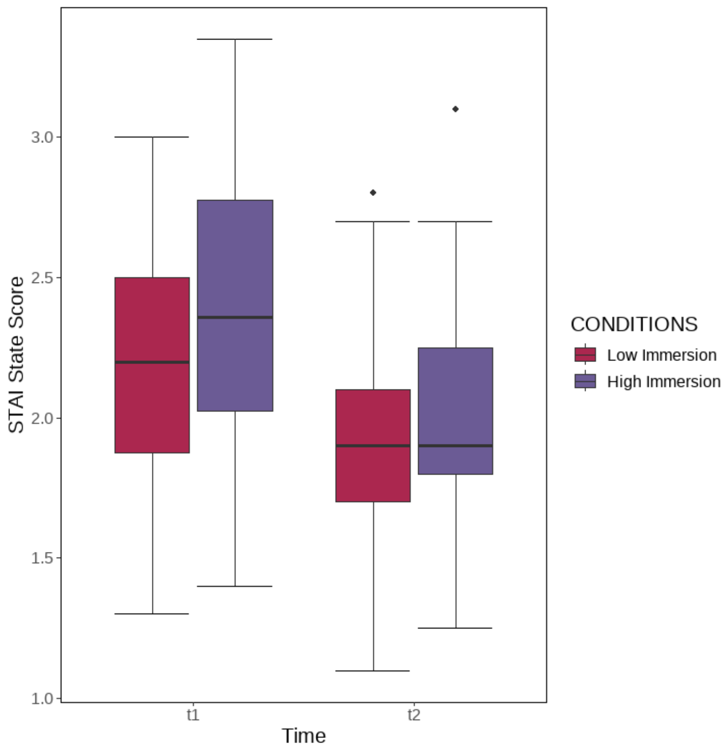
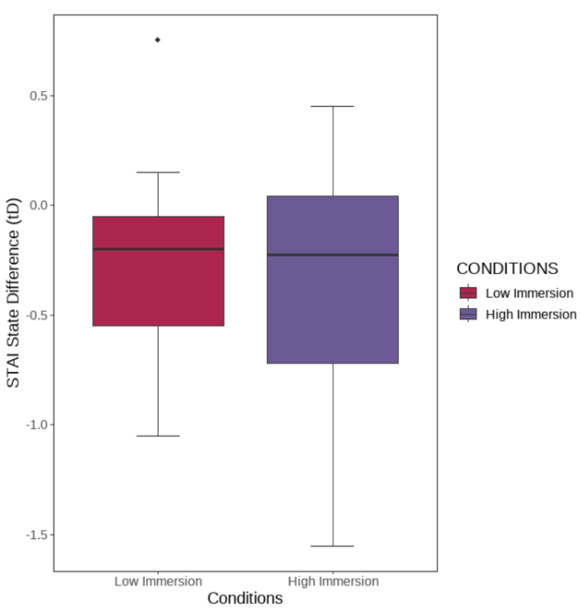


Figure 6.4

The Boxplot for State Trait Anxiety Inventory (STAI) State Score Change for the Two Conditions.



Using a 2 x 2 mixed-measures ANOVA on the STAI State score across the two conditions, we found a significant effect of Time [$F(1, 58) = 28.53$, $p < 0.001$]. However, there was no significant effect for Conditions [$F(1, 58) = 1.06$, $p = 0.31$], nor for the interaction between Conditions and Time [$F(1, 58) = 0.21$, $p = 0.65$] (Table 6.*3*).

Table 6.3
Between-Group Comparisons for the State Trait Anxiety Inventory (STAI) State Scores

Interactions	F(1,58)	Sig (p-value)	Effect size (ges)
Conditions	1.06	0.308	0.013
Time	28.53	**<0.001***	0.112
Conditions X Time	0.21	0.652	0.001

A paired samples t-test conducted on t1 and t2 revealed a significant difference for the Low Immersion condition, with $t(30) = 3.44$, $p < 0.001$* as well as for the High Immersion condition $t(29) = 4.44$, $p = 0.002$* (Table 6.4).

Table 6.4
Paired t-test Between Low and High Conditions

Conditions	n	df	t	p
Low Immersion	31	30	3.44	< 0.001*
High Immersion	30	29	4.44	0.002*

Note: Bonferroni test

STAI Scales Correlation

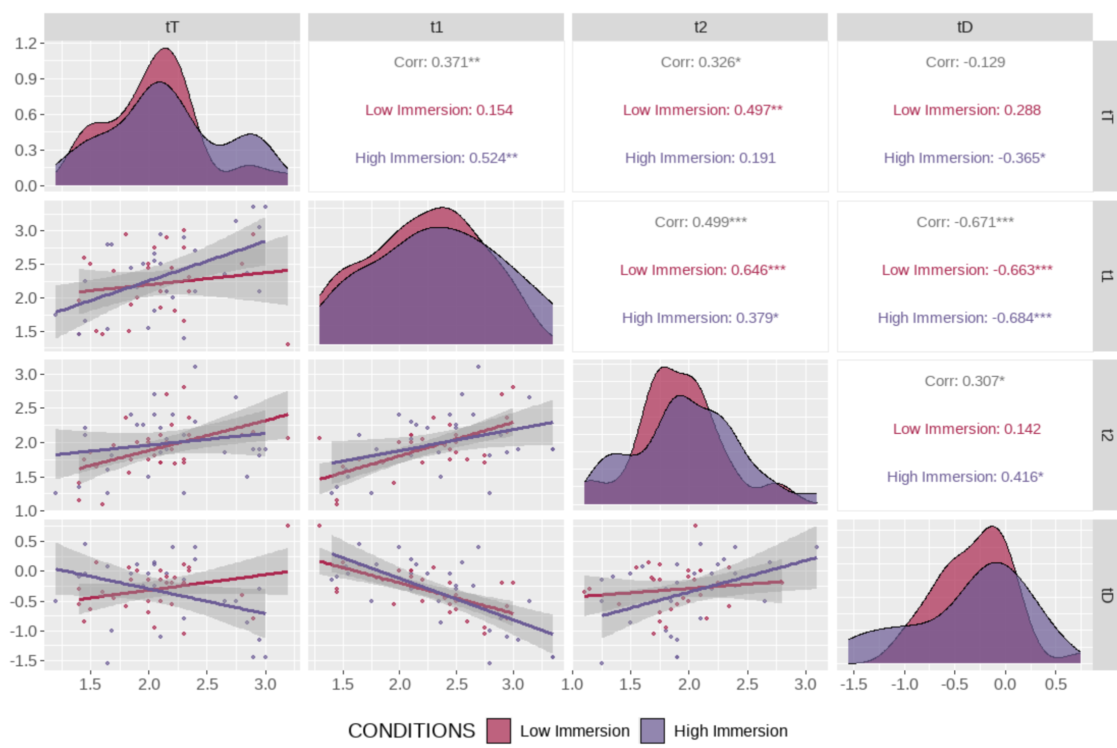
Using the Pearson Correlation Coefficient, we also calculated the correlations between the STAI Scales. Table 6.5 and Figure 6.5 show the results across the two conditions. The results are inconsistent between the two conditions. Results for the same scales are not consistent, for instance, the correlation for tT and t1 for Low Immersion $r = 0.15$ which is small, but it is Moderate for High Immersion $r = 0,52$. This can be seen for tT and t2, t2 and tD as well as t1 and t2.

Table 6.5
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI) Scales.

Low Immersion	**tT**	**t1**	**t2**	**tD**
tT	-	0.02	0.25	0.08
t1	0.154	-	0.44	0.20
t2	**0.497**	**0.646**	-	0.42
tD	0.288	**-0.663**	0.142	-
High Immersion	**tT**	**t1**	**t2**	**tD**
tT	-	0.27	0.04	-0.13
t1	**0.524**	-	0.46	0.18
t2	0.191	**0.379**	-	0.14
tD	**- 0.365**	**-0.684**	**0.416**	-

Note: Values on the left is the r score and the right is the r^2. Values in bold are significant, $p<0.05$

Figure 6.5
Scatterplot Matrix for State Trait Anxiety Inventory (STAI) Scales by Conditions.



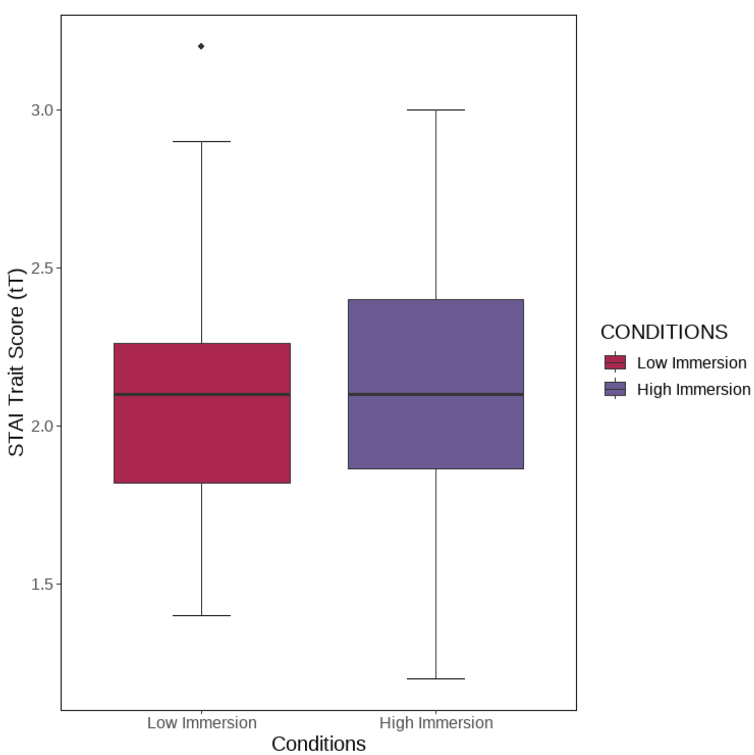
STAI Trait

STAI Trait, which is one of the confounding variables we considered, was also collected and analysed. Table 6.6 presents the mean scores of STAI Trait for the two conditions, while Figure 6.6 displays the boxplot of STAI Trait scores. The mean score for STAI Trait is slightly higher in the Low Immersion condition compared to the High Immersion condition.

Table 6.6
Mean and Standard Deviations for State Trait Anxiety Inventory (STAI) Trait

Conditions	Mean	Standard Deviation
Low Immersion	2.15	0.50
High Immersion	2.06	0.42

Figure 6.6
The Boxplot of State Trait Anxiety Inventory (STAI) Trait by Conditions



To see if there is a systematic difference in STAI Trait between the two conditions, we used an independent two-sample t-test. Table 6.7 shows the results of the analysis. We found there is no statistically significant difference in the mean STAI Trait score between the Low Immersion score (M = 2.15, SD = 0.42) and High Immersion score (M = 2.06, SD = 0.50), where t (61) = 0.78, p = 0.44. The effect size for the difference is measured by Cohen's d, d = 0.20, suggesting that the observed differences are small (Table 6.7).

Table 6.7
t-test for State Trait Anxiety Inventory (STAI) Trait in the Low Immersion and High Immersion Group

	Low Immersion		High Immersion					
	M	**(SD)**	**M**	**(SD)**	***df***	**t**	***p***	**Cohen's *d***
STAI Trait	2.15	0.42	2.06	0.50	56.732	0.784	0.437	0.201

To confirm that there is no significant effect of tT and tD, we also calculated the linear regression between tT and tD. The results shown in Table 6.8 revealed that the covariate, STAI Trait has no significant effect on STAI State Difference, tD.

Table 6.8
State Trait Anxiety Inventory (STAI) Trait Linear Model Regression

Independent Variable	Estimate	t-Value	p-value
Trait	-0.13	-0.952	0.345
Conditions	0.04	-0.353	0.725

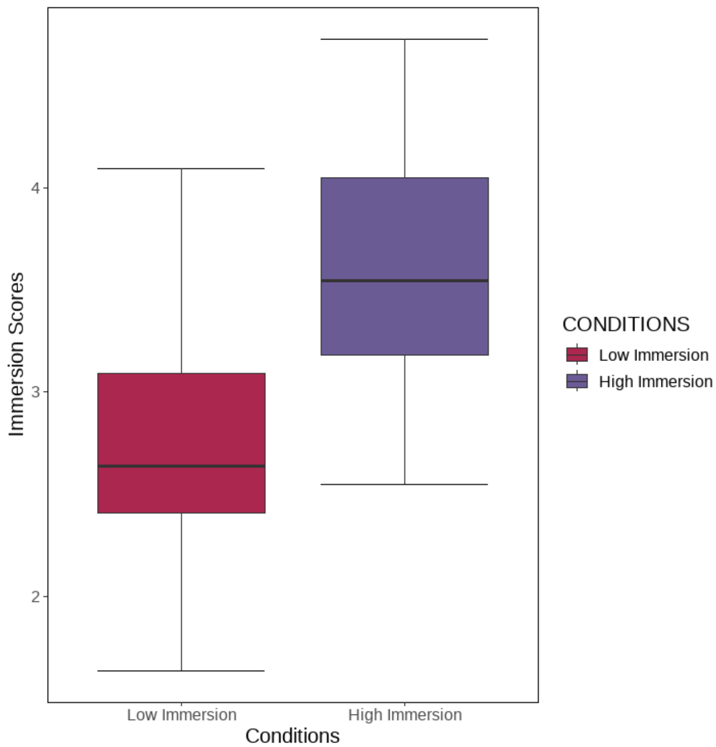
6.2.2 Immersion

We also analysed the Immersion and its effect on stress. Table 6.9 show the mean score between Low Immersion and High Immersion. The overall results show that a high mean score for the High Immersion game, M= 3.58, SD = 0,57 compared to the Low Immersion game, M = 2.76, SD = 0,51. Figure 6.7 shows the box plot for Immersion.

Table 6.9
Mean and Standard Deviation for Immersion

Conditions	Mean	Standard Deviation
Low Immersion	2.77	0.51
High Immersion	3.58	0.57

Figure 6.7
The Boxplot of Immersion for Low and High Immersion Conditions.



We conducted an independent two-sample t-test to examine if there is a significant difference in immersion across conditions. The results indicate that there is a significant difference in immersion across conditions (t (57.80) = 5.92, p < 0.001) (Table 6.10).

Table 6.10
Two Sample t-test for Immersion by Conditions.

	Low Immersion		High Immersion					
	M	(SD)	M	(SD)	*df*	t	*p*	Cohen's *d*
Immersion	2.77	0.51	3.581	0.57	57.803	5.922	<0.001	1.520

Note: Welch Test

Correlation between STAI and Immersion

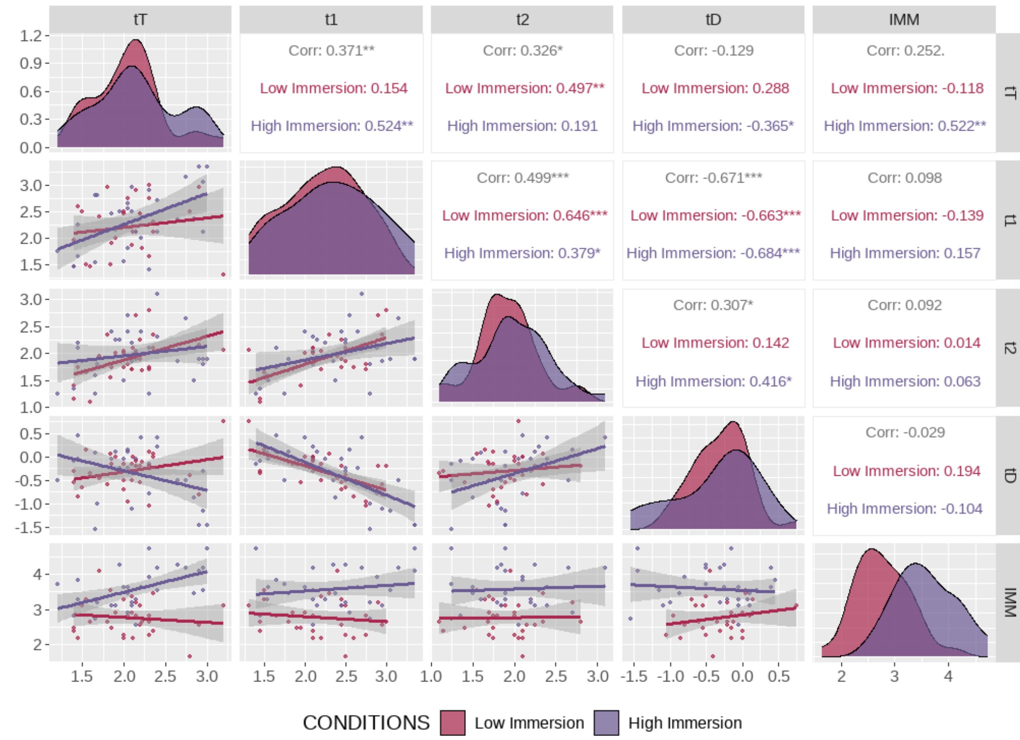
To see the effect of Immersion on stress, we conducted a correlation between STAI Scales and Immersion. Table 6.11 and Figure 6.8 summarises the results for the two conditions. Aside from tT and SIEQ for High Immersion which shows a moderate correlation r = 0.52. Other results do not show any correlation between the two variables.

Table 6.11
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI) Scales and Acute Stress Appraisal (ASA) Scale.

Low Immersion	tT	t1	t2	tD	SIEQ
tT	-	0.023	0.250	0.084	0.014
t1	0.154	-	0.423	0.436	0.020
t2	**0.497**	**0.646**	-	0.020	0.000
tD	0.288	**-0.663**	0.142	-	0.036
SIEQ	-0.118	-0.139	0.014	0.194	-
High Immersion	**tT**	**t1**	**t2**	**tD**	**SIEQ**
tT	-	0.270	0.036	0.130	0.270
t1	**0.524**	-	0.144	0.462	0.026
t2	0.191	**0.379**	-	0.176	0.004
tD	**-0.364**	**-0.684**	**0.416**	-	0.010
SIEQ	**0.522**	0.157	0.063	-0.104	-

Notes: Values on the left are the r score, the right are the r^2 scores. Values in bold are significant, $p<0.05$

Figure 6.8
The Scatterplot Matrix for State Trait Anxiety Inventory (STAI) Scales and Immersion by Conditions.



6.2.3 GUESS-18

We also measured other experiences of playing digital games in alleviating anxiety by using the GUESS-18. The scale measures participants' satisfaction with the usability or playability of the game, Narrations, Engrossment, Enjoyment, Creative Freedom, Audio, Personal Gratification, social connectivity and the visuals of the game.

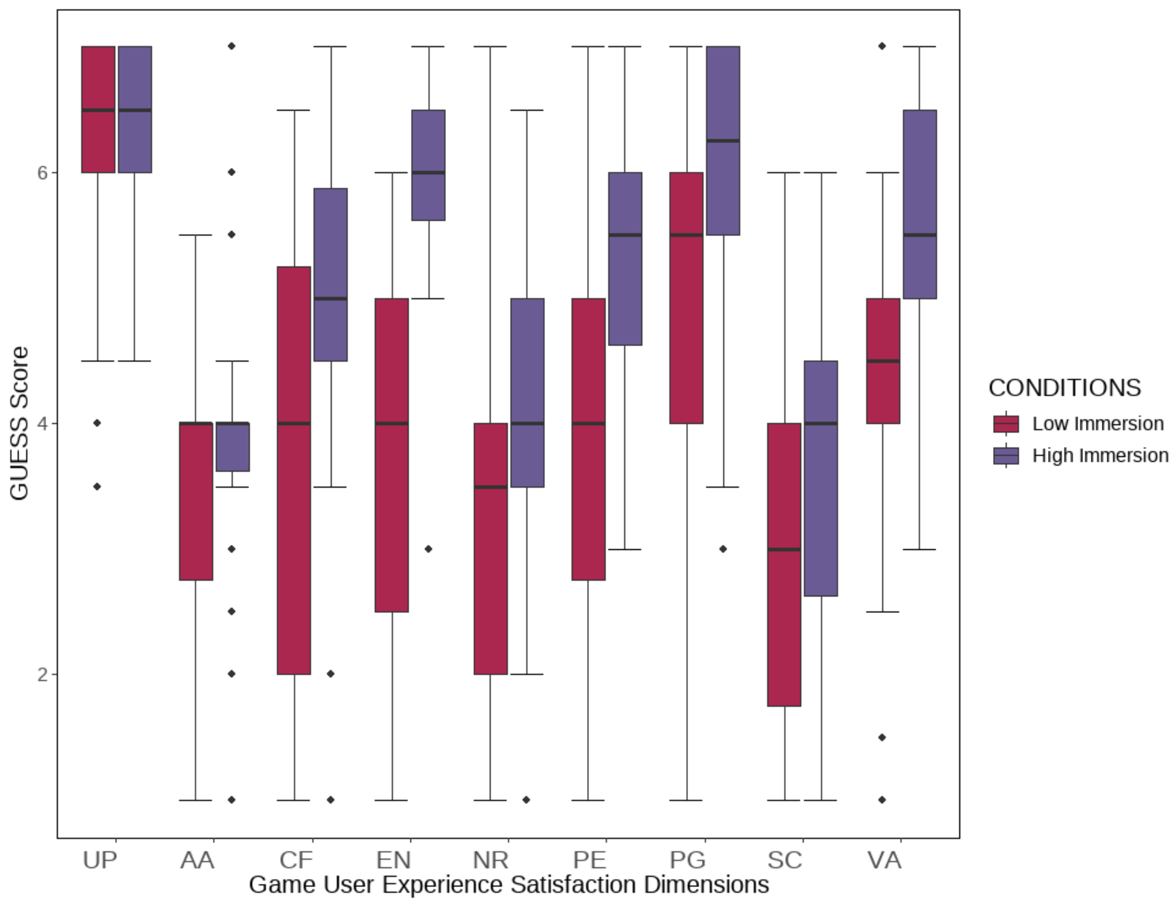
Table 6.12 summarises the mean and standard deviation for GUESS-18. Across the board, we can see that the High Immersion game scored higher compared to the Low Immersion Game for all the constructs. Figure 6.9 shows the box plot for GUESS-18 for both conditions.

Table 6.12
The Mean and Standard Deviation (SD) for Game User Experience Satisfaction Scale (GUESS-18).

GUESS-18 Dimensions	Code	Low Immersion		High Immersion	
		Mean	(SD)	Mean	(SD)
Usability/Playability	UP	6.16	0.94	6.37	0.79
Narrations	NR	3.18	1.58	3.90	1.52
Personal Engrossment	PE	3.98	1.51	5.33	1.13

Enjoyment	EN	3.81	1.57	6.03	0.82
Creative Freedom	CF	3.73	1.84	4.95	1.57
Audio Aesthetic	AA	3.43	1.28	3.77	1.35
Personal Gratification	PG	4.98	1.63	5.98	1.09
Social Connectivity	SC	3.06	1.49	3.60	1.46
Visual Aesthetics	VA	4.18	1.39	5.50	1.05

Figure 6.9
The Boxplot of Game User Experience Satisfaction Scale (GUESS-18) by Conditions



Two samples t-test

Two sample t-test was conducted an independent two-sample t-test to examine if there is a significant difference in game satisfaction across conditions. Table 6.13 summarises the results.

Table 6.13
Two Sample t-test for Game User Experience Satisfaction Scale (GUESS-18)

	t	df	p
Usability/Playability	0.924	57.765	0.359
Narrations	1.817	58.998	0.074
Personal Engrossment	3.961	55.603	< **0.001***
Enjoyment	6.962	45.461	< **0.001***
Creative Freedom	2.802	58.081	0.007
Audio Aesthetic	0.982	58.583	0.330
Personal Gratification	2.826	52.434	0.007
Social Connectivity	1.414	58.988	0.163
Visual Aesthetics	4.194	55.702	< **0.001***

Correlation between State Trait Anxiety Inventory (STAI) Difference and Game Satisfaction

We conducted Pearson correlation analyses to examine the correlation coefficients between the STAI Difference (tD) and GUESS-18. Table 6.14 displayed the correlations for both Low and High Immersion conditions.

Table 6.14

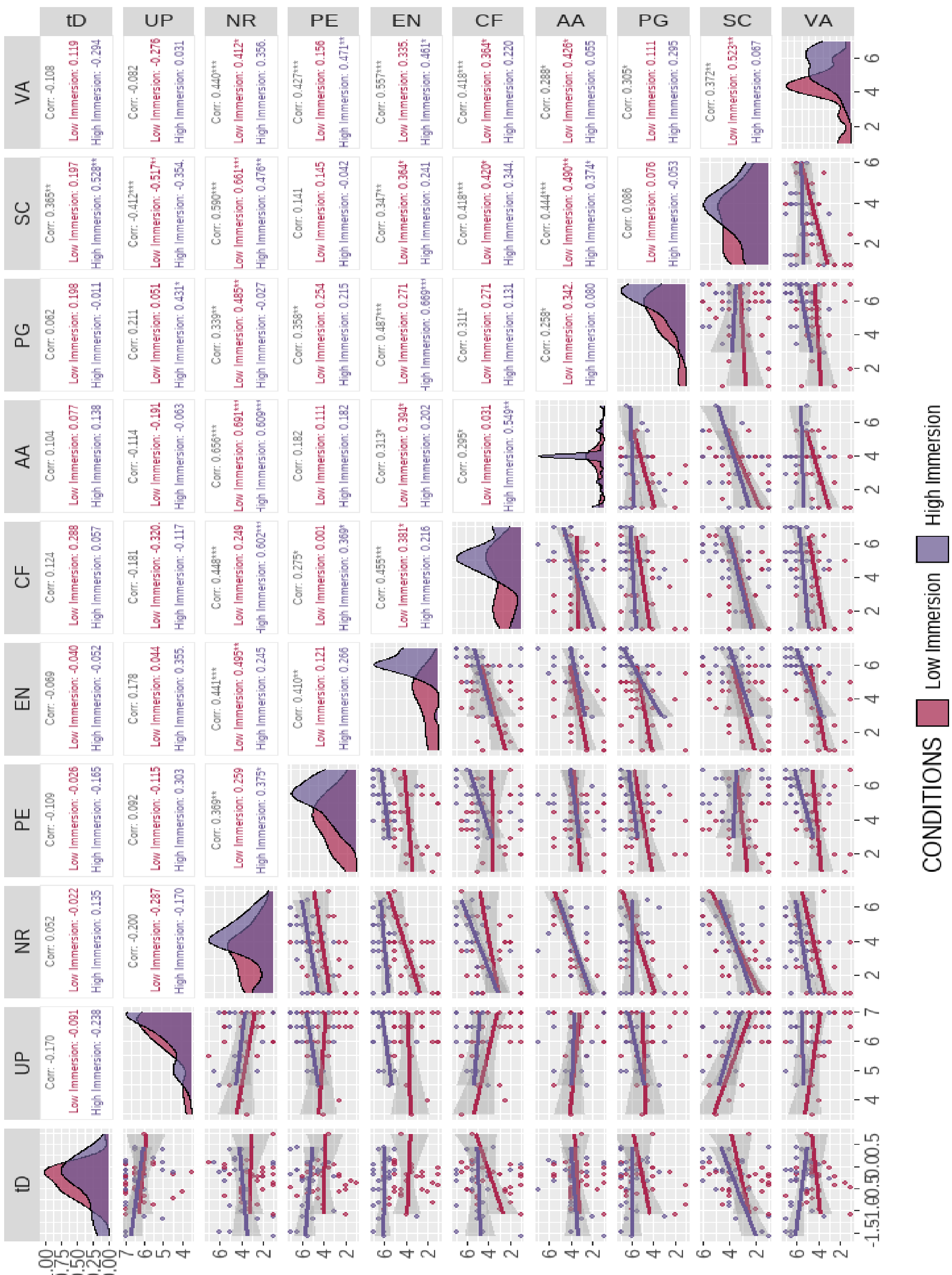
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI) State Change (tD) and Game User Experience Satisfaction Scale (GUESS-18).

Low Immersion	**tD**	**UP**	**NR**	**PE**	**EN**	**CF**	**AA**	**PG**	**SC**	**VA**
tD	-	0.008	0	0.001	0.002	0.083	0.006	0.039	0.039	0.014
UP	-0.091	-	0.082	0.013	0.002	0.102	0.036	0.003	0.267	0.076
NR	-0.022	-0.287	-	0.067	0.245	0.062	0.477	0.235	0.437	0.17
PE	-0.026	-0.115	0.259	-	0.015	0	0.012	0.065	0.021	0.024
EN	-0.04	0.044	**0.495**	0.121	-	0.145	0.155	0.073	0.132	0.112
CF	0.288	-0.32	0.249	0.001	**0.381**	-	0.001	0.073	0.176	0.132
AA	0.077	-0.191	**0.691**	0.111	**0.394**	0.031	-	0.117	0.24	0.181
PG	0.198	0.051	**0.485**	0.254	0.271	0.271	0.342	-	0.006	0.012
SC	0.197	**-0.517**	**0.661**	0.145	0.364	**0.42**	**0.49**	0.076	-	0.274
VA	0.119	-0.276	**0.412**	0.156	0.335	**0.364**	**0.426**	0.111	**0.523**	-
High Immersion	**tD**	**UP**	**NR**	**PE**	**EN**	**CF**	**AA**	**PG**	**SC**	**VA**
tD	-	0.057	0.018	0.027	0.003	0.003	0.138	0	0.279	0.086
UP	-0.238	-	0.029	0.092	0.126	0.014	-0.063	0.186	0.125	0.001
NR	0.135	-0.17	-	0.141	0.06	0.362	0.609	0.001	0.227	0.127
PE	-0.165	0.303	**0.375**	-	0.071	0.136	0.182	0.046	0.002	0.222
EN	-0.052	0.355	0.245	0.266	-	0.047	0.202	0.448	0.058	0.213
CF	0.057	-0.117	**0.602**	**0.369**	0.216	-	0.549	0.017	0.118	0.048
AA	0.138	-0.063	**0.609**	0.182	0.202	**0.549**	-	0.006	0.14	0.003
PG	-0.011	**0.431**	-0.027	0.215	**0.669**	0.131	0.08	-	0.003	0.087
SC	**0.528**	**-0.354**	**0.476**	-0.042	0.241	0.344	**0.374**	-0.053	-	0.004
VA	-0.294	0.031	0.356	**0.471**	**0.461**	0.22	0.055	0.295	0.067	-

Note: The left values are the r scores, right values are the r^2 scores. Values in bold are significant, $p<0.05$

Figure 6.10

Scatterplot Matrix for Game User Experience Satisfaction Scale (GUESS-18) by Conditions



6.3 Discussion

The main objective of this experiment was to investigate the effect of immersion on short-term state anxiety levels, specifically whether the level of immersion can have a differential effect on state anxiety relief. The experiment used the same protocol and measures as Experiment 1. Two variants of the same game were used: the High Immersion game and the Low Immersion game. The games were assigned according to their respective condition. We hypothesised that participants in the High Immersion condition would experience a significant decrease in stress compared to participants in the Low Immersion condition. However, the analysis did not support this hypothesis. We observed that both groups of participants in the High and Low conditions experienced stress reduction.

The analysis provided several key findings that provide insights into the relationship between immersion and state anxiety. The 2x2 ANOVA showed no significant difference in STAI scores between the Low Immersion and High Immersion conditions; however, a significant effect over time suggests that participants experienced changes in stress levels regardless of the immersion condition. The paired t-tests revealed significant results for both levels of immersion, indicating that both conditions effectively lower anxiety levels. Despite these significant effects, the lack of difference in effectiveness between the two conditions suggests that the level of immersion may not be a significant factor in lowering anxiety levels. This finding is contrary to our hypothesis, as the level of immersion in the gaming environment did not significantly impact on participants' perceived anxiety levels. This is somewhat unexpected, considering the prevalent notion that higher levels of immersion elicit stronger engagement compared to low immersion and when they are more immersed in playing the game, they are less likely to be engaged with the stressors. This also suggest that low level immersion is sufficient for lowering stress.

The trait score was also analysed to as a potential confound and affecting the state result. Using correlation analysis on the STAI scales we found there was no correlation between Trait and the change in anxiety, for both the Low and High Conditions. We conducted further analysis using the t-test; however, we found no significant difference in the trait scores between the two conditions. To confirm that there is no effect of Trait on the change of anxiety, we conducted a linear regression analysis on Trait and Change in Anxiety, and we also did not find a significant effect for Trait on both conditions.

We also performed a correlation analysis between STAI scales and the Immersion scale. We did not find any significant correlation between the change in anxiety and the level of immersion, which supported the initial findings, that there is no effect on anxiety regardless of the level of immersion.

In this experiment, we also explored other experiences of playing games by measuring the game use satisfaction scale, GUESS-18. The scale measures satisfaction by nine constructs: Usability, narratives, Engrossment, Enjoyment, Creative Freedom, Audio aesthetics, Personal Gratification, Social Connectivity, and Visual Aesthetics. Across the nine constructs, we found the mean scores to be higher in the High Immersion condition compared to the Low immersion condition. The t-test, however, suggests that the difference is significant in personal engrossment, enjoyment, and visual aesthetics. However, except for social connectivity in the High Immersion condition, there is no significant correlation between the change in anxiety and game satisfaction. One point to note is that the game was played individually; therefore, the social connectivity is perhaps what they feel if the game has social elements to it, such as playing as a team or playing online. While participants are satisfied with the game they played, there is no evidence that the game supports stress reduction.

Another observation concerned the level of involvement of participants in the assigned activities, which corresponded to their respective conditions. During the experiment, although not formally documented, a considerable number of participants informed the experimenter that they were practising their presentations while playing the game, especially within the low immersion condition. Consequently, in the next experiment, it would be better to introduce an additional question to gauge the level of engagement in the activity they were undertaking.

Overall, the study did not show a direct relationship between game immersion and perceived anxiety. Regardless of the type of game individuals play, they may experience anxiety reduction. It provides a distraction from the stressor regardless of the level of engagement. Which means that less intense activities should be able to reduce their anxiety. This suggests that is engaging in doing some activity that contributed to the anxiety reduction. This raises the question: do games truly aid in stress and anxiety reduction, or could other activities produce similar effects? Therefore, for the next experiment, it would be interesting to measure the effect of playing digital games compared to other activities rather than just playing digital games.

7. Experiment 3: Comparisons between Digital Games and Non-Game Activity

Experiments 1 and 2 have provided evidence that playing digital games can effectively lower stress and anxiety levels. In the first experiment, participants in the gaming condition experienced a significant decrease in stress compared to those in the waiting condition. Supported by the results observed in the survey studies, prompted the investigation into the specific effects of playing experiences, which is immersion, in the second experiment. Although the results of the second experiment also demonstrated a reduction in state anxiety levels, there was no significant difference observed between participants playing low-immersion and high-immersion games. This suggests that regardless of the level of engagement, participants experienced a decrease in state anxiety while engaged in the activity provided. Essentially, the specific game being played may not significantly influence state anxiety reduction; rather, the act of engagement itself appears to be the key factor in anxiety reduction.

To further understand this phenomenon, we conducted the third experiment to compare the effects of playing digital games with non-game activities. If indeed there is no significant difference between playing digital games and other activities in terms of anxiety or anticipatory stress reduction, it would lend support to the theory that engagement, rather than the specific nature of the activity, is the primary driver of anxiety reduction.

The main purpose of this study was to determine the effect of playing digital games and engaging in non-game activities in relieving state anxiety. There were three conditions in this study: participants in the playing digital games conditions were given either a high-immersion or low-immersion game, while participants in the non-game condition were assigned the word counting activity, where they counted the number of words in an article on Information Technology.

We hypothesise that participants engaging in the non-game activity will not demonstrate a decrease in state anxiety stress, while participants in the game conditions will show a decrease in stress. However, we do not expect to find a significant difference in state anxiety reduction between participants playing low and high-immersion games.

7.1 Methodology

7.1.1 Design, Procedures, and Materials

The design and procedures for this experiment closely follow those of Experiment 2 but with the addition of another condition, the counting condition. The three conditions are as follows: counting, low immersion game, and high immersion game. In the counting condition, participants were instructed to count the number of words in the article on Information Technology. Similar to the game conditions, they are given 5 minutes to complete the task. However, this information is not provided to participants to ensure they do not rush through the activity. For this experiment, we used the same games used in Experiment Two, as our previous results indicated that these games provide distinct low and high immersion experiences.

For the non-game activity, the decision to select counting the number of words was based on several criteria. The activity needed to be simple or mundane to avoid eliciting excitement or engagement, and it must be achievable to prevent further frustration or stress. Additionally, it should not be demanding to the extent that it causes extra exertion for the participants. Counting words in an article is considered to be monotonous, repetitive and uninformative (Geana et al., 2016) . Since the task is boring, it was limited to only five minutes to reduce prolonged boredom and its possible effects on stress. We adopted counting because it is considered as a low engagement activity and not exciting. Counting involves a single activity requires the participants to focus only on counting with no other distractions. Additionally, it is not as stimulating as playing digital games as the text is presented on paper using only black it, with minimise stimulating the participants.

The experiment is a 2 x 3 mixed-measure ANOVA experimental design with three conditions. The independent variables consist of the three conditions: counting condition, low immersion condition, and high immersion condition and the pre-and post-intervention (t1 and t2) The dependent variables are the pre-and post-intervention stress levels.

7.1.2 Measures

To measure the level of anxiety, we continued to use the STAI as the main scale. To address the inconsistencies observed in the results of the stress scales used in previous experiments particularly the varying correlation results in Experiment 1 and 2, we introduced the Visual Analogue Scale (VAS) as a secondary measure of stress. Crosswell & Lockwood (2020) also suggest that, in order to obtain a robust stress results, it is advisable to use at least two scales to measure stress.

The Visual Analogue Scale (VAS) was originally introduced by Hayes and Patterson in 1912 as a subjective measure of acute and chronic pain. The scale utilised visual aids to allow individuals to rate the level of pain they experienced. In our research, we have adapted the VAS to measure the stress level experienced by participants, allowing us to compare the results with those obtained from the main scale. Participants were asked to select on a 5-point scale with two endpoints. The scale ranges from 1 to 5, where 1 indicates feeling calm, relaxed, and confident (no distress or stress), and 5 indicates feeling completely distressed (overwhelmed or stressed out). The VAS was also modified to follow the same format as the other stress scale used in the study i.e. the STAI. A 5-point scale was selected to consistency across instruments and to streamline data analysis and interpretation.

Additionally, we also measured the level of immersion and involvement experienced while performing the activities. using two single-item self-report questions adapted from Jennett et al. (2008). Participants rated their immersion and involvement on a 10-point Likert scale, with higher scores indicating greater engagement. The items are presented in Appendix S. Immersion measures the level of engagement experienced by the participants during the activities, while involvement reflects how much participants were focused on the activity compared to other thoughts. The distinction between the two is to determine if participants were more engaged in playing the game or on the task ahead of them.

In this experiment, we were comparing the effect of digital games and non-game activity. While the use of the IEQs was appropriate in the previous experiment – where immersion levels were measured across two variations of digital games – it was not suitable here, as one of the conditions does not involve gameplay. Therefore, a different immersion measure was adopted. Specifically, we used a single-item immersion scale adapted from (Jennett et al., 2008), in which participants were asked to rate how immersed they felt on a scale from 1 to 10. A rating of 1 indicated low immersion, while 10 indicated high level of immersion. This decision was also guided by practical considerations, including the need to reduce participants fatigue due to the length of the experimental protocol, and to ensure a focused assessment of immersion without introducing additional measurement burden.

In the second experiment, several participants reported mentally rehearsing their presentation while playing the game, particularly in the low immersion condition. To assess whether participants were truly engaged in the assigned task, we added the involvement scale. As our primary interest was in participants' involvement in the task itself – either counting or playing game – we designed a simple, task-specific measure following the single-item immersion scale. Participants were asked to rate their level of involvement on a 10-point scale. A rating of 1 indicated low involvement, while 10 indicated high involvement. This allowed us to identify whether participants were focused on the activity or mentally occupied with the upcoming presentation.

7.1.3 Participants

To determine the number of participants for this experiment, we conducted a power calculation using the GPower 3.1 calculator. Based on the effect size from Experiment One (d = 0.77) and aiming for a conventional power level of 80% with and alpha of 0.05, the estimated number of participants required to achieve a good chance of significant results is 99. However, considering the possibility of participant dropout during the experiment, we took a conservative approach and aimed for 102 participants.

All participants were staff and students from the University of York. Participants are convenience samples who responded to our call or participation from our posters and flyers that were posted across campus, and social media posts including Discord, Facebook and Reddit. The posters and flyers provided details about the research and included a link to an online booking system, where participants could schedule individual appointment slots and access information about the experiment location. The inclusion criteria were: (1) age 18 and above; (2) having no mental health issues to avoid inflicting any harm (3) have not participated in experiments 1 and 2, as to ensure that participants are not preparing for the experiment. Participants were randomly allocated to either the Counting, Low Immersion or High Immersion Group. Each participant received a £10 Amazon voucher as compensation for their participation.

A total of 105 participants were recruited, but three participants opted to drop out of the experiment before its completion, resulting in 102 usable datasets for analysis. Each condition comprised of 34 participants. Among the participants, 46 (45.10%) identified as male, 51 (51%) as female, 4 (3.92%) as non-binary, and 1 (0.98%) preferred not to disclose their gender. The age range of the participants ranged from 18 to 60 years old, with a mean age of 27.68 (SD = 7.24). Table *7.1* provides the summary of the demographic distribution of participants, which lasted approximately 30 to 40 minutes.

We also conducted pilot studies for each condition, each involving one participant. The purpose of these pilot studies was to test the flow of the experiments and ensure that all materials were functioning properly.

Table 7.1
Demographic Analysis of the Research Sample

		Counting		Low Immersion		High Immersion		All	
		n	%	n	%	n	%	n	%
Age	18 - 24	10	10	16	16	12	12	38	37
	25 - 34	16	16	16	16	18	18	50	49
	35 – 44	6	6	1	1	4	4	11	11
	45 – 55	2	2	0	0	0	0	2	3
	56 – 60	0	0	1	1	0	0	1	1
Gender	Male	17	17	13	13	16	16	46	45
	Female	15	15	18	18	18	18	51	50
	Non-binary	2	2	2	2	0	0	4	4
	Prefer not to say	0	0	1	1	0	0	1	1
Employment	Unemployed	0	0	2	2	0	0	2	2
	Student	23	23	26	25	26	25	75	74
	Full-time employment	8	8	5	5	7	7	20	20
	Part-time Employment	1	1	1	1	1	1	3	3
	Other	2	2	0	0	0	0	2	2

7.2 Results

The hypothesis posits that participants in both the low and high immersion conditions will experience a reduction in state anxiety, while those in the counting condition will not. However, we do not expect a significant difference between the low and high immersion conditions.

To test this, we employed a 2 x 3 mixed-measures ANOVA to examine whether there were significant differences across three conditions: Counting, Low-Immersion Game, and High-Immersion Games, at two time points (pre- and post-intervention) using both the STAI and VAS scales. Furthermore, a correlation analysis between the STAI State Scale and the VAS scale was conducted to assess whether both scales measure the same construct.

Additionally, we conducted a linear regression analysis on the STAI Trait scores to determine if there is any influence of participants' existing predisposition for anxiety or any other pre-existing conditions on their STAI State scores. However, trait anxiety was not included as a covariate in the main ANOVA models. Lastly, the results section will include an analysis of immersion and involvement scores and their relationship to stress relief.

7.2.1 State-Trait Inventory Scale (STAI)

STAI State

STAI State Change

The mean score and standard deviation of the STAI State score for the three conditions measured at pre (t1) and post (t2) intervention were compared and shown in Table 7.2, along with the STAI State Difference (tD). The result shows a small difference between t1 and t2, indicating a small reduction in stress across the three conditions. Figure 7.1 shows the STAI scores. The change can be seen in Figure 7.2, which is the boxplot for the change in stress score.

STAI State Induction Validation

In studies where a baseline (pre-induction) measure of state anxiety was not collected, an alternative statistical approach was used to assess the effectiveness of the stress induction. A one-sample t-test was conducted on the post-induction STAI State scores to determine whether they were significantly higher than expected non-stressed values. Given that the STAI State uses a 4-point Likert scale, a mean item score of approximately 2 (i.e. "Somewhat") was used a conservative estimate of non-anxious populations. This value served as a benchmark to test whether participants' reported anxiety was significantly elevated after the induction.

The sample mean STAI state score was 2.26 (SD = 0.52). The t-test revealed a significant elevation in state anxiety, $t\ (101) = 2.96$, $p = 0.004$. This suggests that the stress induction effectively elevated anxiety in the experiment.

Table 7.2
State-Trait Anxiety Inventory (STAI) State Scale Mean and Standard Deviation for the Three Conditions.

