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**A Moderated Mediation Approach to Risk Factors for First-Year
University Students' Stress-Related Anxiety and Depression
Koebeli, C.**

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A Moderated Mediation Approach to Risk Factors for First-Year University Students'
Stress-Related Anxiety and Depression

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Abstract

High levels of stress and mental health issues are significant concerns among first-year university students. However, the factors contributing to why some students successfully navigate their first year while others struggle with anxiety and depression have received limited attention. To address this gap, this thesis adopts a moderated mediation approach to identify specific resilience and risk factors associated with stress-related anxiety and depression in first-year students. Specifically, it explores the influence of personality traits, sleep quality, and neurocognitive factors in shaping these outcomes.

Study 1 brings clarity to the existing inconsistencies in the literature regarding the roles of trait and state anxiety in the stress-depression relationship by identifying trait anxiety as a moderator in the relationship between undergraduate-specific life stressors and depression mediated by state anxiety.

Building on these insights, Studies 2 to 4 were the first to identify high trait anhedonia, poor sleep quality, and high cognitive flexibility—along with concurrent high sustained attention and poor inhibitory control—as risk factors in first-year students' stress-related state anxiety and depression. By identifying and elucidating these risk factors, this research provides a comprehensive framework for understanding the interplay between various psychological and cognitive factors in students' mental health during the crucial first year of university.

Given the empirical evidence generated, universities must improve and develop mental health strategies that effectively detect and support students exhibiting these risk factors. By implementing intervention techniques that target stress reduction, anxiety alleviation, and anhedonia mitigation, while simultaneously promoting sleep quality and enhancing inhibitory control, universities can offer a holistic approach to support vulnerable students. These strategies hold immense potential in fostering better mental health outcomes and enhancing

academic success and overall well-being, both during students' university years and as they transition into adult life.

This thesis contributes significantly to the existing body of knowledge by illuminating specific resilience and risk factors that influence stress-related anxiety and depression in first-year university students. Bridging the gap between research and practice provides a foundation for universities to build effective mental health support systems tailored to the unique needs of their students. By addressing these challenges proactively, universities can foster an environment that prioritizes the well-being of their students and empowers them to thrive academically and personally throughout their university journey and beyond.

Keywords: Anxiety, Depression, Stress, Trait Anhedonia, Sleep Quality, Executive Function

Declaration

I declare that all material in this thesis is my own work. Two master's students at the University of Westminster assisted with data collection for 39 participants. The thesis candidate co-supervised these students.

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List of Abbreviations

BDI	Beck Depression Inventory
CANTAB	Cambridge Neurological Test Battery
EF	Executive function
IED	Intra-Extra Dimensional Shift
OLS	Ordinary least squares
PAL	Paired-associate learning
PSQI	Pittsburgh Sleep Quality Inventory
RVP	Rapid visual processing
SEM	Structural equation modeling
SLE	Stressful life event
STAI	State-Trait Anxiety Inventory
USLS	Undergraduate-specific life stressor
USQ	Undergraduate Stress Questionnaire
VIF	Variance inflation rate

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1 Introduction

While entering university is exciting and liberating, it can also be stressful for students. With a typical age range of 18-24 years old, first-year undergraduate students are in a fragile developmental life stage called late adolescence, marked by significant social, emotional, neurological, and cognitive development (Arain et al., 2013; Auerbach et al., 2018; Jaworska & MacQueen, 2015). Throughout late adolescence, the brain remains vulnerable to chronic stress and abusive lifestyles (Arain et al., 2013).

First-year university students are often in a challenging new environment away from home. Currently, approximately 80% of full-time students in Britain leave their hometowns to enter university (Whyte, 2019). For many, this is the first time they must assume responsibility for numerous tasks, including shopping, preparing meals, commuting, and making new friends. The need to adapt socially is vital, as their new environment can include increased financial constraints, housing difficulties, and academic pressure (Cooke et al., 2006). These changes can become overwhelming, leading to experiences that test their capacity for independent living, healthy coping, and emotion regulation.

Exposure to life stressors in late adolescence has been linked to negative mental health outcomes such as anxiety (Byrne et al., 2007; Grant et al., 2004) and depression (Bouma et al., 2008; Waaktaar et al., 2004). High rates of mental health complaints have been reported among first-year university students (McLafferty et al., 2017) compared to late adolescents from the general population (Adalf et al., 2001; Ibrahim et al., 2013; Volken et al., 2021). Higher rates of health complaints may be due to a double transition: from family life to university and adolescence into young adulthood. Both can be particularly stressful for students. In addition, students enrolling in university are passing through the peak age range for the onset of anxiety and depression (Ibrahim et al., 2013; Legerstee et al., 2019; Zivin et al., 2009).

Negative emotional states are reaching clinical levels for university students. Based on the American College Health Association's (2018) National College Health Assessment, 63% of students felt overwhelming anxiety in 2017, and 23% reported being diagnosed or professionally treated for anxiety that same year. Furthermore, Conley et al. (2018) conducted a longitudinal study of students adjusting to college life and found that stress, anxiety, and depression continue to rise during the first semester and remain elevated throughout the second semester. Duffy et al. (2020) also conducted a longitudinal study investigating the prevalence of clinically significant anxiety and depression in new university students, finding that 33% and 28% presented with clinically significant levels of anxiety and depression, respectively, increasing to 36% and 39% by the end of the first year of the study.

These studies illustrate that entering university can be associated with the development of mental health symptoms, including elevated levels of stress, anxiety, and depression. Building on the previous literature, this thesis explores the influence of a student's personality profile, cognitive profile, and sleep quality on stress-related anxiety and depression levels. For example, trait anxiety levels and a proclivity to socialize might predict anxiety and depressive tendencies in a stressful new environment.

1.1 The concept of stress

While stress is part of the human experience, developing a unified definition has been problematic. Numerous definitions have emerged throughout various research fields, each with its own shortcomings.

1.1.1 Stress defined

Within psychological and health domains, stress is fundamentally understood as the perceived imbalance when individual and social resources are inadequate to meet external demands. Emphasizing the subjective experience of stress, Lazarus and Folkman (1984, p. 19) framed it as a relationship with the environment, threatening one's well-being due to resource

limitations. Cohen et al. (2016, p. 577) conceptualized stress as harmful environmental situations influencing a person's mental or physical abilities. Both definitions underscore the perception of resource insufficiency in confronting external pressures. Varying definitions align with Cohen et al.'s (2016) stage model of stress and disease, in which the stressors an individual considers threatening result in behavioral and physiological responses and potential downstream disease implications. These circumstances can be related to a change in the social environment or persist within one's environment. Regardless of the duration of the threat or challenge, most current definitions of stress include an environmental component. Where they differ is in the degree of importance placed on the basic psychological process of perception.

Stress and its underlying neurobiology have transformed over the last few decades. Instead of considering the neurobiology of stress as only triggered under threatening conditions, biological responses to stressors are now considered an adaptive, ongoing process in which the body and brain react to everyday experiences, whether stressful or not (i.e., allostasis; McEwen & Akil, 2020). However, the stress system can become dysregulated and overloaded with stressful experiences. When this occurs, it is detrimental to the brain and can make an individual prone to a range of mental health disorders (McEwen, 2017).

1.1.2 Stressful life events

Stressful life events (SLEs) are experiences that lead to changes in a person's life and necessitate coping and adjusting strategies (Compas, 1987). Accordingly, SLEs are strongly associated with symptoms of anxiety and depression but are more likely to precede the first episode of depression than subsequent episodes (Stroud et al., 2008). The extent to which SLEs affect students' mental health depends on how they cope. For example, a student who has moved into a noisy campus accommodation may try to improve the situation by discussing it with their roommates. Conversely, a student who struggles with social interaction may not feel comfortable attempting to change or discuss the situation.

According to Sokratous et al. (2013), mental health problems primarily stem from the accumulation of challenging experiences and the chronicity of ongoing SLEs (e.g., financial strains and relationship problems) rather than the impact of a single SLE. Individuals may be exposed to many ongoing SLEs during particular periods of life. The first year at university is one such period in which health problems increase dramatically (Duffy et al., 2020).

Exposure to significant SLEs impacts the development of mental health problems such as anxiety (McLaughlin & Hatzenbuehler, 2009; Taher et al., 2015) and depression (Abela & Skitch, 2007; Hammen, 2005; Mazure, 1998; Stroud et al., 2008). However, there is high variability in the susceptibility of a person to the negative effects of SLEs. Therefore, additional vulnerability factors may contribute to the development of stress-related mental health issues. Certain personality traits, sleep quality, and cognition may constitute resilience/vulnerability for SLE-related anxiety and depression.

Like the definitional inconsistencies of stress, there is heterogeneity in operationalizing SLEs ranging from maltreatment during childhood and major life traumas to daily life challenges. Furthermore, the severity and duration of SLEs add further definitional and measurement complexities, particularly for university students (Peltzer & Pengpid, 2015; Sokratous et al., 2013; Tafoya et al., 2019).

1.1.3 Undergraduate-specific life stressors

Since an educational environment often results in an increase in potential stressors, Crandall et al. (1992) identified undergraduate-specific life stressors (USLSs) as a distinct set of SLEs specifically affecting college students. First-year university students may have a proclivity to new stressors in their transition away from their home, contending with issues related to their independence, such as cooking, budgeting, smoking or alcohol consumption, and finding coping mechanisms while living on campus.

Furthermore, as the first year of studies continues, students may face additional issues leading to mounting USLSs, especially when returning home for the holidays to visit their families. Chevrier and Lannegrand (2022) stated, “Leaving home to go to university is a stressful life event that may generate illbeing in the form of homesickness, especially at the beginning of the first year” (para. 2). Thus, there is a dual phenomenon of separation from one’s family and the impact of dealing with SLEs on their own that can lead to increased anxiety and depressive symptoms.

1.2 Stress-related anxiety and depression: Stress exposure (model)

SLEs all represent vulnerability factors for anxiety (Farooqui et al., 2017; Li & Kanazawa, 2016; McLaughlin & Hatzenbuehler, 2009; Taher et al., 2015) and depression (e.g., Friis et al., 2002; Gao et al., 2019; Hankin & Abela, 2005; Nanni et al., 2012; Phillips et al., 2015; Sokratous et al., 2013) in the general population and specifically in first-year university students (Dyson & Renk, 2006; Schofield et al., 2016). About 50% of those with a diagnosis of depression have been exposed to severe stress prior to illness onset (Mazure, 1998). SLEs may be an even stronger predictor for the development of anxiety. Taher et al. (2015) found only 2.8% of individuals with a diagnosis of generalized anxiety did not report a major SLE 1 year prior to the onset of the illness. As such, SLEs have a substantial causal relationship with the onset of depression (Hammen, 2005; Stroud et al., 2008).

However, exposure to SLEs alone may not suffice to trigger mental health disorders. A vulnerability (*diathesis*) to a specific disorder must exist to be triggered through SLEs. The diathesis-stress hypothesis has been the most popular explanation for the etiology of psychopathologies and is a paradigm of clinical and health psychology (Smoller, 2016). Stress diathesis models explore how biological or genetic traits (*diatheses*) interact with environmental stressors to produce disorders such as anxiety and depression. Individuals may differ in how they develop a disorder based on predispositional risk factors and experienced

stress. Most stress diathesis models assume individuals have some level of diathesis for a given psychological disorder (Monroe & Hadjiyannakis, 2002), which can be activated through SLEs and transformed into mental health disorders.

The link between SLEs and the development of mental health problems such as anxiety and depression is crucial, yet studies investigating the stress exposure effect have largely overlooked the bidirectionality between SLEs and mental health problems (Hammen, 1991). Therefore, SLEs can be a predictor and an outcome of depressive symptoms (Mazure et al., 2000; Sokratous et al., 2013). Hammen (1991, 2006) referred to this as the stress generation hypothesis.

1.2.1 Stress generation hypothesis

Over the last two decades, the stress-depression and stress-anxiety relationship has been refined, leading to an evolution of the concept of stress generation. Stress generation is defined as “the contribution of the depressive person to the occurrence of stressful life events” (Hammen & Shih, 2008, p. 409). In other words, the concept of stress generation states that some individuals with a vulnerability to anxiety and depression actively generate SLEs due to their behavioristic characteristics (Daviu et al., 2019; Farmer & Kashdan, 2015; Grant et al., 2003; Grant & McMahon, 2005; Hammen, 2006; Uliaszek et al., 2012). Hasegawa et al. (2022) found a positive association between aggressive behaviors and an increase in SLEs among Japanese university students along with rumination and subsequent stress generation.

For example, if a student with high anxiety receives a poor mark or encounters money troubles, they will likely perceive this event as far more stressful than someone with low anxiety. Here, the perception of stress is subjective, as it depends on individual interpretation rather than the actual event. Kendler et al. (1999) added that for some, exposure to the event does not happen by chance. Instead, they have a tendency to put themselves in situations that likely result in SLEs, elevating the risk for anxiety and depression. Furthermore, Hankin and

Abela (2005) suggested the relationship between stress and mental health disorders is transactional and bidirectional rather than uni-directional.

Evidence for experiencing SLEs due to a person's level of anxiety or depression has been well documented, both in the general population (Liu & Alloy, 2010) and the undergraduate student population specifically (Barker, 2020; Joiner et al., 2005). Joiner et al. (2005) demonstrated that an increase in undergraduate students' reported SLEs over a 5-week period was associated with symptoms of depression but not anxiety. However, in a study following depressed and anxious adolescents 1 year after an initial assessment, Uliaszek et al. (2012) found stress generation effects for both anxiety and depression. The discrepancy may be due to different study designs. While Joiner et al. (2005) assessed stress generation effects related to anxiety and depression after 5 weeks, the baseline and follow-up assessments in Uliaszek et al. (2012) were approximately 1 year apart. This divergence suggests that for anxiety, stress generation may occur at a later time.

Farmer and Kashdan (2015) studied a group of adults with social anxiety disorder and a matched control group from the community to demonstrate stress generation in social anxiety disorder. Participants had to self-monitor stressful social interactions and events and negative and positive affect over 2 weeks. They found that compared to the control group, individuals with social anxiety disorder experienced elevated interpersonal stress, thus substantiating the presence of stress generation effects related to anxiety. Moreover, Harkness and Luther (2001) used a community sample to investigate the relationship between chronic depression and anxiety disorders in respect to stress generation. Their findings revealed that stress generation was strongest for those with comorbid chronic depression and comorbid anxiety.

Given these findings, there is a clear association between stress generation and sub-clinical and clinical anxiety and depression. In addition, stress generation is even more pronounced when individuals suffer from comorbid depression and anxiety.

While substantial evidence supports the causation and generation of stress, other studies have indicated that stressful life events (SLEs) often precede conditions such as anxiety and depression. R.M. Post's (1992) kindling model provides an explanatory framework for this sequence, by suggesting that while initial episodes of mood disorders may be triggered by significant life events or stressors, the link between such triggers and subsequent episodes diminishes over time. This shift suggests a sensitization process where the brain's threshold for mood episode initiation reduces, leading to an increase in the frequency and severity of episodes, even in the absence of the original stressors (Post, 1992). In a comprehensive meta-analysis of 13 studies, Stroud et al. (2008) substantiated the kindling model, demonstrating a stronger link between serious SLEs and initial depressive episodes than subsequent episodes.

Overall, while SLEs often lead to feelings of anxiety and depression, individuals with a vulnerability for anxiety and depression may be more prone to exposing themselves to particularly stressful situations. This raises the question as to why some people expose themselves to greater stress, even though it is likely to cause harm. One proposed theory is genetic, as there is evidence that the reaction to SLEs is inherited.

1.2.1.1 The heritability of stress reaction

While SLEs often happen accidentally, reactions to them may be at least partially inherited (Bemmels et al., 2008; Clarke et al., 2019; Power et al., 2013). This means that while one person experiences an event as a stressor that leads to a related bodily and neurobiological response (e.g., physical tension and the production of a hormone called cortisol), another may not perceive the same event as stressful, thus not resulting in a stress-related neurobiological response.

Therefore, external stressors are not necessarily stressful or threatening on their own; rather, one's perceptual system may interpret them as such, especially when there is a lack of adequate coping resources. Furthermore, there may be a connection between heritability and

perceived stress. Fedorenko et al. (2006) noted that perceived stress is partially heritable based on a study of perceived stress related to three subscales: Trier Inventory for the Assessment of Chronic Stress, Perceived Stress Scale, and the Measure for the Assessment of Stress Susceptibility.

In addition, Assary et al. (2021) studied the effect of environmental sensitivity among adolescents. Their findings revealed the heritability of adverse factors such as stress reactivity. The question remains whether adolescents with heightened sensitivity may have a higher exposure to SLEs and more challenges in resolving them upon entering their first year of university.

Stress resilience

While nearly everyone experiences SLEs, most can cope partly because of resilience. The American Psychological Association (2022) defined resilience as “the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress” (para. 4). Resilience research pertains to why some people fall apart, why others appear to adapt to traumatic life events (Werner, 2011), and why still others thrive. Anyan et al. (2017) investigated enhanced stress resilience mechanisms and determined that those possessing a pronounced ability to adapt to stressors are less likely to develop mental health problems.

Given the large number of stressors to which first-year undergraduate students are exposed, stress resilience plays a fundamental role in their adaptation to a new environment. Therefore, it is vital to not only reduce stress levels, but also identify risk and precipitating and protective factors and implement them into assessment, intervention, and treatment strategies to foster resilience and reduce anxiety and depression among students.

Stress adaptation can lower the likelihood of depression (Southwick & Charney, 2012) and improve treatment outcomes for depressed individuals. However, relatively little is known about contributing resilience factors in first-year undergraduate students. A key to elucidating

stress-related anxiety and depression implications is to identify the characteristics of students with low or high resilience. Identifying modifiable variables could further advance this area, providing insight into improved prevention and intervention strategies for students' anxiety and depression.

1.2.2 General conceptual model of the role of stressors in the etiology of psychopathology

The current theoretical models of the role of life stressors in the etiology of psychopathology are complex. However, most studies fail to include a theoretical context. To address this issue and the lack of a comprehensive framework, Grant et al. (2003) proposed the general conceptual model of the role of SLEs in contributing to mental health symptoms such as anxiety and depression. This model has been broadly applied to the entire life course (Grant & McMahon, 2005). The general conceptual model states the following:

1. Stressors contribute to psychopathological symptoms;
2. Mediators explain the association between stressors and symptoms of psychopathology;
3. Moderators influence the association between stressors and symptoms of psychopathology;
4. There is specificity in the relations among stressors, moderators, and mediators; and
5. Associations among stressors, moderators, mediators, and symptoms of psychopathology are both reciprocal and dynamic.

The model in this thesis focuses on SLEs rather than overall stressors and their role in mental health problems. Second, the model follows this logic: SLEs contribute to (a) depression; (b) the relationship between SLEs and depression is mediated through anxiety; and (c) moderators, such as personality traits, sleep, and executive function influence the association between SLEs and depression. Given the cross-sectional nature of the studies in

this thesis, the reciprocity and dynamics of the stress-anxiety-depression relationship were not addressed.