Conditions	STAI State t1		STAI State t2		STAI State Difference tD	
	Mean	SD	Mean	SD	Mean	SD
Counting	2.23	0.56	2.14	0.49	-0.09	0.511
Low Immersion	2.11	0.48	1.96	0.49	-0.15	0.290
High Immersion	2.12	0.52	1.97	0.49	-0.15	0.461

Figure 7.1

The Box Plot of State-Trait Anxiety Inventory (STAI) State Scale Score t1 and t2 Score for the Three Conditions

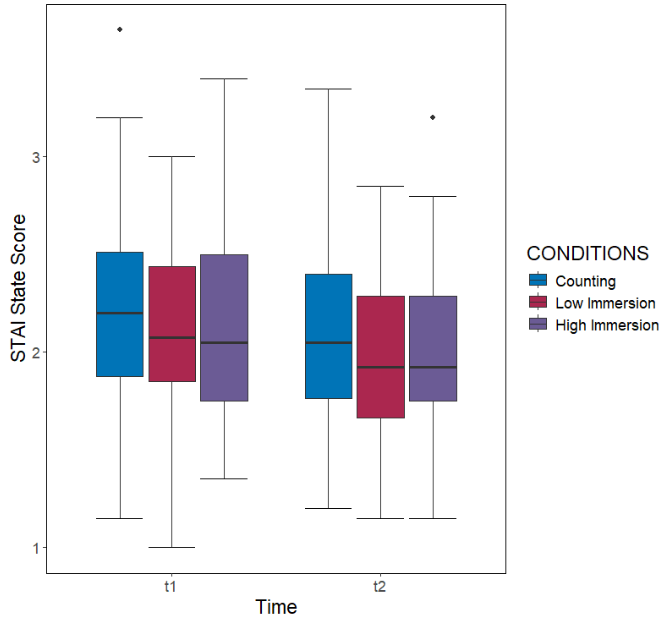
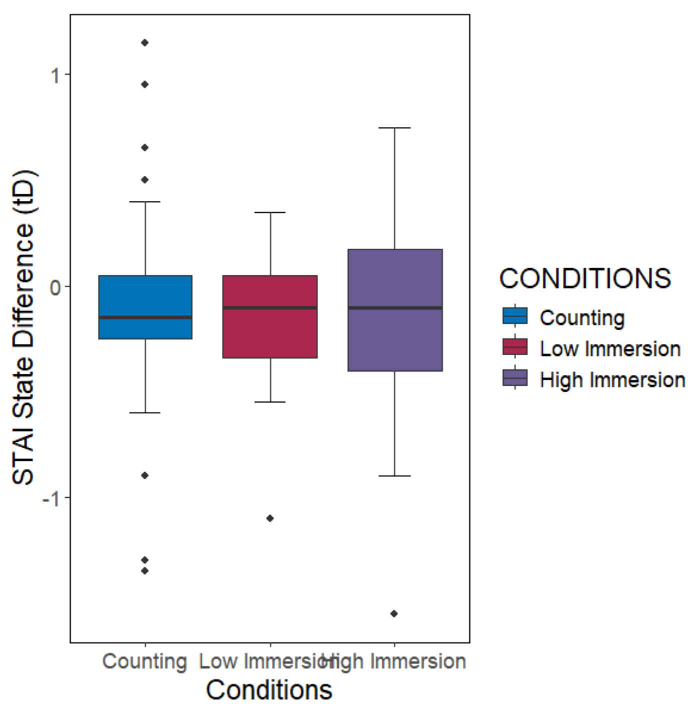


Figure 7.2

The Box Plot for State-Trait Anxiety Inventory (STAI) State Scale Change (tD) for the Three Conditions.



Using a 2 x 3 mixed measure ANOVA on the STAI State scores to calculate across the three conditions, we found a significant effect of Time [F (1, 99) = 9.39, p = 0.003], however, no significant effect for Conditions [F (2, 99) = 1.10, p = 0.34] nor for the interaction [F (2, 99) = 0.19, p = 0.83] as summarised in Table *7.3*.

Table 7.3

Between-Group Comparisons for State-Trait Anxiety Inventory (STAI) State Scale Scores

Interactions	F-value	Sig (p-value)	Effect size (ges)
Conditions	F (2,99) = 1.095	0.339	0.018
Time	F (1,99) = 9.389	0.003*	0.017
Conditions X Time	F (2,99) = 0.193	0.825	0.000

A paired samples t-test conducted on t1 and t2 revealed a significant difference for the Low Immersion condition, with t (33) = 2.87, p = 0.007 (Table 7.4).

Table 7.4

Paired t-test (Bonferroni) Within Subject by Conditions.

Conditions	n	t (33)	p
Counting	34	1.07	0.291
Low Immersion	34	2.87	0.007*
High Immersion	34	1.97	0.057

STAI Scale Correlations

Using the Pearson Correlation Coefficient, we computed the correlations between the STAI scales. Table 7.5 and Figure 7.3 present the results, illustrating the varying correlations among the STAI scales in both conditions.

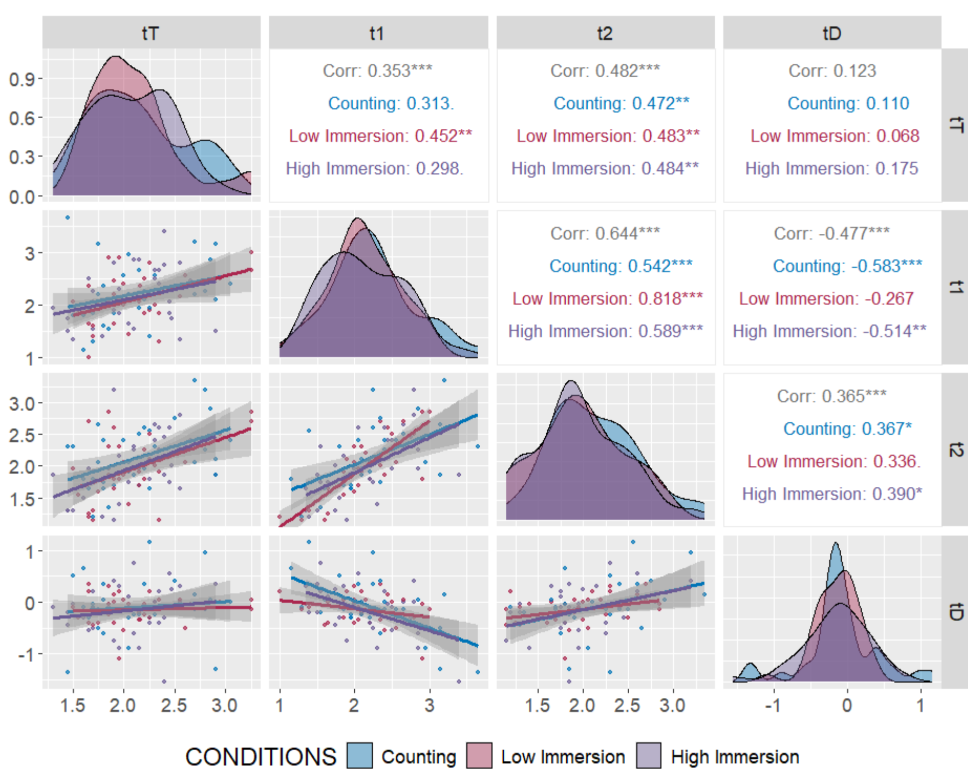
The STAI Trait scale, which assesses pre-existing stress conditions, exhibited weak correlations with the other STAI State scales (t1 and t2) as well as the STAI State Difference (tD). However, there was a strong correlation between STAI State t1 and t2 in both the waiting and gaming conditions: r = 0.851 and r = 0.801, respectively. Additionally, we observed weak to moderate correlations between t1 and tD, and between t2 and tD.

Table 7.5
Pearson Correlation Coefficients Matrix for State-Trait Anxiety Inventory (STAI) State Scales

Counting	**tT**	**t1**	**t2**	**tD**
tT	-	0.098	0.223	0.0.12
t1	0.313	-	0.294	0.339
t2	**0.472**	**0.542**	-	0.135
tD	0.110	**-0.582**	**0.367**	-
Low Immersion	**tT**	**t1**	**t2**	**tD**
tT	-	0.204	0.233	0.005
t1	**0.452**	-	0.669	0.071
t2	**0.483**	**0.818**	-	0.113
tD	0.068	-0.267	0.336	-
High Immersion	**tT**	**t1**	**t2**	**tD**
tT	-	0.090	0.234	0.031
t1	0.300	-	0.347	0.264
t2	**0.484**	**0.589**	-	0.152
tD	0.175	**-0.514**	**0.390**	-

Notes: The top shows r^2 score and the bottom is the r score. Values in bold are significant.

Figure 7.3
The Scatterplot Matrix for State-Trait Anxiety Inventory (STAI) State Scales



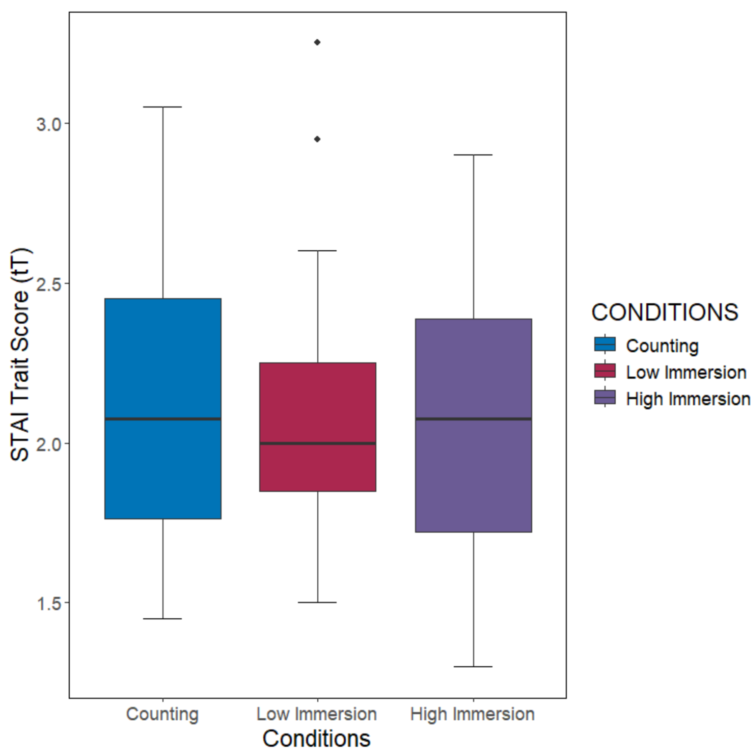
STAI Trait

Similar to experiments one and two, we also examined the relationship between STAI Trait as a confounding variable. Table 7.6 shows the mean numbers of STAI Trait for the three conditions.

Table 7.6
Mean and Standard Deviation for State-Trait Anxiety Inventory (STAI) Trait Scale (tT)

Conditions	Mean	Standard Deviation
Counting	2.13	0.46
Low Immersion	2.10	0.43
High Immersion	2.06	0.40

Figure 7.4
The Box Plot of State-Trait Anxiety Inventory (STAI) Trait Scale



To see if there is a systematic difference in STAI Trait between the three conditions. We used a 1 X 3 ANOVA on STAI Trait across the three conditions, we found no significant difference for Trait [$F (2) = 0.692$, $p = 0.549$] (Table 7.7).

Table 7.7
One-Way ANOVA Table for State-Trait Anxiety Inventory (STAI) Trait Scale and Conditions

Interactions	df	Sum Sq	Mean Sq	F-Value	Pr(>F) P-value
Conditions	2	0.22	0.1105	0.692	0.549
Residuals	201	36.9	0.1836		

Further analysis of Trait using linear regression to investigate the effect of STAI Trait score on the STAI State difference (tD) is shown in Table 7.8. The result shows that the covariate, tT was not significantly related to the participants' STAI State Difference (tD)s.

Table 7.8
Linear Regression for State-Trait Anxiety Inventory (STAI) Trait Scale (tT) and STAI State Difference (tD)

Independent Variable	Estimate	t-Value	p-value
Trait	0.119	1.195	0.235
Conditions	-0.026	-0.500	0.618

7.2.2 Visual Analogues Scale (VAS) for Stress

The mean score and standard deviation of the stress VAS scale score for the three conditions measured pre-intervention (VAS1) and post-intervention (VAS2) were compared and presented in Table 7.9. Additionally, the difference between VAS1 and VAS2 is also displayed in the table. Figure 7.5 the VAS score. The results indicate a slight change in the stress score following the intervention, as depicted in the box plot presented in Figure 7.6.

Table 7.9
Mean and Standard Deviation (SD) of Visual Analogue Scale (VAS) for Stress

Conditions	VAS1		VAS2		VAS Difference (vD)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Counting	2.97	0.83	2.35	0.77	-0.62	1.13
Low Immersion	2.65	0.73	2.32	0.91	-0.33	0.88
High Immersion	2.82	0.80	2.35	0.95	-0.47	1.08

Figure 7.5
The Box Plot of Visual Analogue Scale (VAS), Pre (VAS1) and Post (VAS2)

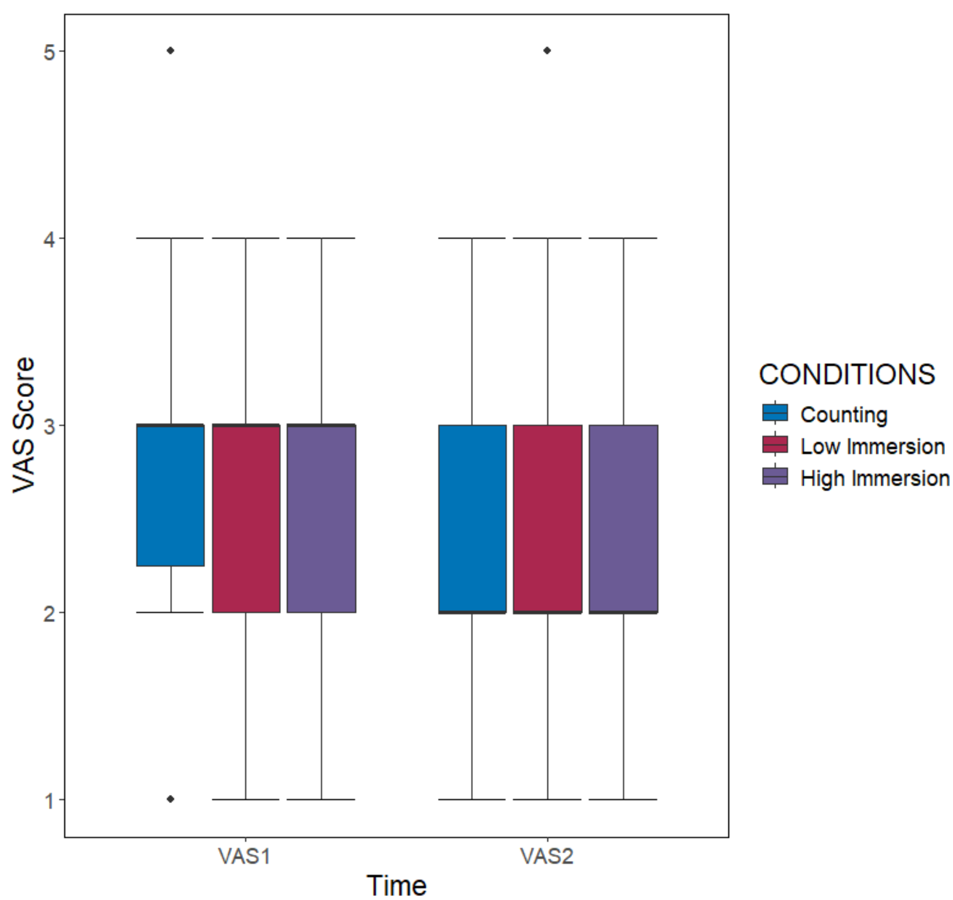
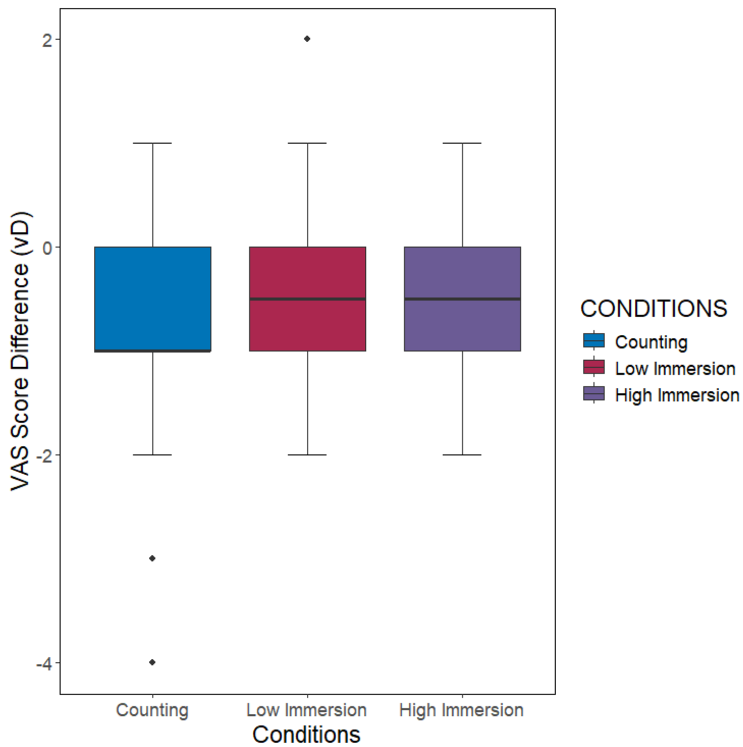


Figure 7.6
The Box Plot of Visual Analogue Scale (VAS) Change (vD)



A 2x3 mixed-measure ANOVA was performed on the VAS scores across the three conditions. The analysis showed a significant effect of Time [F (1, 99) = 21.11, p = 0.00]. However, no significant effects were observed for Conditions [F (2, 99) = 0.63, p = 0.54], nor for the interaction between Time and Conditions [F (2, 99) = 0.69, p = 0.51], as summarised in Table 7.10.

Table 7.10
Between-Group Comparisons for Visual Analogue Scale (VAS)

Interactions	F-value	Sig (p-value)	Effect size (ges)
Conditions	F (2, 99) = 0.62	0.540	0.000
Time	F (1, 99) = 21.11	<0.001*	0.080
Conditions X Time	F (2, 99) = 0.69	0.510	0.010

A follow-up analysis using paired samples t-tests on VAS1 and VAS2 revealed significant differences for the three conditions: Counting (t = 2.87, p = 0.007), Low Immersion (t = 2.15, p = 0.039), and High Immersion (t = 2.54, p = 0.016), respectively (Table 7.11).

Table 7.11
Paired t-test (Bonferroni) Within Subject by Conditions.

Conditions	**n**	**t (33)**	**p**
Counting	34	3.19	0.003**
Low Immersion	34	2.15	0.039*
High Immersion	34	2.54	0.016*

VAS Scale Correlations

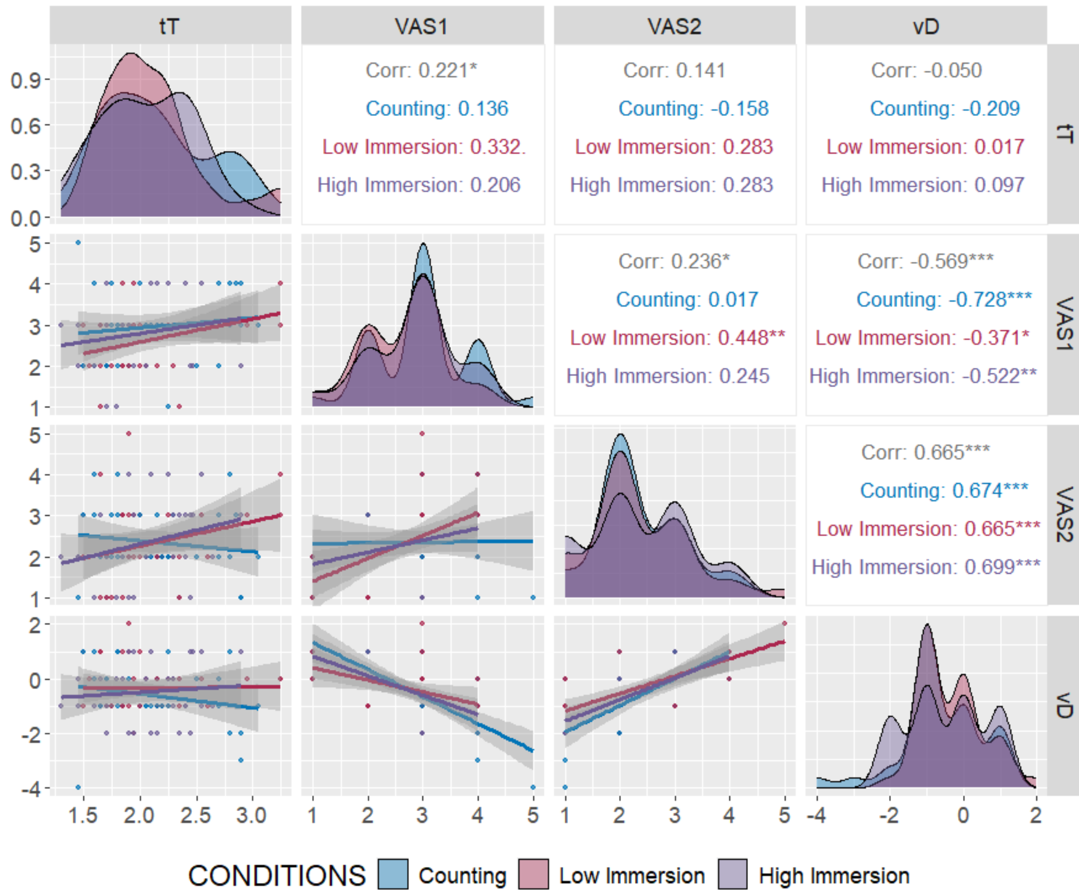
Using the Pearson Correlation Coefficient, we computed the correlations between the VAS scales. Table 7.12 and Figure 7.7 present the results, illustrating the varying correlations among the VAS scales in both conditions.

Table 7.12
Pearson Correlation Coefficients Matrix of for Visual Analogue Scale (VAS)

Counting	**tT**	**VAS1**	**VAS2**	**vD**
tD	-	0.012	0.025	0.044
VAS1	0.136	-	0.000	0.530
VAS2	-0.158	0.017	-	0.454
vD	-0.209	**-0.728**	**0.674**	-
Low Immersion	**tT**	**VAS1**	**VAS2**	**vD**
tD	-	0.110	0.080	0.000
VAS1	0.332	-	0.201	0.138
VAS2	0.283	**0.448**	-	0.442
vD	0.017	**-0.371**	**0.665**	-
High Immersion	**tT**	**VAS1**	**VAS2**	**vD**
tD	-	0.042	0.080	0.009
VAS1	0.206	-	0.060	0.272
VAS2	0.283	0.245	-	0.489
vD	0.097	**-0.522**	**0.699**	-

Notes: The top shows r^2 score and the bottom is the r score. Values in bold are significant.

Figure 7.7
The Scatterplot Matrix for State-Trait Anxiety Inventory (STAI) Trait Scale and Visual Analogue Scale (VAS)



STAI Trait and VAS Stress Relationships

A linear regression analysis was conducted on the STAI Trait Scale and the VAS Difference. The results, shown in Table 7.13, indicate that the covariate, Trait Anxiety, was not significantly associated with participants' stress levels (F (1, 99) = 0.28, p-value = 0.76). Therefore, there is no significant impact of the STAI score on the VAS score.

Table 7.13
Linear Regression Result for State-Trait Anxiety Inventory (STAI) Trait and Visual Analogue Score (VAS)

Independent Variable	Estimate	t-Value	p-value
Conditions	0.07	0.55	0.59
Trait	-0.11	-0.46	0.64

STAI Scale and VAS Scale Correlations

We also examined the relationship between STAI scores and VAS scores across different conditions using Pearson Coefficient Correlation. Table 7.14 provides a summary of the correlation between the two scales, and Figure 7.8 display the matrix scatterplots for STAI and VAS scores across the three conditions.

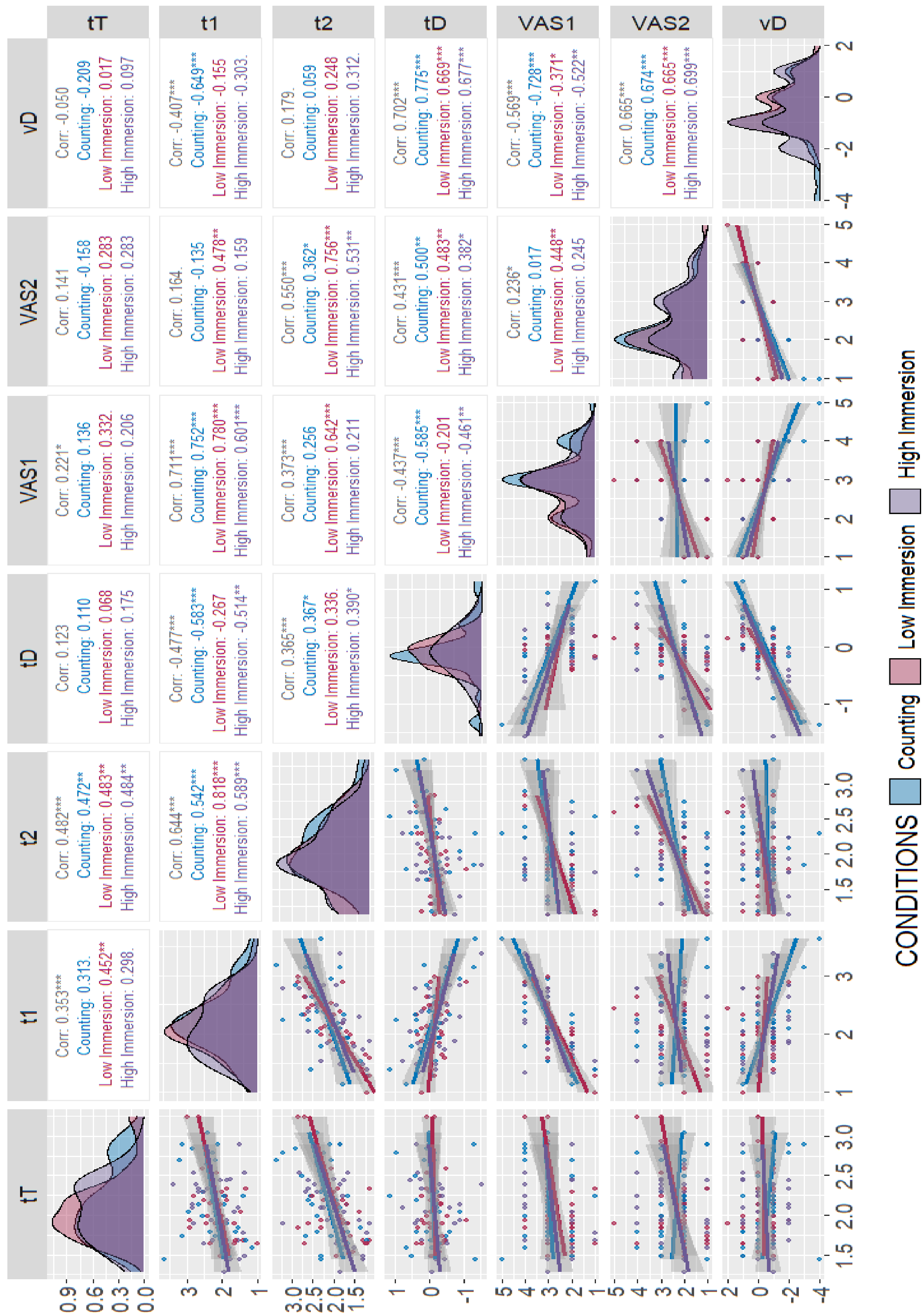
Table 7.14
Pearson Correlation Coefficients Matrix for State-Trait Anxiety Inventory (STAI) and Visual Analogue Scale (VAS)

Counting	**tT**	**t1**	**t2**	**tD**	**VAS1**	**VAS2**	**vD**
tT	-	0.098	0.223	0.012	0.136	0.025	0.044
t1	0.313	-	0.294	0.340	0.752	0.018	0.421
t2	**0.472**	**0.542**	-	0.135	0.256	0.131	0.003
tD	0.110	**-0.583**	**0.367**	-	-0.585	0.250	0.601
VAS1	0.136	**0.752**	0.256	**-0.585**	-	0.000	0.530
VAS2	-0.158	-0.135	**0.362**	**0.500**	**0.017**	-	0.454
vD	-0.209	**-0.649**	0.059	**0.775**	**-0.728**	**0.674**	-
Low Immersion	**tT**	**t1**	**t2**	**tD**	**VAS1**	**VAS2**	**vD**
tT	-	0.204	0.233	0.005	0.110	0.080	0.000
t1	**0.452**	-	0.669	0.071	0.608	0.228	0.024
t2	**0.483**	**0.818**	-	0.113	0.412	0.572	0.062
tD	0.068	-0.267	0.336	-	0.040	0.233	0.448
VAS1	0.332	**0.780**	**0.642**	-0.201	-	0.201	0.138
VAS2	0.283	**0.478**	**0.756**	**0.483**	**0.448**	-	0.442
vD	0.017	-0.155	0.248	0.669	**-0.371**	**0.665**	-
High Immersion	**tT**	**t1**	**t2**	**tD**	**VAS1**	**VAS2**	**vD**
tT	-	0.298	0.484	0.175	0.206	0.283	0.009
t1	0.298	-	0.589	-0.514	0.601	0.159	0.092
t2	**0.484**	**0.589**	-	0.39	0.211	0.531	0.097
tD	0.175	**-0.514**	**0.390**	-	-0.461	0.382	0.458
VAS1	0.206	**0.601**	0.211	**-0.461**	-	0.245	0.272
VAS2	0.283	0.159	**0.531**	**0.382**	0.245	-	0.489
vD	0.097	-0.303	0.312	**0.677**	**-0.522**	**0.699**	-

Notes: The top shows r^2 score and the bottom is the r score. Values in bold are significant.

Figure 7.8

The Scatterplot Matrix for State-Trait Anxiety Inventory (STAI) and Visual Analogue Scales (VAS).



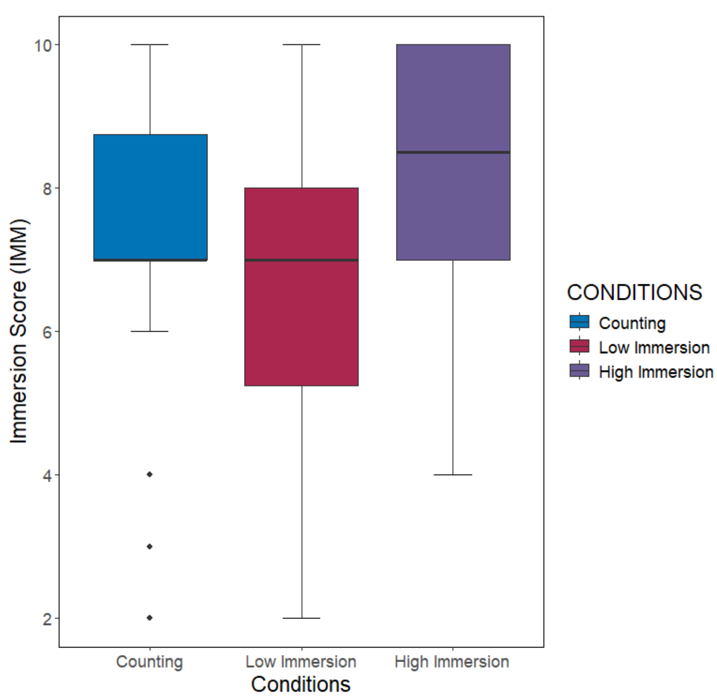
7.2.3 Immersion

We also asked participants to rate their level of immersion on a scale from 1 to 10 while playing the games or counting the number of words. The mean and standard deviation for immersion across the three conditions were compared and presented in Table 7.15. The results reveal that participants reported higher levels of immersion when playing the High Immersion game compared to the Low Immersion game. Interestingly, participants in the Counting condition reported having higher levels of immersion compared to those playing the Low Immersion game. Figure 7.9 shows the box plot for the immersion score.

Table 7.15
Mean and Standard Deviation for Immersion by Conditions.

Conditions	Mean	Standard Deviation
Counting	7.29	2.02
Low Immersion	6.79	2.14
High Immersion	8.21	1.82

Figure 7.9
Box Plot of Immersion in Activities by Conditions



Using a one-way ANOVA on the Immersion scores, we calculated if there was a significant difference among the Immersion scores across different conditions. The analysis revealed a statistically significant difference in Immersion according to Conditions [F (1, 99) = 4.35, p = 0.02] (Table 7.16).

Table 7.16

One-Way ANOVA Between Immersion and Conditions

Interactions	Df	Sum Sq	Mean Sq	F-Value	P-value
Conditions	2	34.8	17.422	4.353	0.0154*
Residual	99	396.2	4.002		

Since the ANOVA test yielded significant results, we proceeded to conduct the Tukey Honestly Significant Difference (HSD) test to perform multiple pairwise comparisons between the means of groups. The Tukey post-hoc test indicated significant pairwise differences between the Low Immersion and High Immersion conditions, with an average difference of -1.41 (Table 7.17).

Table 7.17

Tukey's Multiple Comparisons of Means: 95% Family-Wise Confidence Level

Conditions		Diff	Lower	Upper	P-value adj
High Immersion	Counting	0.91	-2.42	2.07	0.15
Low Immersion	Counting	-0.50	-1.65	0.65	0.56
Low Immersion	High Immersion	-1.40	-2.57	-0.26	0.01*

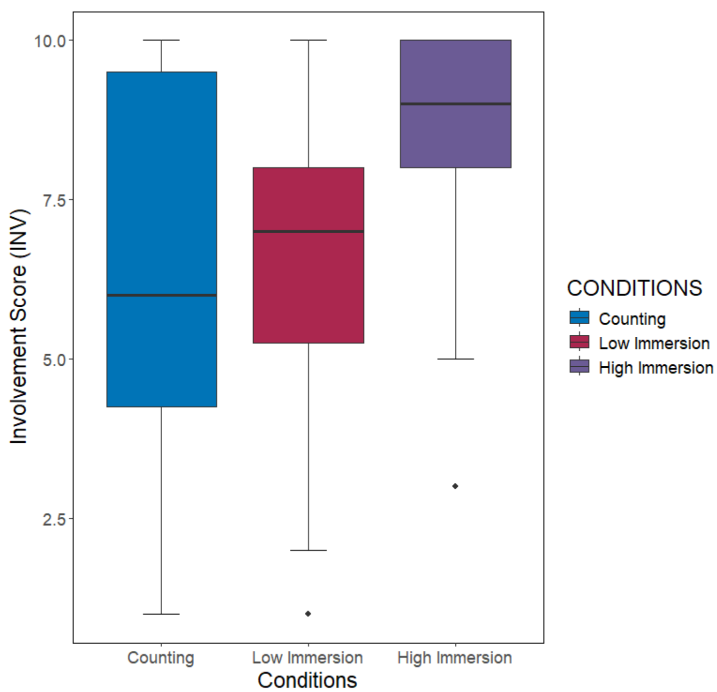
7.2.4 Involvement

Participants also rated their involvement in the activity. It measures the level of involvement with the activity of the presentation that they were about to perform. The mean involvement score across the three conditions is shown in Table 7.18. The findings indicate that participants in the Higher Immersion condition exhibited greater involvement in the activity compared to participants in the Low Immersion and Counting conditions. Figure 7.10 show the box plot for the involvement score.

Table 7.18
Means and Standard Deviation for Involvement by Conditions.

Conditions	Mean	Standard Deviation
Counting	6.47	2.84
Low Immersion	6.38	2.35
High Immersion	8.32	2.00

Figure 7.10
Box Plot of Involvement in Activity by Conditions.



Using a one-way ANOVA on the Involvement scores, we assessed whether there was a significant difference between the Involvement scores across different conditions. The analysis revealed a statistically significant difference in involvement according to Conditions [F (1, 99) = 6.97, p = 0.001], as shown in Table 7.19.

Table 7.19
One-Way ANOVA Between Involvement and Conditions

Interactions	Df	Sum Sq	Mean Sq	F-Value	Pr(>F) P-value
Conditions	2	81.7	40.85	6.974	0.00147*
Residual	99	579.9	5.86		

Since the ANOVA test yielded significant results, we conducted the Tukey Honestly Significant Difference (HSD) test for multiple pairwise comparisons between the means of groups. The results showed a significant pairwise difference between the High Immersion condition and both the Counting and Low Immersion conditions, with average differences of 1.85 and -1.94, respectively. Table 7.20 summarises the results.

Table 7.20
Tukey's Multiple Comparisons of Means: 95% Family-Wise Confidence Level for Involvement

Conditions		Diff	Lower	Upper	P-value adj
High Immersion	Counting	1.85	0.46	3.25	0.01*
Low Immersion	Counting	-0.09	-1.49	1.31	0.99
Low Immersion	High Immersion	-1.94	-3.34	-0.54	0.00*

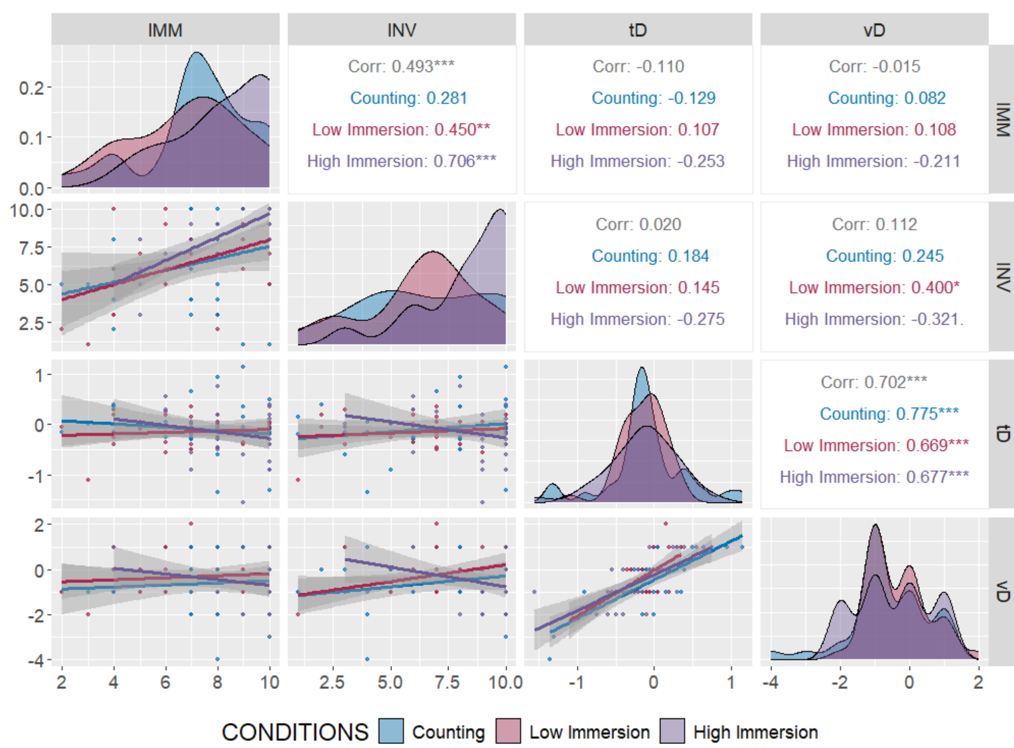
7.2.5 Correlation between Immersion and Involvement with STAI State Difference and VAS Difference

We conducted Pearson correlation coefficients to examine the relationship between Immersion and Involvement with STAI State Difference (tD) and VAS Difference (vD). We found across conditions, there were no correlation to weak correlations between Immersion and the other variables. Involvement displayed weak correlations with tD and vD across conditions. Table 7.21 and Figure 7.11 summarises the results for the correlations. Noteworthy findings emerged in the High Immersion condition, where the correlation between IMM and INV was strong. In contrast, Counting and Low Immersion conditions exhibited weak correlations between Immersion and Involvement.

Table 7.21
Correlation Coefficient for STAI State Difference (tD), VAS Difference (vD), Immersion (IMM) and Involvement (INV) by Conditions

Counting	**IMM**	**INV**	**tD**	**vD**
IMM	-	0.079	0.017	0.007
INV	0.281	-	0.034	0.060
tD	-0.129	0.184	-	0.601
vD	0.082	0.245	**0.775**	-
Low Immersion	**IMM**	**INV**	**tD**	**vD**
IMM	-	0.203	0.011	0.012
INV	0.450	-	0.021	0.160
tD	0.107	0.145	-	0.448
vD	0.108	0.400	0.669	-
High Immersion	**IMM**	**INV**	**tD**	**vD**
IMM	-	0.498	0.064	0.045
INV	**0.706**	-	0.076	0.103
tD	-0.253	-0.275	-	0.458
vD	-0.211	-0.321	**0.677**	-

Figure 7.11
Scatterplot Matrix for Immersion and Involvement with Change in Stress Scores (tD and vD) by Conditions.



7.3 Discussion

The aim of this experiment was to investigate the effect of non-game activity – counting the number of words in a text – compared to playing digital games for anxiety or anticipatory stress management. The experimental protocol was adapted from the protocol used in previous experiments, along with the State-Trait Anxiety Inventory (STAI) as the primary measure and the Visual Analogue Scale (VAS) as the secondary measure. Participants were divided into three conditions: Counting, Low Immersion and High Immersion. We hypothesised that participants in the gaming conditions would experience a decrease in stress levels, with no significant difference between High Immersion and Low-Immersion games. Additionally, we hypothesised that participants in the counting condition would not experience a decrease in stress levels. However, the analysis of both the STAI and VAS scales did not support our hypothesis.

Overall, we observed a reduction in anxiety for all conditions. Further analysis was conducted on both the STAI and VAS scales. Using a 2 x 3 ANOVA, the results for both scales showed no main effect of condition over time, indicating that the different conditions do not significantly impact the outcome. However, further analysis with the t-test on the STAI scale revealed a significant difference for the Low Immersion condition, suggesting that participants experienced a notable reduction in stress levels in this setting. In contrast, the t-test on the VAS scale showed significant differences across all three conditions, indicating that participants experienced varying levels of stress in each of these settings.

Given the inconsistent results between the two anxiety and stress scales, we explored potential reasons for these differences. Firstly, we assessed whether the scales were measuring the same construct (anxiety and stress) by conducting a correlation analysis. The results showed a moderate to strong correlation between the scales across conditions, supporting the notion that both scales likely measure stress. However, several factors may explain the difference between STAI and VAS results. The STAI scale focuses on state anxiety, capturing nuances in stress responses, while the VAS scale measures stress more generally, which could lead to different patterns of significance between the two measures. Furthermore, participants may have engaged with the activities in ways that influenced their anxiety differently than their general perception of stress, leading to disparities between the two measures.

Similar to Experiments 1 and 2, we also considered the effect of Trait on the State Score. The correlation analysis showed that Trait affects the pre-intervention score in the Low Immersion condition and post-intervention condition in all three conditions. Further analyses using the 1 x 3 ANOVA on the Trait score for the three conditions revealed no significant effect. This is further supported by the linear regression result, which also indicated no significant effect of Trait on the State score. Additionally, we found no significant results for the linear regression regarding Trait and change in VAS score, suggesting that trait scores did not affect current stress levels.

Participants' immersion and involvement in the activity were analysed to understand their impact on stress levels. As expected, participants in the high-immersion condition demonstrated higher levels of immersion and involvement compared to the low-immersion and non-game conditions. Interestingly, the non-game condition exhibited a higher mean immersion and involvement score than the low-immersion game, suggesting that word-counting might be more engaging than anticipated. Although counting was meant to be a simple task, the activity of counting may require that they focus on the words and ensuring their counting is correct. This draws their attention from the stressors and providing the mental engagement that contributes to stress reduction. Additionally, the process of counting might create a structured task that gives participants a sense of accomplishment, that may explain why participants in the non-game condition reported higher immersions level than those in the low immersion gaming condition.

Further analysis showed the significant difference in immersion is only observed between low immersion and high immersion but not the other pairs of conditions: Counting and High Immersion nor Counting with Low Immersion. This Indicates that the High Immersion game is more immersive than Low Immersion game, but not significantly different from Counting. In the analysis of involvement, there was a significant difference between High Immersion and Counting, as well as High Immersion with Low Immersion. No significant difference was observed between Low Immersion and Counting. This shows that participants in the High Immersion condition were more involved in the game and less likely to think about the presentation compared to participants in the Counting and Low Immersion conditions. In contrast, there is no difference between participants in the Low Immersion and Counting conditions, indicating that those in these conditions were focused on presentation preparation rather than on playing the low immersion game or counting.

The High Immersion game and Counting may have similar levels of engagement compared to playing the Low Immersion game. However, the involvement scores indicate that participants are less invested in these activities or find them less enjoyable than playing digital games. This may be due to the activities feeling monotonous and less stimulating.

Finally, we explored the correlation between immersion, involvement, and changes in stress scores. The results showed no significant corelations between these factors, except for the strong and positive correlation observed between immersion and involvement in the

High Immersion condition and also the change in STAI state score and VAS score also in the High Immersion condition. These results show that there is a relationship between level of immersion experienced in the High Immersion game and involvement of the game. The higher the level of immersion experienced in the game, the more likely they are invested in the game. Although not significantly correlated, the negative correlation between immersion and involvement with the change in both the STAI state score as well as the VAS indicates that, the more they are immersed and invest in the game, more likely to experience in stress relief.