1.2.2.1 Mediation and moderation

Indirect and conditional effects are beneficial when analyzing the relationship between several variables. Mediators specify how or the mechanism through which a condition occurs (Baron & Kenny, 1986; Holmbeck, 1997). In the relationship between SLEs and psychopathologies, mediators are reactionary to measure the effects of stress and an increase or decrease in response to the effects of SLEs. As such, mediators (e.g., psychological, biological, or social factors) help explain the relationship between variables (Grant et al., 2006; Grant & McMahon, 2005), both statistically and conceptually.

Moderators are characteristics of the individual prior to the experience of stress exposure, which affect the strength or direction between two variables. Moderators of the stress–depression relationship explain an increase or decrease in the probability of developing depressive symptoms as a consequence of the impact of a specific moderator. A moderator may be a vulnerability or protective factor in the stress–depression relationship (Grant et al., 2003; Grant & McMahon, 2005).

A mediator is a variable influenced through the independent variable and affects the dependent variable. In contrast, a moderator is a variable that changes the strength of the relationship between two variables. Accordingly, although certain variables may function as a moderator or a mediator, they are conceptually distinct (Baron & Kenny, 1986; Kraemer et al., 2002).

1.3 The relationship between symptoms stress, anxiety, and depression

Anxiety and depression are highly comorbid conditions in the general population, often co-occurring across the lifespan (Cummings et al., 2014). For individuals with a primary diagnosis of an anxiety disorder, the estimates of lifetime comorbid depression range from 27%

to 77% (Brown et al., 2001). Anxiety and depression are highly prevalent and commonly co-occur in undergraduate university students (Makhubela, 2021; Pérez-Rojas et al., 2017). Several theoretical models aim to establish the high comorbidity between anxiety and depression. The two leading models are the shared etiology model (Neale & Kendler, 1995) and the direct causation model (Avenevoli et al., 2001). The shared etiology model suggests that common risk factors, such as severe SLEs (D'Imperio et al., 2000), socioeconomic disadvantages, family dysfunction, and problems with peers (Shanahan et al., 2008), may account for a large proportion of the co-occurrence of the two disorders (e.g., Kotov et al., 2010). In contrast, the direct causation model suggests that one disorder causes the other or lowers its threshold for manifestation (Avenevoli et al., 2001). Horn and Wuyek (2010) demonstrated anxiety is a determinant for future depression in the general population, while Cassidy et al. (2019) noted that both general and academic anxiety predict depression in university students.

1.3.1 Temporal relationship between the onset of anxiety and depression

Evidence suggests anxiety temporally precedes depression (e.g., de Graaf et al., 2003; Moffitt et al., 2007), leading some to propose that anxiety causes depression (Brady & Kendall, 1992). However, it is not clear whether the anxiety-depression relationship is causal or explained by other factors. Horn and Wuyek (2010) and Starr et al. (2016) noted that anxiety constitutes a direct risk factor for subsequent depression. First, anxiety often occurs prior to the onset of depressive episodes and over long periods of time, can be used to predict episodes of depression, even after controlling for common risk factors. For example, a prospective study by Mathew et al. (2011) showed that even after controlling for common risk factors of anxiety and depression, anxiety measured at Time 1 significantly predicted depression at Time 2. However, after controlling for the same common risk factors, Time 1 depression no longer predicted Time 2 anxiety. Beesdo et al. (2009) supported the view that anxiety temporally

precedes depression, demonstrating the majority of anxiety disorders have their onset in childhood or adolescence, while comorbidity rates between anxiety and depression considerably increase later in life during late adolescence and young adulthood (Ollendick et al., 2005). Finally, Frewen et al. (2012, 2013) found that individuals with comorbid anxiety and depression reported that the former preceded the latter.

1.3.2 The mediating role of anxiety in the relationship between stressful life events and depression

Compas (1987) noted that SLEs refer to experiences leading to life changes that require coping skills and other strategies to make adjustments. Therefore, the relationship between SLEs, anxiety, and depression is complex and bi-directional. Despite this relationship, the evidence points to SLEs preceding anxiety and depression, while anxiety precedes depression. Within the last two decades, the role of anxiety in the relationship between SLEs and depression has been specifically explored. The question is whether anxiety is a mediator (explaining the relationship between SLEs and depression) or a moderator (influencing the relationship between SLEs and depression).

Instrumentalized differently, anxiety may help explain (mediates) the relationship between SLEs and depressive symptoms (Anyan et al., 2017, 2018; Ghorbani et al., 2008; Havnen et al., 2020; Ho, 2021; Kok et al., 2016). However, these studies did not consider two complementary concepts, as most clinicians agree that anxiety operates on two temporal levels: state anxiety, which reflects a transitory psychophysiological state, and trait anxiety, which refers to a relatively stable individual difference in perceiving SLEs as threatening (Andrade et al., 2001; Spielberger et al., 1983). However, none of the studies that suggested anxiety mediates the SLE-depression relationship took a potential conditional effect of trait anxiety on state anxiety into account. Thus, by simplifying complex conditional processes between these

variables, recent studies have overlooked potential conditional effects of trait anxiety on the relationship between SLEs, state anxiety, and depression.

However, when investigating the stress-anxiety-depression relationship, differentiating between state and trait anxiety and considering conditional effect between these variables is important. A variety of assessment tools are available to assess the extent to which a person has experienced SLEs, such as the Adolescent Stress Questionnaire (McKay et al., 2019) and the Perceived Stress Questionnaire (Wisse & Sleebos, 2016). Given the specificity of an undergraduate sample, this thesis investigated the effect of undergraduate specific life stressors on first year students' anxiety and depression.

1.4 Potential moderators in the relationship between stress-related anxiety and depression

Exposure to SLEs significantly impacts the development of mental health problems such as anxiety and depression. In addition, McLafferty et al. (2022) stated, "Elevated levels of suicidality, ADHD, mental ill-health and substance disorders are reported among college students globally, yet few receive treatment" (p. 1), leading to an increased risk of stress and anxiety and potential mood disorders. However, there is high variability in a person's susceptibility to experience the negative effects of stress. Therefore, additional vulnerability factors for developing stress-related mental health issues seem to be involved. The literature suggests that certain personality traits, sleep quality, and cognition constitute resilience/vulnerability for SLE-related anxiety and depression.

As detailed in Section 1.3.2, anxiety mediates the relationship between SLEs and depressive symptoms, contributing to a better understanding of the mechanism underlying the SLEs–depression relationship. The literature suggests that to date, no study has explored the moderating role of personality traits, sleep quality, and cognitive factors in a moderated mediation model with USLSs as the independent variable, depression the dependent variable,

and state anxiety a mediator. This gap is addressed by investigating personality traits (trait anxiety and trait anhedonia), sleep quality and executive function (EF) as moderating factors in the relationship between USLSs and depression mediated through state anxiety.

1.4.1 Personality traits

During the last two decades, personality traits have been increasingly studied as risk and resilience factors in stress-related psychopathologies. Consistent evidence has evolved, suggesting personality traits help to explain who is prone to both stress responsiveness (Xin et al., 2017) and stress-induced mental health problems (DiGangi et al., 2013), specifically depression (Hankin et al., 2010; Matthews et al., 2003; Weger & Sandi, 2018). Although it is well documented that first-year university students experience a large number of USLSs, anxiety, and depression, there is a paucity of research clarifying the role of personality traits as vulnerability or protective factors for USLS-related anxiety and depression. This gap leads to the distinct aims of Studies 1 and 2 of this thesis, which will be defined in the following sections.

1.4.1.1 Trait anxiety

There are two complementary concepts within the study of anxiety: state and trait. State anxiety is a psychophysiological state which reflects the transient reactions related to an adverse event in a specific moment. These reactions can be psychological and physiological in nature and include symptoms such as reduced concentration, irritability, rapid heartbeat, and muscle tension or pain. This mix of mental and physical symptoms can also be experienced when there is no actual threat, only a perceived threat. State anxiety is a transient intense emotional state and is generally associated with a brief increased activity in the sympathetic nervous system but is not connected to specific pathological conditions.

In contrast, trait anxiety refers to anxiety as a personality trait rather than in a passing stressful situation. Trait anxiety is relatively stable over time and has been linked to different

psychopathological conditions. Those with lower levels of trait anxiety feel less stress and worry during adverse events than those with higher levels of trait anxiety. Individuals with higher levels of trait anxiety have a predisposition to chronic feelings of worry and fear as the nervous system is almost on constant alert for potential threats. This can result in longer-lasting anxiety symptoms including insomnia, difficulty concentrating on tasks, mood changes, and fatigue.

When state and trait anxiety work together as a single construct, the higher the level of trait anxiety, the more anxious a person will feel when facing a threat or danger. However, Saviola et al. (2020) suggested state and trait anxiety are separate constructs based on the differences in the way the brain maps each type of anxiety. They posit that trait anxiety can increase and intensify state anxiety as each type of anxiety has unique characteristics that can develop and fluctuate independently of one another.

Trait anxiety is a highly heritable personality characteristic (e.g., Gottschalk & Domschke, 2017) that has been positively linked to stress responses. When exposed to SLEs, individuals with high levels of trait anxiety often react with state anxiety, compared to situations where most others do not show signs of state anxiety (Gidron, 2013). Trait anxiety is associated with a more sensitive autonomic nervous system (Barrett & Armony, 2006), which results in a longer recovery period to neutralize arousal levels (Jakšić et al., 2012; Van der Ploeg, 1980). This delay in recovery from SLEs can make it challenging for trait anxiety people to cope with stress and often results in mental health issues such as anxiety disorders or depression (Jakšić et al., 2012; Van der Ploeg, 1980). Weger and Sandi (2018) proposed that high trait anxiety constitutes a vulnerability phenotype for stress-induced depressive symptoms. High trait anxiety individuals generally experience state anxiety when exposed to SLEs. Accordingly, trait anxiety may be a factor affecting stress-related depression indirectly through elevated state anxiety. However, such a model has not yet been tested.

Compared to the general population, university students have higher levels of stress, state anxiety, trait anxiety, and depression (Franzoi et al., 2020; Ibrahim et al., 2013). State anxiety helps to explain how SLEs translate into depressive symptoms experienced by students. However, a paucity of research has investigated trait anxiety as a moderator of this relationship. Study 1 fills this gap by assessing trait anxiety as a specific vulnerability factor for USLS-related state anxiety and depression.

1.4.1.2 Trait anhedonia

First-year undergraduate students leave their family homes and friends and find themselves in a new challenging environment at university. This situation is exacerbated for those who struggle to fit in and make new friends. The ability to form and maintain a social network requires sophisticated social skills. People with anhedonia typically demonstrate little interest in social interaction and intimate relationships (Cohen et al., 2012) and lack the ability to form a social network (Llerena et al., 2012). According to Silvia and Kwapil (2011), this lack of interest in individuals with anhedonia may stem from a belief that social interaction is unrewarding. Neuropsychological studies support this notion, suggesting symptoms of anhedonia are caused by reward circuit dysregulation (Enneking et al., 2018; Höflich et al., 2019) caused by the long-term impact of chronic stress (Pizzagalli, 2014), which may explain the lack of motivation to strive for rewarding stimuli (Bryant et al., 2017). Given the deficiency in brain reward mechanisms (drive state) and an inability to experience pleasure from social and physical sources (soothing state), it is unsurprising that individuals with high trait anhedonia tend to engage less or withdraw from social interactions, which makes it difficult to form a new social network.

However, a well-functioning social network is a prerequisite for receiving social support, affiliation, and connection (Brailovskaia et al., 2018). Gilbert's (2009b, p. 199) compassion model states that "experiences of inner warmth, safeness and soothing, via

compassion and self-compassion” may help develop social connections and balance critical emotional regulation systems. Furthermore, Depue and Morrone-Strupinsky (2005) specified three types of regulation systems: (a) threat and protection; (b) drive, resource-seeking, and excitement; and (c) contentment, soothing, and safeness. By activating the latter system, increased social interaction may protect against the development of physical and mental health problems (Gilbert, 2009a; Lienert et al., 2017; Yancy et al., 2015). Notably, the absence of a social network can lead to isolation and loneliness, contributing to conditions such as severe depressive disorder (Kawachi & Berkman, 2001) and anxiety disorders (Falk Dahl & Dahl, 2009).

When exposed to the new environment at university, students with anhedonia may experience an increase in their symptoms. As a result, establishing a new social network may be challenging, resulting in little social support and feelings of isolation and loneliness. These feelings increase the risk of stress-related psychological symptoms such as anxiety and depression. Thus far, no study has explored whether anhedonic students are specifically vulnerable to USLS-related state anxiety and depression. Study 2 fills this gap by exploring the moderating role of trait anhedonia in first-year students’ USLS-related anxiety and depression.

1.4.2 Sleep quality

While sleep quantity is important, so is sleep quality (Pilcher et al., 1997). Kline (2013) defined sleep quality as “a person’s satisfaction of the sleep experience, integrating aspects of sleep quantity, sleep initiation, sleep maintenance, and refreshment upon awakening” (p. 1811). Although poor sleep quality is particularly common among adolescents (Şimşek & Tekgül, 2019), it can continue into early adulthood and among first-year university students. Aldhawayn et al. (2020) noted that prevalence rates of poor sleep quality vary depending on measurement tools but can go as high as 75%. First-year university students in the United

Kingdom who typically live in student residences are exposed to several factors that can lead to an increased risk of poor sleep quality.

1.4.2.1 Biological factors

A review of the literature by Carskadon (2011) revealed paired biological and psychosocial factors contribute to reduced sleep quantity in adolescents. During adolescence, the two bioregulatory sleep systems are still developing. First, the sleep/wake homeostatic process which is a persons' drive to sleep is stronger in adolescence. Second, during adolescence there is a delayed shift in the circadian timing system. Melatonin levels (a hormone that increases sleepiness) do not start to rise until later in the evening which pushes biological alertness and bedtimes further into the night. As a result, adolescents feel more alert at night, making it difficult for them to get to sleep earlier than 11 pm. Late sleeping times are specifically problematic for students with early morning classes to attend, which may result in sleep deprivation. Lund et al. (2010) suggested that 25% of first-year university students are sleep deprived as they report less than 6 hours of sleep per night. The National Sleep Foundation recommends the average person aged 18-25 requires 8 hours of sleep for optimal functioning (Hirshkowitz et al., 2015). Reducing a person's optimal sleep time can result in a range of neurobehavioral deficits, including lapses of attention, reduced working memory, reduced cognitive capacity, thought perseveration, and depressive symptoms (Banks & Dinges, 2007; Honn et al., 2020).

1.4.2.2 Environmental factors

Convincing evidence suggests that sleep quality can become affected by other people (Jenni et al., 2005; Rogojanski et al., 2013). Most new university students experience a change in their sleeping environment as they share their accommodations with roommates and sleep in close proximity to them. By sharing their accommodation with roommates, first-year university students often take the opportunity to socialize late into the night which can

contribute to a noisy environment (Foulkes et al., 2019). These factors can negatively affect sleep quantity, sleep initiation, and sleep maintenance, eventually affecting new students' mental and physical health (Stansfeld & Matheson, 2003).

A sense of safety and security stemming from one's interpersonal environment is essential for a good night's sleep (Dahl & Lewin, 2002). Therefore, distress from the interpersonal environment eventually signals it is not safe to fall and stay asleep (Dahl & Lewin, 2002) via heightened psychological and physiological arousal of the body at sleep initiation and during the night (Wang & Liu, 2016). Given first-year university students leave their homes and must find new peers at university, feelings of safety from their interpersonal environment may not yet be present, resulting in trouble falling and staying asleep. Sleep deprivation can increase anxiety while anxiety can affect sleep, leading to a negative cycle of insomnia and anxiety (Suni, 2022).

High exposure to artificial light and overindulgence on the Internet, social media, and on demand television have dramatically changed societal lifestyles. This modern lifestyle has resulted in deviations in natural sleep patterns as many students use multiple forms of technology late into the night. Increased technology may also contribute to students' poor sleep quality and daytime sleepiness. In addition, late-night technology use has been associated with the consumption of caffeinated drinks later in the day (Calamaro et al., 2009).

1.4.2.3 Associations between sleep quality and stressful life events

The connection between stress and sleep quality is intricate, as each cyclically influences the other (Kalmbach et al., 2018). Stress can arise from academic expectations, job pressures, personal problems, or health-related issues, and these stressors can significantly degrade the quality of sleep (Galambos et al., 2010; Kim & Dimsdale, 2007; Litwiller et al., 2017). Moreover, poor sleep is not merely about the lack of sleep but involves issues such as insomnia, frequent nocturnal awakenings, and non-restorative sleep. These manifestations of

sleep deprivation can have severe consequences for daily functioning and overall well-being (Fernandez-Mendoza & Vgontzas, 2013; Kim & Dimsdale, 2007).

The biochemical basis of this reciprocal relationship involves the stress-induced activation of the hypothalamic-pituitary-adrenal (HPA) axis (Balbo et al., 2010). As a critical neuroendocrine system, the HPA axis controls reactions to stress and regulates body processes, including mood, immunity, and energy storage (Herman et al., 2016). Overactivity of the HPA axis due to chronic stress can result in increased production of cortisol, the primary stress hormone in the body, and can disrupt the normal sleep-wake cycle, leading to degraded sleep quality (Balbo et al., 2010).

In contrast, impaired sleep can exacerbate the physiological stress response. Studies have shown that poor sleep can escalate the production of cortisol (Hirotsu et al., 2015). Moreover, a lack of quality sleep can heighten emotional responses to stress, making individuals more susceptible to the adverse effects of stressful situations (Minkel et al., 2012). This vulnerability can create a self-perpetuating cycle where stress continues to impair sleep, and inadequate sleep heightens stress sensitivity.

1.4.2.4 Associations between sleep quality, anxiety and depression

A broad consensus underscores the substantial interrelationship among sleep quality, anxiety, and depression. However, this interrelation is complex and bidirectional, implying that these factors reciprocally influence each other.

Characterized by heightened irritability, diminished capacity for stress management, and altered mood regulation, interrupted sleep may contribute to the emergence and severity of anxiety and depressive disorders (Harvard Medical School, 2007). Numerous prospective studies have reinforced this contention, suggesting that poor sleep quality can precede and instigate the onset of anxiety and depression across diverse age demographics (Alvaro et al.,

2013; Ford & Kamerow, 1989; Gregory et al., 2005; Kalmbach et al., 2015; Lovato & Gradisar, 2014; Lovato et al., 2017; Orchard et al., 2020; Touchette et al., 2012).

Touchette et al. (2012) conducted a longitudinal study and demonstrated that children with sleep disturbances faced a fourfold increase in the risk of anxiety and depression over 18 years. More recently, Orchard et al. (2020) indicated that poor sleep during adolescence could serve as a predictor for anxiety and depression in subsequent stages of life.

Conversely, anxiety and depression can lead to poor sleep quality. Symptoms such as racing thoughts, restlessness, and hyperarousal—common in anxiety disorder—can make it challenging to fall or stay asleep (Taylor et al., 2005). Likewise, insomnia is often a symptom of depression (Baglioni et al., 2011). Furthermore, evidence suggests a cyclical relationship where sleep problems increase the risk for anxiety and depressive disorders and vice versa (Alvaro et al., 2013).

1.4.2.5 The moderating role of sleep quality in the relationship between SLEs, anxiety and depression

Based on the evidence that (a) SLEs generally promote symptoms of anxiety and depression, (b) SLEs seem to trigger poor sleep quality, and (c) poor sleep quality is strongly associated with both anxiety and depression, poor sleep quality is being explored as a risk factor for SLE related anxiety and depression. These findings suggest that sleep quality moderates the relationship between SLEs and depression in healthy adults (Leggett et al., 2016). Furthermore, Ho (2021) investigated the role of sleep quality on the relationship between stress-related anxiety and depression in Facebook users using a moderated mediation model with stress as the independent variable, anxiety as the mediator, and depression as the outcome variable. The study results revealed sleep quality moderated the relationship between stress-related anxiety and depression in this population. Given the findings by Leggett et al. (2016), it is somewhat surprising that Ho (2021) restricted his investigation to the moderating effect of

sleep quality on the stress-induced state anxiety and depression (the second leg of the indirect path), neglecting the possibility that poor sleep quality could also moderate the direct and eventually the first path of the indirect association between stress and depression. Taken together, these findings demonstrate the role of sleep quality as a potential vulnerability factor in stress-related anxiety and depression.

Furthermore, poor sleep quality is associated with symptoms of stress, anxiety, and depression in university students (Al-Khani et al., 2019). However, evidence for these associations, especially among first-year undergraduate students, is still sparse. Even though (a) SLEs are related to students' depressive symptoms; (b) that this relationship is mediated through their levels of state anxiety; and (c) that sleep quality is a moderator of this relationship in the healthy population, no study thus far has explored sleep quality as a potential risk factor for USLS-related state anxiety and depression in first-year university students. Study 3 fills this gap by investigating sleep quality as a risk factor for first-year students' USLS-related anxiety and depression.

1.4.3 Executive functioning

In addition to the role of personality traits and sleep quality as potential vulnerability/resilience factors for USLS-related mental health problems in first-year students, the role of cognitive functioning in this relationship represents another focus of this thesis. Lezak (1982) coined *executive functioning* (EF), also referred to as cognitive control and executive control. Lezak (2012) defined EF as a collection of cognitive processes which allow a person to adapt and react to new situations and intentionally synchronize one's actions. EF consists of a set of associated but distinct higher-order cognitive functions, which allow the individual to carry out complex cognitive tasks (Diamond, 2013; Miyake & Friedman, 2012; Miyake et al., 2000). Despite the burgeoning research interest in EF in recent decades, there is no universally accepted definition for EF (Suchy, 2009).

Accordingly, many EF models overlap and are closely related to memory functioning models. In *Higher Cortical Functions in Man*, Luria (1966) proposed the concept of the executive control system, which refers to a set of cognitive processes involved in goal-directed behavior, problem-solving, planning, and decision-making. He emphasized the role of the prefrontal cortex in orchestrating these functions and highlighted the importance of executive control in human cognition. His insight into executive function and cognitive control has led to further research and contributed to understanding the intricate workings of the human brain and its role in higher-order cognitive processes. In 1968, Atkinson and Shiffrin suggested the multi-store memory model, which involves a unitary system that holds onto information for a relatively short time with little processing involved. Baddeley and Hitch (1974) proposed a working memory model as a multi-component system, including a central executive that coordinates different cognitive systems and distributes attentional resources. Posner (1975) introduced the concept of the attentional network, which consists of three primary components: alerting, orienting, and executive control. The executive control component is responsible for regulating and coordinating cognitive processes, such as working memory, inhibition, and task switching. Norman and Shallice (1986) reformulated the concept of a central executive, suggesting a supervisory attentional system in charge of controlling actions and coping with novel tasks. Thus, a supervisory attentional system is needed when the routine selection of actions is insufficient and where planning and willed actions are required.

1.4.3.1 The concept of executive functioning

EF refers to top-down mental processes (previously acquired knowledge) which enable and monitor goal-directed actions, self-regulation of emotions, mannerisms, and habits, and adaptive behavior (Jurado & Rosselli, 2007; Nigg, 2017; Snyder et al., 2015). Thus, EF is regarded as an opposite pole to bottom-up (automated) behavior (Goschke, 2017). Contrary to

bottom-up processes, EF is defined through slower processing, restricted processing capacity, and sensitivity to interference from automated bottom-up processes (Cohen, 2017).

Despite the general agreement about the core concept of EF, there is less consensus on the conceptual details of the distinct EF components, including their number, function, and associations, which may stem from different research traditions. First, psychologists with a clinical background view EF as a construct composed of abilities or processes typically affected in individuals with brain injuries or neurological conditions. Therefore, clinical conceptualizations mirror the diverse executive dysfunction syndromes found in neurological patients (e.g., Burgess & Shallice, 1996; Duffy & Campbell, 1994; see Suchy, 2009, for an overview of clinical approaches to the conceptualization of EF).

In contrast to the conceptualizations from clinical neuropsychologists, developmental psychologists have proposed that executive function skills are not innate at birth but gradually develop over time (Anderson, 2002). These skills mature following a sequential pattern, commencing in infancy and extending into adulthood, under the influence of both biological and environmental factors (Best & Miller, 2010; Zelazo et al., 2004). Although these skills are generally fully developed by early adulthood, they can continue to evolve throughout one's life (Diamond, 2013; Park & Reuter-Lorenz, 2009; Zelazo et al., 2004). Individual variations in the development of these skills exist and can be influenced by the quality of education (Blair & Raver, 2015), parenting style (Bernier et al., 2010), socioeconomic status (Lawson et al., 2017), and the presence of neurodevelopmental disorders (Biederman et al., 2004).

Finally, the conceptualization of EF by cognitive psychologists or neuroscientists normally relies on research studies experimentally assessing cognition in neurologically healthy individuals. Over the years, cognitive psychologists and neuroscientists have increasingly applied factor analysis resulting in one to six factors. The discrepancy in findings between these studies led to a conceptual debate of whether EF should be regarded as a unitary

construct (one single factor underlies all executive functions) (De Frias et al., 2006) or rather a set of distinct components (Miyake et al., 2000). Referred to as a “black box,” the unitary approach was not regarded as an adequate approach to EF (Baddeley, 1996). Thus, the pioneering empirical work by Miyake et al. (2000) played a seminal role in this debate and has heavily influenced EF research throughout the years. Through a latent variable approach, Miyake et al. (2000) demonstrated that despite their unity by shared features, three associated but clearly separable EF components—namely inhibitory control, working memory, and cognitive flexibility—are mediated by the prefrontal cortex (Siddiqui et al., 2008). Thus, performance on EF tasks primarily relies on these three EF subcomponents (Diamond, 2013; Miyake et al., 2000).

Inhibitory control

Inhibitory control (IC) refers to a person’s ability to control attention, thoughts, behavior, and emotions to withstand automatic responses toward internal predispositions or external temptation and act appropriately, using reasoning to do what is needed (Diamond, 2013; Friedman & Miyake, 2017). Without inhibitory control over the self, people would continually follow old habits and act impulsively. When referring to inhibitory control, Diamond (2013) delineated between (a) interference control (selective attention and cognitive inhibition) and (b) self-control.

Interference control

The brain selectively attends to environmental stimuli throughout the day, consciously or subconsciously. Stimuli (auditory, visual, olfactory, haptic etc.) direct a person’s attention, whether voluntarily or involuntarily. Selective attention (inhibitory control of attention) is the ability to ignore irrelevant stimuli and focus on what is deemed relevant. For example, selective attention is required for a student to concentrate on a lecturer’s speech if other students are fidgeting or if noise from outside construction can be heard as well. An individual can choose

to ignore a particular stimulus and attend to other more relevant stimuli based on their goal (Posner & DiGirolamo, 1998; Theeuwes, 1992, 2010). Selective attention underlies sustained attention (i.e., ability to focus on a stimulus or activity over a long period of time) while inhibiting irrelevant responses (Cohen, 2011, pp. 2440–2443). Sustained attention is imperative for students as they need to stay focused while listening to lectures, reading textbooks, or writing essays. Cognitive inhibition permits a person to suppress prepotent and unwanted mental representations (thoughts or memories including intentional forgetting) not relevant to a specific task (Anderson & Levy, 2009). Therefore, cognitive inhibition is thought to aid working memory by keeping out irrelevant information from a person’s mental workspace (Diamond, 2013).

Self-control

Another aspect of inhibitory control is self-control (behavioral inhibition), which refers to a person’s ability to control and inhibit impulses to engage in appropriate (beneficial) behavior. In other words, it is the ability to resist temptation and urges to engage in pleasures when one is not supposed to engage in those behaviors. For example, people often feel compelled to drive over the speed limit, especially if they have a fast car. Another aspect of self-control pertains to discipline, which is related to delaying gratification (Louie & Glimcher, 2010) to abstain from immediate pleasure for a greater reward later.

Working memory

The second component of EF is working memory. Baddeley (2010) referred to working memory as “the system or systems that are assumed to be necessary in order to keep things in mind while performing complex tasks such as reasoning, comprehension and learning” (p. 136). Reasoning cannot happen without working memory, which allows an individual to bring conceptual knowledge to guide decision-making (e.g., Cowan, 2014).

Three main aspects of working memory are the central executive, visuospatial sketchpad (nonverbal working memory), and phonological loop (verbal working memory) (Baddeley, 2000; Baddeley & Hitch, 1974). Verbal working memory processes the spoken and written language. The visuospatial sketchpad involves working memory components that hold on to and process visual and spatial information. The central executive has a supervisory function and drives the system by controlling the flow of information from and to the verbal working memory and visuospatial sketchpad. While the central executive can be thought of as a control system, the phonological loop and the visuospatial sketchpad can be thought of as storage systems.

Working memory is crucial for making sense of things that unfold over time because the brain needs to hold in memory what happened in the past and relate this information to what may come. For example, to engage in a dialogue, a person must track and connect the previous and the later parts of a conversation. Another example where visuospatial working memory is involved is for mathematical calculations where a plan of action from instructions, considering alternative approaches, or decision-making is needed.

Cognitive flexibility

Cognitive flexibility generally refers to the ability to adjust to changing environmental demands (Armbruster et al., 2012). A person's inhibitory abilities and working memory are important components of cognitive flexibility (Garon et al., 2008). Throughout the day, a person's actions and goals must be updated to adapt to changing environments and thoughts, and actions activated earlier in the day need to be inhibited (Diamond, 2013). As such, cognitive flexibility requires and is based on working memory and inhibition. Cognitive flexibility is strongly linked to intelligence. High cognitive flexibility in students significantly predicts academic performance, especially in domains such as medicine, biology, or physiology (Rhodes & Rozell, 2017).

In this thesis, the understanding of EF is strongly associated with the work by Miyake et al. (2000) and Miyake and Friedman (2012). It is now generally accepted that performance on EF tasks primarily rely on working memory, inhibitory control, and cognitive flexibility (Diamond, 2013; Miyake et al., 2000), whereas practitioners generally distinguish higher-order EF such as reasoning, problem-solving, and planning from these functions (Collins & Koechlin, 2012).

EF performance was assessed through a range of Cambridge neurological test battery subtests. Measures included were as follows: inhibitory control, sustained attention, cognitive flexibility, and working memory. A detailed description of these subtests are in the Chapter 6 methodology (see pp. 97–100). Despite the importance of the neurological background of EF, this thesis limits its focus on the behavioral manifestations of EF.

1.4.3.2 Executive function and stress

Given the prevalence of stress and the constant reliance on EF for everyday functioning, an association between the two seems inevitable. Stress can be broadly divided into acute and chronic. While acute stress relates to the emergence of an immediate, temporally limited, specific stressor, chronic stress pertains to an ongoing perception of threat in a person's life (Shields et al., 2016). Thus, there has been increasing investigation into the relationship between EF and stress over the last two decades (Shields et al., 2016). While most studies focused on the effect of acute stress, less is known about the effect of chronic stress, which may be due to the fact that it is difficult and unethical to induce (Sandi, 2013).

Although there are cases in which various forms of stress interfere with cognitive processing, there are other instances in which stress has been shown to benefit cognition (Sandi, 2013). While chronic stress, especially during childhood, seems to impair EF (Munoz et al., 2015; Sandi, 2013), acute stress can worsen EF for reasoning, planning, and problem-solving, such as working memory (Gagnon & Wagner, 2016; Qin et al., 2009) and cognitive flexibility

(Alexander et al., 2007), but can improve inhibitory control (Chang et al., 2020; Shields et al., 2015, 2016). Notably, while the effect of acute stress on EF seems to be temporary, the effect of chronic stress, especially during childhood, may be permanent.

1.4.3.3 The moderating role of executive functions in stress-related mental health problems

Andres et al. (2016) and Lantrip et al. (2016) suggested that EF (e.g., cognitive flexibility) enables cognitive reappraisal, helping lower stress responsiveness (Liu et al., 2019) and protect against stress-related anxiety and depression (Moore et al., 2008). Shields et al. (2017) substantiated this view using a well-known methodology called the Trier Social Stress Test. They induced acute psychosocial stress in a sample of healthy young adults and examined whether better EF could buffer the negative effect of acute stress on the relationship between recent SLEs and mental and physical health complaints. Their findings revealed that better EF was associated with lower emotional reactivity to SLEs under acute stress but not when acute stress was absent.

This finding suggests that individuals with strong EF under acute stress may be less responsive to stress-related mental and physical health issues. Although not discussed by Shields et al. (2017), their findings indicate that individuals with poor EF skills may be at an increased risk for stress-related mental and physical health. Furthermore, they limited their findings to the induction of acute stress. A particular type of chronic stress (major difficulties defined as ongoing stressful conditions; Brown & Harris, 1978) may similarly affect the relationship between experienced SLEs and psychological and physiological health symptoms. However, this hypothesis has not yet been tested. Thus, it is surprising that relatively little attention has been paid to EF as a vulnerability/resilience factor in regulating stress and associated mental health problems such as anxiety and depression. Study 4 fills this gap by investigating the role of EFs (sustained attention, inhibitory control, cognitive flexibility and

working memory) as risk and protective factor for first-year students' USLS-related anxiety and depression.

1.4.3.4 The importance of studying individual differences in students' executive functioning

EF is crucial for successfully reacting and adapting to a changing environment (Banich, 2009). As such, first-year students with poor EF skills may struggle to adapt to their stressful new environment and experience higher levels of USLS-related anxiety and depression than students with better EF skills. Uncovering the neurocognitive basis of individual differences in psychological vulnerability and resilience to the adverse effects of SLEs may provide insight into the pathophysiology of stress-related anxiety and depression in first-year students. Furthermore, identifying cognitive risk markers for the development of USLS-related anxiety and depression is critical for developing early intervention and prevention strategies, such as cognitive training to combat the typical rise of anxiety and depression in first-year university students. Therefore, the aim of Study 4 is to explore the role of EF in first-year students' stress-related anxiety and depression.

1.5 Current research

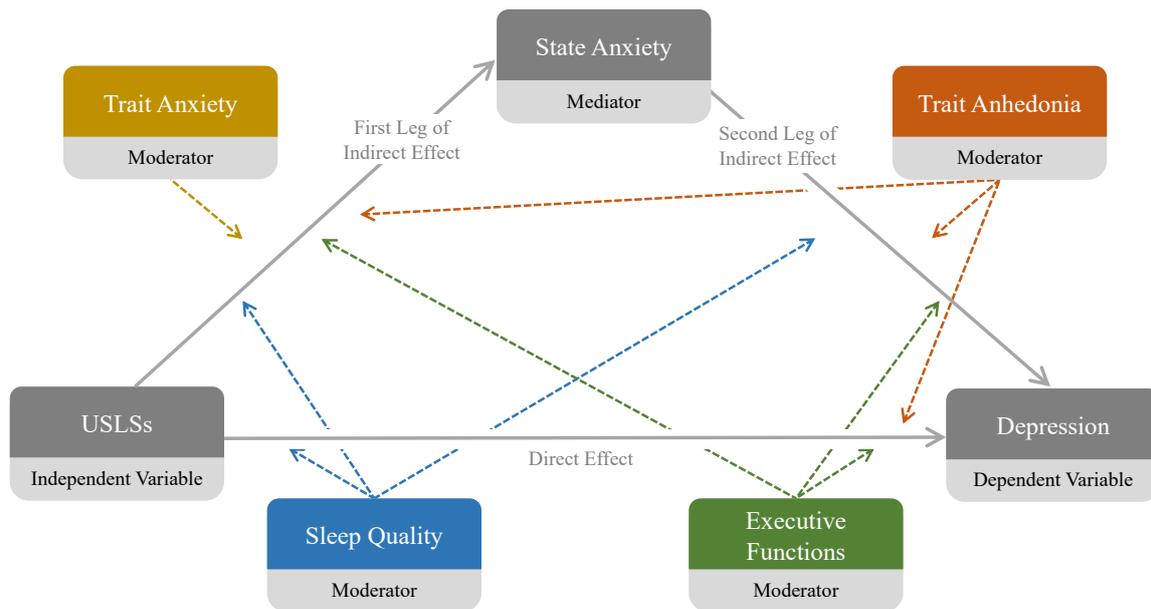
The identification of mental health risk factors for undergraduate students' stress-related anxiety and depression is crucial to enhance existing intervention methods and develop new intervention tools to improve mental well-being and prevent mental illnesses. If early warning signs are ignored, and their causes not addressed at an early age, first-year university students might go on to develop lifelong disabilities, placing a great burden on both the individual and society. Therefore, risk factors related to USLSs, anxiety, and depression should be identified early to provide students with additional mental health support to prevent the exacerbation of risk factors and related mental health issues.

This thesis aims to identify specific risk factors that may help explain why some first-year university students react with elevated symptoms of anxiety and depression to their new

environment. A range of explanatory models elucidating cross-sectional relationships between USLSs, state anxiety, and depression and the constructs of personality traits, sleep quality and EF were developed and tested (see Figure 1-1).

Figure 1-1

Overview of Moderators in the USLSs, State Anxiety, and Depression Relationship



Based on a review of the literature, anxiety-producing thoughts, lack of sociability, sleep quality, and cognitive processes may all play a role in how students navigate an increasingly challenging environment. To assess these factors, a questionnaire battery was used to measure students' stress, anxiety, and depression levels as well as their sleep quality. Three tests from the Cambridge Neuropsychological Test Automated Battery were used to assess cognitive functions. A comprehensive overview of the aims and hypotheses, the resulting studies, and the methodologies used is provided in the next chapter.