The outcome of this experiment adds to our conclusion from experiment 2, where anxiety stress was not alleviated because of the games played but rather having something to do. This suggests that the alleviation of stress may not be solely dependent on the immersive qualities of digital games but rather on the broader context of engaging activities. This insight aligns with our conclusions from Experiment 2, reinforcing the idea that having an engaging task, whether it be gaming or counting, can serve as a distraction from stressors. Future research should further explore the nuances of engagement and immersion across different activities to better understand their roles in stress management.

8. Experiment 4: Comparison of Digital Game, Non-Game Activity and Waiting

From the results observed in Experiment 3, a significant decrease in anxiety levels was noted for participants across all three conditions over time, as evidenced by both the STAI and VAS scales. This suggests that participants experienced stress reduction not only from playing high-immersion and low-immersion games but also from engaging in the counting activity. This leads to the conclusion that engaging to, regardless of the level of immersion, can contribute to stress reduction. While games indeed aid in stress management, so does simple counting, as demonstrated by the results of Experiment Three.

Therefore, in this experiment, our aim is to compare the effects of playing digital games against engaging in non-game activities and doing nothing at all. We hypothesised that participants in all the conditions would experience a slight reduction in their state anxiety level, however, the gaming condition and counting condition would experience a significant state anxiety reduction compared to waiting condition.

8.1 Methodology

8.1.1 Design, Procedures and Materials

The design, process and protocol were similar to Experiment 2 and 3. The conditions are adapted from all three experiments we conducted: Experiment 1, where we measured the effect of playing digital games against waiting; the second experiment, where we assessed the difference in stress relief between low and high-immersion games; and the third experiment, where we compared the effect of playing digital games against counting as the non-game activity. Therefore, the conditions are waiting, counting, and playing games.

This experiment is a 2 x 3 mixed-measure ANOVA design with three conditions. The independent variables were the three conditions, i.e. gaming condition, counting condition and waiting condition. The dependent variables are the pre- and post-intervention stress levels.

In the Gaming condition, participants were given the same game used in Experiment 2 and 3 which is the Two Dots game, however only the High Immersion variant of the game was used in this experiment. This game is adapted from research on video games and attention (Cutting et al., 2020; Cutting & Cairns, 2022). The High Immersion game required players to connect dots of three different colours, matching only dots of the same colour to complete targets. As players achieved each target, a new set of dots appeared, with the difficulty increasing progressively through the stages. The game included multiple colours and achievement targets to enhance engagement and immersion. A one-minute practice round was provided before the actual five-minute game session began. The timer was hidden from players to avoid adding pressure or challenge. Meanwhile, participants in the Counting condition were asked to count the number of words in an article on Information technology as many as possible. In each of these conditions, participants were given 5 minutes to complete, however, this was not relayed to participants as to avoid rushing them and causing unnecessary elevation of stress and anxiety. In the Waiting condition, participants were asked to wait, and they were not expected to do anything.

8.1.2 Measures

The measures we used for this experiment is similar to Experiment 3. We used STAI as the main anxiety scale and VAS for stress as the secondary scale. For immersion and involvement, we also used the same scales as Experiment 3. However, for participants in the Waiting condition, we asked them to write down what they were doing while waiting.

8.1.3 Games and Activities Selection

For the Gaming conditions, participants were asked to play the Two Dots High Immersion game used in Experiment Three. We used this game as it is similar to how games are designed in the wild, just without the extra features that are found in commercial games. Participants in the non-game activity were asked to count the number of words in a document, similar to the activity in Experiment Three. Participants in the Waiting condition were asked to wait, similar to Experiment 1.

8.1.4 Participants

Using the same number as experiment three as our basis, to give a good chance of significance the minimum number of participants in each condition need to be 33. Taking a conservative number of 105, we aimed to get at least 35 participants for each condition. Overall, we obtained 111 participants. Three were not included because one participant attended the previous experiment, and one participant was aware of the protocols, which invalidated the data. One participant did not submit the STAI Trait score, and one did not follow the instructions. Eventually, only 108 participants were included in the analysis, with each condition having 36 participants. There were 46 (45.10%) male participants, 51 (51%) were female, 4 (3.92%) were non-binary, and only 1(0.98%) preferred not to say. The age range of the participants is 18 to 60 years old (M = 28.09, SD = 4. 76).

Participants for this experiment were recruited from the University of York using the same convenience sampling methods described in earlier experiments. Recruitment was conducted through campus posters, flyers, and social media platforms such as Discord, Facebook, and Reddit, which directed potential participants to an online booking system. Inclusion criteria were: (1) age 18 or above, (2) no self-reported mental health issues to avoid risk of harm, and (3) no prior participation in Experiments 1, 2, or 3, to avoid familiarity bias.

Participants were randomly assigned to one of three conditions: Waiting, Counting, or Gaming. Each session lasted approximately 30 to 45 minutes, and participants received a £10 Amazon voucher and £3 cash compensation. Prior to the main study, a pilot test with one participant per condition was conducted to ensure the flow of procedures and functionality of materials.

Table 8.1 presents the demographic breakdown. Of the total participants, 46 (45.10%) identified as male, 51 (51%) as female, 4 (3.92%) as non-binary, and 1 (0.98%) preferred not to disclose their gender. Ages ranged from 18 to 60 years, with a mean of 28.09 (SD = 4.76).

Table 8.1
Demographic Analysis of the Research Sample

		Waiting		**Counting**		**Gaming**		**Full**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Age	18 - 24	29	28	26	25	27	26	82	76
	25 - 34	7	7	10	10	9	9	26	24
Gender	Male	19	19	21	21	14	14	54	50
	Female	16	16	14	14	21	21	51	47
	Non-binary	1	1	1	1	1	1	3	3
Employment	Unemployed	0	0	1	1	0	0	1	1
	Student	33	32	34	33	35	34	102	94
	Full-time employment	0	0	0	0	0	0	0	0
	Part-time Employment	2	2	0	0	1	1	3	3
	Other	1	1	1	1	0	0	2	2

8.2 Results

In our hypothesis, we predicted that participants in all three conditions would experience a decrease in anxiety, with no significant change expected in the waiting condition. Furthermore, we anticipated that there would be no significant difference between counting and gaming conditions.

To test these hypotheses, we employed a 2 x 3 mixed-methods ANOVA to assess differences in state anxiety levels across the three conditions. Additionally, we conducted Pearson correlations for all scales used in the study to examine their relationships. We also performed a correlation analysis between the STAI State Scales and the VAS scale to determine if both scales measure the same construct.

Similar to the analysis of previous experiments, we also conducted a linear regression calculation on the STAI Trait score to measure its effect on stress levels. Finally, we focused on analysing immersion and involvement scores and their relationship with stress relief to gain further insights into the mechanisms underlying stress reduction in different activity conditions.

8.2.1 State-Trait Inventory Scale (STAI)

STAI State

STAI State Change

The total STAI State score was calculated to assess the effect of the conditions on stress levels. The mean scores and standard deviations of the STAI State score for the three conditions measured at pre-intervention (t1) and post-intervention (t2) were compared, along with the difference between t1 and t2 (change in stress), as summarised in Table 8.2. The results indicate a small negative difference between t1 and t2 for the Waiting and Counting conditions. Conversely, the Gaming condition shows a change in the mean score of Mean = -0.43 and SD = 0.76. These findings are illustrated in the box plot in Figure 8.1.

STAI State Induction Validation

In studies where a baseline (pre-induction) measure of state anxiety was not collected, an alternative statistical approach was used to assess the effectiveness of the stress induction. A one-sample t-test was conducted on the post-induction STAI State scores to determine whether they were significantly higher than expected non-stressed values. Given that the STAI State uses a 4-point Likert scale, a mean item score of approximately 2 (i.e. “Somewhat”) was used as a conservative estimate of non-anxious populations. This value served as a benchmark to test whether participants’ reported anxiety was significantly elevated after the induction.

The sample mean STAI state score was 2.23 (SD = 0.53). The t-test revealed a significant elevation in state anxiety, $t(107) = 4.22$, $p < 0.001$. This suggests that the stress induction effectively elevated anxiety in the experiment.

Table 8.2
Mean and Standard Deviation (SD) for State-Trait Anxiety Inventory (STAI) Scale

Conditions	STAI State t1		STAI State t2		STAI Difference tD	
	Mean	SD	Mean	SD	Mean	SD
Waiting	2.16	0.60	2.09	0.45	- 0.07	0.66
Counting	2.28	0.57	2.09	0.64	- 0.19	0.80
Gaming	2.28	0.61	1.85	0.52	- 0.43	0.76

Figure 8.1
The Box Plot of State Trait Anxiety Inventory (STAI) State Score t1 and t2 for the Three Conditions

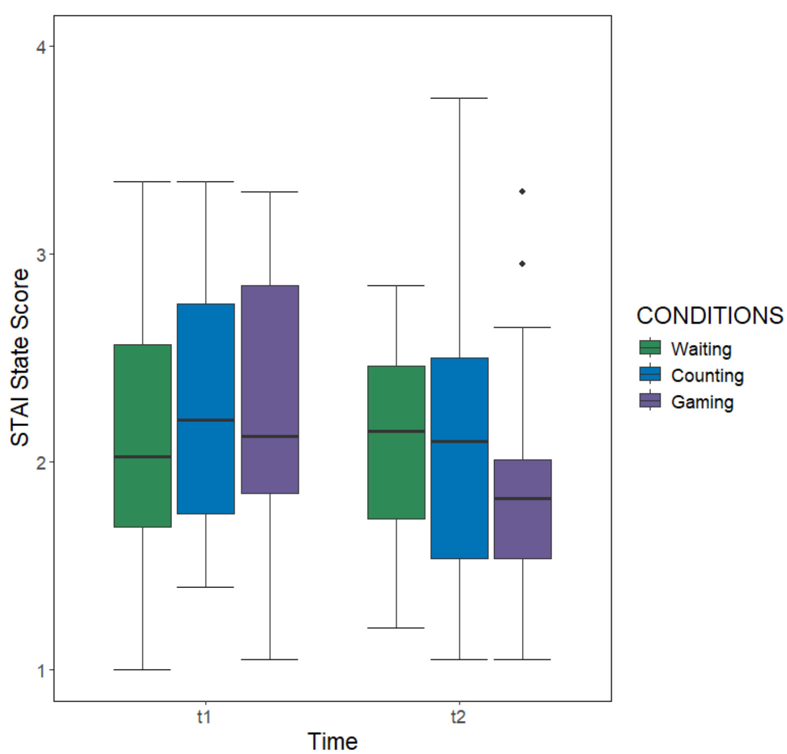
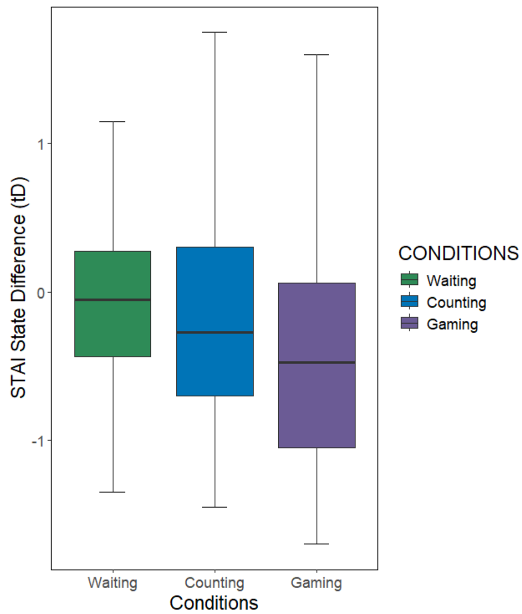


Figure 8.2

The Box Plot of the Change in the State Trait Anxiety Inventory (STAI) State Score t1 and t2 for the Three Conditions



A 2 x 3 mixed-measures analysis of variance (ANOVA) was conducted on the STAI State scores to determine if there was a significant difference between stress scores across the three conditions. The analysis revealed a significant effect for Time [F (1, 105) = 9.80, p = 0.002], indicating a change in stress levels from pre- to post-intervention. However, no significant differences were observed for Conditions [F (1, 105) = 0.69, p = 0.506], nor for the interaction between all three conditions [F (1, 105) = 2.17, p = 0.112], as summarised in Table 8.3.

Table 8.3

Between-Group Comparisons for State Trait Anxiety Inventory (STAI) State Score

Interactions	**F- value**	**Sig (p-value)**	**Effect size (ges)**
Conditions	F (2,105) = 0.69	0.506	0.007
Time	F (1,105) = 9.80	0.002*	0.038
Conditions X Time	F (2,105) = 2.17	0.112	0.017

Further analysis using paired samples t-test conducted on t1 and t2 revealed a significant difference for Gaming condition, with t (35) = 3.33, p = 0.002. (Table 8.4).

Table 8.4
Paired t-test (Bonferroni) Within Subject by Conditions.

Conditions	**n**	**t (35)**	**p**
Waiting	36	0.565	0.576
Counting	36	1.40	0.169
Gaming	36	3.33	0.002*

STAI Scale Correlations

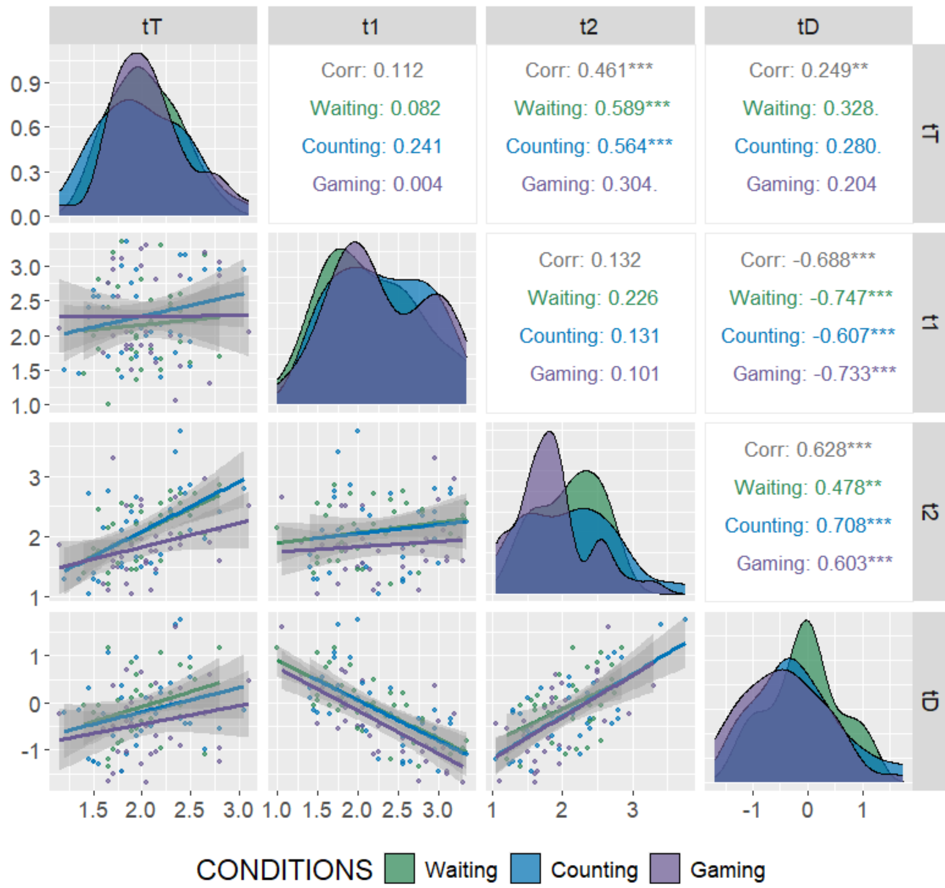
Using Pearson correlation coefficients, we calculated the correlations between the STAI scales. Table 8.5 and Figure 8.3 display the results across the three conditions. Notably, the results are inconsistent among the three conditions. The correlations for the same scales vary, for instance, the correlation between tT and t1 for Low Immersion (r = 0.15) is small, while it is moderate for High Immersion (r = 0.52). This inconsistency can be observed for other scale pairs such as tT and t2, t2 and tD, as well as t1 and t2.

Table 8.5
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI).

Waiting	**tT**	**t1**	**t2**	**tD**
tT	-	0.007	0.347	0.108
t1	0.082	-	0.051	0.558
t2	**0.589**	0.226	-	0.228
tD	0.328	**-0.747**	**0.478**	-
Counting	**tT**	**t1**	**t2**	**tD**
tT	-	0.058	0.318	0.078
t1	0.241	-	0.017	0.368
t2	**0.564**	0.131	-	0.501
tD	0.28	**-0.607**	**0.708**	-
Gaming	**tT**	**t1**	**t2**	**tD**
tT	-	0.000	0.092	0.042
t1	0.004	-	0.010	0.537
t2	0.304	0.101	-	0.364
tD	0.204	**-0.733**	**0.603**	-

Notes: Left values are the r scores, on the right are the r^2 scores. Values in bold are significant, $p<0.05$

Figure 8.3
The Scatterplot Matrix for State Trait Anxiety Inventory (STAI) Scales.



STAI Trait

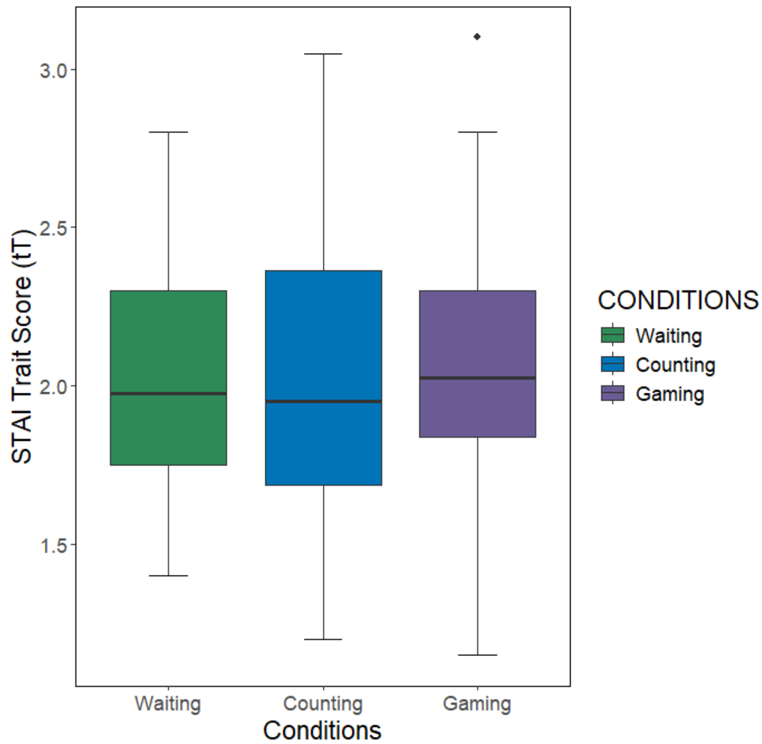
Table 8.6 shows the mean numbers of STAI Trait for the three conditions and Figure 8.4 shows the boxplot Trait score.

Table 8.6
Mean and Standard Deviation for State Trait Anxiety Inventory (STAI) Trait scores (tT)

Conditions	Mean	Standard Deviation
Waiting	2.03	0.35
Counting	2.01	0.44
Gaming	2.07	0.40

Figure 8.4

The Box Plot of State-Trait Anxiety Inventory (STAI) Trait scores (tT)



To determine if there is a systematic difference in STAI Trait between the three conditions we performed a 1 x 3 ANOVA on Trait across the three conditions, we found no significant difference for Trait [F (2) = 0.507, p = 0.603] (Table 8.7).

Table 8.7

One-Way ANOVA Table for State-Trait Anxiety Inventory (STAI) Trait Scores (tT) and Conditions

Interactions	Df	Sum Sq	Mean Sq	F-Value	P-value
Conditions	2	0.16	0.0781	0.507	0.603
Residuals	213	32.82	0.1541		

Further analysis of Trait using linear regression to investigate the effect of STAI Trait score on STAI Difference, tD is presented in Table 8.8. The results suggest that both Trait and Conditions are significant predictors of the STAI Difference, tD.

Table 8.8

Linear Regression Result for State-Trait Anxiety Inventory (STAI) Trait Scores

Independent Variable	Estimate	t-Value	p-value
Trait	0.50	2.81	0.01*
Conditions	0.19	2.26	0.03**

8.2.2 Visual Analogue Scale (VAS) for Stress

The mean score and standard deviation of the VAS score for the three conditions measured pre (VAS1) and post (VAS2) intervention were compared and shown in Table 8.9, along with the difference between VAS1 and VAS2. The results show a small change in the stress score after the intervention, shown in Figure 8.5.

.

Table 8.9

Mean and Standard Deviation (SD) of Visual Analogue Scale (VAS) Score

Conditions	Visual Analogue Score VAS1		Visual Analogue Score VAS2		VAS Difference vD	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Waiting	2.78	0.959	2.31	0.749	-0.47	1.11
Counting	2.78	0.76	2.36	1.20	-0.42	1.50
Gaming	2.78	0.959	2.14	0.899	-0.64	1.10

Figure 8.5

The Box Plot of Visual Analogue Scale (VAS) Scores, Pre (VAS1) and Post (VAS2).

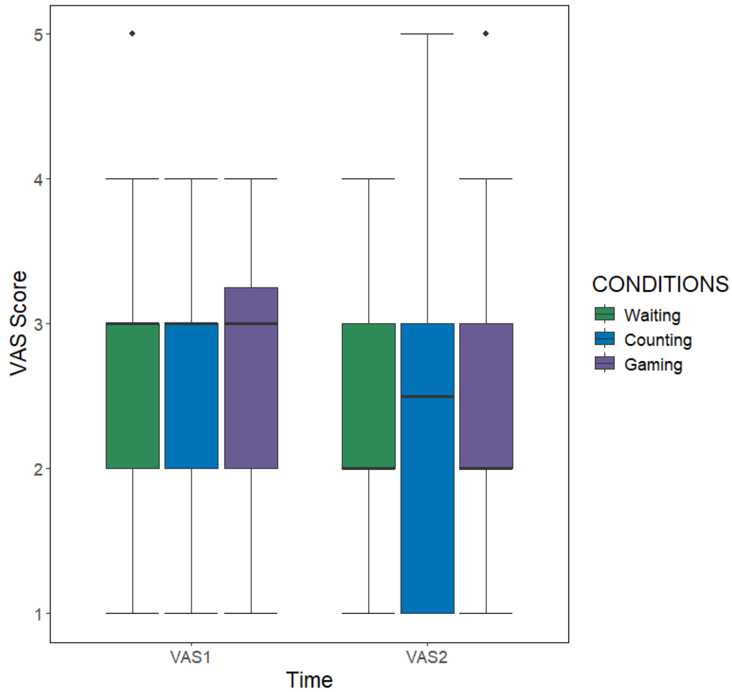
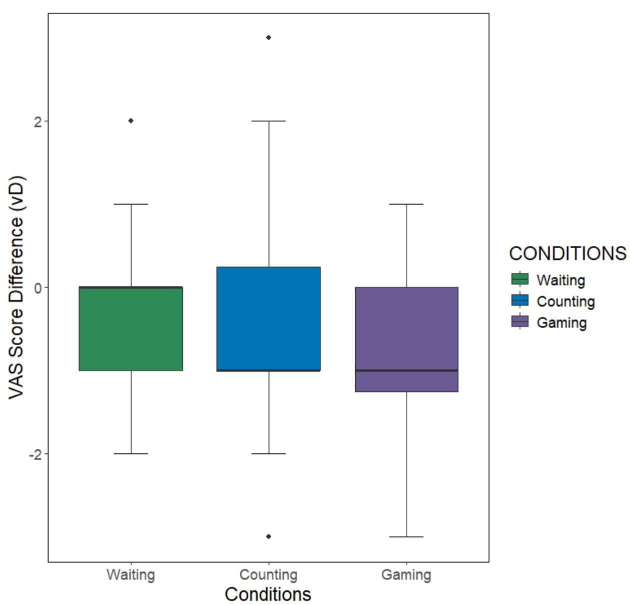


Figure 8.6

The Box Plot of the Change in the Visual Analogue Scale (VAS) Scores



Similar to the STAI scale analysis, we also conducted a 2 x 3 ANOVA on the VAS score to examine if there was a significant difference in stress reduction between the three conditions. The ANOVA results, as shown in Table 8.10, revealed that the score significantly differed for Time [F (1, 105) = 17.930, p = 0.00]. However, it did not show significance for the Conditions [F (1, 105) = 0.251, p = 0.779] or the interaction between Conditions and Time [F (1, 105) = 0.308, p = 0.735] (Table 8.10).

Table 8.10
Between-Group Comparisons for Visual Analogue Scale (VAS) Scores

Interactions	F -Values	Sig (p-value)	Effect size (ges)
Conditions	F (2,105) = 0.251	0.779	0.003
Time	F (1,105) = 17.930	<0.001*	0.071
Conditions X Time	F (2,105) 0.308	0.735	0.003

Following the ANOVA analysis, a paired samples t-test was conducted on VAS1 and VAS2 scores. The results indicated a significant difference for the Waiting condition (t = 2.56, p = 0.015) and Gaming condition (t = 3.49, p = 0.001), while the Counting condition was not statistically significant (t = 1.67, p = 0.105) (Table 8.11).

Table 8.11
Paired t-test (Bonferroni) Within Subject by Conditions.

Conditions	n	t (35)	p
Waiting	36	2.56	0.015*
Counting	36	1.67	0.105
Gaming	36	3.49	0.001**

VAS Scale Correlation

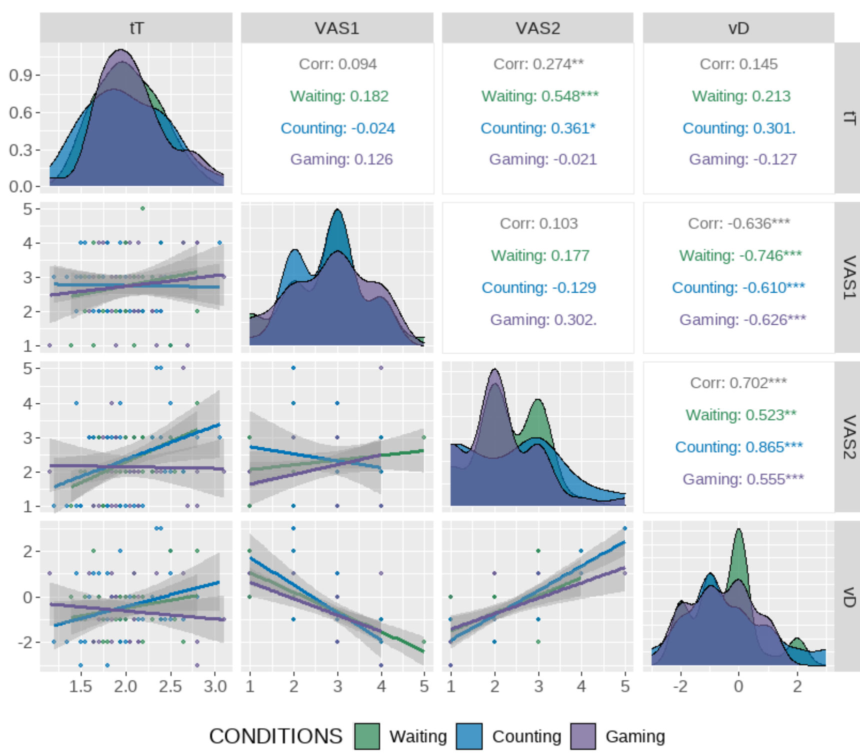
Using the Pearson Correlation Coefficient, we calculated the correlations between the VAS scales. Table 8.12 and Figure 8.7 present the results, illustrating the varying correlations among the VAS scales in both conditions.

Table 8.12:
Pearson Correlation Coefficients Matrix for State-Trait Anxiety Inventory (STAI) Trait and Visual Analogue Scale (VAS) Scores.

Waiting	tT	VAS1	VAS2	vD
tT	-	0.033	0.300	0.045
VAS1	0.182	-	0.031	0.557
VAS2	**0.548**	0.177	-	0.274
vD	0.213	**-0.746**	**0.523**	-
Counting	**tT**	**VAS1**	**VAS2**	**vD**
tT	-	0.001	0.130	0.090
VAS1	-0.024	-	0.017	0.372
VAS2	0.361	-0.129	-	0.748
vD	0.301	**-0.610**	**0.865**	-
Gaming	**tT**	**VAS1**	**VAS2**	**vD**
tT	-	0.016	0.000	0.016
VAS1	0.126	-	0.091	0.392
VAS2	-0.021	0.302	-	0.308
vD	-0.127	**-0.626**	**0.555**	-

Notes: The left values show r scores, and right values shows r^2 scores. Values in bold are significant, $p<0.05$

Figure 8.7
The Scatterplot Matrix for Visual Analogue Scale (VAS)



STAI Trait and VAS Relationships

Table 8.13 showed the linear regression analysis on the STAI Trait Scale and the VAS scale. The covariate, Trait Anxiety, was not significantly related to the participants' Stress, F (1, 99) = 0.28, p-value = 0.76. Therefore, the STAI score does not affect the VAS score.

Table 8.13
Linear Regression Result for STAI Trait and Visual Analogue Scale (VAS)

Independent Variable	Estimate	t-Value	p-value
Trait	0.47	1.53	0.128
Conditions	0.094	0.644	0.521

STAI and VAS Correlation

We also investigated the relationship between STAI State and VAS by conditions. Table 8.14 summarises the correlation across the three conditions. The matrix scatterplots for STAI and VAS scales for the three conditions are shown in Figure 8.8.

Table 8.14
Pearson Correlation Coefficients Matrix for State Trait Anxiety Inventory (STAI) Scores and Visual Analogue Scale (VAS) Scores.

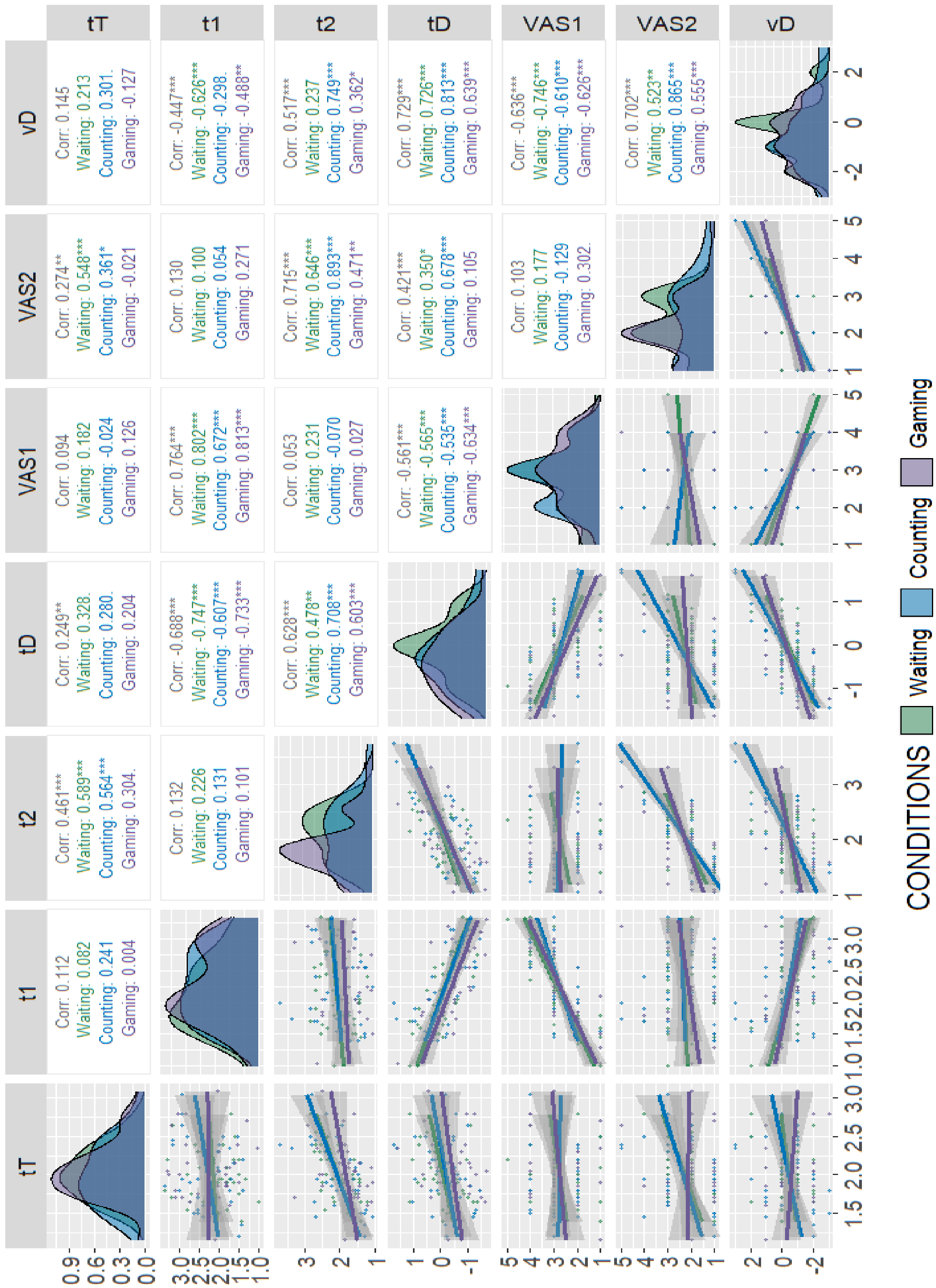
Waiting	**tT**	**t1**	**t2**	**tD**	**VAS1**	**VAS2**	**vD**
tT	-	0.007	0.347	0.108	0.033	0.300	0.045
t1	0.082	-	0.051	0.558	0.643	0.010	0.392
t2	**0.589**	0.226	-	0.228	0.053	0.417	0.056
tD	0.328	**-0.747**	**0.478**	-	0.319	0.123	0.527
VAS1	0.182	**0.802**	**0.231**	**-0.565**	-	0.031	0.557
VAS2	**0.548**	0.100	**0.646**	**0.350**	0.177	-	0.274
vD	0.213	**-0.626**	0.237	**0.726**	**-0.746**	**0.523**	-
Counting	**tT**	**t1**	**t2**	**tD**	**VAS1**	**VAS2**	**vD**
tT	-	0.058	0.318	0.078	0.001	0.130	0.091
t1	0.241	-	0.017	0.368	0.452	0.003	0.089
t2	**0.564**	0.13	-	0.501	0.005	0.797	0.561
tD	0.280	**-0.607**	**0.708**	-	0.286	0.460	0.661
VAS1	-0.024	**0.672**	-0.07	**-0.535**	-	0.017	0.372
VAS2	**0.361**	0.054	**0.893**	**0.678**	-0.129	-	0.748
vD	0.301	-0.298	**0.749**	**0.813**	**-0.610**	**0.865**	-
Gaming	**tT**	**t1**	**t2**	**tD**	**VAS1**	**VAS2**	**vD**

tT	-	0.000	0.092	0.042	0.016	0.000	0.016
t1	0.004	-	0.010	0.537	0.661	0.073	0.238
t2	0.304	0.101	-	0.364	0.001	0.222	0.131
tD	0.204	**-0.733**	**0.603**	-	0.402	0.011	0.408
VAS1	0.126	**0.813**	0.027	**-0.634**	-	0.091	0.392
VAS2	-0.021	0.271	**0.471**	0.105	0.302	-	0.308
vD	-0.127	-0.488	**0.362**	**0.639**	**-0.626**	**0.555**	-

Notes: The left values show r scores, the right values the r^2 score. Values in bold are significant, $p<0.05$

Figure 8.8

The Scatterplot Matrix for State-Trait Anxiety Inventory (STAI) and Visual Analogue Scale (VAS)



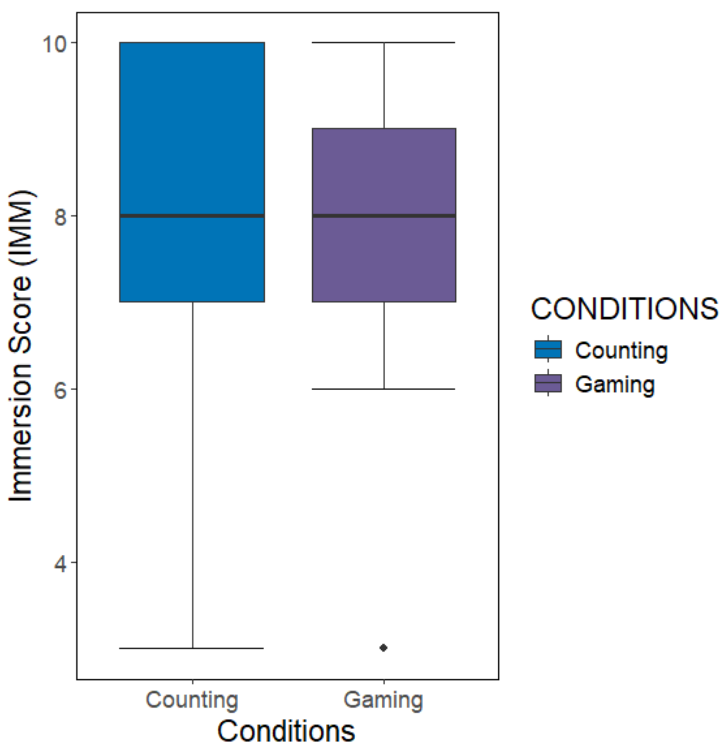
8.2.3 Immersion

We also requested participants to rate their immersion level between 1 and 10 while engaged in playing the games or counting the number of words. The mean and standard deviation for immersion across the two conditions: Counting and Gaming were compared and displayed in Table 8.15 and Figure 8.9. The findings suggest that participants experienced slightly higher immersion when playing the game compared to counting.

Table 8.15
Mean and Standard Deviation for Immersion by Conditions.

Conditions	Mean	Standard Deviation
Counting	8.03	1.84
Gaming	8.08	1.36

Figure 8.9
The Box Plot of Immersion by Conditions.



An independent t-test was conducted to compare the Immersion scores between the two conditions. The results indicated that there was no significant difference in Immersion scores between the conditions ($t(64.4) = -0.145$, $p = 0.885$). Additionally, the effect size calculated using Cohen's d was -0.03, which indicates a negligible result.

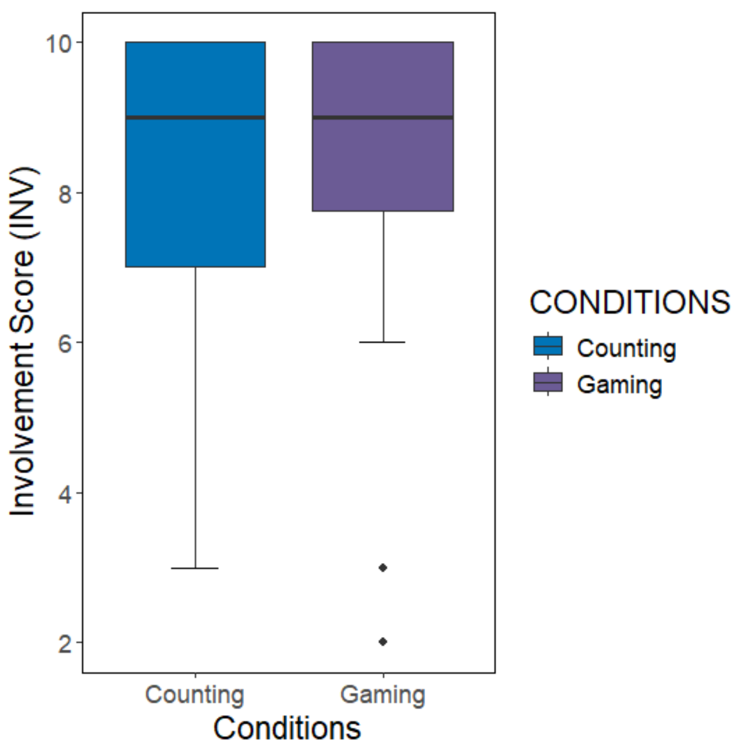
8.2.4 Involvement

Participants also provided ratings for their involvement in the activity, whether counting or playing the game. The mean involvement scores across the two conditions are displayed in Table 8.16 and Figure 8.10. The rate of involvement is only slightly higher for Gaming (M = 8.11, SD = 2.38) compared to Counting (M = 7.94, SD = 2.40).

Table 8.16
Mean and Standard Deviation for Involvement in Counting and Gaming Conditions

Conditions	Mean	Standard Deviation
Counting	7.944	2.402
Gaming	8.111	2.376

Figure 8.10
Box Plot of Involvement by Conditions



An independent t-test was conducted to compare the Involvement scores between the two conditions. The results revealed that there was no significant difference in Involvement scores between the conditions (t (70.0) = -0.296, p = 0.768). Additionally, the effect size calculated using Cohen's d was -0.03, indicating a negligible effect.

8.2.5 Correlation between Immersion and Involvement and the STAI State Difference and VAS Difference

We performed Pearson correlation coefficients to investigate the relationship between Immersion and Involvement with STAI State Difference (tD) and VAS Difference (vD). The results revealed that across conditions, there was a weak to medium correlations between Immersion and the variables. Similarly, Involvement displayed weak correlations with tD and vD across conditions. Table 8.17 and Figure 8.11 summarises the results for the correlations.

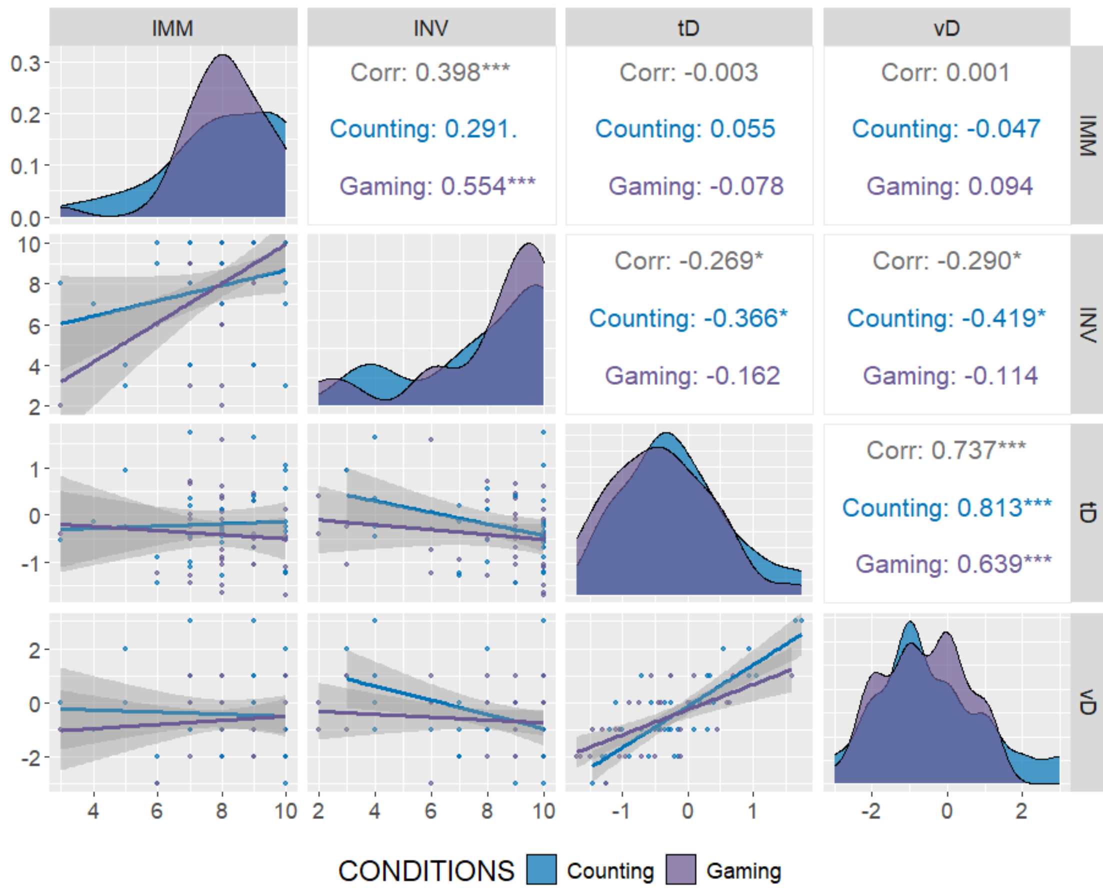
Table 8.17

Correlation Coefficient for Immersion (IMM), Involvement (INV), STAI State Difference (tD), and VAS Difference (vD), by Counting and Gaming Conditions.

Counting	**IMM**	**INV**	**tD**	**vD**
IMM	-	0.085	0.003	0.002
INV	0.291	-	0.134	0.176
tD	0.055	**-0.366**	-	0.661
vD	-0.047	**-0.419**	**0.813**	-
Gaming	**IMM**	**INV**	**tD**	**vD**
IMM	-	0.307	0.006	0.009
INV	**0.554**	-	0.026	0.000
tD	-0.078	-0.162	-	0.408
vD	0.094	-0.014	0.639	-

Figure 8.11

The Scatterplot Matrix for Immersion and Involvement with Change in Stress Scores (tD and vD) for Counting and Gaming Conditions



8.3 Feedback from the Waiting Condition participants.

For participants in the Waiting conditions, we asked what they were thinking of while waiting. A total of 36 participants responded from the Waiting condition. 64% participants answered thinking about matters relating to the interview such as practicing for the interview and mentally reviewing the notes. Meanwhile the rest of the participants were thinking about things not relating to the interview. Appendix V showed the complete response from the participants.