2 Thesis Framework

2.1 Background

This thesis explored the relationship between stress-related mental health problems, sleep, and cognition in first-year university students. Students' first year at university is often challenging and stressful and associated with a prevalence of mental health problems, including anxiety and depression. While some students experience anxiety and depression when facing new challenges at university, others do not report these experiences, suggesting the presence of resilience and vulnerability factors. Identifying vulnerability and resilience markers for poor mental health is crucial to enhancing existing and developing new intervention methods for students' mental illness. The primary aim of this thesis was to investigate the connection between mental health issues in first-year university students, USLSs, and anxiety and depression.

This chapter provides an overview of the studies in this thesis, describes the methods and procedures common to data collection for the overall research project, and details the recruitment procedures.

2.2 Overview of studies

This thesis consists of four studies investigating the relationship between USLSs, state anxiety, and depression. Each chapter focuses on the role of a different moderating variable—trait anxiety, trait anhedonia, sleep quality and executive functioning (EF)—in a core mediation model, with USLSs as the independent variable, depression as the outcome variable, and state anxiety as the mediator variable. Data for all four studies were collected in the framework of a larger investigation (overall research project), with distinct hypotheses and analyses for each study. As all four studies share the same measures of USLSs, state anxiety, and depression, this chapter will focus on these measures.

2.2.1 Study 1

Stressful life events (SLEs), anxiety, and depression are all strongly related, as anxiety may mediate the relationship between SLEs and depressive symptoms (e.g., Anyan et al., 2017, 2018; Ghorbani et al., 2008; Ho, 2021; Kok et al., 2016). However, this evidence is still limited. Furthermore, previous studies have not distinguished between state and trait anxiety as mediators in the stress-depression relationship and have used the two constructs interchangeably. Therefore, studies substantiating and extending previous findings are needed to address this gap.

The aim of Study 1 was to examine the role of state and trait anxiety in USLS-related depressive symptoms. The following hypotheses were examined: (a) state anxiety mediates the relationship between exposure to USLSs and students' depression levels; and (b) trait anxiety moderates the USLS-state anxiety relationship. Findings from this study will lead to further investigation into the role of other moderators in USLS-related state anxiety and depression, including trait anhedonia, sleep quality, EF, and time processing.

2.2.2 Study 2

Trait anhedonia is the diminished experience of pleasure from social and physical sources, is strongly associated with social isolation, and is usually regarded as a symptom within a diagnosis such as generalized anxiety disorders or major depression. Anhedonia may be a symptom and risk factor for psychopathologies (Acheson et al., 2022). Furthermore, chronic stress may induce anhedonia in vulnerable individuals (Tornese et al., 2019). Considering these propositions, when exposed to ongoing life stress, individuals with high trait anhedonia may be at an increased risk of developing mental health problems. Given that first-year students are exposed to high levels of USLSs, those with a vulnerability for high trait anhedonia may be at specific risk of experiencing such problems.

Study 2 explored whether trait anhedonia was a specific risk factor for USLS-related state anxiety and depression. The following hypotheses were addressed: (a) trait anhedonia moderates the direct effect between USLSs and depression; (b) trait anhedonia moderates the association between USLSs and state anxiety; and (c) trait anhedonia moderates the association between state anxiety and levels of depression.

2.2.3 Study 3

The consequences of poor sleep quality are varied and impact the physical and mental health of students. Sleep is a critical factor for physical and mental well-being when transitioning to university yet is often overlooked while adjusting to new life surroundings and experiences. Thus, sleep quality may be another factor that buffers or exacerbates USLS-related anxiety and depression.

Sleep quality can moderate the single relationship between stress and anxiety and stress and depression in single moderation models. Ho (2021) found that Facebook users with elevated stress-related anxiety often reported comorbid depression if their sleep quality was poor. However, no study has explored sleep quality in first-year university students' USLS-related state anxiety and depression through a moderated mediation model in which sleep quality moderates the direct and both legs of the indirect path. Such a model may show where sleep quality has the most impact as a moderating variable.

Study 3 aimed to confirm previous reports of poor sleep quality in first-year university students by exploring the moderating role of sleep quality in their USLS-related anxiety and depression. The main hypotheses for this study are as follows: (a) there is a high prevalence of poor sleep quality in first-year undergraduate students; (b) poor sleep quality is positively related to USLSs, state anxiety, and depressive symptoms; and (c) sleep quality moderates the direct and both legs of the indirect path in a mediation model with USLSs as the independent variable, depression as the dependent variable, and sleep quality as the mediator variable.

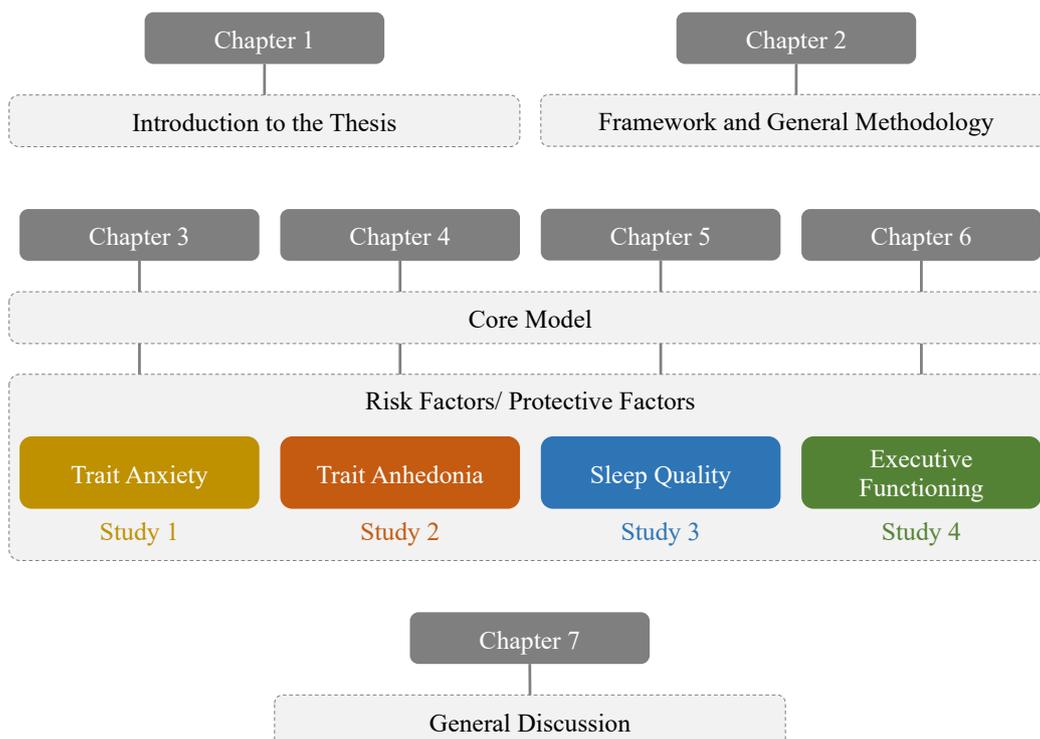
2.2.4 Study 4

Stress, anxiety, and depression often interfere with cognition. Furthermore, EF is a vital cognitive resource in regulating mood, thoughts, and coping with SLEs (Joormann & Gotlib, 2010; Shields et al., 2017). However, little attention has been paid to whether EF can serve as a cognitive resource in coping with life SLE-related anxiety and depression.

The aim of Study 4 was to assess whether EF serves as a cognitive resource in students' ability to cope with USLS-related state anxiety and depression. The hypothesis is that the relationship between USLSs and symptoms of anxiety and depression is shaped by four EFs: inhibitory control, sustained attention, cognitive flexibility, and working memory. Given the small dataset in this study, it was not possible to explore these relationships using one model. Therefore, 12 distinct moderated mediation models were calculated, with each EF moderating the relationship between USLSs and depression, USLSs and state anxiety, and state anxiety-related depression (see Figure 2-1).

Figure 2-1

Thesis Framework



2.3 Modeling approach

This thesis includes four studies, each employing distinct modeling approaches to analyze the data. Study 1 examined a mediation model with USLSs as the independent variable, depression as the dependent variable, and state anxiety as the mediator. This model emerged as significant. A subsequent model was assessed to evaluate whether trait anxiety could moderate the first leg of the indirect pathway. However, this model was not significant. Consequently, a secondary analysis was conducted to determine if trait anxiety could moderate the direct path and the second leg of the indirect path. This analysis led to the testing of Process Model 15, which examined the potential moderating influence of trait anxiety on both the direct path and the second leg of the indirect path.

Study 2 deployed Process Model 59 to assess the moderating influence of trait anhedonia on all aspects of a mediation model, with USLSs as the independent variable, state anxiety the mediator, and depression the dependent variable.

In Study 3, Process Model 59 was initially utilized to explore whether sleep quality moderated the direct path and both legs of the indirect path of a mediation model. The model was constructed with USLSs as the independent variable, state anxiety as the mediator, and depression as the dependent variable. Upon finding no significant moderation effect, the model complexity was reduced. Further analyses using Process Models 5, 7, and 14 explored sleep quality's potential moderating role on the direct path and both legs of the indirect path.

Finally, Study 4 investigated the potential moderating role of four distinct executive function components: working memory, cognitive flexibility, sustained attention, and inhibitory control. This study was achieved using Process Models 5, 7, and 14, leading to 12 moderated mediations. Process Model 1 was subsequently utilized to evaluate if inhibitory control could moderate the direct relationships between both sustained attention and depression and cognitive flexibility and depression.

2.4 Measuring USLSs, anxiety, and depression

Students' stress, anxiety, and depression levels were measured using pen-and-paper questionnaires. The Undergraduate Stress Questionnaire (USQ; Crandall et al., 1992) was used to assess the number of USLSs encountered. Students' state and trait anxiety were measured through the State-Trait Anxiety Inventory (STAI) forms Y-1 and Y-2 (Spielberger et al., 1983). Finally, depression levels were assessed through the Beck Depression Inventory-II (BDI-II; Beck et al., 1996). Furthermore, all participants in this research project completed the same demographic questionnaire. Paper versions of the questionnaires were used because they often generate higher response rates and more honest responses than online questionnaires (Dommeyer et al., 2002; Ebert et al., 2018; Nulty, 2008).

2.4.1 Undergraduate Stress Questionnaire

The USQ is an 82-item checklist reflecting potential USLSs undergraduate students may encounter. Each checked item is rated 1 point and reflects a specific USLS. The total score ranges from 0 to 82, with higher scores portending greater levels of experienced stress. The USQ is a relatively efficient instrument (less than 5 minutes to complete) and is simple in administration and scoring.

The USQ assesses undergraduate students' university stressful life events (USLSs). Crandall et al. (1992) conducted initial studies on the USQ and reported satisfactory psychometric properties, including acceptable internal consistency, split-half reliability, and test-retest reliability. Regarding internal consistency, Crandall et al. (1992) utilized the Kuder-Richardson Formula 20 as an equivalent to Cronbach's alpha and found a high level of internal consistency ($KR20 = 0.8$; Kuder & Richardson, 1937) in the initial studies. Despite its established reliability and validity, the USQ is not widely utilized outside published theses (e.g., Sloan, 2015). While there are other instruments available for studying undergraduate students' stress, such as the Perceived Stress Scale and the Hassles Assessment Scale (Sarafino

& Ewing, 1999), the USQ was selected for this thesis due to its alignment with assessing undergraduate SLEs.

2.4.2 State-Trait Anxiety Inventory

The STAI is a widely used self-report questionnaire incorporating two distinct concepts: state and trait anxiety (Spielberger et al., 1983). The two subscales each contain 20 statements, and responses are measured on a 4-point Likert scale. Good psychometric properties have been reported for the STAI in young adults and college students (Maynard et al., 2010; Stojanović et al., 2020; Vitasari et al., 2011). Therefore, the STAI has frequently been used to screen for anxiety issues among college students (Seok et al., 2018).

The state anxiety subscale asks respondents to report anxious feelings at the time they complete the questionnaire. To measure state and trait anxiety, the STAI follows a Likert scale response format ranging from 1 (*not at all*) to 4 (*very much so*). Given that the two subscales are 20-item measures, scores range from 20 to 80, with higher scores indicating greater anxiety. Franzoi et al. (2020) noted a cutoff of 40 for the distinct subscales for the presence or absence of state and trait anxiety among university students. The Cronbach's alpha coefficients for the STAI are typically quite high, indicating good internal consistency reliability. According to Spielberger et al. (1983), the developers of the STAI, Cronbach's alpha coefficients for the S-Anxiety scale range from .86 to .95, and the coefficients for the T-Anxiety scale range from .86 to .92 in adult samples.

2.4.3 Beck Depression Inventory-II

The BDI-II is a self-report rating inventory of 21 items measuring characteristics, attitudes, and symptoms of depression (Beck et al., 1996). The items consist of four ordinal categories (1, 2, 3, 4). Higher scores on items 1-13 refer to psychological symptoms, and higher scores on items 14-21 indicate the presence of such symptoms. Generally, a higher score on a specific item or the overall scale suggests higher symptom severity. The BDI-II has high

internal consistency and test-retest reliability (Gomes-Oliveira et al., 2012). The Cronbach's alpha for the BDI-II in non-clinical adolescents has been reported as .89, indicating excellent internal consistency (Lee et al., 2013). The BDI-II is one of the most widely used instruments to screen for depressive symptoms and assess the severity of depressive symptoms in adolescents and adults (Whisman et al., 2000). The BDI-II has also been widely used to investigate depression in undergraduate student populations (Cassady et al., 2019; Villatte et al., 2017). BDI-II scores range from 0 to 63, with higher scores correlating with more severe depressive symptoms.

2.5 Statistical analysis across studies

The same statistical procedures were used to analyze data from the four studies in this thesis: (a) descriptive statistics (mean/standard deviations), (b) correlational analysis, and (c) inferential statistics (Mann Whitney U test and a regression-based path analysis approach), and moderated mediation.

2.5.1 Choice of statistical method: PROCESS versus SEM

While conducting the literature review and formulating hypotheses, it became evident that a statistical methodology capable of dealing with multiple variables and complex associations was needed. The research design required defining indirect or conditional effects. Indirect effects ensue if the dependent variable indirectly influences the outcome variable through a third variable (Hayes, 2018). The effect chain is referred to as mediation. Conditional effects exist if the extent and possibly the sign of an association between two variables change as a function of the level of a third variable (Sarstedt et al., 2020). Conditional effects are called moderations. When combining these two effects, the research design represented an indirect conditional effect, which is referred to as moderated mediation (Preacher et al., 2007).

Any categorical data analysis method such as analysis of variance necessitates a decision on arbitrary cutoff points to create subgroups. It was not possible to justify such an

approach, as the data was continuous. However, although regression analysis is suitable for continuous data analysis, it does not allow for an evaluation of indirect conditional effects (Hayes, 2018). Therefore, path analysis is arguably the most viable statistical method capable of testing complex associations. The two most common path analysis implementations are (a) ordinary least squares (OLS) regression, and (b) factor or component-based structural equation modeling (SEM; Sarstedt et al., 2020).

The former is available free of charge as a computational tool called PROCESS running within SPSS, SAS, and R (Hayes, 2018). The latter is available through commercial applications such as AMOS, LISREL, EQS, and Mplus. In both analysis types, researchers create a structural diagram defining the relationships between the investigated variables. Each arrow in the diagram represents either a variable affecting another variable or a variable affecting an association between two other variables. While PROCESS uses a modified multiple regression model, SEM uses factor-based estimators (CB-SEM, such as maximum-likelihood) or component-based estimators (PLS-SEM, such as partial-least squares) to determine the model coefficients (Schamberger et al., 2020). After completion of the analysis, each path receives a coefficient. Together with the intercepts, the coefficients may be used to estimate the level of the outcome variable for a given set of input variables. The coefficients also express the extent to which the outcome variable level is expected to differ between two individuals, showing a given difference in a particular contributing variable (Hayes, 2018).

If mediation is present in the model design, the total effect of the independent variable on the outcome variable is the sum of the coefficients of the direct and indirect paths. If an effect is moderated, the coefficient of the interaction term specifies the extent to which the effect of the moderated relationship varies when the moderator changes by one unit. The effect size of a moderated relationship is inherently not constant (since it is moderated) and corresponds to a specific level of the moderator variable (Hayes, 2015).

The benefits of using PROCESS outweighed the drawbacks compared to SEM. A more detailed rationale follows below:

- While SEM provides more flexibility in research design (no constraints in the path diagram, more than one independent and dependent variable), the models intended for use in our research design were already available in PROCESS. Using SEM, models would have needed to be constructed from the beginning.
- PROCESS automatically generates a suite of inference statistics using bootstrapping. A bootstrap is a sample equal in size to the dataset generated by randomly drawing cases, with the condition that each case is put back into the dataset before the next draw occurs. For each bootstrap sample, the model coefficients are then calculated. To determine the statistical significance of the model coefficients, 10,000 bootstraps and a 95% confidence interval were used. Most SEM applications require considerable programming skills to generate the same level of inference statistics (Hayes et al., 2017).
- The size of the recruitable sample was limited by the pool of available undergraduate students. In general, PROCESS tends to require a smaller sample size than SEM to achieve the same level of power (Donnelly et al., 2022).
- SEM offers measures to assess the overall model fit and PROCESS does not. While this aspect is convenient, researchers may feel compelled to tweak the model to optimize its fit, thus potentially diverting from testing the initially specified hypotheses (Hayes et al., 2017).
- An additional advantage of SEM is the ability to consider measurement error when dealing with latent variable effects (Hayes et al., 2017). However, for models based on observed variables, the results obtained from the two methods are nearly identical.

2.5.2 Statistical significance

In this research project, the level of statistical significance (α ; the probability of committing a type I error by mistakenly rejecting the null hypothesis) was set to 0.05. Since an OLS-based estimation was used for the model's parameters, the following assumptions were verified to avoid type I errors.

2.5.2.1 Continuous variables

All variables causally affected by another variable (mediators, outcome variables) must be continuous. A continuous variable can assume any value within a given range and is only limited by numeric accuracy (Casson & Farmer, 2014). This was the case for all study datasets.

2.5.2.2 Independence of observations

Observations must not be autocorrelated. The Durbin-Watson test is only available for longitudinal designs (Baltes-Götz, 2019). Since this research design was cross-sectional and did not contain any hierarchical structures (all participants were first-year undergraduate students from the University of Westminster), the cases were not autocorrelated.

2.5.2.3 Linear relationships

The relationship between each predictor variable (independent variable, moderator, mediator) and the subsequent dependent variable must be approximately linear (Ernst & Albers, 2017). This was the case in each of the four distinct studies based on assessing locally estimated scatterplot smoothing (LOESS) lines in bivariate scatter plots.

2.5.2.4 Homoscedasticity

Homoscedasticity is fulfilled if error variances are the same for all independent and moderator variable combinations. This is generally assessed by plotting the studentized residuals against the predictor variable levels. PROCESS offers the option to use robust standard errors (HC method; Hayes & Cai, 2007). PROCESS was used to produce robust standard errors for all the models.

2.5.2.5 *Absence of strong multicollinearity*

Predictor variables cannot be correlated with each other. In traditional multiple regression analysis, the absence of strong multicollinearity can be tested with correlation matrices, variance inflation factors (VIFs), condition indices, and variance proportions (Anyan et al., 2017). In the case of moderated mediation models, Hayes (2015), Disatnik and Sivan (2014), and McClelland et al. (2016) all noted that high correlations between predictor variables and their interaction terms are within the nature of moderated mediation models and do not constitute a multicollinearity problem. They recommend that the diagnostic process focuses on potential multicollinearity issues between independent, mediating, and moderating variables. In the models in Study 1, the correlation matrix revealed that the only pairing showing a correlation above the stipulated cutoff ($r > 0.8$) was the association of trait anxiety with state anxiety (Spearman's rho of 0.907, $p < .01$).

None of the variable pairings in Studies 2 to 4 showed a Spearman's rho above the cutoff. Statistical literature differs to what levels of VIFs indicate strong multicollinearity between predictor variables. While there is consensus that VIFs exceeding 10 confirm strong multicollinearity and are problematic (James et al., 2022; Kim, 2019; Menard, 2001; Vittinghoff et al., 2011), levels between 5 and 10 are considered a cause for concern and warrant closer inspection (e.g., Chatterjee & Simonoff, 2020; O'Brien, 2007). Levels below 2.5 indicate the absence of any strong collinearity between predictor variables. In this thesis, all models investigated had VIFs below 1.5 except for state anxiety (VIF of 5.649) and trait anxiety (VIF of 5.432) in PROCESS model 15 in Study 1. The variance proportions for the dimension with a condition index above 15 was 0.94 for state and trait anxiety (above the cutoff of 0.9).

Spielberger (1972) proposed that state and trait anxiety are two strongly related but distinct anxiety types. Saviola et al. (2020) substantiated this view in a recent neuroimaging

study, providing convincing evidence for neuroanatomical and functional differences between the two anxiety types. Based on this evidence, it was decided to investigate a moderating role of trait anxiety in the USLSs-state anxiety-depression relationship despite the statistical indicators for potential multicollinearity issues. The condition indices and variance proportions were below the problematic thresholds for all other models in this thesis.

2.5.2.6 No unusual points

A dataset must not contain any cases that have a significant high influence on the overall model or on individual model parameters. The investigated models were rebuilt in SPSS as multiple regressions and inspected for Cooks' D (the effect of removing a data point on all the parameters combined), DFFITS (the effect of removing a data point on overall model fit) and DFBETAS (the effect of removing a data point on a single parameter). Each regression diagnostic can be interpreted with an absolute cutoff, a size-dependent cutoff or by visual inspection of the indexed scatter plot. For each model in this thesis (that turned out to be significant), all cases were clearly below the absolute cutoff thresholds (Cooks' D: 1; DFFITS: +/-2; DFBETAS: +/-2). While some cases exceeded the sample size-adjusted cutoffs, it was decided not to remove them from the distinct samples as they did not seem to be unusual enough based on the inspection of the indexed scatter plots generated in SPSS.

2.5.2.7 Normal distribution of residuals

Residuals should be approximately normally distributed. The mean error must be zero for any predictor variable level. If the sample size is larger than 50 cases and bootstrapping is used to estimate the model parameters, the residuals do not need to be normally distributed. The bootstrap inference was used for the coefficients of all model parameters (Baltes-Götz, 2019).

2.5.3 Power analysis

An a priori power analysis is a statistical procedure performed before a study to determine the minimum sample size needed for adequate statistical power, which is the probability of correctly rejecting the null hypothesis if it is false (Kyonka, 2018). An a priori power analysis was not conducted in this research because of changes in the focus after the original data collection period.

An alternative to an a priori power analysis is post hoc power analysis. However, conducting a post hoc power analysis for moderated mediation designs would have required a Monte Carlo simulation (Donnelly et al., 2022), which is not available in PROCESS and would have involved substantial programming. Furthermore, various statisticians have argued that post hoc power analysis is “flawed and meaningless” (e.g., Gelman, 2019; Zhang et al., 2019).

The fundamental critique against post hoc power analyses is grounded in the understanding that they can yield misleading estimates of statistical power (Hoenig & Heisey, 2001). When applied post hoc, these analyses may overestimate the power when the study identifies a statistically significant effect or conversely underestimate the power when the study fails to detect such an effect (Goodman & Berlin, 1994).

Moreover, these critiques underscore that post hoc power analyses rely on the observed data (Hoenig & Heisey, 2001). As such, the resultant findings inherently depend on the sample from which they were derived, limiting their capacity to be generalized to other samples or the larger population (Lenth, 2001). This limitation compromises the replicability and reliability of research findings predicated on post hoc power analyses (Ioannidis, 2005). Thus, due to these concerns, post hoc power analysis was deemed unsuitable for the studies in this thesis.

2.5.4 Covariates

Research mediation analysis experts have noted the importance of including confounding variables in mediation models, as the decomposition of total effects into direct

and indirect effects relies on the inclusion of such variables (Cole & Hernán, 2002; Robins & Greenland, 1992). Therefore, when designing this research project, variables that could confound the results of the distinct studies were considered. To statistically partial out the influence of confounding variables, age and sex were used as covariates in the conditional process models. The literature has shown the following variables are associated with the mediator and outcome variables in this thesis and have been taken into consideration as covariates.

2.5.4.1 Sex

Female students are more likely to present with symptoms of anxiety and depression than male students (Gao et al., 2019; Ghaedi & Mohd Kosnin, 2014; Li et al., 2020). Therefore, sex was added to the distinct models as a covariate. However, preliminary analysis revealed that sex was not correlated with any other variable in the research project and therefore was excluded from the main analysis.

2.5.4.2 Age

Age-related differences in anxiety, depression, sleep, and cognition are well-documented across the life span (Cornelis et al., 2019; Hammarberg et al., 2020; Hublin et al., 2017; Mahoney et al., 2015). Age is often used as a confounding variable to assess relationships between these factors. Therefore, age was also considered as a covariate in the models. However, there is a paucity of studies investigating the influence of age on undergraduate student stress-related anxiety and depression, sleep, and cognition. This may be because undergraduate students are predominantly of similar age, and there are limited opportunities to explore age-related differences in this group. This may also explain the absence of findings in the few studies investigating age-related mental health problems in undergraduate students (Ghaedi & Mohd Kosnin, 2014). Given this evidence and the small differences in age across the sample, age was not used as a covariate in the analysis.

2.5.5 Data storage, entry, and cleaning

Paper copies of the completed questionnaires were stored in a locked cabinet in the PhD researcher's home. After each day of data collection, questionnaire data identification was removed prior to being stored on the researcher's password protected personal computer. Questionnaire data was entered into an Excel spreadsheet created by the researcher. Questionnaires were checked for missing values upon return from each participant which ensured there was no missing data.

2.5.6 Participants and recruitment

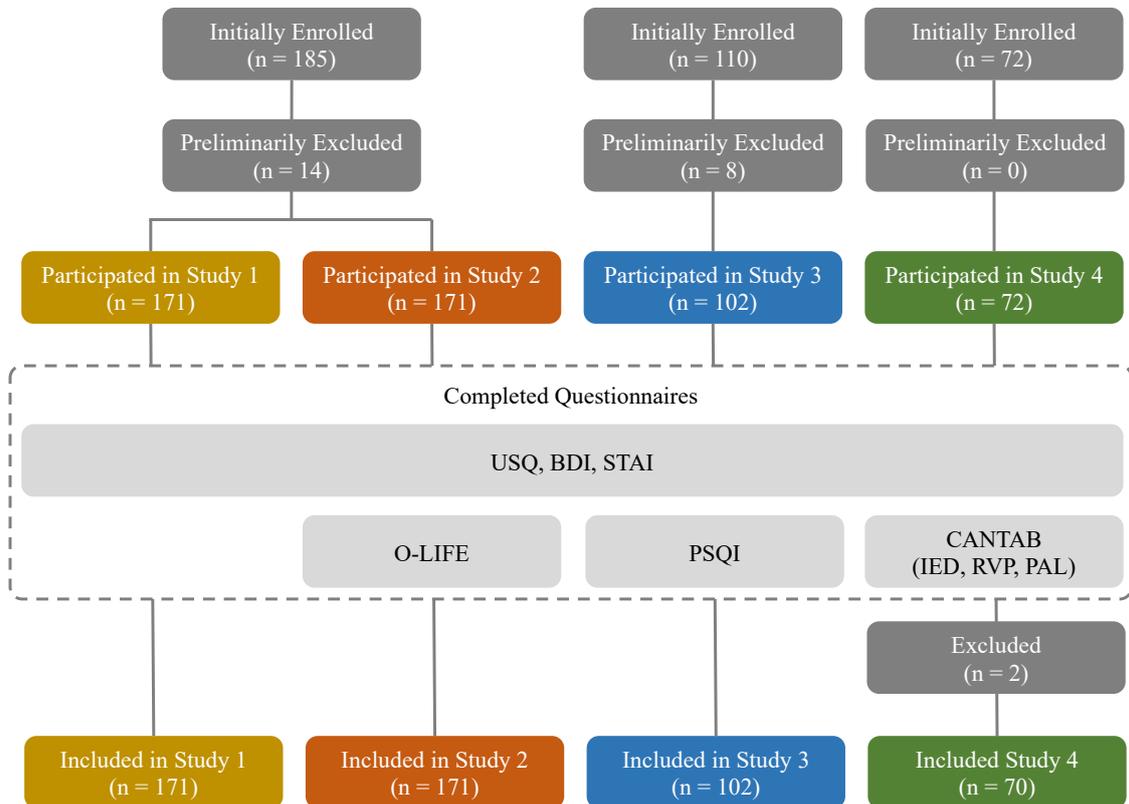
A total of 185 first-year undergraduate psychology students attending the University of Westminster were recruited from the SONA Research Participation Scheme. SONA is an electronic system allowing undergraduate students to receive course credits in exchange for research participation. Exclusion criteria consisted of (a) current diagnoses of depression, anxiety disorders, ADHD, or psychotic disorders; or (b) use of psychoactive drugs. Data was collected over three separate testing periods.

Upon arrival, participants were provided with an informed consent form. After agreeing to participate in this research project, students completed a demographic questionnaire, the USQ, the BDI, and the STAI. Participants were allocated to each of the four distinct studies as they filled in an additional questionnaire or completed a neurocognitive test battery. A total of 185 participants enrolled in Studies 1 and 2. Fourteen students were preliminarily excluded, 10 did not fully complete the questionnaire battery, and two withdrew from the research project. Furthermore, two were excluded due to psychological and cognitive problems. A total of 110 students initially enrolled in Study 3. Eight were preliminarily excluded as they failed to complete the sleep measure. Finally, 72 participants enrolled in Study 4. One was excluded because she was not in a position to complete the cognitive tests. A second student was excluded due to a technology-related issue with the cognitive test battery (see Figure 2-2 for

an overview of the sampling process). Ethical approval for this research was granted by the University of Westminster Research Ethics Committee.

Figure 2-2

Sampling Process Flowchart to Demonstrate the Procedure Followed in the Distinct Studies



Note. Studies 1 and 2 merged stress, anxiety, and depression measures from all participants across all studies.

3 The role of state and trait anxiety in the stress-depression relationship: A moderated mediation approach (Study 1)

3.1 Introduction

First-year university students may be prone to experiencing varying levels of depressed mood. With symptoms including sadness, irritability, emptiness, poor concentration, guilt, low self-esteem, hopelessness, suicidal thoughts, and low sleep quality, depression can affect a person's life on personal, familial, social, educational, and occupational levels (World Health Organization, 2021).

There are indications of a relationship between life stress and depressive symptoms in the general population, with stress as a causal factor for depression (e.g., Evans et al., 2014; Ge et al., 2009). In addition, stress correlates with psychological constructs such as anxiety, which underlies depression (e.g., Beekman et al., 2000; Konstantopoulou et al., 2020). However, anxiety is a normal stress reaction and can be beneficial in certain situations. For example, it can alert potential dangers, helping people pay greater attention to their surroundings and become prepared for a fight or flight reaction. According to Saviola et al. (2020), anxiety is “a unidimensional construct including both *state* and *trait anxiety*, considered to be different sides of the same coin” (para. 2).

State anxiety is an acute form reflecting a transitory emotional state, characterized by cognitive (apprehension), emotional (fear), and physiological (activation of the autonomic nervous system) changes in response to a temporary threatful event at a specific moment. Thus, adverse experiences accompanying state anxiety prompt a person to find ways to deal with the situation and reduce anxiety (Spielberger, 1972). State anxiety is a natural human response; a person does not need to have an underlying condition to experience fear in a threatening situation (Hutchins & Young, 2018). As a temporary, acute form, state anxiety is distinct from trait anxiety.

Trait anxiety is part of an individual's personality and is a relatively stable biological predisposition to perceiving SLEs as threatening (Andrade et al., 2001; Spielberger et al., 1983). Trait anxiety is strongly associated with psychopathological anxiety and may promote the risk of psychopathological disorders such as depression (Spielberger et al., 1983; Weger & Sandi, 2018). High trait anxiety individuals are more likely to experience situations as threatening, have a passive coping style when dealing with environmental challenges, and exhibit attentional bias and cognitive inflexibility (Weger & Sandi, 2018; Wilson et al., 2018; Xin et al., 2017).

Furthermore, trait anxiety is generally expressed through higher levels of state anxiety under threatening circumstances (Gray, 1988; Horikawa & Yagi, 2012; Payne, 1983). As an interplay between environmental stressors and a genetic vulnerability factor (trait anxiety), this may help explain the manifestation of state anxiety and depression. Thus, it is critical to distinguish between state and trait anxiety when exploring human anxiety (Wiedemann, 2015).

A potential mediating or moderating role of anxiety in the relationship between life stress exposure and depressive symptoms suggests that anxiety may be a robust mediator that explains the associations between these variables (Anyan et al., 2017, 2018; Ghorbani et al., 2008; Havnen et al., 2020; Kok et al., 2016). Table 3-1 below provides an overview of the samples, measurement tools, and findings of supporting studies.

However, these studies did not differentiate between state and trait anxiety in their models (Anyan et al., 2017; Ghorbani et al., 2008; Havnen et al., 2020) or only included one or the other (Anyan et al., 2018; Kok et al., 2016). By simplifying complex conditional processes between these variables, these studies may have overlooked additional conditional effects of trait anxiety on the relationship between SLEs, state anxiety, and depression (with state anxiety as a mediator).

Table 3-1*Anxiety's Mediating Role on the Stress-Depression Relationship*

Authors	Participants	Sample Characteristic	Tools	Findings
Ghorbani et al., 2008	197, 191	Undergraduate students	Perceived Stress Scale (Gohen et al., 1983), Hospital Anxiety Scale (Zigmond & Snaith, 1983), Hospital Depression Scale (Zigmond & Snaith, 1983)	Generalised anxiety mediates perceived stress depression relationship
Kok et al, 2016	1125	Cardiac patients	Childhood Trauma Questionnaire, Trait Anxiety, Becks Depression Questionnaire	Trait anxiety mediates childhood trauma depression relationship
Anyan, Worsely and Hjemdal, 2017	206, 210	Undergraduate students	Stressful negative life events questionnaire (Hjemdal et al., 2006), Generalised anxiety disorder questionnaire, Patients health questionnaire (depression)	State anxiety mediates stress depression relationship
Anjan et al., 2018	206, 210	Undergraduate students	Adolescent stress questionnaire (Byrne et al., 2007), Spielberger's State-Trait Anxiety Inventory, Short mood and feeling questionnaire (Angold et al., 1995)	State anxiety mediates stress depression relationship
Havnen et al., 2020	671	General population, 18+	Perceived stress scale, General Anxiety Disorder Questionnaire, Patient health questionnaire	Generalised anxiety mediated stress depression relationship
Ho, 2021	354	Facebook users from the general population	Depression, Anxiety and Stress Scale 21 (DASS 21)	Anxiety mediates stress depression relationship

No study to date has explored the relationship between first-year undergraduate students' USLSs, state anxiety, and depression while considering trait anxiety as a risk factor. To address this gap, this study investigated whether (a) USLSs are associated with depressive symptoms in first-year undergraduate students; (b) a possible association can be explained through their state anxiety; and (c) those with high trait anxiety are more vulnerable to experience stress-related anxiety and depression.

Given that personality traits are an established vulnerability factor in stress-related anxiety disorders and depression, trait anxiety potentially moderates the indirect relationship mediated via state anxiety, between USLSs and depression in first-year undergraduate students. Therefore, a moderated mediation model was used to establish the pathways through which the indirect effects of exposure to USLSs mediated by state anxiety on depressive symptoms vary systematically across undergraduate students' trait anxiety levels (low, average, and high). Such a model resolves the shortcomings of simple mediated or moderated models that result in simplifications of complex processes.

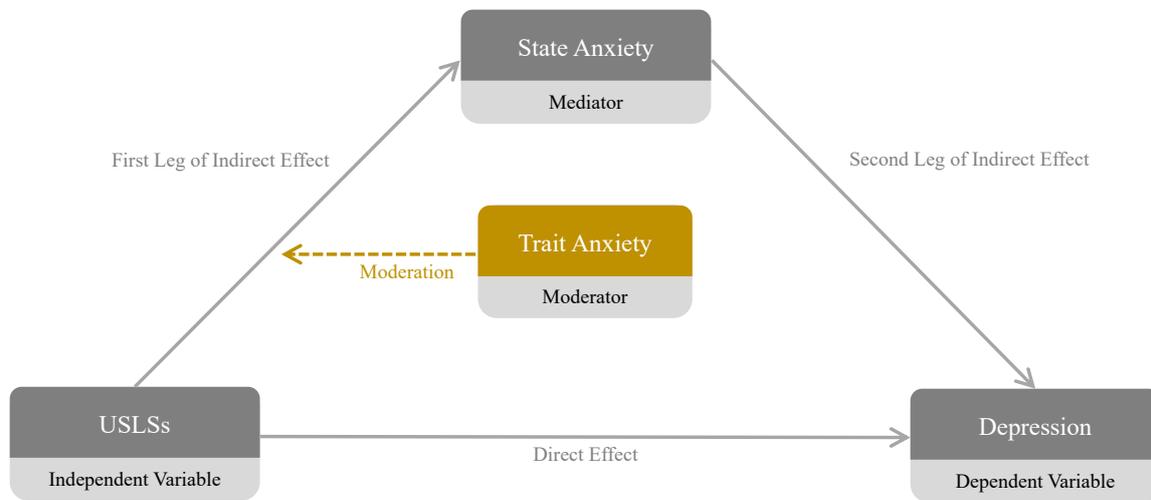
The aim of Study 1 was to examine the role of state and trait anxiety in USLS-related depressive symptoms. To address this aim, this study examined several related hypotheses:

1. First-year undergraduate students show high levels of stress, anxiety, and depression.
2. Exposure to USLSs is positively associated with state anxiety, trait anxiety, and depressive symptoms.
3. State anxiety mediates the relationship between exposure to USLSs and depressive symptoms.
4. Trait anxiety moderates the first leg of the indirect path between USLSs and depression.