These responses reveal two distinct patterns of engagement during the waiting period: (1) Focused preparation and, (2) Coping mechanism.

Focused Preparation: Many participants were clearly using the waiting time to enhance their readiness for the interview, indicating an understanding of the importance of mental preparation in performance contexts. Their focus on practicing and reviewing suggests a methodical approach to tackling anxiety and ensuring they present themselves well.

Coping Mechanisms: On the other hand, the non-interview-related thoughts demonstrate the inclination to seek distraction from the stressful situation such as engaging with the environment and performing self-soothing activities such as humming, tapping their feet and deep breathing.

8.4 Discussion

Following the outcome of the three experiments, we investigated the impact of playing digital games compared to non-game activity and doing nothing at all: Waiting, Counting, and Gaming on participants' state anxiety levels using the same protocol and measures as the previous experiment. We hypothesised that participants in the Counting and Gaming condition would experience a reduction in state anxiety compared to Waiting condition. The mean difference between the three conditions showed participants from all conditions experienced a reduction in state anxiety. However, the analysis of both the STAI and VAS scales did not support our hypothesis.

The analysis using 2 x 3 mixed measures ANOVA was conducted on both STAI and VAS scales. The results showed that only time exhibited a significant difference, while no significant difference was observed for condition and the interaction between conditions and time. This indicates that there is an overall change in anxiety levels from pre- to post-intervention across all conditions, but it was not affected by condition. However, further analysis with the t-test on the STAI scale revealed a significant difference for the Gaming condition, suggesting that participants experienced a notable reduction in anxiety levels in this setting, highlighting the potential stress-reducing benefits of gaming activities compared to waiting or counting. In contrast, the t-test on the VAS scale showed significant differences for Waiting and Gaming conditions, indicating that participants experienced varying levels of anxiety in each of these settings. The feedback from the Waiting condition showed that more than half of the participants were practising for the presentation. This may have contributed to the significant difference observed in the Waiting condition, unlike participants in the counting condition, they were not able to practice and prepare more for the presentation, instead they were focusing on the counting activity instead. In the coping strategy discussed in Chapter 2, problem-focused people prefer to deal with stressors by facing it head on. This highlights the differences in coping strategies employed by individuals.

Similar to Experiments 1 to 3, we also analysed the STAI Trait scores, the results indicated no systematic differences across conditions however, both trait anxiety levels and the specific conditions were significant predictors of changes in anxiety levels. This is contradictory to what we found in experiments one, two and three. Meaning that the state score is affected by the participants tendency to respond anxiously to the situation. This is likely to due to the majority of participants being students of the university and the experiment was conducted during assessment season. According to Tze Ping et al. (2008), students who experience anxiety traits are likely to exhibit high state score and that trait and state are context-dependent, meaning that stressful situations in life may have impacted the overall result.

The correlation analysis of the STAI and VAS scales revealed varying correlations across conditions, highlighting the complexity of anxiety responses and the influence of contextual factors. Several reasons may contribute to these complexities. For example, participants might experience different levels of anxiety when engaging in gaming compared to waiting or counting. Gaming could provide distraction and engagement, leading to lower anxiety levels, while waiting might heighten feelings of restlessness or impatience. In the Counting condition, participants may feel less excited due to the monotonous counting task, finding it tedious, which could result in increased levels of anxiety due to boredom.

In the examination of immersion and involvement levels during different activities (counting or gaming) and their correlation with changes in anxiety levels showed no significant differences between conditions. Indicating that the immersive levels and involvement level for both counting and gaming are similar. The results also showed weak correlations between immersion, involvement, and changes in anxiety levels across conditions, indicating limited influence of subjective experiences on the anxiety outcomes.

The overall result showed that playing the game can reduce acute state anxiety level. This is supported by the t-test results for the STAI score. Similarly, VAS also supports this notion. However, contrary to the paired t-test for STAI, the VAS also showed a significant difference for participants in the waiting condition. The conflicting results between the STAI and VAS scales further emphasise the inherent differences and challenges associated with these measures, as discussed in Chapter 3. Additionally, participants in the waiting condition were able to use the time to practice for the interview and this can be seen from the feedback they provided. Contrary to the results in Experiment 3, counting did not show any significant difference in both the STAI and VAS scale, highlighting the complex relationship between state anxiety and coping strategies that individuals employ. Suggesting that anxiety levels are influenced not only by the activities participants engage in but also by their experiences and preferred coping methods. Therefore, it is crucial to consider both individual differences and situational factors when examining anxiety responses.

9. Summary of the Experiments

The results across the experiments showed that playing games does help with stress and anxiety reduction, but so do other activities as shown in Experiment 3 and 4. It is the engagement to activities that provide the stress relief. Additionally, the experiments also showed that immersion does not contribute to the reduction of stress, as shown in Experiment 2. Table 9.1 shows the summary of results from all experiments.

Table 9.1
Summary of Experimental Results

Exp	Conditions	Result
1	Waiting and Gaming	1. Mean scores showed decrease in stress for all conditions. 2. STAI Scale: 2X2 ANOVA showed significance effect in time and the interaction between condition and time only. 3. ASA Scale: 2X2 ANOVA showed significant effect for time and interaction between condition and time The post-task showed an increase in acute stress level, indicating the tasks are considered to be threatening (stressful).
2	Low Immersion and High Immersion Game	1. Mean scores showed decrease in acute state anxiety across the two conditions. 2. STAI Scale: - 2X2 ANOVA showed significant effect in time only. - Paired t-test showed both Low and High Immersion conditions are significant
3	Counting, Low Immersion and High Immersion	1. Mean scores showed decrease in acute state anxiety across the three conditions. 2. STAI Scale: - 2X3 ANOVA showed significant effect in time only. - Paired t-test showed only Low Immersion condition is significant 3. VAS Scale: - 2X3 ANOVA showed significant effect in time only. - Paired t-test showed significant for all three conditions.
4	Waiting, Counting and High Immersion	1. Mean scores showed decrease in acute state anxiety across the three conditions. 2. STAI Scale: - 2X3 ANOVA showed significant effect in time only. - Paired t-test showed only Gaming condition is significant 3. VAS Scale: - 2X3 ANOVA showed significant effect in time only. - Paired t-test showed only significant for Waiting and Gaming conditions.

10. Conclusion

The aim of this thesis is to investigate the effectiveness of playing digital games at alleviating stress and anticipatory stress and anxiety. Quantitative methods were used to measure the effect of player experiences on psychological stress. Overall, two survey studies and four experimental studies were conducted. The survey studies measured various aspects of playing experience and the relationship with perceived stress anxiety, while the experimental studies were to observe causal effect of playing games on psychological stressor. This section will highlight the main outcomes of the research followed by the contribution and limitations from the studies.

10.1 Answering Research Questions

The overarching research question is "Can playing digital games help with reducing stress and anxiety induced by stressful event, and if so, what aspects of playing digital games support this?"

To answer the main research question, it was further broken down into three more specific questions:

1. Is there a relationship between playing digital games and perceived stress?
2. What aspect of playing digital game experiences help with alleviating perceived stress?
3. To what extent does playing digital games affect psychological stress and anxiety-induced by stressful events?

Overall, the results are inconsistent across the studies. Given this outcome it is difficult to provide a conclusive answer as to whether playing games can alleviate stress and anxiety. In the survey studies, there was no correlation between perceived stress and the motivation to play nor was there relationship with the games they played. However, analysis of the factors within the motivation scale did suggest that there might be a relationship between perceived stress and other aspects of playing game experience such as efficacy in playing game or how confident they are in their abilities and skills in playing game. Additionally, there is also correlation between the tendency for immersion/playing engrossment with perceived stress.

On the other hand, the experiments did show that playing games could lower stress and state anxiety level, but so could other forms of activities. The experiments also did not show if the experience of immersion could support the alleviation of stress and state anxiety. This is observed throughout the experiments from both the primary and secondary scales.

The analysis also incorporated qualitative questions from Experiment 1 and Experiment 4, where participants were asked: 1) how they felt about playing the game while waiting for the interview, and 2) what they were thinking about while waiting for the interview. Despite the inconsistent results across the studies, several intriguing outcomes emerged from the research. The following section will look at the outcome of each of the studies that were conducted by answering each of the research questions.

10.1.1 Is there are relationship between playing digital games and perceived stress?

Playing games has become a common part of people's daily lives (McGonigal, 2012). The motivation to play is attributed to many facets of digital game experiences (McKechnie-Martin et al. (2024). Evidence suggests that digital games can support wellbeing and reduce stress (Bowman & Tamborini, 2012; Tyack & Wyeth, 2021) by helping players disengage from stressors, relax, and give a sense of autonomy, while also stopping them from ruminating on stressors (De Aquino Lopes et al., 2014). To better understand whether the motivation to play games is related to stress and anxiety, this thesis explored the relationship between perceived stress, the motivation to play, and game preferences. However, the analysis showed there was no clear relationship between gaming motivation and perceived stress. Upon further examination of the factors that motivate gaming behaviour, it was observed that there is a negative relationship between game self-efficacy and perceived stress, along with a positive relationship between immersion and perceived stress. A similar observation was also seen in the individual games analysis between PUBG and Genshin Impact. This emphasises the need for exploring these two motivational factors further.

Game self-efficacy refers to the gamers' confidence in their abilities and skills (Sanchez & Langer, 2020). According to Csíkszentmihályi (1990, 2008) skills and challenge are intertwined; and a balance between them is necessary to experience flow, or the feeling of being "in the game" (Chen, 2007). When we talk about game challenges, it is the measure of difficulty that the game presents (Denisova et al., 2020). The more challenging the game is, the more engaging it could be to the player. In video games, challenge is represented by the various levels. By levelling up in the gameplay, players are able to enjoy the game more and, in turn, be more engaged in the gameplay more (Schell, 2014). Thus, the negative correlation between perceived stress and game self-efficacy suggests that greater challenges in games may correlate with lower stress.

Conversely, the results showed a positive correlation between immersion and perceived stress, indicating that as the level immersion increases, so does the level of stress increases. The literature on the strategies for managing stress and motivation to play games discussed in Chapter 2 posits that people play games because it enables the players to escape the real from the real world. As noted from Coomans & Timmermans

(1997), immersion is the feeling of being engaged in a make-believe world and the feeling of "being in the game" Jennett et al. (2008). Based on this, the immersive experience of playing games provides a psychological avenue to escape from the realities of life and stressors.

Additionally, the result also showed a weak but positive correlation between perceived stress and intimidation with the game. This indicated that as the perceived stress increases, so is their intimidation when playing the game. According to Keebler et al. (2020), this intimidation is not a factor that measures the motivation to play but rather negative perception of playing game. This result implied that, as the stress level increases, they find games to be more confusing and difficult to control. The analysis of variance showed that the is a significant difference between the level of intimidation among the top games. Interestingly, Among Us had the highest median scored, while League of Legends: Wild Rift (LOL), scored the lowest, suggesting that Among Us is more intimidating than LOL. Based on the design of the game, Among Us might be viewed as more complex compared to LOL, as it requires social manipulation, which can be less straight forward than the objectives of LOL. Furthermore, in Among Us, players switch between being a Crewmate and an Imposter, which could potentially create confusion on roles in the game.

In the examination of the relationship between perceived stress and the preferred games (the top games played), the analysis showed there is not much difference in terms of stress levels across the top games played, further analysis also showed there is no significant difference in perceived stress levels between these games. This suggests that there may not be specific games that people prefer when they are stressed. There are, however, differences observed in the motivation to play among each of the top games, which varies significantly, across the games. Suggesting, these games, provide different experiences to the players. Further analysis into the differences between the games showed with the exception of prone to immersion, other factors are significantly different for all the games. Particularly, for "Among Us" which is different in terms of the intentional gameplay, game self-efficacy, enjoyment, and intimidation compared to other games. The lack of differences in the immersive experience across the game highlighted that there is no difference in the immersive experience between the games.

We proposed that it was the unique design and simplicity of "Among Us" that might contribute to these differences, highlighting the role of game design and aesthetics in influencing player motivation and experience. Niedenthal (2009) described aesthetic "as to how the games look, sound and present itself", which can be in various graphic or visual styles, that could give rise to various expressions such as pleasure. According to Lau et al. (2017), coupled with the immersive experience of games, the aesthetics and interactivity of games could provide a positive experience that could change cognitive perceptions that lead to mental disorders.

The findings from this survey study led to the development of the second survey study, that also addresses the second research questions, which is to investigate aspects of playing experience that has the potential to alleviate stress. Game experiences that involve the use of skills, as well as the experience of immersion were examined in the second survey study. Additionally, game aesthetics were also examined as proposed in the discussion earlier.

10.1.2 What aspects of playing digital game experiences help with alleviating perceived stress?

Based on the results discussed earlier, motivation is not directly associated with perceived stress; however, it highlights other motivational factors that may influence perceived stress. The results indicated that game self-efficacy negatively correlates with perceived stress. As previously highlighted, skills are related to the ability to overcome challenges; in other words, challenges serve as a measure of skills (Denisova et al., 2020). Therefore, one of the aims of the second survey is to examine the relationship between game challenges and perceived stress. Additionally, the results from the first survey showed a positive correlation between immersion and perceived stress. Implying that as participants gets more stress, so does the rate of immersion experiences by the players. Furthermore, it was suggested that one of the factors that causes difference observed in the results. Therefore, the second aim of the second survey is to measure the relationship between perceived stress and the various aspects of game experiences, including immersion and aesthetics.

Analysis of the top games played showed a significant difference in perceived stress levels across these games, particularly between Noita and SuperStar Series and varying levels of challenge across the top games played. Similar results observed for the game PUBG in survey 1 and 2, where this game showed a negative correlation with perceived stress. Contrary to these results, the main analysis in this survey 2, revealed a positive correlation between game challenges and perceived stress, this is similar to the individual games like Genshin Impact, SuperStar Series, and Fate/Grand Order. This suggesting that as games become more challenging, so does the level of stress. The contrary results indicated that people choose games to play that gives them the right level of challenges (Csikszentmihalyi, 2008) and that this choice has no direct relationship with their perceived stress level. This also suggests that people choose game that they enjoy or preferred.

In the satisfaction scale, the results showed a positive correlation between perceived stress and play engrossment, indicating that as the level of stress increases, so does the level of engrossment. The results also revealed a significant difference in the level of engrossment experiences across the top games played. These differences can be observed in games like Noita and Pokémon GO. Similarly, PUBG, Genshin Impact, SuperStar Series, and Fate/Grand Order also exhibited this pattern.

Conversely, the results yielded a negative correlation between perceived stress and enjoyment, indicating that as the level of enjoyment increases, the level of perceived stress decreases. Further analysis of perceived stress and individual games was conducted, focusing on PUBG, Genshin Impact, SuperStar Series, and Fate/Grand Order. PUBG showed a significant negative correlation only with audio aesthetics, while Genshin Impact exhibited a significant positive correlation with all factors except for enjoyment and personal gratification. The analysis for SuperStar Series revealed that none of the correlations were significant; however, there was a positive and significant correlation with personal engrossment for Fate/Grand Order.

The overall results demonstrated that each of these games provides different levels of experience for the players, making it difficult to determine which aspects of these experiences could provide stress relief. However, several key observations can be made from the results. First, the experiences of immersion (Survey 1) and the related experience of play engrossment (Survey 2) in playing games are consistently positively correlated with perceived stress throughout the analysis. Second, there is a consistent negative correlation between perceived stress and enjoyment.

These findings did not necessarily explain whether games could support stress relief; however, they help direct the research toward exploring the actual effects of acute stress on immersion. As we did not find strong evidence to support that games alleviate stress, the next part of the thesis will focus on experiments to determine if there is a cause-and-effect relationship between stress and playing games. Hence, the next section of the thesis will discuss experiments on games for stress.

10.1.3 To what extent does playing digital games affect psychological stress and anxiety-induced by stressful events?

To answer this, experimental studies were designed. They were based on the standard protocol for inducing acute stress, the Trier Social Stress Test (TSST). Acute stress is short-term stress that occurs infrequently (Pratt & Barling, 1988), which describes the tasks within the TSST. Established measures for stress and the experiences of playing games were used to measure the effects from the experiments (Chapter 4). Altogether, four experiments were conducted to measure the effect of playing games on acute stress. The first experiment was to measure the effect of playing a game and doing nothing; the second experiment was to measure the effect of immersion on anxiety-induced by stressful event; the third experiment was to measure the effect of playing a game against non-game activity on anxiety-induced by stressful event; and finally, to measure the effect of playing a game against non-game activity and doing nothing. The main scale to measure stress reactivity was the State-Trait Anxiety Inventory (STAI) scale. Other scales were also used to measure different aspects of stress. In the experiment, we used the Acute Stress Appraisal (ASA) to measure the effectiveness of the tasks in the protocol at inducing acute stress. We also added the Visual Analog Scale (VAS) in Experiments 2 and 3.

In the first experiment (Chapter 5), we measured the difference in stress levels between playing and not playing a digital game on acute stress. In the initial analysis of the mean scores, both participants in the waiting and gaming conditions demonstrated a reduction in stress. Further findings reveal a significant main effect of time, indicating that there is a change in the level of stress across the two time points. More importantly, there is a significant interaction effect between time and condition, and gaming was significantly different, suggesting the impact of gaming on stress reduction compared to those in the waiting condition. These results show that gaming can be an effective tool for coping with stress. This supports the notion that games help with stress reduction (Chen, 2021; Collins & Cox, 2014; De Aquino Lopes et al., 2014; Reinecke, 2009).

Because we were able to see the effects from Experiment 1, the rest of the experiments were conducted using the same protocol. However, rather than using the full TSST, we adapted the TSST to focus on the anticipation phase of stress or anxiety by omitting the actual stressful tasks, however, this was hidden from them until after they completed the surveys. This adaptation significantly reduced the experimental time to approximately 30 to 40 minutes compared to the original design which took almost one hour to complete. This approach aligns with Pulopulos et al. (2020), concept of anticipatory stress, which is the expectation of negative events.

In the second experiment (Chapter 6), we measured the differences between low and high immersion games on anxiety. Based on the results from Surveys 1 and 2, in which the rate of immersion increases as the level of stress increases, it was indicated that people with high levels of stress tend to experience high levels of immersion. Therefore, to measure whether immersion could help with reducing anxiety, this experiment was designed to assess the effect of immersion on anxiety. This was done by comparing the effects of low and high immersive games on anxiety. The games used are two variants of the same game called Two Dots. We also measured the immersive level of these and showed that each demonstrated the intended level of immersion.

The analysis showed that participants in both conditions experienced a reduction in anxiety; however, there was no significant difference between the two games. The outcome indicated that both games are effective at lowering participants anxiety level and shows that even low immersion games could successfully manage anxiety. It seems that, rather than immersion, it is the engagement of games that contributed to the reduction in anxiety, which is precursor to immersion Brown & Cairns (2004). It could also suggest that because they are feeling anxious, they are prone to feeling immersed regardless of immersive levels. Hence, low level immersive games also able to successfully do cognitive distancing or be detracted from the stressor (Larsen & Christenfeld, 2011). This also implies that perhaps it is not the game, but rather the act of being distracted that causes anxiety reduction. (Miller et al., 1988) highlighted that individuals adopt different coping strategies depending on their preferences. Therefore, the third experiment was conducted to measure the effect of playing games against non-game activity. Although, it was noted that coping varies between individuals, this experiment only compared gaming with a simple activity. As we are not trying to measure the effectiveness of other coping strategies.

The third experiment (Chapter 7) conducted, compared the effects of playing digital games with non-game activities. The non-game activities involved counting the number of words. Similar to Experiments 1 and 2, the results also showed that participants in all three conditions experienced a reduction in stress and anxiety. The mean scores indicated that low immersive games and high immersive games had a slightly higher reduction in stress and anxiety compared to those in the counting condition. The analysis further revealed that there is no significant difference between playing low and high immersive games, nor with counting, for both the STAI and VAS scales. This suggests that it may not be playing games that reduces stress and anxiety but rather being engaged in any activity. This result support the result in experiment 2. that immersion does not significantly impact stress and anxiety reduction; as long as the person is cognitively distracted from the stressor, it could effectively lower stress and anxiety.

To conclusively determine the effect of playing games on anxiety, the fourth experiment (Chapter 8) was designed to compare the effect of playing digital games against doing non-game activity and waiting. In the first experiment, we saw a significant effect in the reduction of stress observed in the gaming condition. Therefore, comparing the effect of playing games, waiting, and counting showed the overall effect. Indeed, similar to the result in all three experiments, participants demonstrated a reduction in their stress and anxiety levels. Participants in the gaming conditions showed the highest reduction compared to the other two. However, the analysis of variance on the STAI scale did not show a significant effect observed for conditions only over time, but the t-test showed there is a significant difference for people who played games. Similar to what was observed in Experiment 1, where gaming is significantly shown to support stress reduction.

Similarly, the VAS also showed no significant results observed over conditions, only over time. However, contrary to the findings in the STAI scale, the t-test showed a significant difference in both waiting and gaming conditions. This contradictory result can be attributed to the design of the VAS scale, or it could mean that the VAS is more sensitive to detecting changes. Furthermore, the qualitative result also showed that participants in the Waiting condition were practising for the interview. This may have contributed to the result observed in the VAS score. According to the coping theory discussed earlier, this is considered as problem-focused coping, where they face the stressor rather than avoiding them.

One thing to note is that, in the previous three experiments, the Trait score does not affect the State score. However, in this experiment, the linear regression showed it might be affecting the State score. This is potentially due to majority of the participant being students at the university and the experiment was conducted during assessment season.

One notable result from the experiment is that the immersion score and involvement score between gaming and counting are similar. However, the result did show significant result for the counting condition. Which seem to indicate, although counting is engaging, it is not helping with their stress. This could mean that, even though the level of engagement is similar for both activities, counting is not as enjoyable as playing games. In the coping strategy, replacement gratification involves doing activities they enjoy, considering counting are repetitive and monotonous it could lead boredom and the need for exploration (Geana et al., 2016), hence, it is not simply engagement that help reduce stress, but also other factors.

The overall outcomes from these experiments are:

The level of immersion does not affect the reduction of stress and anxiety. In the survey studies, the positive correlation between perceived stress and immersion could be attributed to the concept of replacement gratification or engaging into any activities that they enjoy. Meaning that people engaged in playing game as they experience and increased stress. However, the experimental result did not support the more the immersive the game the more stress reduction experience. Furthermore, our experiments also showed that it is not the game itself that contributes to stress reduction, but rather any activities that are cognitively engaging.

Additionally, our studies indicated that people viewed playing games as a distraction from the tasks in both positive and negative lights. Perhaps this relates to the coping style each individual has. In the Lazarus & Delongis (1983) distinction of coping styles, problem-focused individuals are most likely, prefer to face the stressor head on. Practising and preparing for the job interview, would be considered as such. However, for the emotion-focused people, they viewed gaming as a way to distract them from the stress and manage their emotions.

Another factor to consider is the moderating effects of stress and immersion. While the finding suggests a relationship between perceived stress and immersion, it remains unclear whether the increased immersion reduces anxiety, or whether lower anxiety enables greater immersion. Both directions are plausible. For example, highly immersive gameplay may distract individuals from stressors, facilitating temporary relief from anxiety (Liszio & Masuch, 2019). Conversely, individuals experiencing elevated anxiety may struggle to become immersed in a game due to intrusive thoughts inhibiting their ability to focus. The relationship may vary across individuals; for some, immersion acts as a buffer against anxiety, while for others, anxiety disrupts the immersive experience.

Anecdotal accounts from participants in Experiment 3 indicated that playing Low Immersion game allowed them to think about the task, recall information, and practice while playing the game. Therefore, in the fourth experiment, we added one question, If they were practising the presentation while waiting. Majority of the participants indicated that, they did in fact practice while waiting. This could affect the overall score. Hence, the result observed particularly for the VAS score in the fourth experiment.

The feedback highlights that playing games can be a useful tool for managing stress and providing a temporary distraction from anxiety-inducing tasks. However, the effectiveness of games in reducing stress and aiding preparation varies based on personal preferences and the type of game played. While games can help calm nerves and provide a mental break, they may also divert attention away from important preparation tasks. Future research could further explore how different types of games and personal preferences affect their usefulness in stress management and task performance.

10.2 Research Contributions

In this research, the effect of playing digital game on stress and anxiety induced by stressful event was measured. Just as the literatures have shown, games may help with reducing stress and the anticipation of stress or anxiety, but there is nothing particularly unique about games. Other activities may also effectively lower stress. This implies that it is not just the act of playing games that contributes to stress and anxiety reduction; rather, it is the engagement in activities that provide distraction and gratification. People adopt various coping techniques to reduce stress and anxiety. There is evidence to show that exercising, doing yoga, watching television and scrolling through social media helps with managing stress.

What differentiates these techniques is likely due to the accessibility of games. With the widespread use of smartphones and tablets, games are available anytime and anywhere, allowing people to easily pick up their devices and engage in stress and anxiety relief when needed. Moreover, there are varieties of gaming options available ranging from casual to role-playing adventures, allowing them to select their preferred games. At times, these games are free or at a low-cost, which makes them more appealing. This makes gaming a common choice for individuals seeking distraction and relief from stress and anxiety, providing a brief escape from whatever is causing them distress.

Secondly, the studies also showed that the playing experience does not influence the reduction of stress or anxiety. Although immersion in games can enhance enjoyment, it does not significantly impact the overall effectiveness of games in reducing anxiety. This further highlight that the mere act of engaging with a game, rather than the depth of immersion is what primarily contributes to stress relief. Consequently, individuals may benefit from various gaming experience regardless of how deeply immersed they are in the gameplay.

A key contribution of this study is the adaptation of a stress-induction paradigm inspired by the Trier Social Stress Test (TSST), tailored for digital game research. While the full TSST protocol was not used, the study introduced a condition in which participants were aware they would soon perform a stressful task, creating a period of anticipatory stress. This approach enabled us to examine the effects of playing a digital game during this anticipatory phase, rather than after peak stress levels. The findings suggest that games can serve as coping tools when individuals are in a heightened state of anxiety due to upcoming stress. In this context, games function not as recovery tools, but as proactive interventions, helping individuals manage stress before it reaches its peak. Stress and anticipatory stress are closely intertwined, with anticipatory stress often manifesting through heightened anxiety responses. This approach enabled us to examine the effects of playing a digital game during this anticipatory phase, rather than after peak stress levels. The findings suggest that games can serve as coping tools when individuals are in a heightened state of anxiety due to upcoming stress. In this context, games function not as recovery tools, but as proactive interventions, helping individuals manage stress before it reaches its peak.

10.3 Limitations and Future Work

There are several limitations to this research, future work could focus on these key areas to enhance understanding and applicability.

1. Did not make distinctions between coping styles

In the studies we conducted, we did not make clear distinctions between the different coping styles, which could influence how they perceived the activities. Coping styles refer to the strategies individuals employ to manage stress. While emotional-focused individuals may find playing games helpful for managing stress, those using problem-focused strategies would rather seek solutions to the problem rather than playing games. Furthermore, for emotional-focused individuals, gaming might not be the preferred replacement gratification activity. People may employ different strategies to cope with stress, ranging from exercising to scrolling through social medias such as TikTok or Instagram.

Future studies should aim to explore the difference between emotional-focused (blunters and problem-focused (monitor) styles. These differences can help identify the most effective interventions for stress management. There are activities that are easy to engage with that help with reducing stress, such as watching TikTok, YouTube Shorts, or Instagram. Like games, these are also to engaging and easy to pick-up.

2. Did not make distinctions between gamers and non-gamers

In the studies conducted, there was no distinctions made between the people who play games and those who do not. In the replacement gratification concept, people employ activities that they enjoy in order to cope with stress. Playing games may not be the preferred strategy.

In future studies, it would be beneficial to specifically recruit gamers rather than a random sample of the general population. Gamers are likely to have more experience and familiarity with various game mechanics, genres, and the emotional responses associated with gameplay. This targeted approach can lead to more insightful results, as the motivations and stress-relief strategies employed by gamers may differ significantly from those of non-gamers.

3. Gaming Preferences

The experimental studies relied on only one game to measure its effects on stress relief, which introduces the potential for game bias. Individual game preferences can significantly influence participants' experiences and their perceptions of stress relief. For instance, players who enjoy the selected game are likely to experience greater enjoyment and immersion. This bias could skew the findings, suggesting that the game itself is effective in reducing stress when, in reality, it may simply be the participants' enjoyment that drives the results.

Just as there is differences in the coping strategies people employ, there is also preference in the type of games people play. Some may favour shooting games, while other may gravitate toward a more casual games like puzzle or matching games. Understanding this diverse preference could help paint a better picture by incorporating a variety of games in the research.

4. The experiment did not measure peak stress

In the experimental studies, peak stress was not measured. Peak stress is at the highest point of stress experienced by the participants. According to (Birkett, 2011c) this occurs during the presentation. It represents the highest level of stress experienced during the experiment, which means that the change in stress level from pre-intervention to post-intervention could be small, making it difficult to detect and show significant difference in stress levels.

Future work should look at comparing the effects of playing games before and after performing the tasks. This comparison would help determine whether games are being used more as recovery tool or as a proactive strategy for managing stress, or whether they provide relief after experiencing stress, rather than addressing the stress as it occurs.

5. Using Alternative Tasks Instead of Presentations

In the qualitative feedback, it was evident that participants were practising while waiting to be called. This led to participants focusing on performing well rather the feeling of stress itself. The Trier Social Stress Test (TSST) protocol places participants in a situation where they are expected to perform well under high pressure. This focus on performance can distract participants from reflecting on their actual feelings of stress, leading them to concentrate more on their actions and how they perform rather than on their emotional state. Some may interpret the tasks (presentation and mental math test) as a challenge rather than a threat. Consequently, the results may not accurately capture the relationship between gaming and stress relief.

Future studies could benefit from using a different protocol induces psychological stress without focusing on performance. The stressor in the protocol should enable participants to engage naturally with their emotional responses, without the influence of performance. Therefore, a clearer understanding of how gaming can alleviate stress can be observed.

APPENDIX

Appendix A: Grounding Exercise

In case of a PANIC ATTACK, these exercises could help calm it down.

1. Move the participant to another room and ask them to sit down.
2. Perform a breathing exercise.
   Ask the participant to take a deep breath by placing one hand on their chest and another on their stomach. They should feel the movement on the stomach and not on their chest.
3. Engage them by asking simple questions, such as.
   a. Where they live
   b. Their phone numbers
   c. What course are they taking?
   d. Any personal simple question.
4. Grounding technique i.e. asks them the 5 senses questions.
   a. Ask 5 things they can hear
   b. Ask 4 things they can see
   c. Ask 3 things they can feel (touch)
   d. Ask 1 thing they can taste
   e. Ask 2 things they can smell

NB.

- "Open door" has practitioners working office hours – this is strictly for university student.
- The Security or 111 for non-university participants.

Appendix B: Perceived Stress Scale

Perceived Stress Scale (PSS – 10)

The questions in this scale ask you about your feelings and thoughts during THE LAST FOUR WEEKS. In each case, please indicate which response is applicable by selecting one of the options to represent HOW OFTEN you felt or thought a certain way.

In the last month, how often have you been upset because of something that happened unexpectedly?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you felt that you were unable to control the important things in your life?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you felt nervous and “stressed”?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you felt confident about your ability to handle your personal problems?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you felt that things were going your way?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you found that you could not cope with all the things that you had to do?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you been able to control irritations in your life?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you felt that you were on top of things?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

In the last month, how often have you been angered because of things that were outside of your control?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

how often have you felt difficulties were piling up so high that you could not
overcome them?

- ○ Never
- ○ Almost Never
- ○ Sometimes
- ○ Fairly Often
- ○ Very Often

Appendix C: Game Play Frequency

The questions in following scale ask you what game do you play, how frequent, and when do you play the game(s).

What game have you played the most in the last four week?

____

What other game have you played in the last four week?

____

How often on average do you play game?

- ○ Everyday
- ○ A few times a week
- ○ Once per week
- ○ A few times per month
- ○ Once a month
- ○ A few times per year
- ○ Once per year
- ○ Not at all

How often do you play games in a typical week?

- ○ Everyday
- ○ More than 3 times a week
- ○ 2 or 3 times a week
- ○ Once a week
- ○ Not at all

How many hours each week do you spend playing game EACH WEEK?

- ○ Less than 1 hour a week
- ○ 1 – 2 hours a week
- ○ 2 – 4 hours a week
- ○ 4 – 7 hours a week
- ○ 7 – 12 hours a week
- ○ 12 – 20 hours a week
- ○ More than 20 hours a week
- ○ Not at all

How many hours do you spend playing game EACH DAY?

- Less than an hour each day
- 1 – 2 hours per day
- 2 – 4 hours per day
- 4 – 7 hours per day
- 7 – 12 hours per day
- 12 – 20 hours per day
- More than 20 hours a day
- Not at all

When do you typically play game? (You can pick more than one)

- Before School
- Before Work
- After School
- After Work
- In between classes
- In between work
- Breaktime
- Whenever I can
- Other (please insert): ________________________

Appendix D: Demographics Items

Demographics

Please indicate your age range.

- ◯ Under 18
- ◯ 18 - 24 years old
- ◯ 25 - 34 years old
- ◯ 35 - 44 years old
- ◯ 45 - 55 years old
- ◯ 56 - 60 years old
- ◯ 61 or older

Gender

- ◯ Male
- ◯ Female
- ◯ Non-binary / third gender
- ◯ Prefer not to say

Employment

- ◯ Unemployed
- ◯ Student
- ◯ Full-time employment
- ◯ Part-time employment
- ◯ Other ____

Age

- ◯ Under 18
- ◯ 18 – 24 years old
- ◯ 25 – 34 years old
- ◯ 35 – 44 years old

- 45 – 55 years old
- 56 – 60 years old
- 61 or older

Gender

- Male
- Female
- Prefer not to say

Highest Qualification

- Primary Education
- Secondary Education
- Sixth Form Colleges
- Vocational and Technical Education
- Bachelor’s Degree
- Master’s Degree
- Doctoral Degree

Employment

- Unemployed
- Student
- Full-time employment
- Part-time employment
- Other: ______________________

Appendix E: Video Game Pursuit Items (VGPu)

Game Pursuit Scale

The questions in the next scale ask you about your game pursuit, confidence in playing game, enjoyment of playing game, experience in game flow, and comfort with video game activities. In each case, please indicate which response is applicable.

I spend many hours each week playing video games.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I have searched for information (e.g., magazine or websites) to improve my gaming skills.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I plan to continue improving my video game skills.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I am proactive in seeking ways to improve my video game skills.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree

I deliberately seek out video games to play.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I would call myself a serious gamer.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree Strongly Agree
I am good at video games, compared to others.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I am confident playing video games.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I have good video game skills.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I have a lot of experience with playing video games.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree

Based on my knowledge of previous video games, I can easily see through the rules of a game.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I can keep up with a video game that moves quickly.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I enjoy playing video games.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

Video games are fun.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I like playing video games.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I think video games are entertaining.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I lose track of time when I play video games.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

When I play video games, I lose track of my senses (e.g., can't tell if I am getting hungry or tired).

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I am fully immersed when I play video games.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

Video games are intimidating to me.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I would need help to figure out the controls of a video game.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

Learning how to play a video game is confusing to me.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Neither agree nor disagree
- ○ Somewhat agree
- ○ Strongly Agree

I find video game rules confusing.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
It takes me a long time to understand the controls of a video game.	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree
I find it difficult to understand video games	○ Strongly disagree ○ Somewhat disagree ○ Neither agree nor disagree ○ Somewhat agree ○ Strongly Agree

Appendix F: Survey 1 - Tukey's HSD

Perceived Stress Scale		Mean Diff	lwr	upr	p adj
Counter Strike: Global Offensive	Among Us	-0.29	-0.88	0.30	0.71
Genshin Impact	Among Us	-0.07	-0.55	0.42	1.00
League of Legends: Wild Rift	Among Us	-0.40	-0.93	0.12	0.22
Mobile Legends: Bang Bang	Among Us	-0.53	-1.10	0.05	0.09
PlayerUnknown's Battlegrounds	Among Us	-0.16	-0.64	0.32	0.92
Genshin Impact	Counter Strike: Global Offensive	0.22	-0.32	0.76	0.83
League of Legends: Wild Rift	Counter Strike: Global Offensive	-0.12	-0.69	0.46	0.99
Mobile Legends: Bang Bang	Counter Strike: Global Offensive	-0.24	-0.86	0.38	0.87
PlayerUnknown's Battlegrounds	Counter Strike: Global Offensive	0.13	-0.41	0.66	0.98
League of Legends: Wild Rift	Genshin Impact	-0.34	-0.80	0.12	0.28
Mobile Legends: Bang Bang	Genshin Impact	-0.46	-0.98	0.06	0.11
PlayerUnknown's Battlegrounds	Genshin Impact	-0.10	-0.51	0.32	0.98
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.12	-0.68	0.44	0.99
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.24	-0.22	0.70	0.64
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.37	-0.15	0.88	0.32

Tukey's HSD Perceived Stress and Top Games Played

IGP		Mean Diff	lwr	upr	p adj
Counter Strike: Global Offensive	Among Us	1.07	0.32	1.81	***0.00***
Genshin Impact	Among Us	0.91	0.30	1.51	***0.00***
League of Legends: Wild Rift	Among Us	0.86	0.20	1.52	***0.00***
Mobile Legends: Bang Bang	Among Us	0.61	-0.12	1.33	0.15
PlayerUnknown's Battlegrounds	Among Us	0.73	0.12	1.33	***0.01***
Genshin Impact	Counter Strike: Global Offensive	-0.16	-0.84	0.52	0.98
League of Legends: Wild Rift	Counter Strike: Global Offensive	-0.21	-0.93	0.52	0.96
Mobile Legends: Bang Bang	Counter Strike: Global Offensive	-0.46	-1.24	0.33	0.53
PlayerUnknown's Battlegrounds	Counter Strike: Global Offensive	-0.34	-1.02	0.33	0.68
League of Legends: Wild Rift	Genshin Impact	-0.04	-0.63	0.54	1.00
Mobile Legends: Bang Bang	Genshin Impact	-0.30	-0.96	0.36	0.78
PlayerUnknown's Battlegrounds	Genshin Impact	-0.18	-0.70	0.34	0.92
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.25	-0.96	0.45	0.90
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.14	-0.72	0.44	0.98
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.12	-0.54	0.77	1.00

Tukey's HSD Intention to Game Play and Top Games Played

Game Self Efficacy		Mean Diff	lwr	upr	p adj
Counter Strike: Global Offensive	Among Us	1.18	0.40	1.97	***0.00***
Genshin Impact	Among Us	0.86	0.21	1.50	***0.00***
League of Legends: Wild Rift	Among Us	1.26	0.57	1.96	***0.00***

Mobile Legends: Bang Bang	Among Us	1.03	0.26	1.80	***0.00***
PlayerUnknown's Battlegrounds	Among Us	0.74	0.10	1.38	***0.01***
Genshin Impact	Counter Strike: Global Offensive	-0.33	-1.05	0.39	0.77
League of Legends: Wild Rift	Counter Strike: Global Offensive	0.08	-0.69	0.84	1.00
Mobile Legends: Bang Bang	Counter Strike: Global Offensive	-0.15	-0.98	0.68	0.99
PlayerUnknown's Battlegrounds	Counter Strike: Global Offensive	-0.44	-1.16	0.27	0.48
League of Legends: Wild Rift	Genshin Impact	0.41	-0.21	1.02	0.40
Mobile Legends: Bang Bang	Genshin Impact	0.18	-0.52	0.87	0.98
PlayerUnknown's Battlegrounds	Genshin Impact	-0.11	-0.67	0.44	0.99
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.23	-0.97	0.51	0.95
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.52	-1.13	0.10	0.15
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.29	-0.98	0.40	0.83

Tukey's HSD Game Self-Efficacy and Top Games Played

EOG		**Mean Diff**	**lwr**	**upr**	**p adj**
Counter Strike: Global Offensive	Among Us	0.44	-0.18	1.05	0.32
Genshin Impact	Among Us	0.66	0.15	1.16	***0.00***
League of Legends: Wild Rift	Among Us	0.19	-0.35	0.74	0.91
Mobile Legends: Bang Bang	Among Us	0.19	-0.40	0.79	0.93
PlayerUnknown's Battlegrounds	Among Us	0.15	-0.35	0.65	0.95
Genshin Impact	Counter Strike: Global Offensive	0.22	-0.34	0.78	0.87
League of Legends: Wild Rift	Counter Strike: Global Offensive	-0.24	-0.84	0.36	0.84
Mobile Legends: Bang Bang	Counter Strike: Global Offensive	-0.24	-0.89	0.41	0.89
PlayerUnknown's Battlegrounds	Counter Strike: Global Offensive	-0.28	-0.84	0.28	0.69
League of Legends: Wild Rift	Genshin Impact	-0.46	-0.95	0.02	0.07
Mobile Legends: Bang Bang	Genshin Impact	-0.46	-1.01	0.08	0.15
PlayerUnknown's Battlegrounds	Genshin Impact	-0.50	-0.94	-0.07	***0.01***
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.00	-0.58	0.59	1.00
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.04	-0.52	0.44	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.04	-0.58	0.50	1.00

Tukey's HSD Enjoyment of Game Play and Top Games Played

PGI		**Mean Diff**	**lwr**	**upr**	**p adj**
Counter Strike: Global Offensive	Among Us	0.17	-0.83	1.16	1.00
Genshin Impact	Among Us	0.40	-0.42	1.21	0.71
League of Legends: Wild Rift	Among Us	0.08	-0.80	0.96	1.00
Mobile Legends: Bang Bang	Among Us	-0.35	-1.32	0.62	0.90
PlayerUnknown's Battlegrounds	Among Us	-0.01	-0.82	0.79	1.00
Genshin Impact	Counter Strike: Global Offensive	0.23	-0.68	1.14	0.98
League of Legends: Wild Rift	Counter Strike: Global Offensive	-0.08	-1.05	0.89	1.00
Mobile Legends: Bang Bang	Counter Strike: Global Offensive	-0.52	-1.56	0.53	0.71
PlayerUnknown's Battlegrounds	Counter Strike: Global Offensive	-0.18	-1.08	0.72	0.99

League of Legends: Wild Rift	Genshin Impact	-0.32	-1.10	0.47	0.85
Mobile Legends: Bang Bang	Genshin Impact	-0.75	-1.63	0.13	0.14
PlayerUnknown's Battlegrounds	Genshin Impact	-0.41	-1.11	0.29	0.53
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.43	-1.37	0.51	0.76
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.10	-0.87	0.68	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.33	-0.54	1.21	0.87

Tukey's HSD Prone to Game Immersion and Top Games Played

IWG		**Mean Diff**	**lwr**	**upr**	**p adj**
Counter Strike: Global Offensive	Among Us	-0.59	-1.55	0.37	0.47
Genshin Impact	Among Us	-0.67	-1.46	0.11	0.14
League of Legends: Wild Rift	Among Us	-1.17	-2.02	-0.32	***0.00***
Mobile Legends: Bang Bang	Among Us	-0.76	-1.69	0.17	0.18
PlayerUnknown's Battlegrounds	Among Us	-0.32	-1.10	0.46	0.83
Genshin Impact	Counter Strike: Global Offensive	-0.08	-0.96	0.79	1.00
League of Legends: Wild Rift	Counter Strike: Global Offensive	-0.58	-1.51	0.35	0.47
Mobile Legends: Bang Bang	Counter Strike: Global Offensive	-0.17	-1.18	0.84	1.00
PlayerUnknown's Battlegrounds	Counter Strike: Global Offensive	0.27	-0.60	1.14	0.95
League of Legends: Wild Rift	Genshin Impact	-0.50	-1.25	0.26	0.40
Mobile Legends: Bang Bang	Genshin Impact	-0.09	-0.93	0.76	1.00
PlayerUnknown's Battlegrounds	Genshin Impact	0.35	-0.33	1.03	0.66
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.41	-0.50	1.32	0.77
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.85	0.10	1.59	***0.02***
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.44	-0.41	1.28	0.66

Tukey's HSD Intimidation with Game and Top Games Played

Appendix G: Challenge Originating from Recent Gameplay Interaction Scale (CORGIS)

CORGIS
The questions in the next scale ask your perception of challenge the game presents. Please answer the next part of the survey in relation with the game that you have played the most in LAST 4 WEEKS that you have listed in the previous question.

Q22. Succeeding in the game required much planning.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q23. I had to memorise a lot of different things when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q24. I had to think several steps ahead when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q25. I had to prepare for the things that the game threw at me.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q26. Playing the game requires great effort.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q27. I felt challenged when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q28. I had lots of different things to think about at once in the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q29. The game made me manage several tasks at the same time.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q30. I had to constantly keep track of what was going on in the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q31. I had to think actively when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q32. Playing the game required me to do my best.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)

- Strongly agree (7)

Q33. This game is more than just a game to me.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q34. The things that happened in the game made me sad.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q35. I invested much thought into the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q36. I felt a sense of responsibility for characters and events in the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)

- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q37. The game made me think about real life issues.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q38. Playing the game was stimulating.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q39. I felt a sense of suspense when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q40. The game had moral dilemmas in it where the choice was not obvious.

- Strongly disagree (1)
- Disagree (2)

- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q41. The game involved making moral choices that I didn't agree with.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q42. I had to react quickly when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q43. I had to act quickly when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q44. Thinking fast was an important part of the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q45. Quickly responding to the things that I saw was an important part of the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q46. I had to make snap decisions when playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q47. There were some decisions in the game that I regretted.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)

- Strongly agree (7)

Q48. I wonder how different the outcome in the game would be had I chosen a different option.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q49. I had to make difficult choices in the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q50. I had to think about possible alternatives for my actions in the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q51. The game made me think hard about my decisions.

- Strongly disagree (1)

- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

QAC. Please choose Somewhat agree for this question.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Appendix H: Game User Experience Satisfaction Scale (GUESS-18)

GUESS-18 Based on your experience playing this game, please rate the following statements on a scale from "Strongly Disagree" to "Strongly Agree".

Q1. I find the controls of the game to be straightforward.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q2. I find the game's interface to be easy to navigate.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q3. I am captivated by the game's story from the beginning.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q4. I enjoy the fantasy or story provided by the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)

- Agree (6)
- Strongly agree (7)

Q5. I feel detached from the outside world while playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q6. I do not care to check events that are happening in the real world during the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q7. I think the game is fun.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q8. I feel bored while playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q9. I feel the game allows me to be imaginative.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q10. I feel creative while playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q11. I enjoy the sound effects in the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q12. I feel the game's audio (e.g., sound effects, music) enhances my gaming experience.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q13. I am very focused on my own performance while playing the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q14. I want to do as well as possible during the game.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q15. I find the game supports social interaction (e.g., chat) between players.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q16. I like to play this game with other players.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q17. I enjoy the game's graphics.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Q18. I think the game is visually appealing.

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Neither agree nor disagree (4)
- Somewhat agree (5)
- Agree (6)
- Strongly agree (7)

Appendix I: Survey 2 - Tukey's HSD

CORGIS

PSS and Top Games Played		Mean diff	lwr	upr	p adj
Final Fantasy XIV	Fate/Grand Order	-0.09	-0.92	0.73	1.00
Fire Emblem Heroes	Fate/Grand Order	0.00	-0.49	0.50	1.00
Genshin Impact	Fate/Grand Order	0.34	-0.18	0.87	0.62
Idle Heroes	Fate/Grand Order	-0.08	-0.73	0.58	1.00
League of Legends: Wild Rift	Fate/Grand Order	0.17	-0.36	0.71	1.00
Mobile Legends: Bang Bang	Fate/Grand Order	-0.15	-0.80	0.50	1.00
Noita	Fate/Grand Order	-0.49	-1.25	0.27	0.63
PlayerUnknown's Battlegrounds	Fate/Grand Order	-0.09	-0.92	0.73	1.00
Pokémon GO	Fate/Grand Order	-0.20	-0.70	0.30	0.98
Pokémon Legends: Arceus	Fate/Grand Order	0.28	-0.47	1.04	0.99
SuperStar Series	Fate/Grand Order	0.35	-0.07	0.77	0.22
VALORANT	Fate/Grand Order	-0.06	-0.77	0.65	1.00
Fire Emblem Heroes	Final Fantasy XIV	0.09	-0.77	0.95	1.00
Genshin Impact	Final Fantasy XIV	0.43	-0.44	1.31	0.91
Idle Heroes	Final Fantasy XIV	0.01	-0.94	0.97	1.00
League of Legends: Wild Rift	Final Fantasy XIV	0.27	-0.62	1.15	1.00
Mobile Legends: Bang Bang	Final Fantasy XIV	-0.06	-1.02	0.90	1.00
Noita	Final Fantasy XIV	-0.40	-1.43	0.64	0.99
PlayerUnknown's Battlegrounds	Final Fantasy XIV	0.00	-1.08	1.08	1.00
Pokémon GO	Final Fantasy XIV	-0.11	-0.97	0.75	1.00
Pokémon Legends: Arceus	Final Fantasy XIV	0.38	-0.66	1.41	0.99
SuperStar Series	Final Fantasy XIV	0.44	-0.38	1.26	0.85
VALORANT	Final Fantasy XIV	0.03	-0.97	1.03	1.00
Genshin Impact	Fire Emblem Heroes	0.34	-0.24	0.92	0.75
Idle Heroes	Fire Emblem Heroes	-0.08	-0.77	0.62	1.00
League of Legends: Wild Rift	Fire Emblem Heroes	0.17	-0.41	0.76	1.00
Mobile Legends: Bang Bang	Fire Emblem Heroes	-0.15	-0.85	0.54	1.00
Noita	Fire Emblem Heroes	-0.49	-1.28	0.30	0.69
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	-0.09	-0.95	0.77	1.00
Pokémon GO	Fire Emblem Heroes	-0.20	-0.75	0.35	0.99
Pokémon Legends: Arceus	Fire Emblem Heroes	0.28	-0.51	1.08	0.99
SuperStar Series	Fire Emblem Heroes	0.35	-0.14	0.83	0.45
VALORANT	Fire Emblem Heroes	-0.06	-0.81	0.68	1.00
Idle Heroes	Genshin Impact	-0.42	-1.13	0.30	0.77
League of Legends: Wild Rift	Genshin Impact	-0.17	-0.78	0.44	1.00
Mobile Legends: Bang Bang	Genshin Impact	-0.49	-1.21	0.22	0.52
Noita	Genshin Impact	-0.83	-1.64	-0.02	***0.04***
PlayerUnknown's Battlegrounds	Genshin Impact	-0.43	-1.31	0.44	0.91
Pokémon GO	Genshin Impact	-0.54	-1.12	0.04	0.10
Pokémon Legends: Arceus	Genshin Impact	-0.06	-0.87	0.76	1.00
SuperStar Series	Genshin Impact	0.01	-0.51	0.52	1.00
VALORANT	Genshin Impact	-0.40	-1.17	0.36	0.87
League of Legends: Wild Rift	Idle Heroes	0.25	-0.47	0.97	0.99
Mobile Legends: Bang Bang	Idle Heroes	-0.08	-0.89	0.74	1.00
Noita	Idle Heroes	-0.41	-1.31	0.49	0.95
PlayerUnknown's Battlegrounds	Idle Heroes	-0.02	-0.97	0.94	1.00
Pokémon GO	Idle Heroes	-0.12	-0.82	0.57	1.00

Pokémon Legends: Arceus	Idle Heroes	0.36	-0.54	1.26	0.98
SuperStar Series	Idle Heroes	0.43	-0.22	1.07	0.59
VALORANT	Idle Heroes	0.01	-0.84	0.87	1.00
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.33	-1.05	0.39	0.95
Noita	League of Legends: Wild Rift	-0.66	-1.48	0.16	0.26
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.27	-1.15	0.61	1.00
Pokémon GO	League of Legends: Wild Rift	-0.37	-0.96	0.21	0.64
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.11	-0.71	0.93	1.00
SuperStar Series	League of Legends: Wild Rift	0.17	-0.35	0.70	1.00
VALORANT	League of Legends: Wild Rift	-0.24	-1.01	0.53	1.00
Noita	Mobile Legends: Bang Bang	-0.34	-1.24	0.56	0.99
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.06	-0.90	1.02	1.00
Pokémon GO	Mobile Legends: Bang Bang	-0.05	-0.75	0.65	1.00
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	0.44	-0.46	1.34	0.92
SuperStar Series	Mobile Legends: Bang Bang	0.50	-0.14	1.14	0.32
VALORANT	Mobile Legends: Bang Bang	0.09	-0.77	0.95	1.00
PlayerUnknown's Battlegrounds	Noita	0.40	-0.64	1.43	0.99
Pokémon GO	Noita	0.29	-0.51	1.09	0.99
Pokémon Legends: Arceus	Noita	0.77	-0.21	1.75	0.30
SuperStar Series	Noita	0.84	0.09	1.59	***0.01***
VALORANT	Noita	0.43	-0.52	1.37	0.95
Pokémon GO	PlayerUnknown's Battlegrounds	-0.11	-0.97	0.75	1.00
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	0.38	-0.66	1.41	0.99
SuperStar Series	PlayerUnknown's Battlegrounds	0.44	-0.38	1.26	0.85
VALORANT	PlayerUnknown's Battlegrounds	0.03	-0.97	1.03	1.00
Pokémon Legends: Arceus	Pokémon GO	0.48	-0.31	1.28	0.71
SuperStar Series	Pokémon GO	0.55	0.06	1.04	***0.01***
VALORANT	Pokémon GO	0.14	-0.61	0.89	1.00
SuperStar Series	Pokémon Legends: Arceus	0.06	-0.69	0.81	1.00
VALORANT	Pokémon Legends: Arceus	-0.35	-1.29	0.59	0.99
VALORANT	SuperStar Series	-0.41	-1.11	0.29	0.76

PSS and Cognitive Challenge		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	1.58	0.35	2.81	***0.00***
Fire Emblem Heroes	Fate/Grand Order	0.78	0.04	1.52	***0.03***
Genshin Impact	Fate/Grand Order	0.31	-0.47	1.10	0.97
Idle Heroes	Fate/Grand Order	0.44	-0.53	1.41	0.93
League of Legends: Wild Rift	Fate/Grand Order	1.93	1.14	2.72	***0.00***
Mobile Legends: Bang Bang	Fate/Grand Order	1.52	0.55	2.49	***0.00***
PlayerUnknown's Battlegrounds	Fate/Grand Order	1.31	0.08	2.54	***0.03***
Pokémon GO	Fate/Grand Order	-0.33	-1.08	0.41	0.93
Pokémon Legends: Arceus	Fate/Grand Order	0.80	-0.33	1.93	0.44
SuperStar Series	Fate/Grand Order	0.64	0.02	1.27	***0.04***
Fire Emblem Heroes	Final Fantasy XIV	-0.80	-2.08	0.48	0.63
Genshin Impact	Final Fantasy XIV	-1.26	-2.57	0.04	0.07
Idle Heroes	Final Fantasy XIV	-1.14	-2.57	0.28	0.26
League of Legends: Wild Rift	Final Fantasy XIV	0.35	-0.96	1.67	1.00
Mobile Legends: Bang Bang	Final Fantasy XIV	-0.06	-1.48	1.37	1.00
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.27	-1.89	1.34	1.00

Pokémon GO	Final Fantasy XIV	-1.91	-3.20	-0.63	***0.00***
Pokémon Legends: Arceus	Final Fantasy XIV	-0.78	-2.32	0.76	0.87
SuperStar Series	Final Fantasy XIV	-0.93	-2.15	0.28	0.32
Genshin Impact	Fire Emblem Heroes	-0.47	-1.33	0.39	0.80
Idle Heroes	Fire Emblem Heroes	-0.34	-1.38	0.69	0.99
League of Legends: Wild Rift	Fire Emblem Heroes	1.15	0.28	2.02	***0.00***
Mobile Legends: Bang Bang	Fire Emblem Heroes	0.74	-0.29	1.77	0.42
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	0.52	-0.76	1.80	0.96
Pokémon GO	Fire Emblem Heroes	-1.11	-1.94	-0.29	***0.00***
Pokémon Legends: Arceus	Fire Emblem Heroes	0.02	-1.16	1.20	1.00
SuperStar Series	Fire Emblem Heroes	-0.14	-0.86	0.58	1.00
Idle Heroes	Genshin Impact	0.12	-0.95	1.19	1.00
League of Legends: Wild Rift	Genshin Impact	1.62	0.71	2.52	***0.00***
Mobile Legends: Bang Bang	Genshin Impact	1.21	0.14	2.27	***0.01***
PlayerUnknown's Battlegrounds	Genshin Impact	0.99	-0.32	2.30	0.33
Pokémon GO	Genshin Impact	-0.65	-1.51	0.22	0.35
Pokémon Legends: Arceus	Genshin Impact	0.49	-0.73	1.70	0.97
SuperStar Series	Genshin Impact	0.33	-0.44	1.10	0.95
League of Legends: Wild Rift	Idle Heroes	1.50	0.42	2.57	***0.00***
Mobile Legends: Bang Bang	Idle Heroes	1.09	-0.13	2.30	0.13
PlayerUnknown's Battlegrounds	Idle Heroes	0.87	-0.56	2.30	0.67
Pokémon GO	Idle Heroes	-0.77	-1.81	0.27	0.37
Pokémon Legends: Arceus	Idle Heroes	0.37	-0.98	1.71	1.00
SuperStar Series	Idle Heroes	0.21	-0.75	1.16	1.00
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.41	-1.48	0.66	0.98
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.63	-1.94	0.69	0.90
Pokémon GO	League of Legends: Wild Rift	-2.27	-3.14	-1.39	***0.00***
Pokémon Legends: Arceus	League of Legends: Wild Rift	-1.13	-2.35	0.09	0.10
SuperStar Series	League of Legends: Wild Rift	-1.29	-2.06	-0.51	***0.00***
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.22	-1.64	1.21	1.00
Pokémon GO	Mobile Legends: Bang Bang	-1.85	-2.89	-0.82	***0.00***
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.72	-2.06	0.62	0.81
SuperStar Series	Mobile Legends: Bang Bang	-0.88	-1.83	0.08	0.11
Pokémon GO	PlayerUnknown's Battlegrounds	-1.64	-2.92	-0.36	***0.00***
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.50	-2.04	1.04	0.99
SuperStar Series	PlayerUnknown's Battlegrounds	-0.66	-1.88	0.56	0.80
Pokémon Legends: Arceus	Pokémon GO	1.13	-0.05	2.32	0.08
SuperStar Series	Pokémon GO	0.98	0.25	1.70	***0.00***
SuperStar Series	Pokémon Legends: Arceus	-0.16	-1.28	0.96	1.00

PSS and Emotional Challenge		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	0.09	-1.12	1.30	1.00
Fire Emblem Heroes	Fate/Grand Order	-0.85	-1.58	-0.12	***0.01***
Genshin Impact	Fate/Grand Order	-0.59	-1.36	0.18	0.34
Idle Heroes	Fate/Grand Order	-1.40	-2.36	-0.44	***0.00***
League of Legends: Wild Rift	Fate/Grand Order	-0.52	-1.30	0.26	0.58
Mobile Legends: Bang Bang	Fate/Grand Order	-0.62	-1.58	0.33	0.61
Noita	Fate/Grand Order	-1.19	-2.30	-0.08	***0.02***
PlayerUnknown's Battlegrounds	Fate/Grand Order	-0.39	-1.61	0.82	1.00

Pokémon GO	Fate/Grand Order	-1.42	-2.15	-0.68	***0.00***
Pokémon Legends: Arceus	Fate/Grand Order	-0.83	-1.94	0.29	0.39
SuperStar Series	Fate/Grand Order	-1.08	-1.70	-0.47	***0.00***
VALORANT	Fate/Grand Order	-0.49	-1.53	0.55	0.93
Fire Emblem Heroes	Final Fantasy XIV	-0.94	-2.20	0.32	0.38
Genshin Impact	Final Fantasy XIV	-0.68	-1.97	0.61	0.87
Idle Heroes	Final Fantasy XIV	-1.49	-2.90	-0.08	***0.03***
League of Legends: Wild Rift	Final Fantasy XIV	-0.61	-1.90	0.68	0.94
Mobile Legends: Bang Bang	Final Fantasy XIV	-0.71	-2.12	0.69	0.90
Noita	Final Fantasy XIV	-1.28	-2.80	0.24	0.20
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.48	-2.08	1.11	1.00
Pokémon GO	Final Fantasy XIV	-1.51	-2.78	-0.24	***0.01***
Pokémon Legends: Arceus	Final Fantasy XIV	-0.92	-2.43	0.60	0.72
SuperStar Series	Final Fantasy XIV	-1.17	-2.38	0.03	0.06
VALORANT	Final Fantasy XIV	-0.58	-2.05	0.88	0.98
Genshin Impact	Fire Emblem Heroes	0.26	-0.59	1.11	1.00
Idle Heroes	Fire Emblem Heroes	-0.55	-1.57	0.47	0.85
League of Legends: Wild Rift	Fire Emblem Heroes	0.33	-0.52	1.19	0.99
Mobile Legends: Bang Bang	Fire Emblem Heroes	0.23	-0.79	1.25	1.00
Noita	Fire Emblem Heroes	-0.34	-1.51	0.83	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	0.46	-0.80	1.72	0.99
Pokémon GO	Fire Emblem Heroes	-0.57	-1.38	0.25	0.50
Pokémon Legends: Arceus	Fire Emblem Heroes	0.03	-1.14	1.19	1.00
SuperStar Series	Fire Emblem Heroes	-0.23	-0.94	0.48	1.00
VALORANT	Fire Emblem Heroes	0.36	-0.74	1.46	1.00
Idle Heroes	Genshin Impact	-0.81	-1.86	0.24	0.34
League of Legends: Wild Rift	Genshin Impact	0.07	-0.82	0.97	1.00
Mobile Legends: Bang Bang	Genshin Impact	-0.03	-1.08	1.02	1.00
Noita	Genshin Impact	-0.60	-1.79	0.60	0.91
PlayerUnknown's Battlegrounds	Genshin Impact	0.20	-1.09	1.49	1.00
Pokémon GO	Genshin Impact	-0.83	-1.68	0.03	0.07
Pokémon Legends: Arceus	Genshin Impact	-0.23	-1.43	0.96	1.00
SuperStar Series	Genshin Impact	-0.49	-1.25	0.26	0.61
VALORANT	Genshin Impact	0.10	-1.03	1.23	1.00
League of Legends: Wild Rift	Idle Heroes	0.88	-0.18	1.94	0.22
Mobile Legends: Bang Bang	Idle Heroes	0.78	-0.42	1.97	0.61
Noita	Idle Heroes	0.21	-1.11	1.53	1.00
PlayerUnknown's Battlegrounds	Idle Heroes	1.01	-0.40	2.42	0.45
Pokémon GO	Idle Heroes	-0.02	-1.04	1.01	1.00
Pokémon Legends: Arceus	Idle Heroes	0.57	-0.75	1.90	0.97
SuperStar Series	Idle Heroes	0.32	-0.63	1.26	1.00
VALORANT	Idle Heroes	0.91	-0.35	2.17	0.45
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.10	-1.16	0.96	1.00
Noita	League of Legends: Wild Rift	-0.67	-1.87	0.53	0.82
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.13	-1.17	1.42	1.00
Pokémon GO	League of Legends: Wild Rift	-0.90	-1.76	-0.04	***0.03***
Pokémon Legends: Arceus	League of Legends: Wild Rift	-0.31	-1.51	0.90	1.00

SuperStar Series	League of Legends: Wild Rift	-0.56	-1.33	0.20	0.40
VALORANT	League of Legends: Wild Rift	0.03	-1.11	1.16	1.00
Noita	Mobile Legends: Bang Bang	-0.57	-1.89	0.76	0.97
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.23	-1.18	1.64	1.00
Pokémon GO	Mobile Legends: Bang Bang	-0.80	-1.82	0.23	0.32
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.20	-1.53	1.12	1.00
SuperStar Series	Mobile Legends: Bang Bang	-0.46	-1.41	0.48	0.92
VALORANT	Mobile Legends: Bang Bang	0.13	-1.13	1.39	1.00
PlayerUnknown's Battlegrounds	Noita	0.80	-0.72	2.32	0.87
Pokémon GO	Noita	-0.23	-1.40	0.94	1.00
Pokémon Legends: Arceus	Noita	0.36	-1.08	1.80	1.00
SuperStar Series	Noita	0.11	-1.00	1.21	1.00
VALORANT	Noita	0.70	-0.69	2.08	0.90
Pokémon GO	PlayerUnknown's Battlegrounds	-1.03	-2.29	0.24	0.26
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.43	-1.95	1.09	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-0.69	-1.89	0.51	0.78
VALORANT	PlayerUnknown's Battlegrounds	-0.10	-1.57	1.36	1.00
Pokémon Legends: Arceus	Pokémon GO	0.59	-0.58	1.76	0.90
SuperStar Series	Pokémon GO	0.33	-0.38	1.05	0.94
VALORANT	Pokémon GO	0.93	-0.18	2.03	0.21
SuperStar Series	Pokémon Legends: Arceus	-0.26	-1.36	0.84	1.00
VALORANT	Pokémon Legends: Arceus	0.33	-1.05	1.72	1.00
VALORANT	SuperStar Series	0.59	-0.44	1.62	0.78

PSS and Performative Challenge		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	4.01	2.63	5.39	***0.00***
Fire Emblem Heroes	Fate/Grand Order	0.78	-0.04	1.61	0.08
Genshin Impact	Fate/Grand Order	2.53	1.65	3.41	***0.00***
Idle Heroes	Fate/Grand Order	0.23	-0.86	1.32	1.00
League of Legends: Wild Rift	Fate/Grand Order	4.09	3.20	4.97	***0.00***
Mobile Legends: Bang Bang	Fate/Grand Order	4.06	2.97	5.14	***0.00***
Noita	Fate/Grand Order	3.54	2.28	4.81	***0.00***
PlayerUnknown's Battlegrounds	Fate/Grand Order	4.32	2.94	5.70	***0.00***
Pokémon GO	Fate/Grand Order	1.66	0.83	2.49	***0.00***
Pokémon Legends: Arceus	Fate/Grand Order	3.80	2.53	5.06	***0.00***
SuperStar Series	Fate/Grand Order	2.82	2.12	3.52	***0.00***
VALORANT	Fate/Grand Order	4.28	3.10	5.46	***0.00***
Fire Emblem Heroes	Final Fantasy XIV	-3.23	-4.66	-1.79	***0.00***
Genshin Impact	Final Fantasy XIV	-1.48	-2.94	-0.02	***0.04***
Idle Heroes	Final Fantasy XIV	-3.78	-5.38	-2.18	***0.00***
League of Legends: Wild Rift	Final Fantasy XIV	0.08	-1.39	1.55	1.00
Mobile Legends: Bang Bang	Final Fantasy XIV	0.05	-1.55	1.64	1.00
Noita	Final Fantasy XIV	-0.47	-2.19	1.26	1.00
PlayerUnknown's Battlegrounds	Final Fantasy XIV	0.31	-1.50	2.12	1.00
Pokémon GO	Final Fantasy XIV	-2.35	-3.79	-0.91	***0.00***
Pokémon Legends: Arceus	Final Fantasy XIV	-0.21	-1.94	1.51	1.00

SuperStar Series	Final Fantasy XIV	-1.19	-2.55	0.18	0.16
VALORANT	Final Fantasy XIV	0.27	-1.39	1.93	1.00
Genshin Impact	Fire Emblem Heroes	1.75	0.78	2.71	***0.00***
Idle Heroes	Fire Emblem Heroes	-0.55	-1.71	0.60	0.93
League of Legends: Wild Rift	Fire Emblem Heroes	3.30	2.33	4.27	***0.00***
Mobile Legends: Bang Bang	Fire Emblem Heroes	3.27	2.12	4.43	***0.00***
Noita	Fire Emblem Heroes	2.76	1.43	4.09	***0.00***
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	3.54	2.10	4.97	***0.00***
Pokémon GO	Fire Emblem Heroes	0.88	-0.05	1.80	0.08
Pokémon Legends: Arceus	Fire Emblem Heroes	3.01	1.69	4.34	***0.00***
SuperStar Series	Fire Emblem Heroes	2.04	1.23	2.84	***0.00***
VALORANT	Fire Emblem Heroes	3.50	2.25	4.74	***0.00***
Idle Heroes	Genshin Impact	-2.30	-3.49	-1.10	***0.00***
League of Legends: Wild Rift	Genshin Impact	1.56	0.54	2.57	***0.00***
Mobile Legends: Bang Bang	Genshin Impact	1.53	0.33	2.72	***0.00***
Noita	Genshin Impact	1.01	-0.34	2.37	0.38
PlayerUnknown's Battlegrounds	Genshin Impact	1.79	0.33	3.25	***0.00***
Pokémon GO	Genshin Impact	-0.87	-1.84	0.10	0.13
Pokémon Legends: Arceus	Genshin Impact	1.27	-0.09	2.63	0.09
SuperStar Series	Genshin Impact	0.29	-0.57	1.15	1.00
VALORANT	Genshin Impact	1.75	0.47	3.03	***0.00***
League of Legends: Wild Rift	Idle Heroes	3.86	2.65	5.06	***0.00***
Mobile Legends: Bang Bang	Idle Heroes	3.83	2.47	5.18	***0.00***
Noita	Idle Heroes	3.31	1.81	4.81	***0.00***
PlayerUnknown's Battlegrounds	Idle Heroes	4.09	2.49	5.69	***0.00***
Pokémon GO	Idle Heroes	1.43	0.27	2.59	***0.00***
Pokémon Legends: Arceus	Idle Heroes	3.57	2.07	5.07	***0.00***
SuperStar Series	Idle Heroes	2.59	1.52	3.66	***0.00***
VALORANT	Idle Heroes	4.05	2.62	5.48	***0.00***
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.03	-1.23	1.17	1.00
Noita	League of Legends: Wild Rift	-0.54	-1.91	0.82	0.98
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.23	-1.23	1.70	1.00
Pokémon GO	League of Legends: Wild Rift	-2.43	-3.40	-1.45	***0.00***
Pokémon Legends: Arceus	League of Legends: Wild Rift	-0.29	-1.65	1.08	1.00
SuperStar Series	League of Legends: Wild Rift	-1.27	-2.13	-0.40	***0.00***
VALORANT	League of Legends: Wild Rift	0.20	-1.09	1.48	1.00
Noita	Mobile Legends: Bang Bang	-0.51	-2.01	0.99	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.27	-1.33	1.86	1.00
Pokémon GO	Mobile Legends: Bang Bang	-2.39	-3.56	-1.23	***0.00***
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.26	-1.76	1.24	1.00
SuperStar Series	Mobile Legends: Bang Bang	-1.24	-2.31	-0.16	***0.01***
VALORANT	Mobile Legends: Bang Bang	0.23	-1.21	1.66	1.00
PlayerUnknown's Battlegrounds	Noita	0.78	-0.95	2.50	0.95
Pokémon GO	Noita	-1.88	-3.21	-0.55	***0.00***
Pokémon Legends: Arceus	Noita	0.25	-1.38	1.89	1.00
SuperStar Series	Noita	-0.72	-1.97	0.53	0.78
VALORANT	Noita	0.74	-0.83	2.31	0.94

Pokémon GO	PlayerUnknown's Battlegrounds	-2.66	-4.10	-1.22	***0.00***
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.52	-2.25	1.20	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-1.50	-2.87	-0.14	***0.02***
VALORANT	PlayerUnknown's Battlegrounds	-0.04	-1.70	1.62	1.00
Pokémon Legends: Arceus	Pokémon GO	2.14	0.81	3.47	***0.00***
SuperStar Series	Pokémon GO	1.16	0.35	1.97	***0.00***
VALORANT	Pokémon GO	2.62	1.37	3.87	***0.00***
SuperStar Series	Pokémon Legends: Arceus	-0.98	-2.23	0.27	0.31
VALORANT	Pokémon Legends: Arceus	0.48	-1.09	2.05	1.00
VALORANT	SuperStar Series	1.46	0.29	2.63	***0.00***

PSS and Decision-Making Challenge		**Mean diff**	**Lower**	**Upper**	**p adj**
Final Fantasy XIV	Fate/Grand Order	-0.48	-1.94	0.99	1.00
Fire Emblem Heroes	Fate/Grand Order	0.88	0.00	1.76	***0.05***
Genshin Impact	Fate/Grand Order	-0.47	-1.41	0.46	0.90
Idle Heroes	Fate/Grand Order	0.94	-0.22	2.10	0.25
League of Legends: Wild Rift	Fate/Grand Order	1.76	0.82	2.71	***0.00***
Mobile Legends: Bang Bang	Fate/Grand Order	1.15	0.00	2.31	0.05
Noita	Fate/Grand Order	1.15	-0.20	2.50	0.18
PlayerUnknown's Battlegrounds	Fate/Grand Order	0.92	-0.54	2.39	0.66
Pokémon GO	Fate/Grand Order	-0.87	-1.76	0.02	0.06
Pokémon Legends: Arceus	Fate/Grand Order	0.31	-1.03	1.66	1.00
SuperStar Series	Fate/Grand Order	0.19	-0.55	0.94	1.00
VALORANT	Fate/Grand Order	1.25	-0.01	2.50	0.05
Fire Emblem Heroes	Final Fantasy XIV	1.36	-0.17	2.88	0.14
Genshin Impact	Final Fantasy XIV	0.00	-1.55	1.56	1.00
Idle Heroes	Final Fantasy XIV	1.42	-0.28	3.12	0.22
League of Legends: Wild Rift	Final Fantasy XIV	2.24	0.68	3.81	***0.00***
Mobile Legends: Bang Bang	Final Fantasy XIV	1.63	-0.07	3.33	0.08
Noita	Final Fantasy XIV	1.63	-0.21	3.46	0.14
PlayerUnknown's Battlegrounds	Final Fantasy XIV	1.40	-0.52	3.32	0.43
Pokémon GO	Final Fantasy XIV	-0.39	-1.92	1.14	1.00
Pokémon Legends: Arceus	Final Fantasy XIV	0.79	-1.04	2.63	0.97
SuperStar Series	Final Fantasy XIV	0.67	-0.78	2.13	0.95
VALORANT	Final Fantasy XIV	1.72	-0.05	3.50	0.06
Genshin Impact	Fire Emblem Heroes	-1.35	-2.38	-0.33	***0.00***
Idle Heroes	Fire Emblem Heroes	0.06	-1.17	1.29	1.00
League of Legends: Wild Rift	Fire Emblem Heroes	0.88	-0.15	1.92	0.19
Mobile Legends: Bang Bang	Fire Emblem Heroes	0.27	-0.96	1.50	1.00
Noita	Fire Emblem Heroes	0.27	-1.14	1.68	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	0.04	-1.48	1.57	1.00
Pokémon GO	Fire Emblem Heroes	-1.75	-2.73	-0.77	***0.00***
Pokémon Legends: Arceus	Fire Emblem Heroes	-0.57	-1.98	0.84	0.98
SuperStar Series	Fire Emblem Heroes	-0.69	-1.54	0.17	0.27
VALORANT	Fire Emblem Heroes	0.37	-0.96	1.69	1.00

Idle Heroes	Genshin Impact	1.41	0.14	2.69	***0.01***
League of Legends: Wild Rift	Genshin Impact	2.24	1.16	3.32	***0.00***
Mobile Legends: Bang Bang	Genshin Impact	1.63	0.36	2.90	***0.00***
Noita	Genshin Impact	1.62	0.18	3.07	***0.01***
PlayerUnknown's Battlegrounds	Genshin Impact	1.40	-0.16	2.95	0.13
Pokémon GO	Genshin Impact	-0.40	-1.43	0.64	0.99
Pokémon Legends: Arceus	Genshin Impact	0.79	-0.66	2.23	0.84
SuperStar Series	Genshin Impact	0.67	-0.25	1.58	0.42
VALORANT	Genshin Impact	1.72	0.36	3.08	***0.00***
League of Legends: Wild Rift	Idle Heroes	0.82	-0.46	2.10	0.63
Mobile Legends: Bang Bang	Idle Heroes	0.21	-1.23	1.66	1.00
Noita	Idle Heroes	0.21	-1.39	1.81	1.00
PlayerUnknown's Battlegrounds	Idle Heroes	-0.02	-1.72	1.68	1.00
Pokémon GO	Idle Heroes	-1.81	-3.05	-0.57	***0.00***
Pokémon Legends: Arceus	Idle Heroes	-0.63	-2.23	0.97	0.99
SuperStar Series	Idle Heroes	-0.75	-1.89	0.40	0.60
VALORANT	Idle Heroes	0.31	-1.22	1.83	1.00
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.61	-1.89	0.67	0.93
Noita	League of Legends: Wild Rift	-0.61	-2.07	0.84	0.97
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.84	-2.41	0.72	0.85
Pokémon GO	League of Legends: Wild Rift	-2.63	-3.67	-1.59	***0.00***
Pokémon Legends: Arceus	League of Legends: Wild Rift	-1.45	-2.90	0.00	0.05
SuperStar Series	League of Legends: Wild Rift	-1.57	-2.49	-0.64	***0.00***
VALORANT	League of Legends: Wild Rift	-0.52	-1.89	0.85	0.99
Noita	Mobile Legends: Bang Bang	0.00	-1.60	1.60	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.23	-1.93	1.47	1.00
Pokémon GO	Mobile Legends: Bang Bang	-2.02	-3.26	-0.78	***0.00***
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.84	-2.44	0.76	0.87
SuperStar Series	Mobile Legends: Bang Bang	-0.96	-2.10	0.18	0.21
VALORANT	Mobile Legends: Bang Bang	0.09	-1.43	1.62	1.00
PlayerUnknown's Battlegrounds	Noita	-0.23	-2.06	1.61	1.00
Pokémon GO	Noita	-2.02	-3.44	-0.60	***0.00***
Pokémon Legends: Arceus	Noita	-0.84	-2.58	0.90	0.93
SuperStar Series	Noita	-0.96	-2.29	0.38	0.45
VALORANT	Noita	0.10	-1.58	1.77	1.00
Pokémon GO	PlayerUnknown's Battlegrounds	-1.79	-3.32	-0.26	***0.01***
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.61	-2.44	1.23	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-0.73	-2.18	0.73	0.90
VALORANT	PlayerUnknown's Battlegrounds	0.32	-1.45	2.10	1.00
Pokémon Legends: Arceus	Pokémon GO	1.18	-0.23	2.60	0.21
SuperStar Series	Pokémon GO	1.06	0.20	1.93	***0.00***
VALORANT	Pokémon GO	2.12	0.78	3.45	***0.00***
SuperStar Series	Pokémon Legends: Arceus	-0.12	-1.45	1.21	1.00
VALORANT	Pokémon Legends: Arceus	0.93	-0.74	2.61	0.82
VALORANT	SuperStar Series	1.05	-0.19	2.30	0.19

GUESS-18

PSS and UP		Mean diff	Lower	Upper	p adj
Final Fantasy XIV	Fate/Grand Order	-0.07	-1.18	1.03	1.00
Fire Emblem Heroes	Fate/Grand Order	0.01	-0.65	0.68	1.00
Genshin Impact	Fate/Grand Order	-0.07	-0.78	0.63	1.00
Idle Heroes	Fate/Grand Order	-0.54	-1.41	0.33	0.69
League of Legends: Wild Rift	Fate/Grand Order	-0.54	-1.25	0.18	0.37
Mobile Legends: Bang Bang	Fate/Grand Order	-0.04	-0.91	0.83	1.00
Noita	Fate/Grand Order	0.20	-0.81	1.22	1.00
PlayerUnknown's Battlegrounds	Fate/Grand Order	-0.29	-1.40	0.81	1.00
Pokémon GO	Fate/Grand Order	-0.31	-0.98	0.36	0.95
Pokémon Legends: Arceus	Fate/Grand Order	-0.21	-1.22	0.81	1.00
SuperStar Series	Fate/Grand Order	-0.37	-0.93	0.20	0.61
VALORANT	Fate/Grand Order	0.04	-0.90	0.99	1.00
Fire Emblem Heroes	Final Fantasy XIV	0.09	-1.07	1.24	1.00
Genshin Impact	Final Fantasy XIV	0.00	-1.18	1.18	1.00
Idle Heroes	Final Fantasy XIV	-0.47	-1.75	0.81	0.99
League of Legends: Wild Rift	Final Fantasy XIV	-0.46	-1.64	0.72	0.98
Mobile Legends: Bang Bang	Final Fantasy XIV	0.03	-1.25	1.31	1.00
Noita	Final Fantasy XIV	0.27	-1.11	1.66	1.00
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.22	-1.67	1.23	1.00
Pokémon GO	Final Fantasy XIV	-0.24	-1.39	0.92	1.00
Pokémon Legends: Arceus	Final Fantasy XIV	-0.14	-1.52	1.25	1.00
SuperStar Series	Final Fantasy XIV	-0.30	-1.39	0.80	1.00
VALORANT	Final Fantasy XIV	0.12	-1.22	1.45	1.00
Genshin Impact	Fire Emblem Heroes	-0.09	-0.86	0.69	1.00
Idle Heroes	Fire Emblem Heroes	-0.55	-1.48	0.38	0.74
League of Legends: Wild Rift	Fire Emblem Heroes	-0.55	-1.33	0.23	0.48
Mobile Legends: Bang Bang	Fire Emblem Heroes	-0.05	-0.98	0.88	1.00
Noita	Fire Emblem Heroes	0.19	-0.88	1.25	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	-0.31	-1.46	0.84	1.00
Pokémon GO	Fire Emblem Heroes	-0.32	-1.06	0.42	0.97
Pokémon Legends: Arceus	Fire Emblem Heroes	-0.22	-1.29	0.84	1.00
SuperStar Series	Fire Emblem Heroes	-0.38	-1.03	0.26	0.75
VALORANT	Fire Emblem Heroes	0.03	-0.97	1.03	1.00
Idle Heroes	Genshin Impact	-0.47	-1.43	0.49	0.92
League of Legends: Wild Rift	Genshin Impact	-0.46	-1.28	0.35	0.79
Mobile Legends: Bang Bang	Genshin Impact	0.03	-0.93	0.99	1.00
Noita	Genshin Impact	0.27	-0.82	1.36	1.00
PlayerUnknown's Battlegrounds	Genshin Impact	-0.22	-1.40	0.95	1.00
Pokémon GO	Genshin Impact	-0.24	-1.01	0.54	1.00
Pokémon Legends: Arceus	Genshin Impact	-0.14	-1.23	0.95	1.00
SuperStar Series	Genshin Impact	-0.30	-0.99	0.39	0.97
VALORANT	Genshin Impact	0.12	-0.91	1.14	1.00
League of Legends: Wild Rift	Idle Heroes	0.00	-0.96	0.97	1.00
Mobile Legends: Bang Bang	Idle Heroes	0.50	-0.59	1.59	0.95

Noita	Idle Heroes	0.74	-0.46	1.95	0.70
PlayerUnknown's Battlegrounds	Idle Heroes	0.25	-1.04	1.53	1.00
Pokémon GO	Idle Heroes	0.23	-0.70	1.17	1.00
Pokémon Legends: Arceus	Idle Heroes	0.33	-0.87	1.54	1.00
SuperStar Series	Idle Heroes	0.17	-0.69	1.03	1.00
VALORANT	Idle Heroes	0.58	-0.57	1.73	0.90
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.50	-0.47	1.46	0.89
Noita	League of Legends: Wild Rift	0.74	-0.36	1.83	0.56
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.24	-0.94	1.42	1.00
Pokémon GO	League of Legends: Wild Rift	0.23	-0.56	1.02	1.00
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.33	-0.77	1.42	1.00
SuperStar Series	League of Legends: Wild Rift	0.17	-0.53	0.87	1.00
VALORANT	League of Legends: Wild Rift	0.58	-0.45	1.61	0.81
Noita	Mobile Legends: Bang Bang	0.24	-0.96	1.45	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.25	-1.54	1.03	1.00
Pokémon GO	Mobile Legends: Bang Bang	-0.27	-1.20	0.67	1.00
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.17	-1.37	1.04	1.00
SuperStar Series	Mobile Legends: Bang Bang	-0.33	-1.19	0.53	0.99
VALORANT	Mobile Legends: Bang Bang	0.08	-1.07	1.23	1.00
PlayerUnknown's Battlegrounds	Noita	-0.49	-1.88	0.89	0.99
Pokémon GO	Noita	-0.51	-1.58	0.56	0.93
Pokémon Legends: Arceus	Noita	-0.41	-1.72	0.90	1.00
SuperStar Series	Noita	-0.57	-1.57	0.44	0.80
VALORANT	Noita	-0.16	-1.42	1.10	1.00
Pokémon GO	PlayerUnknown's Battlegrounds	-0.01	-1.17	1.14	1.00
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	0.09	-1.30	1.47	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-0.07	-1.17	1.02	1.00
VALORANT	PlayerUnknown's Battlegrounds	0.34	-1.00	1.67	1.00
Pokémon Legends: Arceus	Pokémon GO	0.10	-0.97	1.17	1.00
SuperStar Series	Pokémon GO	-0.06	-0.72	0.59	1.00
VALORANT	Pokémon GO	0.35	-0.65	1.36	0.99
SuperStar Series	Pokémon Legends: Arceus	-0.16	-1.17	0.84	1.00
VALORANT	Pokémon Legends: Arceus	0.25	-1.01	1.51	1.00
VALORANT	SuperStar Series	0.41	-0.52	1.35	0.96

PSS and Narratives		**Mean diff**	**Lower**	**Upper**	**p adj**
Final Fantasy XIV	Fate/Grand Order	0.01	-1.40	1.43	1.00
Fire Emblem Heroes	Fate/Grand Order	-1.42	-2.27	-0.57	***0.00***
Genshin Impact	Fate/Grand Order	-0.29	-1.19	0.61	1.00
Idle Heroes	Fate/Grand Order	-3.01	-4.13	-1.89	***0.00***
League of Legends: Wild Rift	Fate/Grand Order	-1.25	-2.16	-0.34	***0.00***
Mobile Legends: Bang Bang	Fate/Grand Order	-1.23	-2.34	-0.11	***0.02***
Noita	Fate/Grand Order	-1.78	-3.08	-0.48	***0.00***
PlayerUnknown's Battlegrounds	Fate/Grand Order	-2.04	-3.46	-0.63	***0.00***
Pokémon GO	Fate/Grand Order	-2.35	-3.21	-1.49	***0.00***

Pokémon Legends: Arceus	Fate/Grand Order	-0.37	-1.67	0.93	1.00
SuperStar Series	Fate/Grand Order	-2.72	-3.44	-2.00	***0.00***
VALORANT	Fate/Grand Order	-1.13	-2.34	0.08	0.10
Fire Emblem Heroes	Final Fantasy XIV	-1.43	-2.91	0.04	0.07
Genshin Impact	Final Fantasy XIV	-0.30	-1.80	1.21	1.00
Idle Heroes	Final Fantasy XIV	-3.02	-4.66	-1.38	***0.00***
League of Legends: Wild Rift	Final Fantasy XIV	-1.26	-2.77	0.25	0.21
Mobile Legends: Bang Bang	Final Fantasy XIV	-1.24	-2.88	0.40	0.37
Noita	Final Fantasy XIV	-1.79	-3.56	-0.02	***0.05***
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-2.06	-3.91	-0.20	***0.02***
Pokémon GO	Final Fantasy XIV	-2.36	-3.84	-0.89	***0.00***
Pokémon Legends: Arceus	Final Fantasy XIV	-0.38	-2.15	1.39	1.00
SuperStar Series	Final Fantasy XIV	-2.73	-4.13	-1.33	***0.00***
VALORANT	Final Fantasy XIV	-1.14	-2.85	0.57	0.57
Genshin Impact	Fire Emblem Heroes	1.13	0.14	2.12	***0.01***
Idle Heroes	Fire Emblem Heroes	-1.59	-2.78	-0.40	***0.00***
League of Legends: Wild Rift	Fire Emblem Heroes	0.17	-0.83	1.17	1.00
Mobile Legends: Bang Bang	Fire Emblem Heroes	0.19	-1.00	1.38	1.00
Noita	Fire Emblem Heroes	-0.35	-1.72	1.01	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	-0.62	-2.10	0.85	0.97
Pokémon GO	Fire Emblem Heroes	-0.93	-1.88	0.02	0.06
Pokémon Legends: Arceus	Fire Emblem Heroes	1.05	-0.31	2.42	0.32
SuperStar Series	Fire Emblem Heroes	-1.30	-2.13	-0.47	***0.00***
VALORANT	Fire Emblem Heroes	0.29	-0.99	1.57	1.00
Idle Heroes	Genshin Impact	-2.72	-3.95	-1.49	***0.00***
League of Legends: Wild Rift	Genshin Impact	-0.96	-2.01	0.08	0.10
Mobile Legends: Bang Bang	Genshin Impact	-0.94	-2.17	0.29	0.34
Noita	Genshin Impact	-1.49	-2.88	-0.09	***0.02***
PlayerUnknown's Battlegrounds	Genshin Impact	-1.76	-3.26	-0.25	***0.01***
Pokémon GO	Genshin Impact	-2.06	-3.06	-1.07	***0.00***
Pokémon Legends: Arceus	Genshin Impact	-0.08	-1.48	1.32	1.00
SuperStar Series	Genshin Impact	-2.43	-3.32	-1.55	***0.00***
VALORANT	Genshin Impact	-0.84	-2.16	0.47	0.64
League of Legends: Wild Rift	Idle Heroes	1.76	0.52	2.99	***0.00***
Mobile Legends: Bang Bang	Idle Heroes	1.78	0.39	3.17	***0.00***
Noita	Idle Heroes	1.23	-0.31	2.78	0.28
PlayerUnknown's Battlegrounds	Idle Heroes	0.97	-0.68	2.61	0.76
Pokémon GO	Idle Heroes	0.66	-0.54	1.85	0.83
Pokémon Legends: Arceus	Idle Heroes	2.64	1.10	4.19	***0.00***
SuperStar Series	Idle Heroes	0.29	-0.81	1.39	1.00
VALORANT	Idle Heroes	1.88	0.41	3.35	***0.00***
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.02	-1.21	1.26	1.00
Noita	League of Legends: Wild Rift	-0.53	-1.93	0.88	0.99
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.79	-2.30	0.72	0.87
Pokémon GO	League of Legends: Wild Rift	-1.10	-2.11	-0.09	***0.02***
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.88	-0.52	2.29	0.66
SuperStar Series	League of Legends: Wild Rift	-1.47	-2.36	-0.58	***0.00***