The analysis followed a mediated moderation approach using PROCESS to analyze the data. Figure 3-1 below depicts the path diagram of the model tested in this study. Identifying a significant mediation effect would confirm previous research findings, suggesting a mediating role of anxiety in the stress-depression relationship. Finding a moderating effect of trait anxiety on the indirect relationship would suggest trait anxiety is a vulnerability factor for USLS-related state anxiety and depression. This study contributes to a more precise understanding of students' vulnerability to state anxiety and depression when exposed to USLSs, thus furthering the understanding of anxiety and depression etiology in this group.

Figure 3-1

Hypothesized Moderated Mediation Model: PROCESS Model 8



Note. State anxiety is the mediator and trait anxiety is the moderator in the USLS-Depression relationship.

3.2 Materials and methods

3.2.1 Participants

The sample of this study consisted of 171 students from the University of Westminster (81.9% females), with a mean age of 20.21 years (min = 18, max = 29, $SD = 2.15$). Details about participant recruitment, the provision of informed consent, and procedures are similar across studies and described in the framework of this thesis (see pp. 44–45).

3.2.2 Measures

All participants filled in three questionnaires (USQ, BDI, and STAI) and reported their age and sex (see Chapter 2 for further details about these questionnaires and the data collection process).

3.3 Statistical analysis

The means for USLSs, state and trait anxiety, and depression were calculated and compared. These values established clinical cutoff scores to test the first hypothesis. The second hypothesis was tested using Spearman's rank-order correlation for associations between (a) USLSs and state anxiety, (b) state anxiety and depression, and (c) USLSs and depression.

Spearman's correlation was chosen after the assumption of bivariate normality for the distributions of the paired variables was violated based on the Shapiro-Wilk test. Hypotheses 3 and 4 were tested using the PROCESS macro by Hayes (Version 4.0) running in SPSS 28. All model parameters were estimated using 10,000 non-parametric bootstrapping and bias-corrected confidence intervals (applying Davidson-MacKinnon, HC3) of 95%, as Jin et al. (2019) suggested. If the bootstrapped confidence interval boundaries did not contain zero, the effect under investigation was regarded as statistically significant. The third hypothesis was tested with a mediation model applying PROCESS model 4 (see Figure 3-2). When it became evident that the mediation effect was significant, a decision was made to test the fourth hypothesis.

The mediation model was expanded to a moderated mediation model (PROCESS model 8) by adding trait anxiety as a moderator of the direct and indirect paths (see Figure 3-1). Since the moderation effect on the first leg of the indirect relationship between USLSs and depression was not significant, the dataset was further explored. PROCESS model 15 tested a potential moderation effect of trait anxiety on the second leg of the indirect path (see Figure 3-4). Interaction effects were evaluated by analyzing regions of significance at the mean and one standard deviation above and below. Sex and age were identified as potential covariates with the predictor variables in the path analysis models. Spearman's correlation was calculated for age with USLSs and state and trait anxiety to determine whether the value was high enough for further analysis. The Mann-Whitney U test evaluated whether sex as a dichotomous variable should be included as a covariate.

Since an OLS-type path analysis was used, it was necessary to verify the relevant assumptions to avoid type I errors. The dataset consisted of continuous variables, and the observations were not auto correlated. Locally estimated scatterplot smoothing (LOESS) lines were used in bivariate scatter plots generated in SPSS to assess the linearity of the relationships

between (a) USLSs and state anxiety, (b) state anxiety and depression, and (c) USLSs and depression. PROCESS produced robust confidence intervals according to the method referred to as HC3 (Hayes & Cai, 2007). The models were rebuilt in SPSS to verify the absence of strong multicollinearity between predictor variables and the absence of unusual points. Given that the dataset had a sample size greater than 50 and bootstrapping was used to estimate all model parameters, the residuals did not need to be normally distributed. No a priori or post hoc power analyses were conducted.

3.4 Results

3.4.1 Hypothesis 1: First-year undergraduate students show high levels of USLSs, anxiety, and depression

Study participants reported a mean level of USLSs of 19.70 ($SD = 10.82$). The distribution was skewed to the right (standardized skewness = 3.77) with normal kurtosis. The majority showed anxiety levels above the clinical cutoff score of 40 (53% for state anxiety; 58% for trait anxiety). The mean levels for both anxiety types were also above the clinical cutoff (state anxiety: $M = 42.21$, $SD = 10.82$; trait anxiety: $M = 45.11$, $SD = 11.50$). State and trait anxiety scores did not show non-normal skewness and kurtosis levels. The mean depression score in this sample was 14.09 ($SD = 10.69$). Most participants showed minimal or mild levels of depression (57% and 20%, respectively). However, 11% reported moderate depression, and 11% showed severe symptoms of depression. The distribution of depression scores was skewed to the right (standardized skewness of 6.35) and heavy-tailed (standardized kurtosis of 3.22). For an overview of the descriptive statistics and the presence of clinical anxiety and depression in this sample, see Tables 3-2 and 3-3, respectively.

Table 3-2*Descriptive Statistics*

Item	<i>M</i>	<i>SD</i>	Range	Skewness		Kurtosis	
				Value	<i>SE</i>	Value	<i>SE</i>
USLSs	19.70	10.82	54	0.702	0.186	-0.010	0.369
State Anxiety	42.21	10.82	48	0.474	0.186	-0.294	0.369
Trait Anxiety	45.11	11.50	52	0.479	0.186	-0.357	0.369
Depression	14.09	10.69	52	1.181	0.186	1.188	0.369
Age	20.21	2.15	11	1.665	0.186	2.834	0.369

Table 3-3*Presence of Clinical Anxiety and Depression*

Item	<i>N</i>	%
State Anxiety		
No clinical state anxiety	81	47%
Clinical state anxiety	90	53%
Trait anxiety		
No clinical trait anxiety	72	42%
Clinical trait anxiety	99	58%
Depression		
Minimal depression (≥ 13)	98	57%
Mild depression (14-19)	35	21%
Moderate depression (20-28)	19	11%
Severe depression (29-63)	19	11%

3.4.2 Hypothesis 2: Exposure to USLSs is positively related with levels of anxiety and symptoms of depression

USLSs correlated positively with state anxiety ($\rho = 0.408$, $p < .01$), trait anxiety ($\rho = 0.402$; $p < .01$), and depression ($\rho = 0.523$, $p < .01$). State anxiety also showed a positive and significant correlation with trait anxiety ($r = 0.903$; $p < .01$) and depression ($\rho = 0.754$; $p < .01$). Similarly, trait anxiety showed a positive correlation with depression ($\rho = 0.747$; $p < .01$). Table 3-4 provides an overview of the correlational analysis.

Table 3-4

Pearson and Spearman Correlations for All Measures

	USLSs	State Anxiety	Trait Anxiety	Depression
State Anxiety	0.408***			
Trait Anxiety	0.402***	0.903***		
Depression	0.523***	0.754***	0.747***	
Age	0.134	0.109	0.111	0.059

*** Correlation is significant at the 0.01 level (2-tailed).

3.4.3 Hypothesis 3: State anxiety mediates the impact of USLSs on the occurrence of depressive symptoms

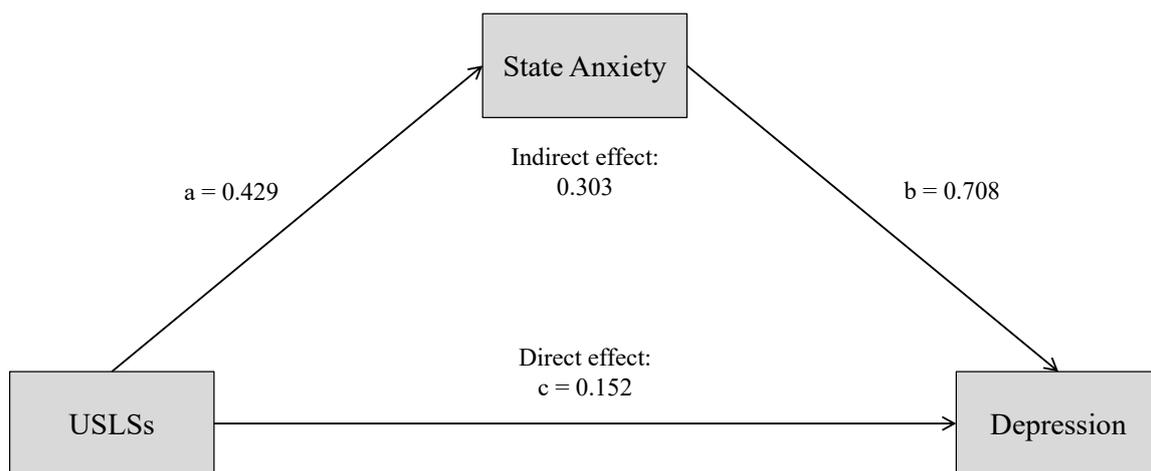
Age was not included as a covariate, as the Spearman's correlation with depression was weak and not significant (see Table 3-4). The distributions of the depression scores by sex were similar, as determined by visual inspection. Thus, the dataset qualified for the Mann-Whitney U test, which revealed that sex made a significant difference with respect to depressive symptoms (female mean rank of 89.72, male mean rank of 69.21, $p < .05$). Consequently, only sex was included as a covariate in the mediation and moderated mediation models.

Using PROCESS model 4, depression was the independent variable, USLSs was the dependent variable, state anxiety was the mediator, and sex was a covariate (see Figure 3-2).

All associations in this model (direct, indirect, and each indirect path leg) were statistically significant. The total effect of USLSs on depression was 0.456, of which 0.152 was attributable to the direct effect (USLSs-depression relationship) and 0.303 to the indirect effect (USLSs-state anxiety-depression relationship). The indirect legs had effect sizes of 0.429 (USLSs-state anxiety) and 0.708 (state anxiety-depression). For example, if Student B has an USLSs score 10 points higher than Student A, with an effect size of 0.456 in the association between USLSs and depression, Student B is likely to have a depression score 4.56 points higher than Student A.

Figure 3-2

Process Model 4



Note. Sex was used as a covariate.

3.4.4 Hypothesis 4: Trait anxiety moderates the extent of the influence of USLSs on state anxiety in the indirect association of USLSs and depression

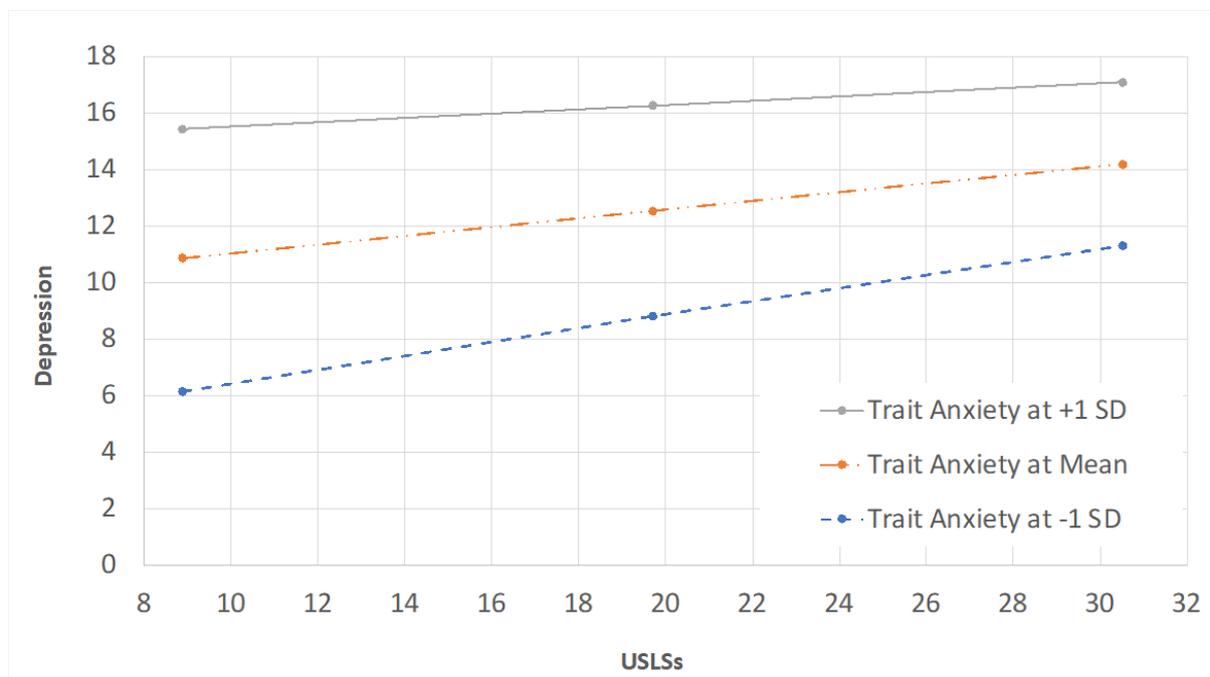
Using PROCESS model 8, trait anxiety was added as a moderator of the direct relationship between USLSs and depression and the association between USLSs and state anxiety (first leg of the indirect path). This model was rejected, as the direct path, the first leg of the indirect path, and both interaction terms were not statistically significant. Using PROCESS model 15, trait anxiety was again added as a moderator, but this time trait anxiety

acted as a moderator of the direct relationship and the association between state anxiety and depression (the second leg of the indirect path; see Figure 3-3).

For those scoring around the mean in trait anxiety, the total effect of USLSs on depression was 0.299, of which 0.153 was attributable to the direct effect (USLSs-depression relationship) and 0.146 to the indirect effect (USLSs-state-anxiety-depression relationship). The direct (unmediated) association between USLSs and depression was significant except for students with trait anxiety scores at one standard deviation above the mean or more. The first leg of the indirect effect (USLSs-state-anxiety relationship) showed a significant coefficient of 0.429. The second leg of the indirect association (state-anxiety-depression relationship) revealed a positive association of 0.339 and was significant except for a subset of individuals scoring at or below one standard deviation below the mean in trait anxiety (see Figure 3-3).

Figure 3-3

Interaction Effect Between USLSs and Trait Anxiety on Depression

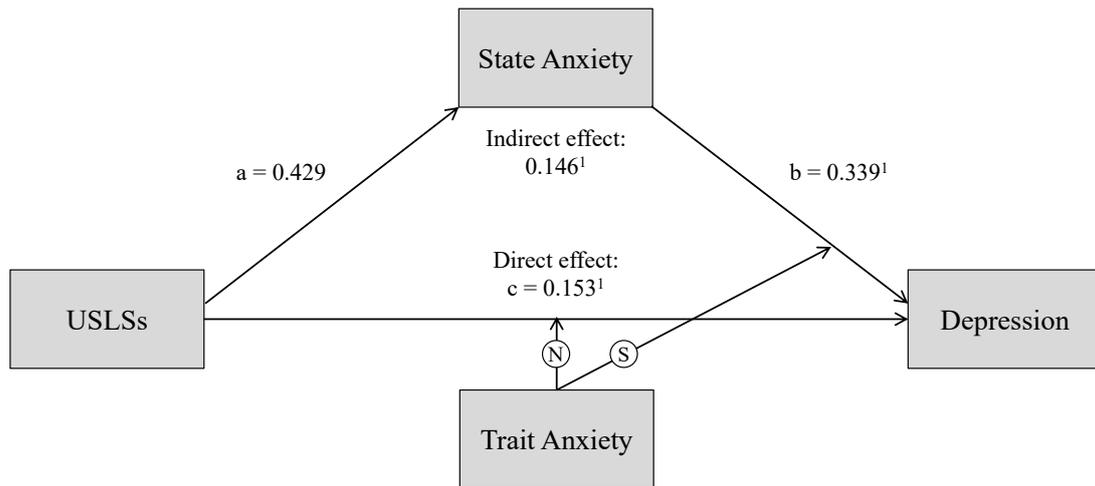


Overall, trait anxiety had a significant moderating effect on depression when interacting with state anxiety (see Figures 3-4 and 3-5). As a result, the indirect effect of 0.146 for students scoring at the mean in trait anxiety decreased to 0.062 for those with trait anxiety scores at one

standard deviation below the mean and increased to 0.229 for those with trait anxiety levels at one standard deviation above the mean. However, overall trait anxiety was not a significant moderator in the direct relationship between USLSs and depression (see Figure 3-6).

Figure 3-4

Moderated Mediation: PROCESS Model 15



¹ Effect size shown at the mean level of trait anxiety.

Gender was used as a covariate.

Ⓢ Interaction effect is significant. Ⓝ Interaction effect is not significant.

Note. Adapted from Hayes (2018).

Figure 3-5

Interaction Effect Between State Anxiety and Trait Anxiety on Depression

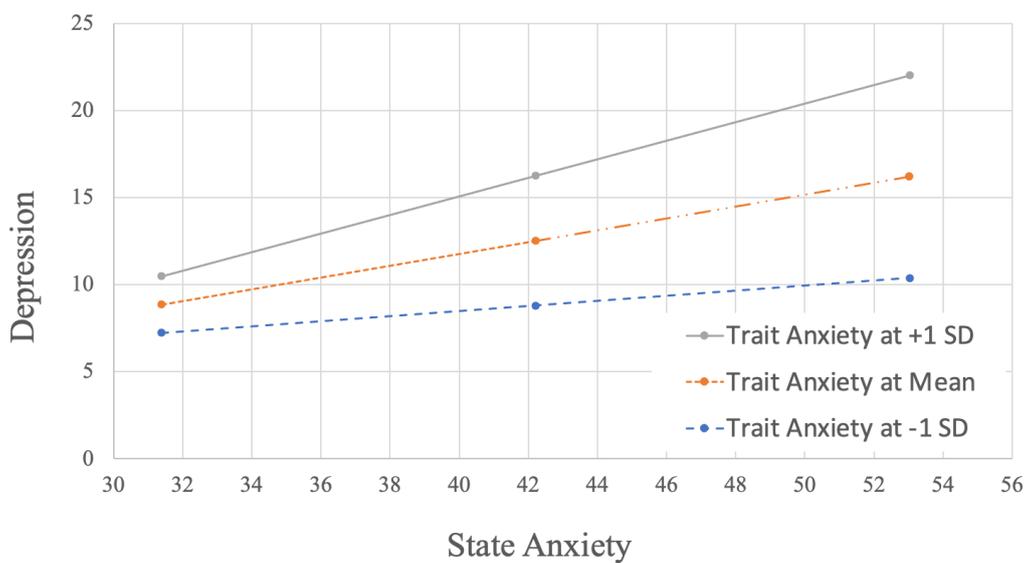
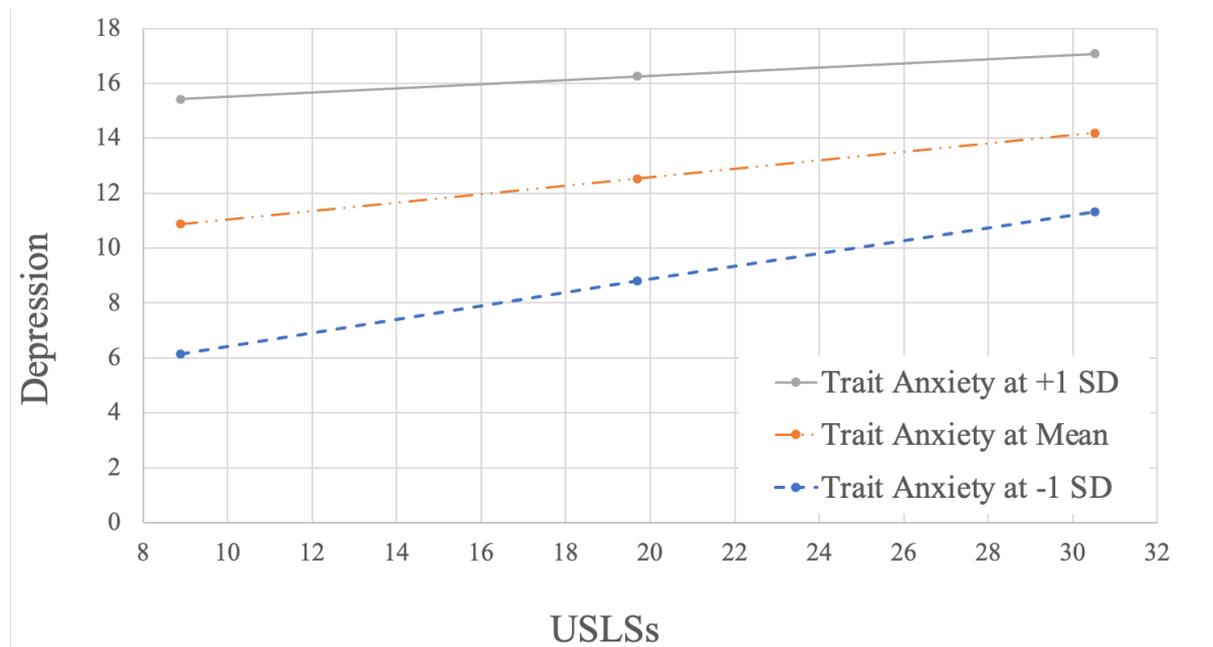


Figure 3-6

Interaction Effect Between USLSs and Trait Anxiety on Depression



3.5 Discussion

3.5.1 Statement of major findings

First-year university students find themselves in a challenging and unfamiliar environment. Exposure to numerous stressors may lead to mental health problems such as anxiety and depression. The aim was to advance the understanding of the relationship between USLSs, state and trait anxiety and depression in first-year university students. Therefore, this study investigated the extent of distress and considered a potential relationship between USLSs, state anxiety and depressive symptoms while accounting for trait anxiety as a risk factor in this process.

3.5.1.1 Hypothesis 1

It was hypothesized that first-year undergraduate students show high levels of USLSs, anxiety, and depression. Consistent with predictions and in support of findings from previous studies, students showed concerning levels of life stress, state anxiety, trait anxiety, and depression. Regarding recently experienced life stressors, first-year undergraduate students at

the University of Westminster reported similar high degrees of USLSs as previous studies (e.g., Sloan, 2015). For anxiety, 53% reported state anxiety higher than the suggested clinical cutoff of 40% (Addolorato et al., 1999), and 58% reported clinical levels of trait anxiety with the same clinical cutoff. The percentage of students reporting clinical levels of state and trait anxiety was in line with Franzoi et al. (2020). Compared to studies relying on other measurement tools (e.g., Gulec Oyekcin et al., 2017; Shah et al., 2020; Wörfel et al., 2016), the percentage of students reporting clinical levels of anxiety was higher in this study. Given the thresholds retained by Beck et al. (1996), 78% of the sample could be considered “not depressed,” 11% mildly depressed, and 11% severely depressed (score of 20 or more). These findings are in line with previous studies investigating depression prevalence in undergraduate university students (de Sá Junior et al., 2018; Villatte et al., 2017).

It could be beneficial to replicate this study in a late adolescent sample from the general population, as the prevalence of SLEs, anxiety, and depression may differ. Given that undergraduate students in the social sciences and humanities are at high risk for mental health problems (Naseem & Munaf, 2017), this study focused on undergraduate psychology students. However, it could be valuable to replicate this study for graduate and postgraduate students, who are also at risk for mental health problems (Evans et al., 2018; Hazell et al., 2020).

3.5.1.2 Hypothesis 2

The findings support the second hypothesis, which states exposure to USLSs is positively related to levels of anxiety and symptoms of depression. This study found that students who reported high USLSs had greater levels of anxiety and depression than those who experienced few USLSs. This finding is in line with Schofield et al. (2016), who suggested high levels of anxiety and depression in students reflect prolonged exposure to SLEs. In line with the literature, this study’s findings implicate that exposure to USLSs is strongly associated

with symptoms of anxiety and depression in undergraduate students (Doyle et al., 2021; Ramón-Arbués et al., 2020).

For the hypothesized covariates, sex played a significant role in the manifestation of depressive symptoms. In line with Ghaedi and Mohd Kosnin (2014) and contradictory to Gao et al. (2020), females had higher depression levels than males. Contrary to earlier studies (e.g, Gao et al., 2020), no sex differences regarding symptoms of anxiety and reports of life stress were found in this study.

3.5.1.3 Hypothesis 3

Regarding the third hypothesis that state anxiety mediates the impact of USLSs on the occurrence of depressive symptoms, the mechanisms underlying the relationship between SLEs and depressive symptoms are beginning to be understood, with anxiety playing a mediating role in the stress-depression relationship. In other words, anxiety helps explain how exposure to life stressors translates into feelings of depression. Given that undergraduate university students are exposed to many USLSs and report high levels of depression, the third hypothesis addressed the extent to which state anxiety helped explain how USLSs translate into depression.

Mediation analysis revealed that the effect of USLSs on depressive symptoms was partially exerted via state anxiety levels. Consistent with extant studies, anxiety also linked the relationship between life stress and depression (Anyan et al., 2017, 2018; Ghorbani et al., 2008; Havnen et al., 2020; Kok et al., 2016), supporting that symptoms of anxiety precede subsequent development of depression (Batterham et al., 2013; Price et al., 2016). In line with these studies, anxiety only partially mediated the USLSs-depression relationship, as the unmediated association between USLSs and depression remained significantly positive. In other words, some students developed depressive symptoms without experiencing elevated anxiety levels. This finding supports that depression can be divided into two qualitatively different categories

(with and without anxiety; Maes et al., 1994) and adds to the literature, demonstrating that this classification exists in the subclinical population.

The Perceived Stress Scale, Stressful Negative Life Events Questionnaire, and Adolescent Stress Questionnaire assess the stress-anxiety-depression relationship in undergraduate students (Anyan et al., 2017, 2018; Ghorbani et al., 2008). Thus, study results support and extend previous findings by demonstrating that exposure to USLSs is associated with anxiety and depression, as observed when measured with other instruments that assess life stress and physiological symptoms. The USQ in this study is a useful instrument to investigate stress-related anxiety and depression in an undergraduate student population.

3.5.1.4 Hypothesis 4

When investigating the fourth hypothesis that trait anxiety moderates the extent of the influence of USLSs on state anxiety in the indirect association of USLSs and depression, trait anxiety did not significantly interact with USLSs to predict state anxiety (first path of the indirect effect), as USLS-related state anxiety was not dependent on students' trait anxiety. When exposed to USLSs, many students experienced state anxiety independent of their anxious personality type. This finding directly supports the view that state anxiety is a temporary natural human response to a threat for which a person does not need to have an underlying anxiety condition (Hutchins & Young, 2018).

Although not originally hypothesized, a post hoc analysis was also conducted to explore whether (a) state anxiety interacts with trait anxiety to predict depression (the second leg of the indirect path); and (b) USLSs interact with trait anxiety to predict depression (direct path). Path analysis revealed that when exposed to stress-related state anxiety, students with elevated trait anxiety were at an increased risk of experiencing comorbid depressive symptoms. This result is intriguing for several reasons. First, the finding that high trait anxiety students are at an increased risk for depression and low trait anxiety students at a decreased risk adds to the

research on depression and anxiety comorbidity (e.g., Starr et al., 2016). Second, the finding that trait anxiety is a moderator in the stress-anxiety-depression relationship with state anxiety as a mediator shows that the processes underlying the stress-depression relationship are more complex than previously suggested (Anyan et al., 2017, 2018; Ghorbani et al., 2008; Havnen et al., 2020; Kok et al., 2016).

Comparing the regions of significance for the two interactions stated above, for individuals scoring high in trait anxiety, the indirect effect (state anxiety affecting depression as a mediator and interacting with trait anxiety to affect depression) had higher explanatory power than the direct path. Conversely, for those scoring low in trait anxiety, the direct path (USLSs affecting depression directly and interacting with trait anxiety to affect depression) had higher explanatory power than the indirect path.

3.5.2 Suggestions for interventions

The study results demonstrated that students with anxious personality characteristics are at a specific depression risk when exposed to USLS-related feelings of anxiety. Universities should identify students with high trait anxiety early after entering university and actively offer interventions proven to reduce stress and anxiety, such as mindfulness training or muscle relaxation (Arianti & Novera, 2019; Dolbier & Rush, 2012; Garland et al., 2017; Liu et al., 2019). This strategy may help students with anxious personality characteristics from developing comorbid depressive symptoms.

3.5.3 Limitations and future directions

Limitations are in line with the general thesis limitations and are covered in the overall discussion in Chapter 7. When exploring models with anxiety as a mediator of the stress-depression relationship, future research studies should consider state anxiety as a mediator and trait anxiety as a moderator.

3.5.4 Conclusion

Study findings confirm a high prevalence of psychological distress among first-year university students. Accordingly, while some students have USLS-related depressive symptoms without experiencing state anxiety, others experience both USLS-related anxiety and depression. In addition, other students presenting with USLS-related anxiety show depressive symptoms dependent on their trait anxiety level (medium and high but not low). By identifying trait anxiety as a moderator in the relationship between USLSs and depression mediated by state anxiety, this study clarified inconsistencies in the literature on the role of trait and state anxiety in the stress-depression relationship. Finally, findings extend the literature on stress-related anxiety and depression by suggesting that similar to other SLEs, USLSs predict students' anxiety and depression.

As a risk factor associated with USLSs, state anxiety, and depression, trait anxiety among first-year undergraduate students should be identified as early as possible to provide a range of mental health support and prevent exacerbation of associated mental health problems. This study demonstrated that incoming university students with anxious personality characteristics are at an increased risk of stress-related state anxiety and depression. Other personality characteristics among students may increase the risk of USLS-related state anxiety and depression. Study 2 investigates if first-year students who do not find pleasure in rewarding stimuli (such as social interactions) due to introversion are at an increased risk for USLS-related state anxiety and depression.

4 Trait anhedonia: A risk factor for USLS-related anxiety and depression in first-year university students (Study 2)

4.1 Introduction

First-year undergraduate students often leave behind their families and friends when attending university. They leave their familiar surroundings and find themselves in a new, challenging environment. This abrupt change can leave students feeling disoriented, overwhelmed, and stressed during their first year of studies. The situation becomes even more pronounced for those who struggle to fit in and make new friends due to a lack of social skills and competence (Llerena et al., 2012; Stichter et al., 2011). The inability to build a new social network at university may result in loneliness, leading to anxiety and depression (Eisenberg et al., 2021). This issue can have long-term effects on their academic performance and lead to long-term mental health problems. For this reason, it is crucial for universities to understand the risk factors for USLS-related anxiety and depression among students who struggle socially. Students who engage less with social contacts due to a personality predisposition may be at an increased risk of stress-related anxiety and depression.

Anhedonia is a reduced or absent ability to experience pleasure or loss of interest in response to rewarding stimuli (Pelizza & Ferrari, 2009). Based on a deficient reward processing mechanism (Enneking et al., 2018; Höflich et al., 2019), anhedonia results in reduced motivation to engage in rewarding stimuli (Bryant et al., 2017). Anhedonia has been put forward as a primary symptom of major depression (e.g., Edwards & Koob, 2011) and a personality trait that contributes to a vulnerability to developing anxiety, depression, and schizophrenia (Loas, 1996; Mason et al., 2005). Although previously measured as a state (transient) or trait (stable) construct (Loas et al., 2009), trait anhedonia has gained momentum in recent years. A reduction in hedonic capacity in anhedonia is an enduring trait in the

nonclinical population (Chan et al., 2012), which may predict the development of later psychopathologies (Kendall et al., 2015), such as anxiety and depression.

Stress can play a significant role in the development of anhedonia. Both early life stress and chronic stress (e.g., through social isolation) seem to increase anhedonia (Acero-Castillo et al., 2021; Bolton et al., 2018) in vulnerable individuals (Prakash et al., 2020). There is also evidence that individuals with high levels of anhedonia have a lower stress threshold (Fortunati et al., 2015), placing them at an increased risk for stress-related anxiety and depression.

The literature on the connection between anhedonia and stress-related anxiety and depression is sparse. However, one study by Winer et al. (2017) investigated the mediating effect of state anhedonia on the relationship between anxiety and depression. They reported that state anhedonia partially mediates the relationship between anxiety and depression over time. In conclusion, they found anxiety may translate into depression through anhedonia. This finding may lead to a more nuanced understanding of the role of state anhedonia in the manifestation of anxiety-related depression. However, the authors provided little evidence as to whether individuals with high trait anhedonia are at an increased risk of experiencing anxiety and anxiety-related depression. Furthermore, Winer et al. (2017) did not consider stress as a process by which anxiety and anhedonia translate into depression. No study to date has examined whether individuals with high trait anhedonia are at an increased risk for stress-related anxiety and depression.

Chapter 3 established that trait anxiety is a moderator of the second leg of a mediation model, with USLSs as the predictor, state anxiety as the mediator, and depression as the outcome variable. As such, trait anxiety constitutes an elevated risk that students who experience state anxiety under stressful life conditions will present with comorbid depression. This study investigated whether trait anhedonia, another personality characteristic, constitutes

a risk factor for first-year university students to experience USLS-related anxiety and depression.

Although SLEs and anhedonia are risk factors for state anxiety and depression, no study has examined their interrelationship in the manifestation of state anxiety and depression. This study investigated how direct, indirect, and conditional factors contribute to depression among students to understand the role of state anxiety and trait anhedonia in the USLSs-depression relationship.

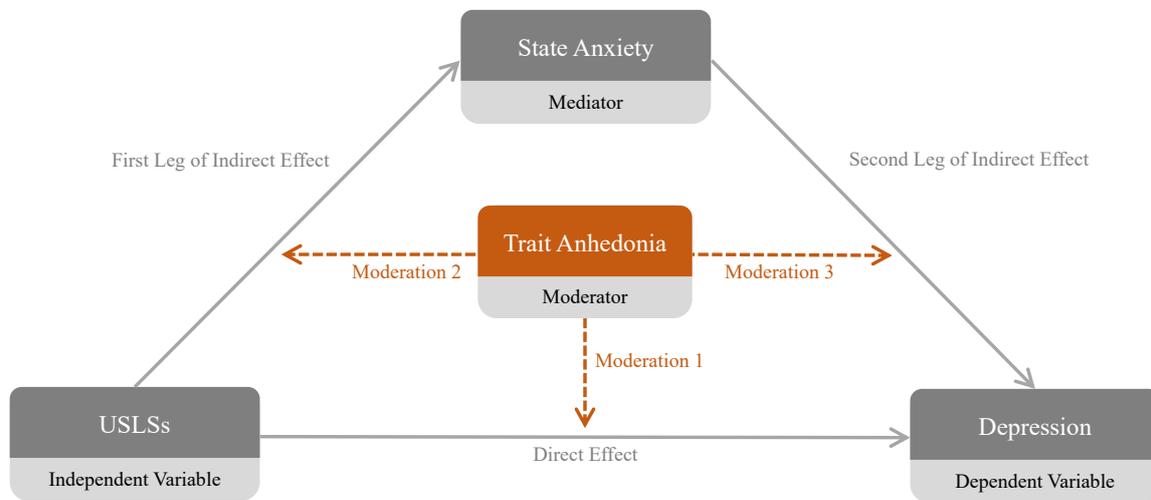
Based on Study 1 findings, state anxiety mediates the relationship between USLSs and depression and anhedonia levels buffer or promote the negative effect of USLSs on state anxiety and depression. The specific hypotheses for this study are as follows:

1. Trait anhedonia is positively associated with USLSs, state anxiety, and depressive symptoms.
2. Trait anhedonia moderates the association between USLSs and state anxiety (i.e., the first leg of the indirect relationship between USLSs and depressive symptoms).
3. Trait anhedonia moderates the association between state anxiety and levels of depression (i.e., the second leg of the indirect effect between USLSs and depressive symptoms).
4. Trait anhedonia moderates the direct effect between USLSs and depression.

A moderated mediation model was tested with USLSs as the predictor variable, depression as the outcome variable, state anxiety as the mediator, and trait anhedonia as the moderator of the direct and both legs of the indirect path (see Figure 4-1).

Figure 4-1

Hypothesized Moderated Mediation Model: PROCESS Model 59



4.2 Materials and methods

4.2.1 Participants

Similar to Study 1, 171 first-year undergraduate students from the University of Westminster (140 females; 31 males) participated in this study. Details about participant recruitment, the provision of informed consent, and procedures are similar across studies and described in the framework of this thesis (see pp. 44–45).

4.2.2 Measures

All participants completed three questionnaires (USQ, BDI, and STAI) and reported their sex and age (see Chapter 2 for further details about these questionnaires and the data collection process). In addition, they completed the trait anhedonia subscale of the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason et al., 1995), a self-report assessment tool including 25 items describing a lack of pleasure from social and physical sources as well as an avoidance of intimacy. The scale has a dichotomous response format. Cross-sectional questionnaires and neurocognitive and psychophysiological studies support the psychometric validity of O-LIFE subscales (Burch et al., 1998; Mason et al., 1995). Specifically, the Introvertive Anhedonia (IA) subscale of the Oxford-Liverpool Inventory of

Feelings and Experiences (O-LIFE) display excellent internal consistency with a reported Cronbach's Alpha of .85, indicating a high degree of reliability (Mason et al., 2005).

4.3 Statistical analysis

The first hypothesis was tested using Spearman's rank-order correlation for associations between trait anhedonia and (a) USLSs, (b) state anxiety, and (c) depression. The remainder of the hypotheses were tested using model 59 from the PROCESS macro by A. Hayes with identical parameters regarding the number of bootstraps, confidence intervals, and the bias correction methodology (see Figure 4-1). The model is a moderated mediation similar to what was tested in Chapter 3, with the main difference being that trait anhedonia is a moderator of the direct and indirect relationship between USLSs and depression levels.

4.4 Results

The study sample was identical to Chapter 3, with the exception that anhedonia was included as a moderating variable. Based on the previous findings, sex was used as a covariate.