VALORANT	League of Legends: Wild Rift	0.12	-1.20	1.44	1.00
Noita	Mobile Legends: Bang Bang	-0.55	-2.09	1.00	0.99
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.82	-2.46	0.83	0.91
Pokémon GO	Mobile Legends: Bang Bang	-1.12	-2.32	0.07	0.09
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	0.86	-0.68	2.40	0.82
SuperStar Series	Mobile Legends: Bang Bang	-1.49	-2.59	-0.39	***0.00***
VALORANT	Mobile Legends: Bang Bang	0.10	-1.37	1.57	1.00
PlayerUnknown's Battlegrounds	Noita	-0.27	-2.04	1.50	1.00
Pokémon GO	Noita	-0.57	-1.94	0.79	0.97
Pokémon Legends: Arceus	Noita	1.41	-0.27	3.09	0.21
SuperStar Series	Noita	-0.94	-2.23	0.34	0.41
VALORANT	Noita	0.65	-0.97	2.26	0.98
Pokémon GO	PlayerUnknown's Battlegrounds	-0.31	-1.78	1.17	1.00
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	1.68	-0.09	3.45	0.08
SuperStar Series	PlayerUnknown's Battlegrounds	-0.68	-2.08	0.73	0.93
VALORANT	PlayerUnknown's Battlegrounds	0.91	-0.79	2.62	0.86
Pokémon Legends: Arceus	Pokémon GO	1.98	0.62	3.35	***0.00***
SuperStar Series	Pokémon GO	-0.37	-1.21	0.47	0.96
VALORANT	Pokémon GO	1.22	-0.06	2.51	0.08
SuperStar Series	Pokémon Legends: Arceus	-2.35	-3.64	-1.07	***0.00***
VALORANT	Pokémon Legends: Arceus	-0.76	-2.38	0.85	0.94
VALORANT	SuperStar Series	1.59	0.39	2.79	***0.00***

PSS and Play Engrossment		**Mean diff**	**Lower**	**Upper**	**p adj**
Final Fantasy XIV	Fate/Grand Order	0.80	-0.99	2.58	0.96
Fire Emblem Heroes	Fate/Grand Order	-0.05	-1.12	1.02	1.00
Genshin Impact	Fate/Grand Order	-0.04	-1.17	1.10	1.00
Idle Heroes	Fate/Grand Order	-0.69	-2.10	0.72	0.92
League of Legends: Wild Rift	Fate/Grand Order	0.46	-0.68	1.61	0.98
Mobile Legends: Bang Bang	Fate/Grand Order	-0.32	-1.72	1.09	1.00
Noita	Fate/Grand Order	1.15	-0.49	2.78	0.49
PlayerUnknown's Battlegrounds	Fate/Grand Order	0.52	-1.26	2.30	1.00
Pokémon GO	Fate/Grand Order	-1.07	-2.14	0.01	0.06
Pokémon Legends: Arceus	Fate/Grand Order	0.51	-1.13	2.15	1.00
SuperStar Series	Fate/Grand Order	-0.17	-1.08	0.74	1.00
VALORANT	Fate/Grand Order	0.81	-0.72	2.34	0.86
Fire Emblem Heroes	Final Fantasy XIV	-0.85	-2.70	1.01	0.95
Genshin Impact	Final Fantasy XIV	-0.83	-2.73	1.06	0.96
Idle Heroes	Final Fantasy XIV	-1.49	-3.56	0.58	0.44
League of Legends: Wild Rift	Final Fantasy XIV	-0.33	-2.24	1.57	1.00
Mobile Legends: Bang Bang	Final Fantasy XIV	-1.11	-3.18	0.95	0.85
Noita	Final Fantasy XIV	0.35	-1.88	2.58	1.00
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.28	-2.62	2.06	1.00
Pokémon GO	Final Fantasy XIV	-1.86	-3.72	0.00	***0.05***
Pokémon Legends: Arceus	Final Fantasy XIV	-0.29	-2.52	1.94	1.00

SuperStar Series	Final Fantasy XIV	-0.97	-2.73	0.80	0.84
VALORANT	Final Fantasy XIV	0.01	-2.14	2.17	1.00
Genshin Impact	Fire Emblem Heroes	0.01	-1.23	1.26	1.00
Idle Heroes	Fire Emblem Heroes	-0.64	-2.14	0.86	0.97
League of Legends: Wild Rift	Fire Emblem Heroes	0.51	-0.74	1.77	0.98
Mobile Legends: Bang Bang	Fire Emblem Heroes	-0.27	-1.77	1.23	1.00
Noita	Fire Emblem Heroes	1.20	-0.52	2.91	0.50
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	0.57	-1.29	2.43	1.00
Pokémon GO	Fire Emblem Heroes	-1.02	-2.21	0.18	0.19
Pokémon Legends: Arceus	Fire Emblem Heroes	0.56	-1.16	2.28	1.00
SuperStar Series	Fire Emblem Heroes	-0.12	-1.16	0.93	1.00
VALORANT	Fire Emblem Heroes	0.86	-0.75	2.47	0.86
Idle Heroes	Genshin Impact	-0.66	-2.20	0.89	0.97
League of Legends: Wild Rift	Genshin Impact	0.50	-0.82	1.82	0.99
Mobile Legends: Bang Bang	Genshin Impact	-0.28	-1.83	1.26	1.00
Noita	Genshin Impact	1.18	-0.58	2.94	0.56
PlayerUnknown's Battlegrounds	Genshin Impact	0.56	-1.34	2.45	1.00
Pokémon GO	Genshin Impact	-1.03	-2.28	0.23	0.24
Pokémon Legends: Arceus	Genshin Impact	0.55	-1.21	2.30	1.00
SuperStar Series	Genshin Impact	-0.13	-1.24	0.98	1.00
VALORANT	Genshin Impact	0.85	-0.81	2.50	0.89
League of Legends: Wild Rift	Idle Heroes	1.16	-0.40	2.71	0.39
Mobile Legends: Bang Bang	Idle Heroes	0.38	-1.38	2.13	1.00
Noita	Idle Heroes	1.84	-0.11	3.78	0.08
PlayerUnknown's Battlegrounds	Idle Heroes	1.21	-0.86	3.28	0.76
Pokémon GO	Idle Heroes	-0.37	-1.88	1.13	1.00
Pokémon Legends: Arceus	Idle Heroes	1.20	-0.74	3.15	0.69
SuperStar Series	Idle Heroes	0.52	-0.86	1.91	0.99
VALORANT	Idle Heroes	1.50	-0.35	3.36	0.25
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.78	-2.34	0.77	0.90
Noita	League of Legends: Wild Rift	0.68	-1.08	2.45	0.99
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.06	-1.85	1.96	1.00
Pokémon GO	League of Legends: Wild Rift	-1.53	-2.80	-0.26	***0.00***
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.05	-1.72	1.81	1.00
SuperStar Series	League of Legends: Wild Rift	-0.63	-1.76	0.49	0.81
VALORANT	League of Legends: Wild Rift	0.35	-1.32	2.01	1.00
Noita	Mobile Legends: Bang Bang	1.46	-0.48	3.41	0.37
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.84	-1.23	2.91	0.98
Pokémon GO	Mobile Legends: Bang Bang	-0.75	-2.25	0.76	0.91
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	0.83	-1.12	2.77	0.97
SuperStar Series	Mobile Legends: Bang Bang	0.15	-1.24	1.54	1.00
VALORANT	Mobile Legends: Bang Bang	1.13	-0.73	2.98	0.71
PlayerUnknown's Battlegrounds	Noita	-0.63	-2.86	1.61	1.00
Pokémon GO	Noita	-2.21	-3.93	-0.49	***0.00***
Pokémon Legends: Arceus	Noita	-0.64	-2.75	1.48	1.00
SuperStar Series	Noita	-1.31	-2.94	0.31	0.25
VALORANT	Noita	-0.34	-2.37	1.70	1.00

Pokémon GO	PlayerUnknown's Battlegrounds	-1.58	-3.45	0.28	0.19
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.01	-2.24	2.22	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-0.69	-2.46	1.08	0.99
VALORANT	PlayerUnknown's Battlegrounds	0.29	-1.86	2.44	1.00
Pokémon Legends: Arceus	Pokémon GO	1.57	-0.15	3.30	0.11
SuperStar Series	Pokémon GO	0.90	-0.16	1.95	0.19
VALORANT	Pokémon GO	1.88	0.26	3.49	***0.01***
SuperStar Series	Pokémon Legends: Arceus	-0.68	-2.30	0.94	0.97
VALORANT	Pokémon Legends: Arceus	0.30	-1.73	2.33	1.00
VALORANT	SuperStar Series	0.98	-0.53	2.49	0.62

PSS and Enjoyment		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	-0.15	-1.43	1.12	1.00
Fire Emblem Heroes	Fate/Grand Order	-0.22	-0.99	0.54	1.00
Genshin Impact	Fate/Grand Order	-0.15	-0.96	0.66	1.00
Idle Heroes	Fate/Grand Order	-0.60	-1.61	0.40	0.73
League of Legends: Wild Rift	Fate/Grand Order	-0.25	-1.07	0.57	1.00
Mobile Legends: Bang Bang	Fate/Grand Order	0.27	-0.73	1.28	1.00
Noita	Fate/Grand Order	0.59	-0.58	1.76	0.90
PlayerUnknown's Battlegrounds	Fate/Grand Order	-0.43	-1.71	0.84	1.00
Pokémon GO	Fate/Grand Order	-0.20	-0.98	0.57	1.00
Pokémon Legends: Arceus	Fate/Grand Order	0.59	-0.58	1.76	0.90
SuperStar Series	Fate/Grand Order	-0.65	-1.30	0.00	***0.05***
VALORANT	Fate/Grand Order	-0.24	-1.34	0.85	1.00
Fire Emblem Heroes	Final Fantasy XIV	-0.07	-1.39	1.26	1.00
Genshin Impact	Final Fantasy XIV	0.01	-1.35	1.36	1.00
Idle Heroes	Final Fantasy XIV	-0.45	-1.93	1.03	1.00
League of Legends: Wild Rift	Final Fantasy XIV	-0.10	-1.46	1.26	1.00
Mobile Legends: Bang Bang	Final Fantasy XIV	0.43	-1.05	1.91	1.00
Noita	Final Fantasy XIV	0.74	-0.85	2.34	0.94
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.28	-1.95	1.40	1.00
Pokémon GO	Final Fantasy XIV	-0.05	-1.38	1.28	1.00
Pokémon Legends: Arceus	Final Fantasy XIV	0.74	-0.85	2.34	0.94
SuperStar Series	Final Fantasy XIV	-0.49	-1.76	0.77	0.99
VALORANT	Final Fantasy XIV	-0.09	-1.63	1.45	1.00
Genshin Impact	Fire Emblem Heroes	0.07	-0.82	0.96	1.00
Idle Heroes	Fire Emblem Heroes	-0.38	-1.45	0.69	0.99
League of Legends: Wild Rift	Fire Emblem Heroes	-0.03	-0.93	0.87	1.00
Mobile Legends: Bang Bang	Fire Emblem Heroes	0.49	-0.58	1.56	0.95
Noita	Fire Emblem Heroes	0.81	-0.42	2.04	0.59
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	-0.21	-1.54	1.12	1.00
Pokémon GO	Fire Emblem Heroes	0.02	-0.84	0.87	1.00
Pokémon Legends: Arceus	Fire Emblem Heroes	0.81	-0.42	2.04	0.59
SuperStar Series	Fire Emblem Heroes	-0.43	-1.17	0.32	0.79
VALORANT	Fire Emblem Heroes	-0.02	-1.18	1.13	1.00

Idle Heroes	Genshin Impact	-0.45	-1.56	0.65	0.98
League of Legends: Wild Rift	Genshin Impact	-0.10	-1.04	0.84	1.00
Mobile Legends: Bang Bang	Genshin Impact	0.42	-0.68	1.53	0.99
Noita	Genshin Impact	0.74	-0.52	1.99	0.76
PlayerUnknown's Battlegrounds	Genshin Impact	-0.28	-1.64	1.07	1.00
Pokémon GO	Genshin Impact	-0.05	-0.95	0.84	1.00
Pokémon Legends: Arceus	Genshin Impact	0.74	-0.52	1.99	0.76
SuperStar Series	Genshin Impact	-0.50	-1.30	0.29	0.66
VALORANT	Genshin Impact	-0.10	-1.28	1.09	1.00
League of Legends: Wild Rift	Idle Heroes	0.35	-0.76	1.46	1.00
Mobile Legends: Bang Bang	Idle Heroes	0.88	-0.38	2.13	0.50
Noita	Idle Heroes	1.19	-0.20	2.58	0.18
PlayerUnknown's Battlegrounds	Idle Heroes	0.17	-1.31	1.65	1.00
Pokémon GO	Idle Heroes	0.40	-0.68	1.47	0.99
Pokémon Legends: Arceus	Idle Heroes	1.19	-0.20	2.58	0.18
SuperStar Series	Idle Heroes	-0.05	-1.04	0.95	1.00
VALORANT	Idle Heroes	0.36	-0.97	1.68	1.00
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.52	-0.59	1.63	0.94
Noita	League of Legends: Wild Rift	0.84	-0.43	2.10	0.58
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.18	-1.54	1.18	1.00
Pokémon GO	League of Legends: Wild Rift	0.05	-0.86	0.95	1.00
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.84	-0.43	2.10	0.58
SuperStar Series	League of Legends: Wild Rift	-0.40	-1.20	0.40	0.91
VALORANT	League of Legends: Wild Rift	0.01	-1.19	1.20	1.00
Noita	Mobile Legends: Bang Bang	0.32	-1.07	1.71	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.70	-2.18	0.77	0.93
Pokémon GO	Mobile Legends: Bang Bang	-0.48	-1.55	0.60	0.96
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	0.32	-1.07	1.71	1.00
SuperStar Series	Mobile Legends: Bang Bang	-0.92	-1.91	0.07	0.10
VALORANT	Mobile Legends: Bang Bang	-0.52	-1.84	0.81	0.99
PlayerUnknown's Battlegrounds	Noita	-1.02	-2.62	0.58	0.64
Pokémon GO	Noita	-0.79	-2.02	0.44	0.63
Pokémon Legends: Arceus	Noita	0.00	-1.51	1.51	1.00
SuperStar Series	Noita	-1.24	-2.40	-0.08	***0.02***
VALORANT	Noita	-0.83	-2.29	0.62	0.79
Pokémon GO	PlayerUnknown's Battlegrounds	0.23	-1.10	1.56	1.00
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	1.02	-0.58	2.62	0.64
SuperStar Series	PlayerUnknown's Battlegrounds	-0.22	-1.48	1.05	1.00
VALORANT	PlayerUnknown's Battlegrounds	0.19	-1.35	1.73	1.00
Pokémon Legends: Arceus	Pokémon GO	0.79	-0.44	2.02	0.63
SuperStar Series	Pokémon GO	-0.45	-1.20	0.31	0.75
VALORANT	Pokémon GO	-0.04	-1.20	1.12	1.00
SuperStar Series	Pokémon Legends: Arceus	-1.24	-2.40	-0.08	***0.02***
VALORANT	Pokémon Legends: Arceus	-0.83	-2.29	0.62	0.79
VALORANT	SuperStar Series	0.41	-0.67	1.48	0.99

CF

PSS and Creative Freedom		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	0.88	-0.82	2.58	0.88
Fire Emblem Heroes	Fate/Grand Order	0.41	-0.61	1.43	0.98
Genshin Impact	Fate/Grand Order	0.49	-0.59	1.58	0.95
Idle Heroes	Fate/Grand Order	-0.96	-2.30	0.38	0.46
League of Legends: Wild Rift	Fate/Grand Order	0.11	-0.99	1.20	1.00
Mobile Legends: Bang Bang	Fate/Grand Order	-0.21	-1.55	1.13	1.00
Noita	Fate/Grand Order	1.69	0.12	3.25	***0.02***
PlayerUnknown's Battlegrounds	Fate/Grand Order	0.04	-1.66	1.74	1.00
Pokémon GO	Fate/Grand Order	-0.68	-1.71	0.35	0.59
Pokémon Legends: Arceus	Fate/Grand Order	0.73	-0.83	2.29	0.94
SuperStar Series	Fate/Grand Order	-1.70	-2.57	-0.84	***0.00***
VALORANT	Fate/Grand Order	0.82	-0.64	2.28	0.81
Fire Emblem Heroes	Final Fantasy XIV	-0.47	-2.24	1.30	1.00
Genshin Impact	Final Fantasy XIV	-0.38	-2.19	1.42	1.00
Idle Heroes	Final Fantasy XIV	-1.84	-3.81	0.14	0.10
League of Legends: Wild Rift	Final Fantasy XIV	-0.77	-2.58	1.04	0.97
Mobile Legends: Bang Bang	Final Fantasy XIV	-1.09	-3.06	0.89	0.83
Noita	Final Fantasy XIV	0.81	-1.32	2.94	0.99
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.83	-3.06	1.40	0.99
Pokémon GO	Final Fantasy XIV	-1.56	-3.33	0.22	0.15
Pokémon Legends: Arceus	Final Fantasy XIV	-0.15	-2.27	1.98	1.00
SuperStar Series	Final Fantasy XIV	-2.58	-4.26	-0.89	***0.00***
VALORANT	Final Fantasy XIV	-0.06	-2.11	2.00	1.00
Genshin Impact	Fire Emblem Heroes	0.09	-1.10	1.28	1.00
Idle Heroes	Fire Emblem Heroes	-1.37	-2.80	0.06	0.08
League of Legends: Wild Rift	Fire Emblem Heroes	-0.30	-1.50	0.90	1.00
Mobile Legends: Bang Bang	Fire Emblem Heroes	-0.62	-2.05	0.81	0.97
Noita	Fire Emblem Heroes	1.28	-0.36	2.91	0.31
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	-0.36	-2.13	1.41	1.00
Pokémon GO	Fire Emblem Heroes	-1.09	-2.23	0.05	0.08
Pokémon Legends: Arceus	Fire Emblem Heroes	0.32	-1.31	1.96	1.00
SuperStar Series	Fire Emblem Heroes	-2.11	-3.10	-1.11	***0.00***
VALORANT	Fire Emblem Heroes	0.41	-1.12	1.95	1.00
Idle Heroes	Genshin Impact	-1.45	-2.93	0.02	0.06
League of Legends: Wild Rift	Genshin Impact	-0.39	-1.64	0.87	1.00
Mobile Legends: Bang Bang	Genshin Impact	-0.70	-2.18	0.77	0.93
Noita	Genshin Impact	1.19	-0.49	2.87	0.47
PlayerUnknown's Battlegrounds	Genshin Impact	-0.45	-2.26	1.36	1.00
Pokémon GO	Genshin Impact	-1.17	-2.37	0.02	0.06
Pokémon Legends: Arceus	Genshin Impact	0.24	-1.44	1.91	1.00
SuperStar Series	Genshin Impact	-2.20	-3.26	-1.14	***0.00***
VALORANT	Genshin Impact	0.33	-1.25	1.91	1.00
League of Legends: Wild Rift	Idle Heroes	1.07	-0.42	2.55	0.45
Mobile Legends: Bang Bang	Idle Heroes	0.75	-0.92	2.42	0.96
Noita	Idle Heroes	2.64	0.79	4.50	***0.00***

PlayerUnknown's Battlegrounds	Idle Heroes	1.00	-0.97	2.98	0.89
Pokémon GO	Idle Heroes	0.28	-1.15	1.72	1.00
Pokémon Legends: Arceus	Idle Heroes	1.69	-0.16	3.54	0.11
SuperStar Series	Idle Heroes	-0.74	-2.07	0.58	0.81
VALORANT	Idle Heroes	1.78	0.01	3.55	***0.05***
Mobile Legends: Bang Bang	League of Legends: Wild Rift	-0.32	-1.80	1.17	1.00
Noita	League of Legends: Wild Rift	1.58	-0.11	3.26	0.09
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	-0.06	-1.88	1.75	1.00
Pokémon GO	League of Legends: Wild Rift	-0.79	-1.99	0.42	0.61
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.62	-1.06	2.31	0.99
SuperStar Series	League of Legends: Wild Rift	-1.81	-2.88	-0.74	***0.00***
VALORANT	League of Legends: Wild Rift	0.71	-0.87	2.30	0.96
Noita	Mobile Legends: Bang Bang	1.89	0.04	3.75	***0.04***
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.25	-1.72	2.23	1.00
Pokémon GO	Mobile Legends: Bang Bang	-0.47	-1.90	0.97	1.00
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	0.94	-0.91	2.79	0.90
SuperStar Series	Mobile Legends: Bang Bang	-1.49	-2.82	-0.17	***0.01***
VALORANT	Mobile Legends: Bang Bang	1.03	-0.74	2.80	0.77
PlayerUnknown's Battlegrounds	Noita	-1.64	-3.77	0.49	0.33
Pokémon GO	Noita	-2.36	-4.01	-0.72	***0.00***
Pokémon Legends: Arceus	Noita	-0.95	-2.97	1.06	0.94
SuperStar Series	Noita	-3.39	-4.93	-1.84	***0.00***
VALORANT	Noita	-0.86	-2.80	1.08	0.96
Pokémon GO	PlayerUnknown's Battlegrounds	-0.72	-2.50	1.05	0.98
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	0.69	-1.44	2.81	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-1.75	-3.43	-0.06	***0.03***
VALORANT	PlayerUnknown's Battlegrounds	0.78	-1.27	2.83	0.99
Pokémon Legends: Arceus	Pokémon GO	1.41	-0.23	3.05	0.18
SuperStar Series	Pokémon GO	-1.02	-2.03	-0.02	***0.04***
VALORANT	Pokémon GO	1.50	-0.04	3.04	0.07
SuperStar Series	Pokémon Legends: Arceus	-2.43	-3.98	-0.89	***0.00***
VALORANT	Pokémon Legends: Arceus	0.09	-1.85	2.03	1.00
VALORANT	SuperStar Series	2.52	1.08	3.96	***0.00***

PSS and Audio Aesthetics		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	0.63	-0.98	2.24	0.99
Fire Emblem Heroes	Fate/Grand Order	-0.06	-1.03	0.91	1.00
Genshin Impact	Fate/Grand Order	0.53	-0.51	1.57	0.90
Idle Heroes	Fate/Grand Order	-2.77	-4.04	-1.49	***0.00***
League of Legends: Wild Rift	Fate/Grand Order	-0.12	-1.16	0.92	1.00
Mobile Legends: Bang Bang	Fate/Grand Order	-0.08	-1.35	1.19	1.00
Noita	Fate/Grand Order	-0.02	-1.50	1.46	1.00
PlayerUnknown's Battlegrounds	Fate/Grand Order	-0.04	-1.65	1.57	1.00
Pokémon GO	Fate/Grand Order	-2.93	-3.90	-1.95	***0.00***
Pokémon Legends: Arceus	Fate/Grand Order	0.29	-1.19	1.78	1.00

SuperStar Series	Fate/Grand Order	-0.53	-1.36	0.29	0.62
VALORANT	Fate/Grand Order	0.41	-0.97	1.79	1.00
Fire Emblem Heroes	Final Fantasy XIV	-0.69	-2.37	0.99	0.98
Genshin Impact	Final Fantasy XIV	-0.10	-1.82	1.62	1.00
Idle Heroes	Final Fantasy XIV	-3.40	-5.27	-1.52	***0.00***
League of Legends: Wild Rift	Final Fantasy XIV	-0.74	-2.46	0.98	0.97
Mobile Legends: Bang Bang	Final Fantasy XIV	-0.71	-2.58	1.16	0.99
Noita	Final Fantasy XIV	-0.65	-2.67	1.37	1.00
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-0.67	-2.78	1.45	1.00
Pokémon GO	Final Fantasy XIV	-3.55	-5.24	-1.87	***0.00***
Pokémon Legends: Arceus	Final Fantasy XIV	-0.33	-2.35	1.68	1.00
SuperStar Series	Final Fantasy XIV	-1.16	-2.76	0.44	0.43
VALORANT	Final Fantasy XIV	-0.22	-2.17	1.73	1.00
Genshin Impact	Fire Emblem Heroes	0.59	-0.55	1.73	0.88
Idle Heroes	Fire Emblem Heroes	-2.71	-4.06	-1.35	***0.00***
League of Legends: Wild Rift	Fire Emblem Heroes	-0.05	-1.19	1.08	1.00
Mobile Legends: Bang Bang	Fire Emblem Heroes	-0.02	-1.37	1.34	1.00
Noita	Fire Emblem Heroes	0.04	-1.51	1.59	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	0.02	-1.65	1.70	1.00
Pokémon GO	Fire Emblem Heroes	-2.86	-3.94	-1.78	***0.00***
Pokémon Legends: Arceus	Fire Emblem Heroes	0.36	-1.20	1.91	1.00
SuperStar Series	Fire Emblem Heroes	-0.47	-1.41	0.47	0.91
VALORANT	Fire Emblem Heroes	0.47	-0.99	1.93	1.00
Idle Heroes	Genshin Impact	-3.29	-4.70	-1.89	***0.00***
League of Legends: Wild Rift	Genshin Impact	-0.64	-1.84	0.56	0.85
Mobile Legends: Bang Bang	Genshin Impact	-0.61	-2.01	0.80	0.97
Noita	Genshin Impact	-0.55	-2.15	1.05	1.00
PlayerUnknown's Battlegrounds	Genshin Impact	-0.57	-2.29	1.16	1.00
Pokémon GO	Genshin Impact	-3.45	-4.60	-2.31	***0.00***
Pokémon Legends: Arceus	Genshin Impact	-0.23	-1.83	1.37	1.00
SuperStar Series	Genshin Impact	-1.06	-2.08	-0.04	***0.03***
VALORANT	Genshin Impact	-0.12	-1.62	1.39	1.00
League of Legends: Wild Rift	Idle Heroes	2.65	1.24	4.06	***0.00***
Mobile Legends: Bang Bang	Idle Heroes	2.69	1.10	4.28	***0.00***
Noita	Idle Heroes	2.74	0.99	4.50	***0.00***
PlayerUnknown's Battlegrounds	Idle Heroes	2.73	0.86	4.60	***0.00***
Pokémon GO	Idle Heroes	-0.16	-1.52	1.20	1.00
Pokémon Legends: Arceus	Idle Heroes	3.06	1.30	4.82	***0.00***
SuperStar Series	Idle Heroes	2.23	0.98	3.49	***0.00***
VALORANT	Idle Heroes	3.18	1.50	4.85	***0.00***
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.04	-1.37	1.44	1.00
Noita	League of Legends: Wild Rift	0.09	-1.51	1.69	1.00
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.08	-1.64	1.80	1.00
Pokémon GO	League of Legends: Wild Rift	-2.81	-3.96	-1.66	***0.00***
Pokémon Legends: Arceus	League of Legends: Wild Rift	0.41	-1.19	2.01	1.00
SuperStar Series	League of Legends: Wild Rift	-0.42	-1.43	0.60	0.98
VALORANT	League of Legends: Wild Rift	0.53	-0.98	2.03	0.99

Noita	Mobile Legends: Bang Bang	0.06	-1.70	1.82	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.04	-1.83	1.91	1.00
Pokémon GO	Mobile Legends: Bang Bang	-2.85	-4.21	-1.48	***0.00***
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	0.38	-1.38	2.13	1.00
SuperStar Series	Mobile Legends: Bang Bang	-0.45	-1.71	0.80	0.99
VALORANT	Mobile Legends: Bang Bang	0.49	-1.19	2.17	1.00
PlayerUnknown's Battlegrounds	Noita	-0.02	-2.03	2.00	1.00
Pokémon GO	Noita	-2.90	-4.46	-1.34	***0.00***
Pokémon Legends: Arceus	Noita	0.32	-1.60	2.23	1.00
SuperStar Series	Noita	-0.51	-1.98	0.96	0.99
VALORANT	Noita	0.43	-1.41	2.27	1.00
Pokémon GO	PlayerUnknown's Battlegrounds	-2.89	-4.57	-1.20	***0.00***
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	0.33	-1.68	2.35	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	-0.49	-2.09	1.10	1.00
VALORANT	PlayerUnknown's Battlegrounds	0.45	-1.50	2.40	1.00
Pokémon Legends: Arceus	Pokémon GO	3.22	1.66	4.78	***0.00***
SuperStar Series	Pokémon GO	2.39	1.44	3.35	***0.00***
VALORANT	Pokémon GO	3.34	1.87	4.80	***0.00***
SuperStar Series	Pokémon Legends: Arceus	-0.83	-2.29	0.64	0.80
VALORANT	Pokémon Legends: Arceus	0.12	-1.72	1.95	1.00
VALORANT	SuperStar Series	0.94	-0.42	2.31	0.51

PSS and Personal Gratification		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	1.22	0.04	2.40	***0.03***
Fire Emblem Heroes	Fate/Grand Order	0.57	-0.14	1.27	0.27
Genshin Impact	Fate/Grand Order	0.57	-0.18	1.32	0.35
Idle Heroes	Fate/Grand Order	0.62	-0.31	1.55	0.58
League of Legends: Wild Rift	Fate/Grand Order	1.21	0.46	1.97	***0.00***
Mobile Legends: Bang Bang	Fate/Grand Order	1.24	0.31	2.17	***0.00***
Noita	Fate/Grand Order	1.33	0.25	2.41	***0.00***
PlayerUnknown's Battlegrounds	Fate/Grand Order	1.28	0.10	2.45	***0.02***
Pokémon GO	Fate/Grand Order	0.16	-0.56	0.87	1.00
Pokémon Legends: Arceus	Fate/Grand Order	1.10	0.02	2.18	***0.04***
SuperStar Series	Fate/Grand Order	1.18	0.58	1.78	***0.00***
VALORANT	Fate/Grand Order	1.48	0.47	2.49	***0.00***
Fire Emblem Heroes	Final Fantasy XIV	-0.65	-1.88	0.57	0.86
Genshin Impact	Final Fantasy XIV	-0.65	-1.90	0.60	0.88
Idle Heroes	Final Fantasy XIV	-0.60	-1.97	0.76	0.96
League of Legends: Wild Rift	Final Fantasy XIV	-0.01	-1.26	1.25	1.00
Mobile Legends: Bang Bang	Final Fantasy XIV	0.02	-1.34	1.39	1.00
Noita	Final Fantasy XIV	0.11	-1.37	1.58	1.00
PlayerUnknown's Battlegrounds	Final Fantasy XIV	0.06	-1.49	1.60	1.00
Pokémon GO	Final Fantasy XIV	-1.06	-2.29	0.16	0.17
Pokémon Legends: Arceus	Final Fantasy XIV	-0.12	-1.59	1.35	1.00
SuperStar Series	Final Fantasy XIV	-0.04	-1.21	1.13	1.00
VALORANT	Final Fantasy XIV	0.26	-1.16	1.68	1.00

Genshin Impact	Fire Emblem Heroes	0.00	-0.82	0.83	1.00
Idle Heroes	Fire Emblem Heroes	0.05	-0.94	1.04	1.00
League of Legends: Wild Rift	Fire Emblem Heroes	0.65	-0.18	1.48	0.32
Mobile Legends: Bang Bang	Fire Emblem Heroes	0.67	-0.32	1.66	0.54
Noita	Fire Emblem Heroes	0.76	-0.37	1.89	0.57
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	0.71	-0.52	1.93	0.78
Pokémon GO	Fire Emblem Heroes	-0.41	-1.20	0.38	0.88
Pokémon Legends: Arceus	Fire Emblem Heroes	0.53	-0.60	1.66	0.94
SuperStar Series	Fire Emblem Heroes	0.61	-0.08	1.30	0.14
VALORANT	Fire Emblem Heroes	0.91	-0.16	1.97	0.19
Idle Heroes	Genshin Impact	0.05	-0.98	1.07	1.00
League of Legends: Wild Rift	Genshin Impact	0.64	-0.22	1.51	0.40
Mobile Legends: Bang Bang	Genshin Impact	0.67	-0.35	1.69	0.60
Noita	Genshin Impact	0.76	-0.41	1.92	0.61
PlayerUnknown's Battlegrounds	Genshin Impact	0.70	-0.55	1.96	0.80
Pokémon GO	Genshin Impact	-0.41	-1.24	0.41	0.91
Pokémon Legends: Arceus	Genshin Impact	0.53	-0.63	1.69	0.95
SuperStar Series	Genshin Impact	0.61	-0.13	1.34	0.22
VALORANT	Genshin Impact	0.91	-0.19	2.00	0.22
League of Legends: Wild Rift	Idle Heroes	0.60	-0.43	1.63	0.77
Mobile Legends: Bang Bang	Idle Heroes	0.63	-0.53	1.78	0.85
Noita	Idle Heroes	0.71	-0.57	1.99	0.82
PlayerUnknown's Battlegrounds	Idle Heroes	0.66	-0.71	2.03	0.92
Pokémon GO	Idle Heroes	-0.46	-1.45	0.53	0.94
Pokémon Legends: Arceus	Idle Heroes	0.48	-0.80	1.77	0.99
SuperStar Series	Idle Heroes	0.56	-0.35	1.48	0.70
VALORANT	Idle Heroes	0.86	-0.36	2.08	0.48
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.03	-1.00	1.05	1.00
Noita	League of Legends: Wild Rift	0.11	-1.05	1.28	1.00
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.06	-1.19	1.32	1.00
Pokémon GO	League of Legends: Wild Rift	-1.06	-1.89	-0.22	***0.00***
Pokémon Legends: Arceus	League of Legends: Wild Rift	-0.12	-1.28	1.05	1.00
SuperStar Series	League of Legends: Wild Rift	-0.04	-0.78	0.71	1.00
VALORANT	League of Legends: Wild Rift	0.26	-0.84	1.36	1.00
Noita	Mobile Legends: Bang Bang	0.09	-1.20	1.37	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.03	-1.33	1.40	1.00
Pokémon GO	Mobile Legends: Bang Bang	-1.08	-2.08	-0.09	***0.02***
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.14	-1.43	1.14	1.00
SuperStar Series	Mobile Legends: Bang Bang	-0.06	-0.98	0.85	1.00
VALORANT	Mobile Legends: Bang Bang	0.24	-0.99	1.46	1.00
PlayerUnknown's Battlegrounds	Noita	-0.05	-1.52	1.42	1.00
Pokémon GO	Noita	-1.17	-2.31	-0.03	***0.04***
Pokémon Legends: Arceus	Noita	-0.23	-1.62	1.17	1.00
SuperStar Series	Noita	-0.15	-1.22	0.92	1.00
VALORANT	Noita	0.15	-1.19	1.49	1.00
Pokémon GO	PlayerUnknown's Battlegrounds	-1.12	-2.35	0.11	0.12
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.18	-1.65	1.30	1.00

SuperStar Series	PlayerUnknown's Battlegrounds	-0.10	-1.26	1.07	1.00
VALORANT	PlayerUnknown's Battlegrounds	0.20	-1.22	1.62	1.00
Pokémon Legends: Arceus	Pokémon GO	0.94	-0.19	2.08	0.22
SuperStar Series	Pokémon GO	1.02	0.33	1.72	***0.00***
VALORANT	Pokémon GO	1.32	0.25	2.39	***0.00***
SuperStar Series	Pokémon Legends: Arceus	0.08	-0.99	1.15	1.00
VALORANT	Pokémon Legends: Arceus	0.38	-0.97	1.72	1.00
VALORANT	SuperStar Series	0.30	-0.70	1.30	1.00

PSS and Social Connectivity		**Mean diff**	**lwr**	**upr**	**p adj**
Final Fantasy XIV	Fate/Grand Order	2.96	1.43	4.48	***0.00***
Fire Emblem Heroes	Fate/Grand Order	0.22	-0.70	1.13	1.00
Genshin Impact	Fate/Grand Order	1.52	0.55	2.49	***0.00***
Idle Heroes	Fate/Grand Order	1.75	0.54	2.95	***0.00***
League of Legends: Wild Rift	Fate/Grand Order	2.29	1.31	3.28	***0.00***
Mobile Legends: Bang Bang	Fate/Grand Order	2.87	1.67	4.08	***0.00***
Noita	Fate/Grand Order	-0.05	-1.45	1.35	1.00
PlayerUnknown's Battlegrounds	Fate/Grand Order	3.29	1.76	4.82	***0.00***
Pokémon GO	Fate/Grand Order	1.77	0.85	2.69	***0.00***
Pokémon Legends: Arceus	Fate/Grand Order	0.31	-1.09	1.71	1.00
SuperStar Series	Fate/Grand Order	0.08	-0.70	0.86	1.00
VALORANT	Fate/Grand Order	3.21	1.90	4.52	***0.00***
Fire Emblem Heroes	Final Fantasy XIV	-2.74	-4.33	-1.15	***0.00***
Genshin Impact	Final Fantasy XIV	-1.43	-3.06	0.19	0.14
Idle Heroes	Final Fantasy XIV	-1.21	-2.98	0.56	0.53
League of Legends: Wild Rift	Final Fantasy XIV	-0.66	-2.29	0.97	0.98
Mobile Legends: Bang Bang	Final Fantasy XIV	-0.09	-1.86	1.68	1.00
Noita	Final Fantasy XIV	-3.01	-4.92	-1.10	***0.00***
PlayerUnknown's Battlegrounds	Final Fantasy XIV	0.33	-1.67	2.34	1.00
Pokémon GO	Final Fantasy XIV	-1.19	-2.78	0.40	0.39
Pokémon Legends: Arceus	Final Fantasy XIV	-2.65	-4.56	-0.74	***0.00***
SuperStar Series	Final Fantasy XIV	-2.88	-4.39	-1.36	***0.00***
VALORANT	Final Fantasy XIV	0.25	-1.59	2.09	1.00
Genshin Impact	Fire Emblem Heroes	1.31	0.24	2.37	***0.00***
Idle Heroes	Fire Emblem Heroes	1.53	0.25	2.81	***0.01***
League of Legends: Wild Rift	Fire Emblem Heroes	2.08	1.00	3.16	***0.00***
Mobile Legends: Bang Bang	Fire Emblem Heroes	2.65	1.37	3.94	***0.00***
Noita	Fire Emblem Heroes	-0.27	-1.74	1.20	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	3.07	1.49	4.66	***0.00***
Pokémon GO	Fire Emblem Heroes	1.55	0.53	2.58	***0.00***
Pokémon Legends: Arceus	Fire Emblem Heroes	0.09	-1.37	1.56	1.00
SuperStar Series	Fire Emblem Heroes	-0.13	-1.03	0.76	1.00
VALORANT	Fire Emblem Heroes	2.99	1.61	4.37	***0.00***
Idle Heroes	Genshin Impact	0.22	-1.10	1.55	1.00
League of Legends: Wild Rift	Genshin Impact	0.77	-0.35	1.90	0.53

Mobile Legends: Bang Bang	Genshin Impact	1.35	0.02	2.67	***0.04***
Noita	Genshin Impact	-1.58	-3.08	-0.07	***0.03***
PlayerUnknown's Battlegrounds	Genshin Impact	1.77	0.15	3.39	***0.02***
Pokémon GO	Genshin Impact	0.25	-0.83	1.32	1.00
Pokémon Legends: Arceus	Genshin Impact	-1.21	-2.72	0.29	0.26
SuperStar Series	Genshin Impact	-1.44	-2.39	-0.49	***0.00***
VALORANT	Genshin Impact	1.69	0.27	3.11	***0.01***
League of Legends: Wild Rift	Idle Heroes	0.55	-0.78	1.88	0.98
Mobile Legends: Bang Bang	Idle Heroes	1.13	-0.38	2.63	0.38
Noita	Idle Heroes	-1.80	-3.46	-0.13	***0.02***
PlayerUnknown's Battlegrounds	Idle Heroes	1.55	-0.23	3.32	0.16
Pokémon GO	Idle Heroes	0.02	-1.26	1.31	1.00
Pokémon Legends: Arceus	Idle Heroes	-1.43	-3.10	0.23	0.17
SuperStar Series	Idle Heroes	-1.66	-2.85	-0.48	***0.00***
VALORANT	Idle Heroes	1.46	-0.12	3.05	0.10
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.58	-0.76	1.91	0.97
Noita	League of Legends: Wild Rift	-2.35	-3.86	-0.84	***0.00***
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	1.00	-0.63	2.62	0.70
Pokémon GO	League of Legends: Wild Rift	-0.53	-1.61	0.56	0.92
Pokémon Legends: Arceus	League of Legends: Wild Rift	-1.98	-3.50	-0.47	***0.00***
SuperStar Series	League of Legends: Wild Rift	-2.21	-3.18	-1.25	***0.00***
VALORANT	League of Legends: Wild Rift	0.91	-0.51	2.34	0.63
Noita	Mobile Legends: Bang Bang	-2.92	-4.59	-1.26	***0.00***
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	0.42	-1.35	2.19	1.00
Pokémon GO	Mobile Legends: Bang Bang	-1.10	-2.39	0.19	0.18
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-2.56	-4.22	-0.90	***0.00***
SuperStar Series	Mobile Legends: Bang Bang	-2.79	-3.98	-1.60	***0.00***
VALORANT	Mobile Legends: Bang Bang	0.34	-1.25	1.93	1.00
PlayerUnknown's Battlegrounds	Noita	3.34	1.43	5.25	***0.00***
Pokémon GO	Noita	1.82	0.35	3.30	***0.00***
Pokémon Legends: Arceus	Noita	0.36	-1.45	2.18	1.00
SuperStar Series	Noita	0.13	-1.25	1.52	1.00
VALORANT	Noita	3.26	1.52	5.00	***0.00***
Pokémon GO	PlayerUnknown's Battlegrounds	-1.52	-3.11	0.07	0.08
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-2.98	-4.89	-1.07	***0.00***
SuperStar Series	PlayerUnknown's Battlegrounds	-3.21	-4.72	-1.70	***0.00***
VALORANT	PlayerUnknown's Battlegrounds	-0.08	-1.92	1.76	1.00
Pokémon Legends: Arceus	Pokémon GO	-1.46	-2.93	0.02	0.06
SuperStar Series	Pokémon GO	-1.69	-2.59	-0.79	***0.00***
VALORANT	Pokémon GO	1.44	0.05	2.83	***0.03***
SuperStar Series	Pokémon Legends: Arceus	-0.23	-1.62	1.16	1.00
VALORANT	Pokémon Legends: Arceus	2.90	1.16	4.64	***0.00***
VALORANT	SuperStar Series	3.13	1.84	4.42	***0.00***

PSS and Visual Aesthetics		**Mean diff**	**lwr**	**upr**	**p adj**

Final Fantasy XIV	Fate/Grand Order	0.76	-0.49	2.00	0.71
Fire Emblem Heroes	Fate/Grand Order	0.01	-0.74	0.75	1.00
Genshin Impact	Fate/Grand Order	0.74	-0.05	1.54	0.09
Idle Heroes	Fate/Grand Order	-0.75	-1.73	0.24	0.36
League of Legends: Wild Rift	Fate/Grand Order	-0.59	-1.39	0.21	0.41
Mobile Legends: Bang Bang	Fate/Grand Order	-0.09	-1.07	0.89	1.00
Noita	Fate/Grand Order	-0.01	-1.15	1.13	1.00
PlayerUnknown's Battlegrounds	Fate/Grand Order	-0.52	-1.77	0.73	0.97
Pokémon GO	Fate/Grand Order	-0.80	-1.56	-0.05	***0.03***
Pokémon Legends: Arceus	Fate/Grand Order	-0.92	-2.06	0.23	0.27
SuperStar Series	Fate/Grand Order	-0.25	-0.89	0.38	0.98
VALORANT	Fate/Grand Order	0.30	-0.76	1.37	1.00
Fire Emblem Heroes	Final Fantasy XIV	-0.75	-2.05	0.55	0.77
Genshin Impact	Final Fantasy XIV	-0.02	-1.34	1.31	1.00
Idle Heroes	Final Fantasy XIV	-1.50	-2.95	-0.06	***0.03***
League of Legends: Wild Rift	Final Fantasy XIV	-1.35	-2.68	-0.02	***0.04***
Mobile Legends: Bang Bang	Final Fantasy XIV	-0.85	-2.29	0.60	0.76
Noita	Final Fantasy XIV	-0.77	-2.33	0.79	0.91
PlayerUnknown's Battlegrounds	Final Fantasy XIV	-1.28	-2.91	0.36	0.31
Pokémon GO	Final Fantasy XIV	-1.56	-2.86	-0.26	***0.01***
Pokémon Legends: Arceus	Final Fantasy XIV	-1.68	-3.24	-0.12	***0.02***
SuperStar Series	Final Fantasy XIV	-1.01	-2.25	0.22	0.24
VALORANT	Final Fantasy XIV	-0.45	-1.96	1.05	1.00
Genshin Impact	Fire Emblem Heroes	0.74	-0.14	1.61	0.20
Idle Heroes	Fire Emblem Heroes	-0.75	-1.80	0.29	0.45
League of Legends: Wild Rift	Fire Emblem Heroes	-0.60	-1.48	0.28	0.55
Mobile Legends: Bang Bang	Fire Emblem Heroes	-0.10	-1.14	0.95	1.00
Noita	Fire Emblem Heroes	-0.02	-1.22	1.18	1.00
PlayerUnknown's Battlegrounds	Fire Emblem Heroes	-0.53	-1.82	0.77	0.98
Pokémon GO	Fire Emblem Heroes	-0.81	-1.65	0.03	0.07
Pokémon Legends: Arceus	Fire Emblem Heroes	-0.93	-2.13	0.27	0.33
SuperStar Series	Fire Emblem Heroes	-0.26	-0.99	0.47	0.99
VALORANT	Fire Emblem Heroes	0.30	-0.83	1.42	1.00
Idle Heroes	Genshin Impact	-1.49	-2.57	-0.41	***0.00***
League of Legends: Wild Rift	Genshin Impact	-1.33	-2.25	-0.41	***0.00***
Mobile Legends: Bang Bang	Genshin Impact	-0.83	-1.91	0.25	0.33
Noita	Genshin Impact	-0.75	-1.98	0.48	0.70
PlayerUnknown's Battlegrounds	Genshin Impact	-1.26	-2.59	0.06	0.08
Pokémon GO	Genshin Impact	-1.55	-2.42	-0.67	***0.00***
Pokémon Legends: Arceus	Genshin Impact	-1.66	-2.89	-0.43	***0.00***
SuperStar Series	Genshin Impact	-1.00	-1.77	-0.22	***0.00***
VALORANT	Genshin Impact	-0.44	-1.60	0.72	0.99
League of Legends: Wild Rift	Idle Heroes	0.16	-0.93	1.24	1.00
Mobile Legends: Bang Bang	Idle Heroes	0.66	-0.57	1.88	0.86
Noita	Idle Heroes	0.74	-0.62	2.09	0.84
PlayerUnknown's Battlegrounds	Idle Heroes	0.23	-1.22	1.67	1.00
Pokémon GO	Idle Heroes	-0.06	-1.11	0.99	1.00

Pokémon Legends: Arceus	Idle Heroes	-0.17	-1.53	1.19	1.00
SuperStar Series	Idle Heroes	0.49	-0.48	1.46	0.90
VALORANT	Idle Heroes	1.05	-0.25	2.35	0.25
Mobile Legends: Bang Bang	League of Legends: Wild Rift	0.50	-0.59	1.59	0.95
Noita	League of Legends: Wild Rift	0.58	-0.66	1.81	0.94
PlayerUnknown's Battlegrounds	League of Legends: Wild Rift	0.07	-1.26	1.40	1.00
Pokémon GO	League of Legends: Wild Rift	-0.21	-1.10	0.67	1.00
Pokémon Legends: Arceus	League of Legends: Wild Rift	-0.33	-1.56	0.91	1.00
SuperStar Series	League of Legends: Wild Rift	0.34	-0.45	1.12	0.97
VALORANT	League of Legends: Wild Rift	0.89	-0.27	2.06	0.34
Noita	Mobile Legends: Bang Bang	0.08	-1.28	1.44	1.00
PlayerUnknown's Battlegrounds	Mobile Legends: Bang Bang	-0.43	-1.88	1.02	1.00
Pokémon GO	Mobile Legends: Bang Bang	-0.71	-1.77	0.34	0.55
Pokémon Legends: Arceus	Mobile Legends: Bang Bang	-0.83	-2.19	0.53	0.71
SuperStar Series	Mobile Legends: Bang Bang	-0.16	-1.13	0.81	1.00
VALORANT	Mobile Legends: Bang Bang	0.39	-0.90	1.69	1.00
PlayerUnknown's Battlegrounds	Noita	-0.51	-2.07	1.05	1.00
Pokémon GO	Noita	-0.79	-2.00	0.41	0.59
Pokémon Legends: Arceus	Noita	-0.91	-2.39	0.57	0.70
SuperStar Series	Noita	-0.24	-1.38	0.89	1.00
VALORANT	Noita	0.31	-1.11	1.74	1.00
Pokémon GO	PlayerUnknown's Battlegrounds	-0.28	-1.58	1.02	1.00
Pokémon Legends: Arceus	PlayerUnknown's Battlegrounds	-0.40	-1.96	1.16	1.00
SuperStar Series	PlayerUnknown's Battlegrounds	0.27	-0.97	1.50	1.00
VALORANT	PlayerUnknown's Battlegrounds	0.82	-0.68	2.33	0.83
Pokémon Legends: Arceus	Pokémon GO	-0.12	-1.32	1.09	1.00
SuperStar Series	Pokémon GO	0.55	-0.19	1.29	0.38
VALORANT	Pokémon GO	1.11	-0.02	2.24	0.06
SuperStar Series	Pokémon Legends: Arceus	0.67	-0.47	1.80	0.76
VALORANT	Pokémon Legends: Arceus	1.22	-0.20	2.65	0.17
VALORANT	SuperStar Series	0.56	-0.50	1.61	0.87

Appendix J: Experiment Procedure Manual

Title of Project: Games and Acute Stress
This document describes the standard procedure for administering the Trier Social Stress Test (TSST). It is adapted from the procedure described in: http://www.macses.ucsf.edu/Research/Allostatic/notebook/challenge.html. However, the SOPs have been modified to fit the purpose of the study and assumes only psychological measure obtained.

1) **Objective**

   The aim of the study is to measure the effect of games on stress level. The experiment will collect subjective measures of stress (psychological measures). Self-report scales will be used to collect data at three different phases throughout the experiment;

   a) At the baseline, at the beginning of the experiment before the task briefing using State and Trait Anxiety Inventory - Trait Scale (STAI-TRAIT).
   b) After the task briefing using State and Trait Anxiety Inventory – STATE SCALE (STAI-STATE) and Acute Stress Appraisal (ASA) – Pre-task Scale.
   c) After the intervention (game phase) using State and Trait Anxiety Inventory – STATE SCALE (STAI-STATE) and Acute Stress Appraisal (ASA) – Post-task Scale.

2) **Experiment Set-up (TSST)**
   a) **Participants**
      i) ***Experimenter 1 (E1):***
         E1 is responsible for guiding the subject (S) from one room to another and debriefing the subject.
      ii) ***Confederates (C):***
         Two confederates are used. Neither should have had contact with S prior to the TSST. The confederates may be of any gender.
            1. Confederate 1 (C1): C1 will be the only person to speak to S during the TSST.
            2. Confederate 2 (C2): C2 is the only person to take notes during the procedure.
   b) **Materials**
      i) Questionnaires
      ii) Scripted Material: Script for introduction to the TSST, instructions for the mathematics task, and debriefing script. Copies of the Speaking Task and Debriefing scripted material can be found in the **Appendix A and B** of this SOP. Evaluators should be familiar with this script well in advance of the task.
      iii) Video camera
      iv) Cassette recorder (to play instructions)
      v) Two clipboards and notepads (for each C)
   c) **Environment**
      i) Preparatory Room/ Waiting Room:
         (1) This room should have a comfortable chair or sofa, and bland reading material for the subject.

(2) The subject is placed in this room before and after the TSST.
(3) Paper and pencil/pen with a writing area (clipboard or small table) are available for writing.
ii) Testing Room:
(1) Testing Room containing the game console should be a plain room containing a desk with two chairs behind it.
(2) The Testing Room is the room in which the instructions are given and the speech/Maths task is conducted.
(3) The video camera is set on a tripod behind the Cs.
iii) If only one room is available, the room should have all the available equipment listed in the two rooms above, including two chairs in front of the desk (for the subject and E1) and two chairs behind the desk (for the Cs).

d) Set-up

i) Waiting Room: This is where the participants will wait before starting the experiment. The experiment starts as soon as they enter the next room.
(1) Computer or laptop
(a) for completing the survey.
(2) Consent form
ii) Testing room:
(1) Cs wear white lab coats and are seated behind desk.
(2) Clipboards with notepad and pencil/pen for each
(3) Video camera is focused on subject. The record light should be on and visible to the subject.
(4) Timer is easily visible to subject and the ticking is audible. Subject can see the time left on the timer.
(5) C1 will have scripts to read.
(6) Cassette recorder is on desk

3) Initial Procedures Prior to Speaking Task

a) Upon arrival the subject is greeted by E1.
b) Smoking: Nicotine dependent subjects should have a cigarette two hours prior to TSST. Alternately, subjects may be placed on an appropriate dose of nicotine patch.
c) Caffeine: no caffeinated beverages should be consumed within two hours of the TSST.
d) The subject is then escorted to the Preparatory Room to relax.

4) Basal Measures

a) The following questionnaires will be administered: STAI_TRAIT.

5) Instructions for Speaking Task

a) The E1 turns on the cassette recorder and the instructions for the TSST are played. The instructions are on Appendix A.
b) After the instructions are read, E1 leads the subject back into the Preparatory Room. If the participant asks E1 any questions regarding the task, E1 responds “Do whatever you think is best” or “I do not know any other details."

6) Preparation for Speaking Task

a) Upon arrival in the Preparatory Room, E1 sets the timer for ten minutes. In the Preparatory Room, E1 will give the subject a notepad to make notes for their speech. The subject will be given 10 minutes to prepare. Subject is told that the notepad is to help him/her prepare for their speech, but they will not be able to take their notes into the Testing Room with them.

b) E1 leaves the room for ten minutes.

c) After the alarm goes off, E1 returns to the Preparatory.

d) Speaking Task

   (1) The timer is set for five minutes and C1 tells the subject "Please begin."

   ii) C2 should take notes appropriately every one minute, as if noting the subject's performance. The comments should be brief so that C2s eyes are not taken off the participant for more than a glance.

   iii) If the subject pauses for 20 seconds, the C1 will prompt the subject with "You still have some time. Please continue."

   iv) If the subject asks the Cs a question, C1 should make neutral comments, such as "Do whatever you think is best," "Say whatever comes to your mind," or "Be as creative as you like."

   v) When the alarm sounds, C1 says "Please stop, your time is up."

e) Math Task

   i) C1 then tells the subject "Now we would like you to subtract number 13 from 6233, and keep subtracting 13 from the remainder until we tell you to stop. You should do the subtraction as fast and as accurately as possible."

   ii) Whenever the subject makes an error, the subject needs to restart at 6233. C1 instructs the subject "That's incorrect. Please start again from the beginning." If the subject has forgotten the starting number, C1 provides the number (6233) again.

   iii) At the end of 5 minutes, C1 instructs the subject "Please stop, your time is up. You can go back to your room now."

   iv) If the subject asks questions as to how he/she did, C1 responds "I am not allowed to tell you that. Someone will give you that information later."

f) Adverse Response If at any time the subject appears to be having an adverse reaction, i.e., begins to cry or seems overly agitated, C1 should ask the subject "Are you okay?" "Do you want to stop?" or "Are you okay to continue?" If the subject indicates that they wish to stop, C1 should stop the study immediately and notify the person in charge of the stress test that the participant has had an adverse reaction and needs to be debriefed.

7) Follow-up Measures

a) E1 accompanies the subject back to the Preparatory Room.

b) Post-intervention questionnaires are obtained.

8) Debriefing

Debriefing If subject is not to participate in another TSST, E1 debriefs the subject. See Appendix B for the Debriefing Script.

Appendix K: Participant Information Sheet (Experiments)

Participant Information Sheet
Principal Investigators: Siti Noorfatimah Safar and Prof. Paul Cairns
Study Title: Digital games and the Impact on Daily Life

You are being invited to take part in this study. Before you decide whether or not to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take the time to read the following information carefully and decide if you want to take part in this study. If you have any question or require any further information, please feel free to email at sns538@york.ac.uk.

1. **Purpose of Study.**
   The aim of this research is to investigate the impact of Digital games and daily life stresses.

2. **Participation.**
   This study is totally voluntary and you are under no obligation to take part. The data that you provide will be very useful for our study. If you do decide to take part you will be given this information sheet to keep and will be asked to sign a consent form on the day of the experiment. You have the right to withdraw from the study at any time and without giving any reason. A £10 Amazon voucher will be given to each participant as a token of appreciation.

3. **Participation eligibility.**
   a. ***Age 18 and above***
   b. ***Does not have an existing mental health condition***

   For the management of safety and legal concerns, we are not working with anyone below the eligibility age and due to the nature of the task seen in the next section, we are required to exclude if you have pre-existing mental health condition.

4. **Participant involvement.**
   You will be asked to participate in a social experiment that requires you to perform several tasks. The tasks are intended to be stressful and it is intended to mimic daily stresses, the kind of stress that you experience in day-to-day life. If you are uncomfortable with managing stress, please don't take this study. You will also answer several surveys to gauge your perceived level of stress. Full instructions on how to complete the tasks will be given to you on the day of the experiment and the experiment will take about 30 minutes to complete.

5. **Participant's rights to withdraw.**
   You can withdraw from the study at any point during the survey without giving any reason. A decision to withdraw, or a decision not to take part, will not affect your rights.

6. **Information Usage.**
   All the information collected is confidential and will not be discussed with anyone except the investigators. Participation in the study will not be disclosed to anyone. Reports from the research will not identify anyone who has taken part.

7. **Participant Confidentiality (anonymity).**
   The data/record collected from this research will be kept strictly confidential. You will not be able to be identified or be identifiable in any reports on publications. Any data collected about

you in the survey will be stored online protected by passwords and other relevant security processes and technologies. Data collected may be shared in an anonymized form to allow reuse by the research team and other third parties. These anonymized data will not allow any individuals or their institutions to be identified or identifiable. Anonymized data from this study may also be used in conjunction with research data from other studies for academic purposes. Care will be taken to ensure that individuals cannot be identified from the details presented. All data will be treated in accordance with the Data Protection Act 1998.

8. Contact for further information.

If you have any questions regarding this study, please contact the researcher;

Siti Noorfatimah Safar

Department of Computer Science, University of York.

Email: ***sns538@york.ac.uk*****.**

9. Data Protection Privacy Notice

All information collected will be handled with care in accordance with the General Data Protection Regulation (GDPR) and Data Protection Act 2018. Data will be kept securely and protected from unauthorized access. Under the GDRP, the University of York will act as the "data controller" to ensure appropriate contracts are in place when engaging the services of a data processor. For further data protection questions, comments, or complaints on data protection, please contact the Data Protection Officer, dataprotection@york.ac.uk. Please refer to the University's Guide on GDPR Compliant Research for further details. https://www.york.ac.uk/records-management/dp/

This study has been reviewed by the Physical Science Ethics Committee, University of York.

Appendix L: Task Briefing

Task briefing Script

"You are required to perform a 10-minute presentation for a job interview in front of a camera. Your presentation will be recorded and the recording will be assessed by two trained interviewers on how outgoing, gregarious, and comfortable you are in situations in which you must project yourself as an expert. This is a type of personality test for a trait called extraversion. You will be given a hypothetical situation in which you will be applying for your ideal job. You have dreamed about working in this job for as many years as you can remember. You have just seen an advertisement for this perfect job and decided to apply. After submitting your application, you have been invited for an interview. The job pays a very large salary. You are competing against a lot of other candidates, and the final selection will be made based on your ability to convince the interviewers of how your experiences, abilities, and education make you a better candidate that the others. You will try to convince this panel of interviewers that you are the best candidate for the position. In addition, you will be asked to perform a mental math test, which will give us additional information about your working memory capacity."

"You will have 5 minutes to prepare a detailed speech. After the preparation time has elapsed, you will return and deliver your speech to these interviewers. Your speech should explain why you should get the job."

"Remember, you should try to perform better that all of the other participants. These examiners are specially trained to monitor and rate your speech for its believability and convincingness, and they will compare your performance to that of the others who perform this task. Also, you will be videotaped during the task so that the examiners can go over the videotape carefully and rate the contents of your speech as well as your nonverbal behaviour. Now let us go back to your room so that you can prepare for your job interview."

Appendix M: De-Briefing

Debriefing Script

"You were not actually being evaluated or scored. You were not actually being recorded. Your performance is not compared to other participants. We are examining if Digital games can reduce stress by inducing stress and measuring stress levels pre and post-game intervention, that's why we have been collecting samples from you. We are sorry that we didn't tell you the truth about everything, but if we had, the situation wouldn't be stressful. You did a good job. Thank you for participating. Do you feel okay to go home/leave?"

Debrief Sheet (to be given to the participants)
Principal Investigators: Siti Noorfatimah Safar and Prof. Paul Cairns
Study Title: Digital games and the Impact on Daily Life

E-mail: sns538@york.ac.uk

Thank you for taking part in this study. The sheet will provide you with full details of the study in which you participated.

The purpose of the study was to investigate the impact of Digital games on acute stress. Research on Digital games has shown to have a positive impact on wellbeing. However, further understanding of how Digital games work to bring about the positive impact still requires further research. This study will help with the initial understanding of the effect of Digital games on stress levels and subsequently, further understanding of how Digital games could work in alleviating stress.

You were allocated to an experimental (game intervention) group or a control (non-intervention) group. Participants in both groups were briefed on the task to be completed followed by completing a survey to measure stress traits. This survey measures the general disposition of the participant's stress level. The task is similar for both groups. This is followed by another scale measuring the state of stress. The game intervention group is then given 5 minutes to play Digital games before completing the task. Meanwhile, the control group will wait for their time to perform the task. Once the five minutes is up, the participants are given another set of scales to measure the effect of Digital games on stress levels. We expected that participants in the experimental group's level of stress will be lower compared to the control group. This is because participants in the experimental group would have been distracted from the task given. Some aspects of the study were withheld from you so that your expectations would not affect the outcome, which is why we presented the tasks as separate experiments. For this reason, we ask that you do not discuss the study with anyone else until its conclusion (30/11/2022).

Thank you again for taking part. If there is anything you would like to discuss in relation to this study, please feel free to do so by contacting the researchers. If you would like to withdraw your data, please speak to the researcher listed below or contact her later. The researcher has written your anonymity code on your information sheet. As your data is identified only by this code, you will have to quote it if you want your data to be destroyed at a later date, so please take care not to lose this sheet.

Appendix N: Consent Form

Thank you for your interest in this project. Just to remind you, the data you provide in the course of this project will be treated in the strictest confidence and will be used for research purposes only. Furthermore, as a participant in this research you will never be identified in any outputs (e.g., reports, research articles) that arise from this project, and your data will never be identifiable or viewed by any other party outside the research team.

Please complete the whole of this sheet

	Please tick boxes
1. I can confirm that I am aged 18 and above.	☐
2. I can confirm that I do not have existing mental health condition.	☐
3. I confirm that I have read and understood the information sheet for the above experiment.	☐
4. I have had opportunities to ask questions and my questions have fully been answered.	☐
5. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.	☐
6. I have received enough information about the experiment.	☐
7. I agree to take part in the above experiment.	☐

"This experiment has been explained to me to my satisfaction, and I agree to take part. I understand that I am free to withdraw at any time."

__________________________ ___________ ________________

Name of Participant Date Signature

I have explained the experiment to the above participant and he/she has agreed to take part.

__________________________ ___________ ________________

Name of Participant Date Signature

Appendix O: State-Trait Anxiety Inventory (STAI)

State-Trait Appraisal Inventory Scale (STAI - TRAIT)

For use by Siti Noorfatimah Safar only. Received from Mind Garden, Inc. on July 6, 2022

SELF-EVALUATION QUESTIONNAIRE

STAI AD Form Y-2

Name____Date_________

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate you *generally* feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

For Review Only

STAI - Adult Manual © 1983-2020 Charles D. Spielberger. All rights reserved in all media.
Published by Mind Garden, Inc., www.mindgarden.com 77

STAI-State

For use by Siti Noorfatimah Safar only. Received from Mind Garden, Inc. on July 6, 2022

SELF-EVALUATION QUESTIONNAIRE

STAI AD Form Y-1

Please provide the following information:

Name________________________________ Date______________ S_____

Age________________ Gender (*Circle*) **M** **F** T_____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

For Review Only

STAI - Adult Manual © 1983-2020 Charles D. Spielberger. All rights reserved in all media.
Published by Mind Garden, Inc., www.mindgarden.com

Appendix P: Acute Stress Appraisal (ASA)

Acute Stress Appraisal Pre-task Scale

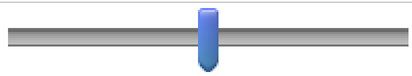
The next section consists of a number of statements to indicate how you are feeling right now regarding the ***task that you are about to complete.***

Please indicate by moving the slider after each statement to indicate how you are feeling right now.

25 The upcoming task is very demanding.

Strongly Disagree | Neutral | Strongly Agree

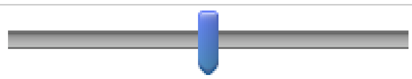
0 1 2 3 4 5 6 7

Never	

26 I am very uncertain about how I will perform during the upcoming task.

Strongly Disagree | Neutral | Strongly Agree

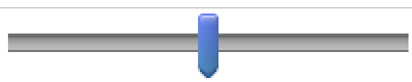
0 1 2 3 4 5 6 7

Never	

27 The upcoming task will take a lot of effort to complete.

Strongly Disagree | Neutral | Strongly Agree

0 1 2 3 4 5 6 7

Never	

28 The upcoming task is very stressful.

Strongly Disagree | Neutral | Strongly Agree

0 1 2 3 4 5 6 7

Never	

29 I have the abilities to perform the upcoming task successfully.

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

30 It is very important to me that I perform well for this task.

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

31 I'm the kind of person who does well in these types of situations.

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

32 A poor performance on this task would be very distressing for me.

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

33 I expect to perform well on this task.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

34 I view the upcoming task as a positive challenge.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

35 I think the upcoming task represents a threat to me.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

36 I feel as if I am in complete control of my performance.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

Acute Stress Appraisal Post-task Scale

The next section consists of a number of statements to indicate how you feeling right now regarding the ***task you*** *have just completed*.

Please indicate by moving the slider after each statement to indicate how you are feeling right now.

95 The task was very demanding.

Strongly Disagree | Neutral | Strongly Agree

0 1 2 3 4 5 6 7

Never	

96 I am very uncertain about how I performed.

Strongly Disagree | Neutral | Strongly Agree

0 1 2 3 4 5 6 7

Never	

97 I exerted a lot of effort during the task.

Strongly Disagree | Neutral | Strongly Agree

0 1 2 3 4 5 6 7

Never	

98 The task is very stressful.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

---

99 I felt that I had the abilities to perform well in the task.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

---

100 It was very important to me that I perform well for this task.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7
Never								

---

101 I believe I performed well on the task.

	Strongly Disagree			Neutral			Strongly Agree	
	0	1	2	3	4	5	6	7

Never	

102 I felt that the task challenged me in a positive way.

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

103 I felt threatened by the task.

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

104 I felt in complete control during the task

Strongly Disagree			Neutral			Strongly Agree	
0	1	2	3	4	5	6	7

Never	

Appendix Q: Short Form Immersion Experience Questionnaire (IEQ-SF)

IEQS

The following consists of 11 questions for which you must provide answers on a scale of 1 to 5, where 1 is selected if you strongly disagree with the item, and 5 is chosen if you strongly agree.

1 I felt focused on the game.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

2 I felt consciously aware of being in the real world whilst playing.

- Strongly Disagree (5)
- Disagree (4)
- Neutral (3)
- Agree (2)
- Strongly Agree (1)

3 I forgot about my everyday concerns.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

4 I felt that I was separated from the real-world environment.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

5 The game was something that I was experiencing, rather than just doing.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

6 I enjoyed playing the game.

- ◯ Strongly Disagree (1)
- ◯ Disagree (2)
- ◯ Neutral (3)
- ◯ Agree (4)
- ◯ Strongly Agree (5)

7 I found myself so involved that I was unaware I was using controls.

- ◯ Strongly Disagree (1)
- ◯ Disagree (2)
- ◯ Neutral (3)
- ◯ Agree (4)
- ◯ Strongly Agree (5)

8 I found the game challenging.

- ◯ Strongly Disagree (1)
- ◯ Disagree (2)
- ◯ Neutral (3)
- ◯ Agree (4)
- ◯ Strongly Agree (5)

9 I felt motivated when playing the game.

- ◯ Strongly Disagree (1)
- ◯ Disagree (2)
- ◯ Neutral (3)
- ◯ Agree (4)
- ◯ Strongly Agree (5)

10 I found the game easy.

- ◯ Strongly Disagree (5)
- ◯ Disagree (4)
- ◯ Neutral (3)
- ◯ Agree (2)
- ◯ Strongly Agree (1)

11 I felt in suspense about whether or not I would do well in the game.

- ◯ Strongly Disagree (1)
- ◯ Disagree (2)
- ◯ Neutral (3)
- ◯ Agree (4)
- ◯ Strongly Agree (5)

12 Please select the correct response for agree (not strongly agree) to confirm that you understand this question.

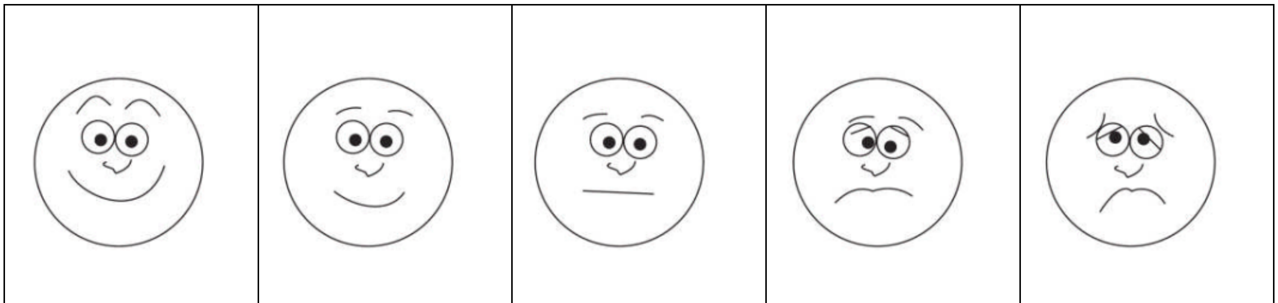
- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Appendix R: Visual Analogue Scale (VAS)

Visual Analogue Scale
Stress Scale

Rate your stress level between 1 to 5.

Calm, Relaxed, Confident. No distress or stress		Somewhat Stressed		Completely distressed, overwhelmed or stressed out



1	2	3	4	5

Appendix S: Game Experience Scale

1. On a scale of 1 to 10, how immersed were you in the activity given?

Not at all Immersed **Completely**

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

2. On a scale of 1 to 10, how involved you were with playing the game or the counting task.

Presentation Counting **Playing Game**

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Appendix T: Acute Stress Appraisal Reliability Measure

Tasks demand appraisal scale reliability – Pre-Task

The items that measure individual demand return a reliability result of alpha = 0.78, which indicates that the content items appear to "tap into" the concept of acute stress appraisal. However, if item ASAPRE8 ("A poor performance on this task would be very distressing for me") were dropped, the reliability is improved by alpha = 0.88.

Tasks resource appraisal scale reliability – Pre-Task

Given that alpha = 0.78 and the items content indicates each item appears to "tap into" the concept of acute stress appraisal, we should keep all three items.

Tasks demand appraisal scale reliability – Post-Task

The items that measure individual demand return a reliability result of alpha = 0.65, which seem to indicate that the content items are not measuring the concept. However, if item ASAPOST2 ("I am uncertain about how I performed"), the reliability is improved to alpha = 0.80.

Tasks resource appraisal scale reliability – Post-Task

Given the alpha = 0.73, the items content indicates the items are able to capture the concept of acute stress appraisal. However, if item ASAPOST6 were dropped the reliability improves by alpha = 076.

Appendix U: Experiment 1: Games Played, Play Frequency and Sentiments on Games

Waiting								
No	**GP**	**PF1**	**PF2**	**PF3**	**PF3**	**PF4**	**GH 1**	**GH2**
1	I Don't Play Game	-	-	-	-	-	Yes	Games might help with brain functioning
2	The Sim City	3 years	Everyd ay	1-2 hours	Less than 1 hour	Breaktime	Yes	I feel that when I play games while I am nervous about something, the games can make me calm and focus on them instead of being worried about stressful situations.
3	League of Legends	8+ years	A few times a week	4-7 hours	1-2 hours	After Work	Yes	I'm fairly confident I would've benefited from some math-based game to prepare myself for the latter interview task.
4	Sudoku	3	A few times a month	Less than 1 hour	Less than 1 hour	After Work,	Yes	I think playing that game helps me collect my thoughts.
5						In between classes, Breaktime , Whenever I can		
6	Chess	1 year	Everyd ay	1-2 hours	Less than 1 hour	After Work, In between work	No	I used the time before the task to try and calm down and focus on the points I would talk about in the presentation
7	I Don't Play Game	-	-	-	-	-	Yes	It helps you to stay calm
8	Apex Legends	Since its launch in February 2019	A few times a week	4-7 hours	2-4 hours	Before Work, Breaktime ,	No	Was not provided
9	I Don't Play Game	-	-	-	-	-	No	I don't think there is a relationship between playing games and being less stressed during the interview.
10	Sort watercolour	1 Year	A few times a month	2-4 hours	7-12 hours	After School, In	Yes	It takes your mind off the task

						between work		
11	Chess, sudoku	3 year	A few times a month	Less than 1 hour	2-4 hours	After School	Yes	It makes you forget about a worrying task and concentrate on the game.
12	Candy Crush	4 months	Everyd ay	2-4 hours	Less than 1 hour	Breaktime , Whenever I can	Yes	Might release any tension and provide a sense of calm
13	Monopoly deal	2 days	5	Less than 1 hour	Less than 1 hour	After School, After Work	Yes	It temporarily makes you forget that you are about to do a difficult task.
14	I Don't Play Game	-	-	-	-	-	No	It depends on what the interview might be. If the interview is going to be like a game and review people's personalities like a game or in a team, maybe playing games in a group with be helpful. However, once you just play you do not learn anything and you play unconsciously. So, I am not sure about it. On the other side, it might help you to forget about the upcoming task and decrease your level of anxiety.
15	Mario Kart	4 years	A few times a month	2-4 hours	Less than 1 hour	Whenever I can, Evening, Before Sleeping	No	My mind was on presenting
16	Persona 5	2 Months	A few times a week	12-20 hours	7-12 hours	After School, In between Classes, Breaktime ,	Yes	I learned from games about what is the best possible thing to say/course of action to take beforehand.
17	Rocket League	1.5 year	A few times a week	2-4 hours	1-2 hours	After Work, Weekends	No	I don't think the game helps me to confront situations like an interview.

18	Apex Legends	2 years	A few times a month	7-12 hours	2-4 hours	After School, After Work, In between Classes, Breaktime , Whenever I can	Yes	It sorts of clears my mind and relieves me from any stress and pressure caused by the task and interview
19	I Don't Play Game	-	-	-	-	-	-	-
20	Word search games	2 years	A few times a week	1-2 hours	1-2 hours	Whenever I can	Yes	It would help to ease any tension or anxiety experienced before the task
21	Plants vs zombies	2 months	Once per week	1-2 hours	1-2 hours	Whenever I can	Yes	For me, it helps my mind to get rid of the nervous feeling before any big task. I feel like if I played any games before my big day, it helped me ease a little bit even though I was slightly unprepared. I tend to get nervous when I think about the position I would be in, so playing any games before any task, makes me relaxed a little bit. I am not saying that it helps me to calm my nerves, but it would definitely help me become less stressful.
22	I Don't Play Game	-	-	-	-	-	-	-
23	Tetris	2.5 years	A few times a week	1-2 hours	Less than 1 hour	Whenever I can	No	Whilst it may destress you it also may take your mind off the task at hand, if this is a task that requires remembering what you need to say, this may cause an issue as you forget what you were planning to say
24	I Don't Play Game	-	-	-	-	-	Yes	It will awaken my brain probably
25	Jackbox	3 months	Once per week	1-2 hours	1-2 hours	After Work	Yes	I think playing a game may help ease some stress, distract from worries and help focus

26	Papers, Please	2 months	A few times a month	2-4 hours	1-2 hours	After School, Breaktime, Whenever I can	Yes	Many games require you to solve problems or make decisions in a matter of hours, which could be helpful to warm up your brain.
27	Best Fiends, Fun Run	2 years	A few times a month	Less than 1 hour	1-2 hours	Breaktime,	Yes	Because sometimes by playing games I can distract myself from thoughts that could disrupt my self-confidence or cause me to overthink and become very anxious before performing the task. Sometimes, the games can help me relax before doing something important.
28	Clash of clans	4 to 5 years	Everyday	2-4 hours	Less than 1 hour	After School, Breaktime,	No	For me, it takes away from a seemingly important task
29	I Don't Play Game	-	-				No	More distraction and I'm not a fan of games in general
30	PUBG and Among US	6 months	A few times a month	2-4 hours	2-4 hours	After School, Breaktime, when me and my friends are all available to play	No	Because I think that if you play any games or if you do anything beforehand, it will distract your mind. And you tend to forget. things if you have any distractions
31	FM2022	2weeks	A few times a week	4-7 hours	1-2 hours	Breaktime,	Yes	Help me to be confident

Gaming

No	GP	PF1	PF2	PF3	PF3	PF4	GH1	GH2
1	Beatstar	about a year, I think	A few times a week	1-2 hours	1-2 hours	Whenever I can	Yes	It helped me feel a little bit more at ease and helped me relax a bit instead of overthinking in the moment
2	Chess	6 months	Everyday	2-4 hours	1-2 hours	In between work	Yes	I was calmed and distracted by the game

3	Baba Is You	4 Months	A few times a week	2-4 hours	1-2 hours	After Work, Evening, Before Sleeping	No	It distracted me from the task. In particular, I forgot some of the things that I wanted to say in the interview task, and therefore I stuttered and stalled as I slowly remembered what I wanted to say.
4	Something like candy crush	3 days	A few times a Month	4-7 hours	2-4 hours	After School, After Work, Breaktime	Yes	When I played games before the presentation, I feel ease in the game and forgot the next presentation in a short time.
5	strategy games	2 years	Everyd ay	Less than 1 hour	Less than 1 hour	before sleeping	No	It's distracting
6	Jewel sliding	3 days	Once per week	Less than 1 hour	1-2 hours	After School, Breaktime	Yes	Distracted me from thinking about the tasks
7	crossword puzzle	2 years	A few times a week	Less than 1 hour	Less than 1 hour	After School, After Work, Breaktime , Whenever I can	No	I needed to focus and be relaxed before I was given the task, so playing that game was not very helpful in making me feel ready or calm.
8	Ooblets	4 weeks	Everyd ay	7-12 hours	1-2 hours	After School, In between classes	Yes	it helped as a distraction and diffused some of the nervousness for the duration of time I was playing, it was also fun and helped me relax.
9	Puzzle	1 month	A few times a week	1-2 hours	1-2 hours	Breaktime	Yes	Help me to feel comfortable
10	Musical chairs	1	Once a month	Not at all	Less than 1 hour	When babysittin g	Yes	It helped take my mind off the interview while waiting and helped to keep me relaxed
11	I played sky: children of the light	1 year	A few times a week	4-7 hours	2-4 hours	Whenever I can	Yes	I think it refreshes or relaxes my mind from the task ahead.

12	Multiversus	Since release so roughly a month I would say	Once per week	2-4 hours	2-4 hours	After School, After Work, when me and my friends are all available to play	Yes	It provided a minor distraction which allowed me to calm down and think properly about the task ahead, instead of feeling anxious, which was preventing me from thinking clearly.
13	Destiny 2	4 years	Everyday	More than 20 hours	7-12 hours	After School	Yes	It reduced my stress however it made me feel like I was going to forget what I had prepared
14	I Don't Play Games						Yes	It was a little useful to calm my nerves. But that is not the kind of game I enjoy.
15	Hay Day, Sudoku	3 years	A few times a week	Less than 1 hour	Less than 1 hour	Breaktime	Yes	It made me more relaxed and calmer
16	Minecraft	On and off for over a decade	A few times a week	4-7 hours	2-4 hours	Breaktime	No	By the time I had to say my speech, I had forgotten what I wanted to say. It did not really impact me when I had to the mental maths though.
17	I Don't Play Games	-	-	-	-	-	No	I felt that playing the game caused me to lose focus and I forgot some of the interview prep I had written prior. However, I don't think overall it caused me to perform worse.
18	Among Us	A week	A few times a week	4-7 hours	1-2 hours	Whenever I can	No	Couldn't focus on memorising the answers/points
19	King God Castle	days	A few times a week	4-7 hours	1-2 hours	Before School, After School, In between classes, Breaktime	Yes	It was fun and helped me calm down a little, which helped, but also slightly distracted me from mentally preparing for the interview which didn't help.
20	I Don't Play Games	-	-	-	-	-	No	Increased stress levels resulted in being more stressed about the task
21	Stellaris	2 years approximately	A few times a week	12-20 hours	7-12 hours	Evening, Before Sleeping	Yes	I feel that even if it did not help my ability, it eased my stress before the presentation.

22	Clash Royale	1 year	A few times a Month	Less than 1 hour	Less than 1 hour	In between classes, In between work, Commuting	No	I should have instead been thinking about the presentation
23	Pokémon cafe mix	2 months	A few times a Month	1-2 hours	Less than 1 hour	After School	No	It distracted me from focusing on the task
24	Mario Cart, Super Smash Bros, Nintendo Switch	Mario cart, totally new for 1 hour. Super smash bros in the past 5 years ago	A few times a Month	Less than 1 hour	2-4 hours	After School	Yes	The music element in the game provided stress relief and made me calm. But only when I played and picked game songs I liked e.g. happier by Marshmello or Sunroof. playing with songs I didn't like wasn't much fun. upbeat common songs were the best.
25	Chess	1 year	A few times a Month	Less than 1 hour	Less than 1 hour	In between work, Breaktime	No	I didn't enjoy the style of the game or the music. It made me feel manipulated.
26	God of War (the one before the latest), Dots	Days	A few times a week	4-7 hours	1-2 hours	After Work	No	Although I played the game, it was a brief distraction. After one round, I browsed the game a bit and picked a calm song from amongst the options in the game, to help me calm down.
27	Shotgun King	15 days	A few times a week	2-4 hours	1-2 hours	After School, After Work, Breaktime , Evening, Before Sleeping	Yes	It allowed me to focus on something else apart from the interview itself. While there were some things I wanted to say that I forgot, I was able to be more confident in the task.
28	I Don't Play Games	-	-	Not at all	-	-	No	I feel I lost my concentration on the presentation task.
29	League of Legends	3 Months	A few times a week	4-7 hours	1-2 hours	After Work	Yes	It was a bit calming to get a rhythm going with the musical game, but then I also stopped to make sure I had clear in my head what I was going to say

30	I Don't Play Games	-	-	-	-	-	Yes	The game distracted my anxious thoughts before performing the tasks. but it also made me forget about some points I noted down beforehand as playing games meant I could not rehearse the task.

Appendix V: Experiment 4 What Were You Thinking of While Waiting?

	Responses	Relating to Interview		Not Related to the Interview
		As the First answer	As Secondary answer	
1	Practising for the interview	/		
2	Just sitting and thinking of possible answers for the interview and some other stuff that I have in my life at the moment	/		
3	I was trying to have a good interview	/		
4	Thinking			/
5	Thinking about the interview	/		
6	Humming			/
7	Thinking about the preparation I’ve done before, spinning around on the spinning chair, simulating the interview, telling myself I'm confident loudly	/		
8	Thinking			/
9	Thinking about what was going to happen next	/		
10	Relax			/
11	Thinking about this text			/
12	Humming, tapping my feet, thinking about irrelevant thoughts			/
13	Looking around the room - reading boxes, thinking about tangential ways the words related to my life			/
14	Reading boxes, thinking about my professional experiences and, at the same time, thinking about my dream job, what I would be?		/	

15	Thinking about what to say as well as my plans for this week	/		
16	There's a lovely painting to look at, reminded me of home.			/
17	Looking around and reviewing my presentation in my head.		/	
18	I was preparing the interview answer, and thinking in mind in what way I could possibly answer them, so they will understand my skill set for their designation.	/		
19	Admiring the old PC by the desk and considering the change in what is considered the "business colours" from browns and beiges in the late 1900s to sleek black and silver of the present day.			/
20	Thinking over my presentation, and talking through it in my head	/		
21	Sitting looking at the processors on the computer			/
22	Sit and look around the room! Also thought about my interview plan and what I could have added.		/	
23	Recall some details about what I have written	/		
24	Thinking about what will happen and practising the interview.	/		
25	Memorising my notes to best prepare for my interview	/		
26	Nothing			/
27	Bit of deep breathing - meditation style, focusing on what I will say		/	
28	Sitting still and thinking about what I am going to say		/	
29	Thinking about various things in my life.			/
30	Thinking about possible outcomes	/		
31	Review my notes	/		

32	Practising my interview presentation in my head.	/		
33	Just sitting			/
34	Thinking about the interview will be like, who the interviewer will be, and will be able to perform well.	/		
35	Practice for the interview	/		
36	Thinking about my abilities to be better further	/		

11. Bibliography

Abd-Alrazaq, A., Alajlani, M., Alhuwail, D., Schneider, J., Akhu-Zaheya, L., Ahmed, A., & Househ, M. (2022). The Effectiveness of Serious Games in Alleviating Anxiety: Systematic Review and Meta-analysis. *JMIR Serious Games*, *10*(1). https://doi.org/10.2196/29137

Agrawal, V., Duggirala, M., & Chanda, S. (2018). Journey: A game on positive affect. *CHI PLAY 2018 - Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*, 373–379. https://doi.org/10.1145/3270316.3271532

Alexiou, A., & Schippers, M. C. (2018). Digital game elements, user experience and learning: A conceptual framework. *Education and Information Technologies*, *23*(6), 2545–2567. https://doi.org/10.1007/s10639-018-9730-6

Allen, A. P., Kennedy, P. J., Dockray, S., Cryan, J. F., Dinan, T. G., & Clarke, G. (2017). The Trier Social Stress Test: Principles and practice. *Neurobiology of Stress*, *6*, 113–126. https://doi.org/10.1016/j.ynstr.2016.11.001

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012). An Arabic version of the Perceived Stress Scale: Translation and validation study. *International Journal of Nursing Studies*, *49*(1), 84–89. https://doi.org/10.1016/j.ijnurstu.2011.07.012

Backor, K., Golde, S., & Nie, N. (2007). *Estimating Survey Fatigue in Time Use Study*.

Bai, Y., Ocampo, J., Jin, G., Chen, S., Benet-Martinez, V., Monroy, M., Anderson, C., & Keltner, D. (2021). Awe, daily stress, and elevated life satisfaction. *Journal of Personality and Social Psychology*, *120*(4), 837–860. https://doi.org/10.1037/pspa0000267

Baik, S. H., Fox, R. S., Mills, S. D., Roesch, S. C., Sadler, G. R., Klonoff, E. A., & Malcarne, V. L. (2019a). Reliability and validity of the Perceived Stress Scale-10 in Hispanic Americans with English or Spanish language preference. *Journal of Health Psychology*, *24*(5), 628–639. https://doi.org/10.1177/1359105316684938

Barnes, S., & Prescott, J. (2018). Empirical evidence for the outcomes of therapeutic video games for adolescents with anxiety disorders: Systematic review. In *JMIR Serious Games* (Vol. 6, Issue 1). JMIR Publications Inc. https://doi.org/10.2196/games.9530

Barré, R., Laurencin, S., Brunel, G., Barthet, P., & Laurencin-Dalicieux, S. (2017). *Quality in Primary Health Care OPUS JOURNALS Qual Prim Health Care* (Vol. 1). https://www.researchgate.net/publication/344242593

Bartels, S. L., van Knippenberg, R. J. M., Dassen, F. C. M., Asaba, E., Patomella, A. H., Malinowsky, C., Verhey, F. R. J., & de Vugt, M. E. (2019). A narrative synthesis systematic review of digital self-monitoring interventions for middle-aged and older adults. *Internet Interventions*, *18*(August), 100283. https://doi.org/10.1016/j.invent.2019.100283

Bassett, J. R., Marshall, P. M., & Spillane, R. (1987). The physiological measurement of acute stress (public speaking) in bank employees. *International Journal of Psychophysiology*, *5*(4), 265–273. https://doi.org/10.1016/0167-8760(87)90058-4

Bates, R., Salsberry, P., & Ford, J. (2017). Measuring Stress in Young Children Using Hair Cortisol: The State of the Science. *Biological Research for Nursing*, *19*(5), 499–510. https://doi.org/10.1177/1099800417711583

Belzung, C., & Griebel, G. (2001). Measuring normal and pathological anxiety-like behaviour in mice: a review. In *Behavioural Brain Research* (Vol. 125). www.elsevier.com/locate/bbr

Berger, B. G. (1994). Coping With Stress: The Effectiveness of Exercise and Other Techniques. In *QUEST* (Vol. 46).

Bermudez, S., Quintero, L. V., Cameirão, M. S., Chirico, A., Triberti, S., Cipresso, P., & Gaggioli, A. (2019). Toward Emotionally Adaptive Virtual Reality for Mental Health Applications. *IEEE Journal of Biomedical and Health Informatics*, *23*(5), 1877–1887. https://doi.org/10.1109/JBHI.2018.2878846

Birk, M. V., Atkins, C., Bowey, J. T., & Mandryk, R. L. (2016). Fostering intrinsic motivation through avatar identification in digital games. *Conference on Human Factors in Computing Systems - Proceedings*, 2982–2995. https://doi.org/10.1145/2858036.2858062

Birk, M. V, Wadley, G., Abeele, V. Vanden, Mandryk, R., & Torous, J. (2018). *2019 - Videogames in mental health*.

Birkett, M. A. (2011). The Trier Social Stress Test protocol for inducing psychological stress. *Journal of Visualized Experiments*, *56*, 1–6. https://doi.org/10.3791/3238

Blascovich, J., & Tomaka, J. (1996). *The Biopsychosocial Model of Arousal Regulation* (pp. 1–51). https://doi.org/10.1016/S0065-2601(08)60235-X

Bostan, B., & Öğüt, S. (2009). Game Challenges and Difficulty Levels: Lessons Learned From RPGs. *International Simulation and Gaming Association Conference*. http://www.gamerankings.com/itemrankings/simpleratings.asp

Bouchard, S., Bernier, F., Boivin, É., Morin, B., & Robillard, G. (2012). Using biofeedback while immersed in a stressful videogame increases the effectiveness of stress management skills in soldiers. *PLoS ONE*, *7*(4). https://doi.org/10.1371/journal.pone.0036169

Bowman, N. D., & Tamborini, R. (2012). Task demand and mood repair: The intervention potential of computer games. *New Media and Society*, *14*(8), 1339–1357. https://doi.org/10.1177/1461444812450426

Bowman, N. D., & Tamborini, R. (2015). “In the Mood to Game”: Selective exposure and mood management processes in computer game play. *New Media and Society*, *17*(3), 375–393. https://doi.org/10.1177/1461444813504274

Brandse, M., & Tomimatsu, K. (2013). Empirical review of challenge design in video game design. *Communications in Computer and Information Science*, *373*(PART I), 398–406. https://doi.org/10.1007/978-3-642-39473-7_80

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brosschot, J. F., Geurts, S. A. E., Kruizinga, I., Radstaak, M., Verkuil, B., Quirin, M., & Kompier, M. A. J. (2014). Does unconscious stress play a role in prolonged cardiovascular stress recovery? *Stress and Health*, *30*(3), 179–187. https://doi.org/10.1002/smi.2590

Brouwer, A. M., & Hogervorst, M. A. (2014). A new paradigm to induce mental stress: The Sing-a-Song Stress Test (SSST). *Frontiers in Neuroscience*, *8 JUL*. https://doi.org/10.3389/fnins.2014.00224

Brown, E., & Cairns, P. (2004). A grounded investigation of game immersion. *CHI '04 Extended Abstracts on Human Factors in Computing Systems*, 1297–1300. https://doi.org/10.1145/985921.986048

Brown, G., & Harris, T. (1978). *Social origins of depression: A study of psychiatric disorder in women*. Free Press.

Butler, O., Herr, K., Willmund, G., Gallinat, J., Kuhn, S., & Zimmermann, P. (2020a). Trauma, treatment and tetris: Video gaming increases hippocampal volume in male patients with combat-related posttraumatic stress disorder. *Journal of Psychiatry and Neuroscience*, *45*(4), 279–287. https://doi.org/10.1503/jpn.190027

Butler, O., Herr, K., Willmund, G., Gallinat, J., Kuhn, S., & Zimmermann, P. (2020b). Trauma, treatment and tetris: Video gaming increases hippocampal volume in male patients with combat-related posttraumatic stress disorder. *Journal of Psychiatry and Neuroscience*, *45*(4), 279–287. https://doi.org/10.1503/jpn.190027

Caillois, R. (2001). *Man, Play, and Games*. University of Illinois Press.

Cairns, P., Cox, A., Berthouze, N., Dhoparee, S., & Jennett, C. (2016). Quantifying the experience of immersion in games. *Cognitive Science of Games and Gameplay Workshop at Cognitive Science*, 26–29.

Cairns, P., & Power, C. (2018). *Measuring Experiences*. *2*, 61–80. https://doi.org/10.1007/978-3-319-73374-6_5

Caplan, R. D., Cobb, S., & French, J. J. R. P. (1975). *Job Demands and Worker Health: Main Effects and Occupational Differences*.

Chen, C. (2021). Playing mobile games for stress recovery purposes: A survey of Chinese adolescents. *Telematics and Informatics*, *56*. https://doi.org/10.1016/j.tele.2020.101481

Chen, J. (2007). Flow in Games (and Everything Else). *Communications of the ACM*, *50*(4).

Cheng, K., & Cairns, P. A. (2005). *Behaviour, Realism and Immersion in Games*.

Choi, Y., Kim, J., & Hong, J.-H. (2022). Immersion Measurement in Watching Videos Using Eye-tracking Data. *IEEE Transactions on Affective Computing*, *13*(4), 1759–1770. https://doi.org/10.1109/TAFFC.2022.3209311

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral science*. Routledge.

Cohen, S. (1994). *PERCEIVED STRESS SCALE*. www.mindgarden.com

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological Stress and Disease. *American Medica Association*, *298*. https://jamanetwork.com/

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396. https://doi.org/10.2307/2136404

Cohen, S., Kessler, R. C., & Gordon, L. U. G. (1997). *Measuring Stress: A Guide for Health and Social Scientists* (S. Cohen, R. C. Kessler, & L. U. G. Gordon, Eds.). Oxford University Press.

Cole, T., Cairns, P., & Gillies, M. (2015). Emotional and functional challenge in core and avant-garde games. *CHI PLAY 2015 - Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, 121–126. https://doi.org/10.1145/2793107.2793147

Collins, E., & Cox, A. L. (2014). Switch on to games: Can digital games aid post-work recovery? *International Journal of Human Computer Studies*, *72*(8–9), 654–662. https://doi.org/10.1016/j.ijhcs.2013.12.006

Collins, E., Cox, A., Wilcock, C., & Sethu-Jones, G. (2019). Digital Games and Mindfulness Apps: Comparison of Effects on Post Work Recovery. *JMIR Mental Health*, *6*(7), e12853. https://doi.org/10.2196/12853

Coomans, M. K. D., & Timmermans, H. J. P. (1997). Towards a taxonomy of virtual reality user interfaces. *Proceedings of the Information Visualization Conference*, 279–284. https://doi.org/10.1109/iv.1997.626531

Cox, A., Cairns, P., Shah, P., & Carroll, M. (2012). Not doing but thinking. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 79–88. https://doi.org/10.1145/2207676.2207689

Coyle, D., O'reilly, G., Van Der Meulen, H., Tunney, C., Cooney, P., & Jackman, C. (2017). *Pesky gNATs: Using Games to Support Mental Health Interventions for Adolescents First steps-Personal Investigator*.

Crosswell, A. D., & Lockwood, K. G. (2020). Best practices for stress measurement: How to measure psychological stress in health research. *Health Psychology Open*, *7*(2). https://doi.org/10.1177/2055102920933072

Csíkszentmihályi, M. (1990). *Flow: The Psychology of Optimal Experience* (1st ed.). Harper Perennial.

Csikszentmihalyi, M. (2008). *Flow: The Psychology of Optimal Experience (Harper Perennial Modern Classics*. Harper Perennial Modern Classics.

Cutting, J., & Cairns, P. (2022). Investigating game attention using the Distraction Recognition Paradigm. *Behaviour & Information Technology*, *41*(5), 981–1001. https://doi.org/10.1080/0144929X.2020.1849402

Cutting, J., Cairns, P., & Kuhn, G. (2020). Nothing else matters: Video games create sustained attentional selection away from task-irrelevant features. *Attention, Perception, and Psychophysics*, *82*(8), 3907–3919. https://doi.org/10.3758/s13414-020-02122-y

Daviu, N., Bruchas, M. R., Moghaddam, B., Sandi, C., & Beyeler, A. (2019). Neurobiological links between stress and anxiety. In *Neurobiology of Stress* (Vol. 11). Elsevier Inc. https://doi.org/10.1016/j.ynstr.2019.100191

De Aquino Lopes, R., Cardoso, A., Júnior, E. A. L., & Lopes, E. J. (2014). Recovery and coping stress supported by serious games. *SeGAH 2014 - IEEE 3rd International Conference on Serious Games and Applications for Health, Books of Proceedings*. https://doi.org/10.1109/SeGAH.2014.7067107

De Grove, F., Cauberghe, V., & Van Looy, J. (2016). Development and Validation of an Instrument for Measuring Individual Motives for Playing Digital Games. *Media Psychology*, *19*(1), 101–125. https://doi.org/10.1080/15213269.2014.902318

de Morais, M. A., de Lima, B. E., & Bandeira Santos, L. C. (2020). Acute Effect of Xbox Exercise on Mood States in Older Adults. *Activities, Adaptation and Aging*, *44*(2), 146–156. https://doi.org/10.1080/01924788.2019.1618689

de Witte, M., Kooijmans, R., Hermanns, M., Hooren, S. van, Biesmans, K., Hermsen, M., Stams, G. J., & Moonen, X. (2021). Self-Report Stress Measures to Assess Stress in Adults With Mild Intellectual Disabilities—A Scoping Review. In *Frontiers in Psychology* (Vol. 12). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2021.742566

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. Springer Science & Business Media, 2013.

Deci, E. L., & Ryan, R. M. (2000). *The 'What' and 'Why' of Goal Pursuits: Human Needs and the Self-Determination of Behavior*.

DeLongis, A., Folkman, S., & Lazarus, R. S. (1988). The Impact of Daily Stress on Health and Mood: Psychological and Social Resources as Mediators. *Journal of Personality and Social Psychology*, *54*(3), 486–495. https://doi.org/10.1037/0022-3514.54.3.486

DeLongis, A., Folkman, S., Lazarus, R. S., Mendelsohn, G. A., Runyan Thanks also to Jim Coyne, W. M., Dunkel-Schetler, C., Felner, R., Kessler, R., Schaefer, C., & Wortman, C. (1988). The Impact of Daily Stress on Health and Mood: Psychological and Social Resources as Mediators. In *Journal of Personality and Social Psychology* (Vol. 54, Issue 3).

Demetrovics, Z., Urbán, R., Nagygyörgy, K., Farkas, J., Zilahy, D., Mervó, B., Reindl, A., Ágoston, C., Kertész, A., & Harmath, E. (2011). Why do you play? The development of the motives for online gaming questionnaire (MOGQ). *Behavior Research Methods*, *43*(3), 814–825. https://doi.org/10.3758/s13428-011-0091-y

Denisova, A., Cairns, P., Guckelsberger, C., & Zendle, D. (2020). Measuring perceived challenge in digital games: Development & validation of the challenge originating from recent gameplay interaction scale (CORGIS). *International Journal of Human Computer Studies*, *137*, 102383. https://doi.org/10.1016/j.ijhcs.2019.102383

Denisova, A., Cairns, P., Guerrera, F., Renaud, S., Tabbò, F., Filosso, P. L., Lau, H. M., Smit, J. H., Fleming, T. M., Riper, H., Langarizadeh, M., Tabatabaei, M. S., Tavakol, K., Naghipour, M., Rostami, A., Moghbeli, F., Cheung, K., Ling, W., Karr, C. J., … Shaked, A. (2017). An inclusive, value sensitive design perspective on future identity technologies. *International Journal of Medical Informatics*, *97*(4), 1–13. https://doi.org/10.1016/j.jbi.2018.03.004

Dickerson, S. S., & Margaret E. Kemeny. (2004). Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychological Bulletin 130.3 : 355*.

Dondio, P., Filonenko, V., & Rocha, M. (2023). Do Games Reduce Math Anxiety? A Meta-Analysis. *Computers & Education*, *194*. https://arrow.tudublin.ie/scschcomart

Dutheil, F., Pereira, B., Moustafa, F., Naughton, G., Lesage, F. X., & Lambert, C. (2017). At-risk and intervention thresholds of occupational stress using a visual analogue scale. *PLoS ONE*, *12*(6). https://doi.org/10.1371/journal.pone.0178948

Eden, D. (1982). Critical Job Events, Acute Stress, and Strain: A Multiple Interrupted Time Series. In *ORGANIZATIONAL BEHAVIOR AND HUMAN PERFORMANCE* (Vol. 30).

Endler, N. S., & Kocovski, N. L. (2001). State and trait anxiety revisited. *Journal of Anxiety Disorders*, *15*(3), 231–245. https://doi.org/10.1016/S0887-6185(01)00060-3

Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B. (2018). More than a feeling: A unified view of stress measurement for population science. *Frontiers in Neuroendocrinology*, *49*, 146–169. https://doi.org/10.1016/j.yfrne.2018.03.001

Ermi, L., & Mäyrä, F. (2005). *Fundamental Components of the Gameplay Experience: Analysing Immersion*.

Ewart, C. K., Jorgensen, R. S., Suchday, S., Chen, E., & Matthews, K. A. (2002). Measuring stress resilience and coping in vulnerable youth: The social competence interview. *Psychological Assessment*, *14*(3), 339–352. https://doi.org/10.1037/1040-3590.14.3.339

Ezzati, A., Jiang, J., Katz, M. J., Sliwinski, M. J., Zimmerman, M. E., & Lipton, R. B. (2014). Validation of the Perceived Stress Scale in a community sample of older adults. *International Journal of Geriatric Psychiatry*, *29*(6), 645–652. https://doi.org/10.1002/gps.4049

Feil, J., & Scattergood, M. (2005). *Beginning Game Level Design* (M. Scattergood, Ed.). ThomsonCourseTechnology.

Fink, G. (2016). *Stress: Concepts, Cognition, Emotion, and Behavior: Handbook of Stress*. https://www.researchgate.net/publication/317026245

Fish, M. T., Russoniello, C. V., & O'Brien, K. (2014). The Efficacy of Prescribed Casual Videogame Play in Reducing Symptoms of Anxiety: A Randomized Controlled Study. *Games for Health Journal*, *3*(5), 291–295. https://doi.org/10.1089/g4h.2013.0092

Fish, M. T., Russoniello, C. V., & O'Brien, K. (2018). Zombies vs. Anxiety: An Augmentation Study of Prescribed Video Game Play Compared to Medication in Reducing Anxiety Symptoms. *Simulation and Gaming*, *49*(5), 553–566. https://doi.org/10.1177/1046878118773126

Foa, E. B., McLean, C. P., Zang, Y., Zhong, J., Powers, M. B., Kauffman, B. Y., Rauch, S., Porter, K., & Knowles, K. (2016). Psychometric properties of the Posttraumatic Diagnostic Scale for DSM–5 (PDS–5). *Psychological Assessment*, *28*(10), 1166–1171. https://doi.org/10.1037/pas0000258

Forte, G., Troisi, G., Pazzaglia, M., Pascalis, V. De, & Casagrande, M. (2022). Heart Rate Variability and Pain: A Systematic Review. *Brain Sciences*, *12*(2), 153. https://doi.org/10.3390/brainsci12020153

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology*, *2*(3), 300–319. https://doi.org/10.1037/1089-2680.2.3.300

French, J. R. P. , J., Roger, W. L., & Cobb, S. (1974). *Adjustment as person-environment fit*.

Frost, S., Kannis-Dymand, L., Schaffer, V., Millear, P., Allen, A., Stallman, H., Mason, J., Wood, A., & Atkinson-Nolte, J. (2022). Virtual immersion in nature and psychological well-being: A systematic literature review. In *Journal of Environmental Psychology* (Vol. 80). Academic Press. https://doi.org/10.1016/j.jenvp.2022.101765

Furze, R. (2014). Challenge. In M. J. P. Wolf & B. Perron (Eds.), *The Routledge Companion to Video Game Studies* (1st ed.). Routledge. https://doi.org/10.4324/9780203114261

Galantino, M. Lou, Baime, M., Maguire, M., Szapary, P. O., & Farrar, J. T. (2005). Association of psychological and physiological measures of stress in health-care professionals during an 8-week mindfulness meditation program: Mindfulness in pratice. *Stress and Health*, *21*(4), 255–261. https://doi.org/10.1002/smi.1062

Gaudry, E., Vagg, P., & Spielberger, C. D. (1975). Validation of the State-Trait Distinction in Anxiety Research. *Multivariate Behavioral Research*, *10*(3), 331–341. https://doi.org/10.1207/s15327906mbr1003_6

Geana, A., Wilson, R. C., Daw, N., & Cohen, J. D. (2016). *Boredom, Information-Seeking and Exploration*.

Gerling, K. M., Klauser, M., & Niesenhaus, J. (2011). Measuring the impact of game controllers on player experience in FPS games. *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011*, 83–86. https://doi.org/10.1145/2181037.2181052

Ghafourifard, M. (2024). Survey Fatigue in Questionnaire Based Research: The Issues and Solutions. *Journal of Caring Sciences*. https://doi.org/10.34172/jcs.33287

Ghoussoub, K., Côté, C. I., Fortier, M., Nauche, B., Rainville, P., & Pagé, M. G. (2024). Investigating the Impact of Stress on Pain: A Scoping Review on Sense of Control, Social-Evaluative Threat, Unpredictability, and Novelty (STUN Model). In *Journal of Pain Research* (Vol. 17, pp. 737–751). Dove Medical Press Ltd. https://doi.org/10.2147/JPR.S450977

Glynn, L. M., Christenfeld, N., & Gerin, W. (2002). The role of rumination in recovery from reactivity: Cardiovascular consequences of emotional states. *Psychosomatic Medicine*, *64*(5), 714–726. https://doi.org/10.1097/01.PSY.0000031574.42041.23

Goes, T. C., Almeida Souza, T. H., Marchioro, M., & Teixeira-Silva, F. (2018). Excitotoxic lesion of the medial prefrontal cortex in Wistar rats: Effects on trait and state anxiety. *Brain Research Bulletin*, *142*, 313–319. https://doi.org/10.1016/j.brainresbull.2018.08.009

González, G., & Vives, A. (2019). Work Status, Financial Stress, Family Problems, and Gender Differences in the Prevalence of Depression in Chile. *Annals of Work Exposures and Health*, *63*(3), 359–370. https://doi.org/10.1093/annweh/wxy107

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). *The Benefits of Playing Video Games*. *69*(1), 66–78. https://doi.org/10.1037/a0034857

Hamari, J., & Keronen, L. (2017). Why do people play games? A meta-analysis. *International Journal of Information Management*, *37*(3), 125–141. https://doi.org/10.1016/j.ijinfomgt.2017.01.006

Hayes, M. H., & Patterson, D. G. (1921). Experimental development of the graphic rating methods. *Psychological Bulletin*, 98–99.

Hellhammer, D. H., Wüst, S., & Kudielka, B. M. (2009). Salivary cortisol as a biomarker in stress research. *Psychoneuroendocrinology*, *34*(2), 163–171. https://doi.org/10.1016/j.psyneuen.2008.10.026

Henze, G. I., Zänkert, S., Urschler, D. F., Hiltl, T. J., Kudielka, B. M., Pruessner, J. C., & Wüst, S. (2017). Testing the ecological validity of the Trier Social Stress Test: Association with real-life exam stress. *Psychoneuroendocrinology*, *75*, 52–55. https://doi.org/10.1016/j.psyneuen.2016.10.002

Hines, E. A., & Brown, G. E. (1936). The cold pressor test for measuring the reactibility of the blood pressure: Data concerning 571 normal and hypertensive subjects. *American Heart Journal*, *11*(1), 1–9. https://doi.org/10.1016/S0002-8703(36)90370-8

Horsch, A., Vial, Y., Favrod, C., Harari, M. M., Blackwell, S. E., Watson, P., Iyadurai, L., Bonsall, M. B., & Holmes, E. A. (2017). Reducing intrusive traumatic memories after emergency caesarean section: A proof-of-principle randomized controlled study. *Behaviour Research and Therapy*, *94*(April), 36–47. https://doi.org/10.1016/j.brat.2017.03.018

Howard, F. (2008). Managing stress or enhancing wellbeing? Positive psychology's contributions to clinical supervision. In *Australian Psychologist* (Vol. 43, Issue 2, pp. 105–113). https://doi.org/10.1080/00050060801978647

Huang, H. C., Wong, M. K., Yang, Y. H., Chiu, H. Y., & Teng, C. I. (2017). Impact of Playing Exergames on Mood States: A Randomized Controlled Trial. In *Cyberpsychology,* *Behavior, and Social Networking* (Vol. 20, Issue 4, pp. 246–250). https://doi.org/10.1089/cyber.2016.0322

Hunicke, R., Leblanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. *AAAI Workshop - Technical Report*, *WS-04-04*, 1–5.

Iacovides, I., & Mekler, E. D. (2019, May 2). The role of gaming during difficult life experiences. *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3290605.3300453

Inchamnan, W., & Wyeth, P. (2013). Motivation during videogame play: Analysing player experience in terms of cognitive action. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/2513002.2513010

Iwata, M., Ota, K. T., & Duman, R. S. (2013). The inflammasome: Pathways linking psychological stress, depression, and systemic illnesses. *Brain, Behavior, and Immunity*, *31*, 105–114. https://doi.org/10.1016/j.bbi.2012.12.008

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human Computer Studies*, *66*(9), 641–661. https://doi.org/10.1016/j.ijhcs.2008.04.004

Johnson, D., Gardner, M. J., & Perry, R. (2018). Validation of two game experience scales: The Player Experience of Need Satisfaction (PENS) and Game Experience Questionnaire (GEQ). *International Journal of Human Computer Studies*, *118*(August 2017), 38–46. https://doi.org/10.1016/j.ijhcs.2018.05.003

Johnson, D., Wyeth, P., & Sweetser, P. (2013). The people-game-play model for understanding videogames' impact on wellbeing. *IEEE Consumer Electronics Society's International Games Innovations Conference, IGIC*, 85–88. https://doi.org/10.1109/IGIC.2013.6659143

Kahn, R. L., Wolfe, D. M., Quinn, R. P., Diedrick, J., Robert, S., & Rosenthal, A. (1964). *CONFLICT AND AMBIGUITY studies in Organizational Roles and Individual Stress* (2nd ed.). Wiley.

Kasl, S. V., & Cobb, S. (1980). The experience of losing a job: Some effects on cardiovascular functioning. *Psychotherapy and Psychosomatics*, *34*(2–3), 88–109. https://doi.org/10.1159/000287452

Keebler, J. R., Shelstad, W. J., Google, D. C. S., Chaparro, B. S., & Phan, M. H. (2020). *Validation of the GUESS-18: A Short Version of the Game User Experience Satisfaction Scale (GUESS)*. http://uxpajournal.org.

Khan, S., & Peña, J. (2017). Playing to beat the blues: Linguistic agency and message causality effects on use of mental health games application. *Computers in Human Behavior*, *71*, 436–443. https://doi.org/10.1016/j.chb.2017.02.024

Kinross, J. M. (2018). Precision gaming for health: Computer games as digital medicine. *Methods*, *151*(September), 28–33. https://doi.org/10.1016/j.ymeth.2018.09.009

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The 'Trier social stress test' - A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*(1–2), 76–81. https://doi.org/10.1159/000119004

Knobloch, S., & Zillmann, D. (2002). *Mood Management via the Digital Jukebox*.

Kowal, M., Conroy, E., Ramsbottom, N., Smithies, T., Toth, A., & Campbell, M. (2021). Gaming your mental health: A narrative review on mitigating symptoms of depression and anxiety using commercial video games. In *JMIR Serious Games* (Vol. 9, Issue 2). JMIR Publications Inc. https://doi.org/10.2196/26575

Kudielka, B. M., Hellhammer, D. H., & Wüst, S. (2009). Why do we respond so differently? Reviewing determinants of human salivary cortisol responses to challenge. In *Psychoneuroendocrinology* (Vol. 34, Issue 1, pp. 2–18). https://doi.org/10.1016/j.psyneuen.2008.10.004

Kühn, S., Gleich, T., Lorenz, R. C., Lindenberger, U., & Gallinat, J. (2014). Playing super mario induces structural brain plasticity: Gray matter changes resulting from training with a commercial video game. *Molecular Psychiatry*, *19*(2), 265–271. https://doi.org/10.1038/mp.2013.120

Kultima, A. (2009). Casual Game Design Values. *Proceedings of the 13th International MindTrek Conference: Everyday Life in the Ubiquitous Era.* https://doi.org/978-1-60558-633-5/09/09

Labuschagne, I., Grace, C., Rendell, P., Terrett, G., & Heinrichs, M. (2019). An introductory guide to conducting the Trier Social Stress Test. In *Neuroscience and Biobehavioral Reviews* (Vol. 107, pp. 686–695). Elsevier Ltd. https://doi.org/10.1016/j.neubiorev.2019.09.032

Lafrenière, M. A. K., Verner-Filion, J., & Vallerand, R. J. (2012). Development and validation of the Gaming Motivation Scale (GAMS). *Personality and Individual Differences*, *53*(7), 827–831. https://doi.org/10.1016/j.paid.2012.06.013

Larsen, B. A., & Christenfeld, N. J. S. (2011). Cognitive distancing, cognitive restructuring, and cardiovascular recovery from stress. *Biological Psychology*, *86*(2), 143–148. https://doi.org/10.1016/j.biopsycho.2010.02.011

Lau, H. M., Smit, J. H., Fleming, T. M., & Riper, H. (2017). Serious games for mental health: Are they accessible, feasible, and effective? A systematic review and meta-analysis. In *Frontiers in Psychiatry* (Vol. 7, Issue JAN). Frontiers Media S.A. https://doi.org/10.3389/fpsyt.2016.00209

Law, E. F., Dahlquist, L. M., Sil, S., Weiss, K. E., Herbert, L. J., Wohlheiter, K., & Horn, S. B. (2011). Videogame distraction using virtual reality technology for children experiencing cold pressor pain: The role of cognitive processing. *Journal of Pediatric Psychology*, *36*(1), 84–94. https://doi.org/10.1093/jpepsy/jsq063

Lazarus, R. S., & Delongis, A. (1983). *Psychological Stress and Coping in Aging*.

Lazarus, R. S., & Folkman, S. (1984). *Stress, Appraisal, and Coping*. Springer.

Lazzaro, N. (2004). Why We Play Games: Four Keys to More Emotion Without Story. *Game Development Conference*.

Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing Research*, *6*(4), 121–127. https://doi.org/10.1016/j.anr.2012.08.004

Lee, Y. H., & Chen, M. (2022). Seeking a Sense of Control or Escapism? The Role of Video Games in Coping with Unemployment. *Games and Culture*. https://doi.org/10.1177/15554120221097413

Liapis, A., Katsanos, C., Sotiropoulos, D., Xenos, M., & Karousos, N. (2015). *Recognizing Emotions in Human Computer Interaction: Studying Stress Using Skin Conductance*. 255–262. https://doi.org/10.1007/978-3-319-22701-6_18ï

Liszio, S., & Masuch, M. (2019). Interactive Immersive Virtual Environments Cause Relaxation and Enhance Resistance to Acute Stress. *Annual Review of Cyber Therapy and Telemedicine*, *17*. https://www.researchgate.net/publication/341353908

Lloyd, C., Smith, J., & Weinger, K. (2005). Stress and Diabetes: A Review of the Links. In *Diabetes Spectrum* (Vol. 18, Issue 2).

Lupien, S. J., Maheu, F., Tu, M., Fiocco, A., & Schramek, T. E. (2007). The effects of stress and stress hormones on human cognition: Implications for the field of brain and cognition. *Brain and Cognition*, *65*(3), 209–237. https://doi.org/10.1016/j.bandc.2007.02.007

Marto, A., & Gonçalves, A. (2022). Augmented Reality Games and Presence: A Systematic Review. In *Journal of Imaging* (Vol. 8, Issue 4). MDPI. https://doi.org/10.3390/jimaging8040091

McEwen, B. (1998). Stress, adaptation, and disease allostasis and allostatic load. *Annals of the New York Academy of Sciences*, *840*, 33–44. https://doi.org/10.1111/j.1749-6632.1998.tb09546.x

McEwen, B., & Sapolsky, R. (2010). How does chronic stress affect your health? *The Hormone Foundation*, *March*. www.hormone.org

McGonagle, K. A., & Kessler, R. C. (1990). Chronic Stress, Acute Stress, and Depressive Symptoms x. In *American Journal of Community Psychology* (Vol. 18, Issue 5).

McGonigal, J. (2012). *Reality Is Broken: Why Games Make Us Better and How They Can Change the World*. Vintage.

McKechnie-Martin, C. T., Cunningham, A., Baumeister, J., & Von Itzstein, G. S. (2024). A Meta-Ethnography of Player Motivation in Digital Games: The 28 Dimensions of Play. *Games and Culture*. https://doi.org/10.1177/15554120241242332

Mekler, E. D., Bopp, J. A., Tuch, A. N., & Opwis, K. (2014). A systematic review of quantitative studies on the enjoyment of digital entertainment games. *Conference on Human Factors in Computing Systems - Proceedings*, 927–936. https://doi.org/10.1145/2556288.2557078

Mendes, W. B., Gray, H. M., Mendoza-Denton, R., Major, B., & Epel, E. S. (2007). Why egalitarianism might be good for your health: Physiological thriving during stressful

intergroup encounters. *Psychological Science*, *18*(11), 991–998. https://doi.org/10.1111/j.1467-9280.2007.02014.x
Miedziun, P., & Czabała, J. C. (2015). *Stress Management Techniques*. 23–30. https://doi.org/10.12740/APP/61082
Miller, S. M., Brody, D. S., & Summerton, J. (1988). Styles of coping with threat: Implications for health. *Journal of Personality and Social Psychology*, *54*(1), 142–148. https://doi.org/10.1037/0022-3514.54.1.142
Monroe, S. M., & Slavich, G. M. (2016). Psychological Stressors: Overview. *Stress: Concepts, Cognition, Emotion, and Behavior: Handbook of Stress*, *3*(1970), 109–115. https://doi.org/10.1016/B978-0-12-800951-2.00013-3
Montag, C., Lachmann, B., Herrlich, M., Zweig, K., De Aquino Lopes, R., Cardoso, A., Lamounier Júnior, E. a, Lopes, E. J., Ansari, S. G., Prasetya, I. S. W. B., Dastani, M., Dignum, F., Keller, G., Schmidt, A., Ballabio, M., Griffiths, M. D., Urbán, R., Quartiroli, A., Demetrovics, Z., … Dixon, M. J. (2021). How computer games can improve your health and fitness. *Computers and Education*, *9*(3), 1–7. https://doi.org/10.1017/S0033291721001410
Myat, A., Cairns, P., & Cutting, J. (2021). *A Short Form Immersive Experience Questionnaire*. University of York.
Nacke, L., Drachen, A., & Göbel, S. (2010). Methods for Evaluating Gameplay Experiece in Serious Gaming Context. In *International Journal of Computer Sciene in Sport*. https://link.springer.com/10.1007/978-3-031-33338-5_2
Nacke, L. E., & Drachen, A. (2011). Towards a framework of player experience research. *Paper Presented at the Second International Workshop on Evaluating Player Experience in Games at FDG 2011, Bordeaux, France*.
Nicolson, N. A. (2008). Measurement of cortisol. *Handbook of Physiological Research Methods in Health Psychology*, 37–74. https://doi.org/10.4135/9781412976244.n3
Niedenthal, S. (2009). *Breaking New Ground: Innovation in Games, Play, Practice and Theory*.
Pallavicini, F., & Pepe, A. (2020). Virtual reality games and the role of body involvement in enhancing positive emotions and decreasing anxiety: Within-subjects pilot study. *JMIR Serious Games*, *8*(2). https://doi.org/10.2196/15635
Pallavicini, F., Pepe, A., & Mantovani, F. (2021). Commercial off-the-shelf video games for reducing stress and anxiety: Systematic review. In *JMIR Mental Health* (Vol. 8, Issue 8). JMIR Publications Inc. https://doi.org/10.2196/28150
Pascoe, M. C., Thompson, D. R., & Ski, C. F. (2017). Yoga, mindfulness-based stress reduction and stress-related physiological measures: A meta-analysis. *Psychoneuroendocrinology*, *86*(January), 152–168. https://doi.org/10.1016/j.psyneuen.2017.08.008
Payne, R. O. Y. (1982). *Whither Stress Research ?: An Agenda for the 1980s Author (s): Roy Payne , Todd D . Jick and Ronald J . Burke Source : Journal of Occupational Behaviour ,*

Jan ., 1982 , Vol . 3 , No . 1 , Special Issue : [Current Issues in Occupational Stress : Theory . *3*(1), 131–145.

Pearlin, L. I., & Schooler, C. (1978). The Structure of Coping. *Journal of Health and Social Behavior*, *19*(1), 2–21.

Pfaff, D. W., Martin, E. M., & Ribeiro, A. C. (2007). Relations between mechanisms of CNS arousal and mechanisms of stress. *Stress*, *10*(4), 316–325. https://doi.org/10.1080/10253890701638030

Pham, Q., Khatib, Y., Stansfeld, S., Fox, S., & Green, T. (2016). Feasibility and Efficacy of an mHealth Game for Managing Anxiety: 'Flowy' Randomized Controlled Pilot Trial and Design Evaluation. *Games for Health Journal*, *5*(1), 50–67. https://doi.org/10.1089/g4h.2015.0033

Porter, A. M., & Goolkasian, P. (2019). Video games and stress: How stress appraisals and game content affect cardiovascular and emotion outcomes. *Frontiers in Psychology*, *10*(APR). https://doi.org/10.3389/fpsyg.2019.00967

Pratt, L. I., & Barling, J. (1988). *Occupational Stress: Issues and Developments in Research* (J. J. Hurrel Jr., L. R. Murphy, S. L. Sauter, & C. L. Cooper, Eds.). Taylor & Francis Ltd.

Pulopulos, M. M., Baeken, C., & De Raedt, R. (2020). Cortisol response to stress: The role of expectancy and anticipatory stress regulation. *Hormones and Behavior*, *117*. https://doi.org/10.1016/j.yhbeh.2019.104587

Reinecke, L. (2009a). Games and Recovery: The Use of Video and Computer Games to Recuperate from Stress and Strain. *Journal of Media Psychology*, *21*(3), 126–142. https://doi.org/10.1027/1864-1105.21.3.126

Reisman, S. (2014). Physiological Stress. *Encyclopedia of Quality of Life and Well-Being Research*, 4810–4810. https://doi.org/10.1007/978-94-007-0753-5_103063

Ridley Stroop», J. (1935). STUDIES OF INTERFERENCE IN SERIAL VERBAL REACTIONS. In *Journal of Experimental Psychology: Vol. XVIII* (Issue 6).

Rigby, S., & Ryan, R. (2007). *ThePlayerExperienceofNeedSatisfaction(PENS)*.

Roozendaal, B., McEwen, B. S., & Chattarji, S. (2009). Stress, memory and the amygdala. In *Nature Reviews Neuroscience* (Vol. 10, Issue 6, pp. 423–433). https://doi.org/10.1038/nrn2651

Roy, A., & Ferguson, C. J. (2016). Competitively versus cooperatively? An analysis of the effect of game play on levels of stress. *Computers in Human Behavior*, *56*, 14–20. https://doi.org/10.1016/j.chb.2015.11.020

Roy, M. P., Kirschbaum, C., & Steptoe, A. (2001). Psychological, cardiovascular, and metabolic correlates of individual differences in cortisol stress recovery in young men. In *Psychoneuroendocrinology* (Vol. 26). www.elsevier.com/locate/psyneuen

Rupp, M. A., Sweetman, R., Sosa, A. E., Smither, J. A., & McConnell, D. S. (2017). Searching for Affective and Cognitive Restoration: Examining the Restorative Effects of Casual Video Game Play. *Human Factors*, *59*(7), 1096–1107. https://doi.org/10.1177/0018720817715360

Russoniello, C., O'brien, K., Russoniello, C. V, & Parks, J. M. (2017). *The effectiveness of casual video games in improving mood and decreasing stress*. https://www.researchgate.net/publication/289131468

Russoniello, C. V., O'Brien, K., & Parks, J. M. (2009). The effectiveness of casual video games in improving mood and decreasing stress. *Journal of Cyber Therapy and Rehabilitation*, *2*(1), 53–66.

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, *30*(4), 347–363. https://doi.org/10.1007/s11031-006-9051-8

Salen, K., & Zimmerman, E. (2004). *Rules of Play: game design fundamentals* (1st ed.). Massachusetts Institute of Technology.

Salleh, M. R. (2008). LIFE EVENT, STRESS AND ILLNESS. In *Malaysian Journal of Medical Sciences* (Vol. 15, Issue 4).

Sanchez, D. R., & Langer, M. (2020). Video Game Pursuit (VGPu) Scale Development: Designing and Validating a Scale With Implications for Game-Based Learning and Assessment. *Simulation and Gaming*, *51*(1), 55–86. https://doi.org/10.1177/1046878119882710

Schell, J. (2014). The Art of Game Design. In *The Art of Game Design*. https://doi.org/10.1201/b17723

Selye, H. (1976). *The Stress of Life* (2nd ed.). McGraw-Hill. https://books.google.com.bn/books?id=PZ9pAAAAMAAJ

Sharma, D. K. (2018). Physiology of Stress and its Management. *Journal of Medicine: Study & Research*, *1*(1), 1–5. https://doi.org/10.24966/msr-5657/100001

Shin, M., Heard, R., Suo, C., & Chow, C. M. (2012). Positive Emotions Associated with 'counter-Strike' Game Playing. *Games for Health Journal*, *1*(5), 342–347. https://doi.org/10.1089/g4h.2012.0010

Sil, S., Dahlquist, L. M., & Burns, A. J. (2013). Case study: Videogame distraction reduces behavioral distress in a preschool-aged child undergoing repeated burn dressing changes: A single-subject design. *Journal of Pediatric Psychology*, *38*(3), 330–341. https://doi.org/10.1093/jpepsy/jss128

Silva Bastos, A., Gomes, R. F., Costa, C., Santos, D., Jos ́, J., Gilvan, J., & Maia, R. (2018). Synesthesia: A Study on Immersive Features of Electronic Games. *SBC Journal on Interactive Systems*, *9*.

Singh, D. K. A., Rahman, N. N. A. A., Rajiman, S., Yin, C. S., Karim, Z. A., Ruslan, A. S., & Singh, R. K. H. (2017). Impact of virtual reality games on psychological well-being and upper limb performance in adults with physical disabilities: A pilot study. *Medical Journal of Malaysia*, *72*(2), 119–121.

Slavich, G. M. (2016). Life Stress and Health: A Review of Conceptual Issues and Recent Findings. *Teaching of Psychology*, *43*(4), 346–355. https://doi.org/10.1177/0098628316662768

Smeets, T., Cornelisse, S., Quaedflieg, C. W. E. M., Meyer, T., Jelicic, M., & Merckelbach, H. (2012). Introducing the Maastricht Acute Stress Test (MAST): A quick and non-invasive approach to elicit robust autonomic and glucocorticoid stress responses. *Psychoneuroendocrinology*, *37*(12), 1998–2008. https://doi.org/10.1016/j.psyneuen.2012.04.012

Snodgrass, J. G., Lacy, M. G., Dengah, H. J. F., Fagan, J., & Most, D. E. (2011). Magical flight and monstrous stress: Technologies of absorption and mental wellness in Azeroth. *Culture, Medicine and Psychiatry*, *35*(1), 26–62. https://doi.org/10.1007/s11013-010-9197-4

Sonnentag, S., Binnewies, C., & Mojza, E. J. (2008). 'Did you have a nice evening?' A day-level study on recovery experiences, sleep, and affect. *Journal of Applied Psychology*, *93*(3), 674–684. https://doi.org/10.1037/0021-9010.93.3.674

Sonnentag, S., & Kruel, U. (2006). Psychological detachment from work during off-job time: The role of job stressors, job involvement, and recovery-related self-efficacy. In *European Journal of Work and Organizational Psychology* (Vol. 15). KOPS.

Spielberger, C. D. (1983). *State-trait anxiety inventory for adults*. Mind Garden.

Spillers, F., & Asimakopoulos, S. (2012). Help me relax! Biofeedback and gamification to improve interaction design in healthcare. *8th International Conference on Design and Emotion: Out of Control - Proceedings*, *September*.

Stockwell, S., Schofield, P., Fisher, A., Firth, J., Jackson, S. E., Stubbs, B., & Smith, L. (2019). Digital behavior change interventions to promote physical activity and/or reduce sedentary behavior in older adults: A systematic review and meta-analysis. *Experimental Gerontology*, *120*(January), 68–87. https://doi.org/10.1016/j.exger.2019.02.020

Stroebe, M., Stroebe, W., Schut, H., Zech, E., & Bout, J. van den. (2002). *Does Disclosure of Emotions Facilitate Recovery From Bereavement? Evidence From Two Prospective Studies.* Journal of Consulting and Clinical Psychology, 70 (1), 169-178. https://doi.org/10.10.37//0022-006X.70.1.169

Swanson, R. A., & Holton, E. F. (2005). *Research in Organizations: Foundations and Methods in Inquiry.* . Berrett-Koehler Publishers.

Sweetser, P., & Wyeth, P. (2005). GameFlow: A Model for Evaluating Player Enjoyment in Games. In *ACM Computers in Entertainment* (Vol. 3, Issue 3).

Taelman, J., Vandeput, S., Spaepen, A., & Van Huffel, S. (2008). Influence of Mental Stress on Heart Rate and Heart Rate Variability. In *IFMBE Proceedings* (Vol. 22). www.springerlink.com

Tausig, M. (1982). Measuring Life Events. In *Journal of Health and Social Behavior* (Vol. 23). https://about.jstor.org/terms

Tomaka, J., Blascovich, J., Kibler, J., & Ernst, J. M. (1997). Cognitive and Physiological Antecedents of Threat and Challenge Appraisal. In *Journal of Personality and Social Psychology Copyright* (Vol. 73, Issue 1). American Psychological Association, Inc.

Torres, L., & Taknint, J. T. (n.d.). *Ethnic Microaggressions, Traumatic Stress Symptoms, And Latino Ethnic Microaggressions, Traumatic Stress Symptoms, And Latino Depression: A Moderated Mediational Model Depression: A Moderated Mediational Model*. https://epublications.marquette.edu/psych_fac/192

Tyack, A., & Wyeth, P. (2021). 'the Small Decisions Are What Makes it Interesting': Autonomy, Control, and Restoration in Player Experience. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CHIPLAY). https://doi.org/10.1145/3474709

Tyack, A., Wyeth, P., & Johnson, D. (2020). Restorative Play: Videogames Improve Player Wellbeing After a Need-Frustrating Event. *Conference on Human Factors in Computing Systems - Proceedings*, *2020-January*. https://doi.org/10.1145/3313831.3376332

Tychsen, A., Hitchens, M., & Brolund, T. (2008). *Motivations for Play in Computer Role-Playing Games*.

Tze Ping, L., Subramaniam, K., & Krishnaswamy, S. (2008). TEST ANXIETY: STATE, TRAIT AND RELATIONSHIP WITH EXAM SATISFACTION. *Malaysian Journal of Medical Sciences*, *15*(2), 18–23.

Vahlo, J., & Karhulahti, V. M. (2020). Challenge types in gaming validation of video game challenge inventory (CHA). *International Journal of Human Computer Studies*, *143*. https://doi.org/10.1016/j.ijhcs.2020.102473

Vedhara, K., Miles, J., Bennett, P., Plummer, S., Tallon, D., Brooks, E., Gale, L., Munnoch, K., Schreiber-Kounine, C., Fowler, C., Lightman, S., Sammon, A., Rayter, Z., & Farndon, J. (2003). An investigation into the relationship between salivary cortisol, stress, anxiety and depression. *Biological Psychology*, *62*(2), 89–96. https://doi.org/10.1016/S0301-0511(02)00128-X

Vella, K., Johnson, D., & Hides, L. (2015). Playing alone, playing with others: Differences in player experience and indicators of wellbeing. *CHI PLAY 2015 - Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, 3–12. https://doi.org/10.1145/2793107.2793118

Viana, R., Dos, M., Andrade, S., Vancini, R., Andre, C., & Lira, B. De. (2021). *Rating of perceived exertion during a single exergame session in healthy young men Revista Brasileira de Prescrição e Fisiologia do Exercício*. *November*.

Villarejo, C., Fernández-Aranda, F., Jiménez-Murcia, S., Peñas-Lledó, E., Granero, R., Penelo, E., Tinahones, F. J., Sancho, C., Vilarrasa, N., Montserrat-Gil de Bernabé, M., Casanueva, F. F., Fernández-Real, J. M., Frühbeck, G., De la Torre, R., Treasure, J., Botella, C., & Menchón, J. M. (2012). Lifetime Obesity in Patients with Eating Disorders: Increasing Prevalence, Clinical and Personality Correlates. *European Eating Disorders Review*, *20*(3), 250–254. https://doi.org/10.1002/erv.2166

Wiemeyer, J., Nacke, L., Moser, C., & Mueller, F. 'Floyd'. (2016). Player Experience. *Serious Games Foundations, Concepts and Practice*, 234–272. https://doi.org/DOI 10.1007/978-3-319-40612-1

Witmer, B. G., & Singer, M. J. (1998). Measuring Presence in Virtual Environments: A Presence Questionnaire. In *Presence* (Vol. 7, Issue 3).
Yee, N. (2006). Motivations for Play in Online Games. *CyberPsychology & Behavior*, *9*(6), 772–775. https://doi.org/10.1089/cpb.2006.9.772
Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361–370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x
Zillmann, D., & Bryant, J. (1985). *Affect, Mood, and Emotion as Determinants of Selective Exposure* (1st ed.). Routledge.