4.4.1 Hypothesis 1: Trait anhedonia is positively associated with USLSs, state anxiety, and depressive symptoms

Participants reported a mean level of trait anhedonia of 8.45 ($SD = 4.64$). The distribution had a range of 23 and showed an above-normal standardized skewness of 3.83 and normal kurtosis. The Mann-Whitney U test revealed no significant sex difference with respect to anhedonia. Trait anhedonia was positively correlated with state anxiety ($r = 0.398$; $p < .01$) and depression ($r = 0.394$; $p < .01$) but not with USLSs.

4.4.2 Hypothesis 2: Trait anhedonia moderates the association between USLSs and state anxiety (i.e., the first leg of the indirect relationship between USLSs and depressive symptoms)

The moderated mediation analysis used to test hypotheses 2 to 4 revealed a total effect size between USLSs and depressive symptoms of 0.390 (measured at mean levels of trait

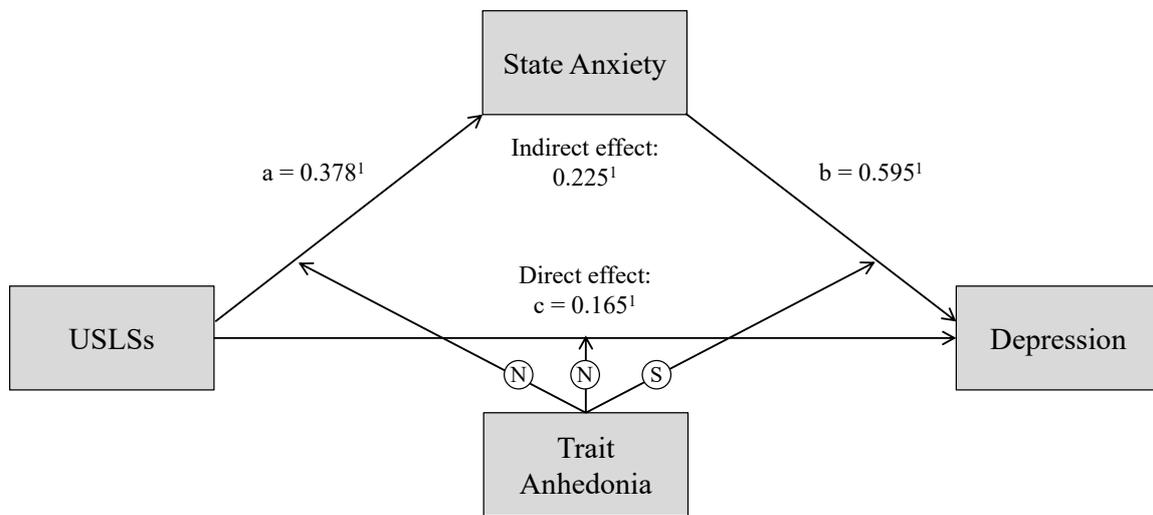
anhedonia), of which 0.165 was attributable to the direct and 0.225 to the indirect effect. The effect size of the first and second leg of the indirect association was 0.378 and 0.595, respectively. The analysis of Hypothesis 3 showed that USLSs did not significantly interact with trait anhedonia to affect state anxiety. The bootstrapped confidence interval with a two-tailed probability of 95% had a lower and upper boundary at -0.007 and 0.073, respectively. As the interval contained the value zero, the interaction was not significant. However, the distribution of bootstrapped coefficients is skewed to the positive side of zero.

4.4.3 Hypothesis 4: Trait anhedonia moderates the association between state anxiety and levels of depression (i.e., the second leg of the indirect effect between USLSs and depressive symptoms)

The model showed that the hypothesized interaction effect was significant, with a coefficient of 0.028. Despite the rejection of Hypothesis 2, the indirect association between USLSs and depression moderated by trait anhedonia was significant for all measured levels of trait anhedonia. It ranged from 0.104 for individuals with trait anhedonia levels one standard deviation below the mean to 0.387 for those one standard deviation above the mean. It also confirms that the interaction of USLSs with trait anhedonia, despite not being significant, was strong enough to maintain the significance of the entire indirect path (see Figures 4-2 and 4-3).

Figure 4-2

Moderated Mediation: Process Model 59

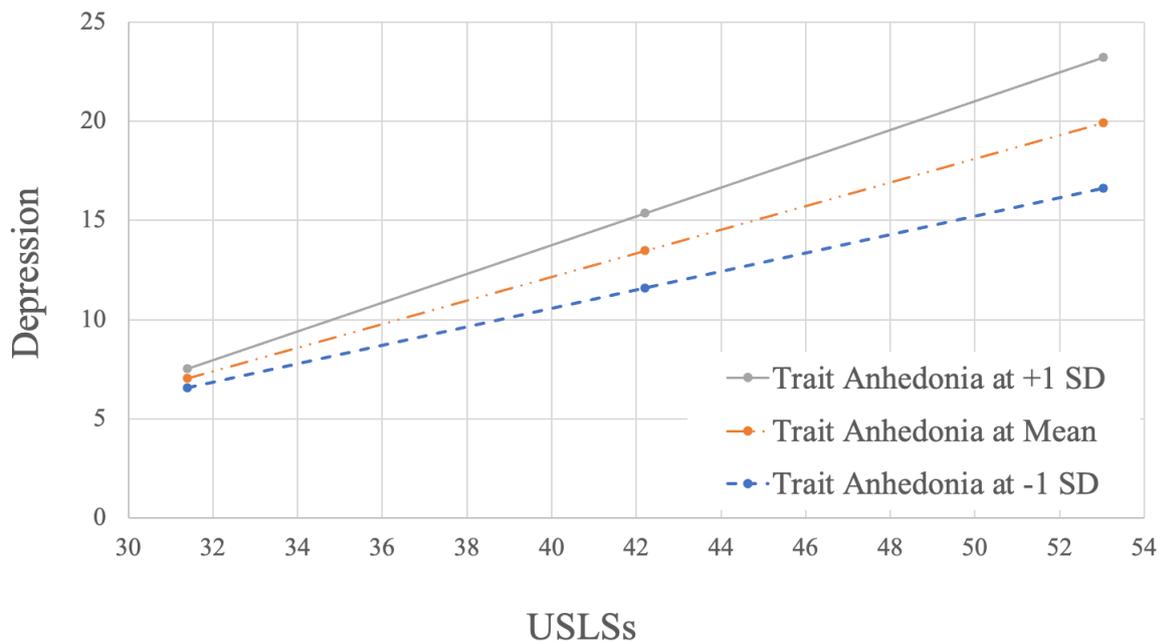


¹ Effect size shown at the mean level of trait anhedonia.
 Gender was used as a covariate.
 (S) Interaction effect is significant. (N) Interaction effect is not significant.

Note. Adapted from Hayes (2018).

Figure 4-3

Interaction Effect Between USLSs and Trait Anxiety on Depression



4.4.4 Hypothesis 5: Trait anhedonia moderates the direct effect between USLSs and depression

The moderation of the direct association between USLSs and trait anhedonia was not significant. The bootstrap boundaries for the coefficient were -0.012 and 0.045. The conditional direct relationship was still significant for certain regions of trait anhedonia. For participants with trait anhedonia scores at the mean or higher, the direct association between USLSs and depressive symptoms was significant, with effect sizes of 0.165 for mean levels of anhedonia and 0.241 for those scoring at one standard deviation above the mean.

4.5 Discussion

4.5.1 Statement of major findings

Study 3 findings were extended by exploring the role of trait anhedonia as a risk factor in the relationship between USLSs, state anxiety, and depression. A moderated mediation approach was used to investigate whether students with high trait anhedonia are at an increased risk of USLSs related to state anxiety and depression. It was assessed whether trait anhedonia moderated the direct relationship between USLSs and depression and both legs of the indirect relationship mediated through state anxiety.

4.5.1.1 Hypothesis 1

In contrast to the first hypothesis that trait anhedonia has a positive association with USLSs, state anxiety, and depressive symptoms, trait anhedonia levels were not significantly associated with the number of self-reported USLSs. Given that the literature suggests early life and chronic stress promote anhedonia and that individuals with high anhedonia levels have a lower stress threshold, this was an unexpected finding. An explanation for this finding may lie in the measurement tools used in this study. First, some USQ items assess psychosocial stressors (e.g., arguments, conflicts between friends, relationship breakups). Individuals with high trait anhedonia typically experience a lack of pleasure from social sources and tend to

avoid intimacy. Therefore, anhedonic students may have fewer interactions, limiting the psychosocial stress that can result. A measurement tool with greater emphasis on psychosocial life stressors, such as financial and transportation problems or general health issues, may have yielded different results.

As hypothesized and in support of previous research studies, trait anhedonia positively correlated with state anxiety and depression levels in students. The strength of the association between USLSs and state anxiety was slightly higher, and the association between USLSs and depression was slightly lower than in previous studies (Liao et al., 2019; Premkumar et al., 2020). However, the differences were minimal and may be attributed to the different measurement tools used to assess SLES, anxiety, and depression among studies.

4.5.1.2 Hypothesis 2

The study's findings did not validate the second hypothesis, which proposed that trait anhedonia would moderate the relationship between USLSs and state anxiety—the initial link in the indirect relationship between USLSs and depressive symptoms when accounting for all anhedonia levels. This finding challenges the previously suggested theory that anhedonia can amplify anxiety under stressful life conditions (Grillo, 2016; Pizzagalli, 2014). However, while the hypothesis was not validated, a trend toward significance was observed. Furthermore, the dataset in this study was relatively small. Consequently, exploring a larger dataset could reveal a more pronounced moderating effect of USLSs and anhedonia on state anxiety. Further studies that use larger datasets could provide more definitive insight into the potential moderating effect of anhedonia on the relationship between USLSs and state anxiety.

4.5.1.3 Hypothesis 3

The third hypothesis focused on the role of trait anhedonia as a moderator in the association between state anxiety and levels of depression—the second leg of the indirect effect between USLSs and depressive symptoms. The statistical analysis revealed that trait

anhedonia had a significant moderating effect on the association between state anxiety and depression. This finding suggests that students scoring at elevated trait anhedonia levels experienced higher levels of USLS-related state anxiety-induced depression. As such, high trait anhedonia levels may promote the adverse effects of USLSs on the development of state anxiety-related depression, while low levels may act as a buffer. These findings add to the literature investigating anxiety-depression comorbidity, as trait anhedonia may be a personality factor that codetermines whether an individual only experiences state anxiety or both state anxiety and comorbid depressive symptoms.

4.5.1.4 Hypothesis 4

The fourth hypothesis focused on the role of trait anhedonia as a moderator in the association between USLSs and depression)—the direct effect between USLSs and depressive symptoms. Findings indicate that trait anhedonia significantly affects this link for students with average or high anhedonia levels, increasing their depressive symptoms. However, this was not the case for students with low anhedonia levels. Overall, the conditional effect of anhedonia on the direct was weaker than on the indirect path. This effect represents a notable finding regarding the role of state anxiety in manifesting USLS-related depressive symptoms. Trait anhedonia plays a minor role in the manifestation of USLS-related depression in the absence of state anxiety, suggesting that students who show depression without comorbid anxiety are less affected by their respective trait anhedonia level. This finding also implies that students who experience state anxiety and anhedonia are specifically vulnerable to USLS-related depression.

4.5.2 Suggestions for interventions

Individuals with anhedonia tend to have deficits in social functioning and an associated lack of social support. However, social support is a critical protective factor in mental health, directly through the benefits gained from social interactions and indirectly as a buffer against

SLEs (Gariépy et al., 2016). A lack of social support is a strong predictor of depression among university students (Alsubaie et al., 2019).

Social skills interventions can increase the frequency of social interaction and (Dodell-Feder & Germine, 2018) elevate negative moods (Shayan & Ahmadi Gatab, 2012). Therefore, students with high trait anhedonia may specifically benefit from interventions aimed at improving social skills, resulting in increased social support that buffers the effect of USLSs on depression. Such interventions could include targeted social skills workshops to help students create social connections with their peers and build a sense of belonging. These workshops may help students develop deficient integral social processes, including self-awareness, the perception and understanding of self and others, emotional regulation, self-compassion, and interpersonal communication skills (Barkus & Badcock, 2019; Garland et al., 2017; Morin, 2011; Wibowo et al., 2022). Over time, improved social skills could make interactions more enjoyable, and perceived rewards would increase hedonic capacity, simultaneously leading to a greater motivation to engage socially. Targeting anhedonia in the context of prevention and intervention complements existing intervention efforts.

4.5.3 Limitations and future directions

The main limitation of this study was a reliance on an overall score of trait anhedonia based on the introverted anhedonia subscale of O-LIFE. Additional studies are needed to provide insight into how distinct aspects of trait anhedonia (e.g. physical, social and consummatory) may affect the relationship between USLSs, anxiety, and depression. Global limitations to this thesis are covered in Chapter 7 for the overall discussion.

4.5.4 Conclusion

This study uncovered the role of anhedonia in USLS-related anxiety and depression among first-year university students. These findings add evidence to anhedonia as a trait-like predictor of a vulnerability to stress-related anxiety and depression (e.g., Pizzagalli, 2014).

Previous literature searches have not identified reports of trait anhedonia as a susceptibility factor for USLS-related state anxiety and depression. By demonstrating a moderating effect of anhedonia on the relationship between USLS-related state anxiety and depression, these findings clarify and extend the literature on the role of anhedonia in affective disturbances. The study findings go beyond previous reports, showing that a student's level of trait anhedonia constitutes a risk factor for state anxiety-related depression and that students with mean and high levels but not low levels of anhedonia were at an increased risk for USLS-related depression.

Furthermore, by demonstrating that anhedonia had a larger effect on the indirect relationship between USLSs and depression (mediated by state anxiety), the study findings suggest anxious students are at specifically high risk for depression when they also present with high trait anhedonia. By identifying trait anhedonia as a susceptibility factor, these findings represent an essential step forward in explaining the mechanisms by which USLSs lead to affective disturbances among first-year university students. From a practical standpoint, these findings indicate that students who do not engage with others or participate in social activities due to anhedonic tendencies may be at a greater risk of developing anxiety-related depression. Other factors may increase the risk of USLS-related state anxiety and depression. Study 3 investigates if first-year students with poor sleep quality are at an increased risk of USLS-related state anxiety and depression.

5 Poor sleep quality: A risk factor for USLS-related anxiety and depression in first-year university students (Study 3)

5.1 Introduction

When moving away from their family, first-year university students encounter a period of adaptation to a new environment. They also undergo psychological challenges as they transition from a more structured environment in high school to independence and autonomy at university. This abrupt autonomy over the self presents numerous challenges (Arnett, 2000), such as separation from family and home, changes in social relationships, financial strains, academic hurdles, and restructuring responsibilities and activities. This challenging situation may result in emotional and physical turmoil, affecting their sleep quality and mental and physical health.

First-year undergraduate students living on campus may be particularly susceptible to sleep disruption due to their sleeping habits. Many students shift from preset sleeping to sharing accommodations with roommates, contributing to a noisier environment due to opportunities to socialize until late (Foulkes et al., 2019). The first year at university also involves new academic challenges, creating social connections, and often taking on part-time jobs. Essential elements of new students' lives are often compromised due to poor sleep hygiene. A disruptive environment that does not promote consistent, uninterrupted sleep and a disordered daily schedule can significantly impact sleep quality. Therefore, sleep quality may be at risk when students start university as they adjust to new life circumstances.

Poor sleep quality is strongly associated with psychological and physiological health and well-being among university students (Pilcher & Ott, 1998). Lund et al. (2010) found that 25% of first-year university students are sleep deprived, reporting less than 6 hours of sleep, which is far less than the National Sleep Foundation's recommended 8.5 hours of sleep for optimal functioning (Hirshkowitz et al., 2015). In addition, Aldhawyan et al. (2020) reported

the prevalence rate of poor sleep among first-year university students to be as high as 75%. Poor sleep quality can adversely affect a student's physical and mental health and academic performance, further impacting their mental health and quality of life, both during and after university (Chen & Chen, 2019; Dinis & Bragança, 2018; Hagedorn et al., 2021).

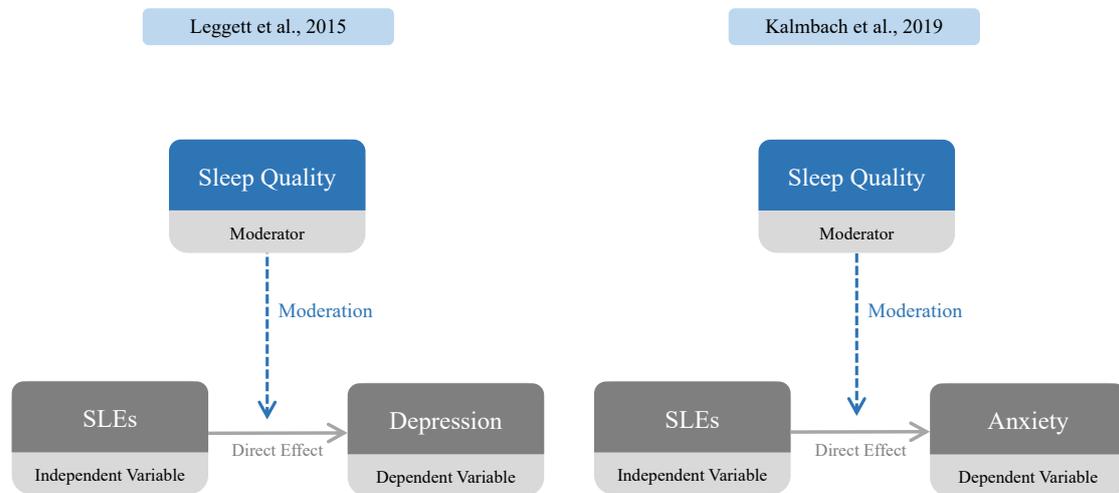
SQ and negative emotional states

University students' exposure to SLEs is positively associated with poor sleep quality (Lee et al., 2013; Li et al., 2019), especially when combined with caffeine intake (Sawah et al., 2015; Simon et al., 2022). Furthermore, poor sleep quality plays a role in the manifestation of anxiety and depression among different age groups of the general population (e.g., Baglioni et al., 2011; Orchard et al., 2020; Simon et al., 2019; van Mill et al., 2010) and specifically in university students (Al-Khani et al., 2019; Li et al., 2020). Although the associations between SLEs, anxiety, depression, and sleep quality are complex and most likely bidirectional, there is strong evidence that stress precedes poor sleep quality (Åkerstedt et al., 2012; Da Estrela et al., 2021) and that poor sleep quality precedes anxiety and depression (Baglioni et al., 2011; Da Estrela et al., 2021; Kalmbach et al., 2015). Thus, sleep quality may be a risk factor for anxiety and depression, especially when combined with SLEs.

Moderation analysis is one method for identifying vulnerability and resilience factors in life event research. Studies using a moderation approach to establish whether individuals with poor sleep quality have an elevated susceptibility to SLE-related anxiety and depression have reported a significant positive moderation effect of sleep quality on these single associations (see Figure 5-1; Kalmbach et al., 2015; Leggett et al., 2016).

Figure 5-1

Illustration of Findings by Leggett et al. (2016) and Kalmbach et al. (2015)

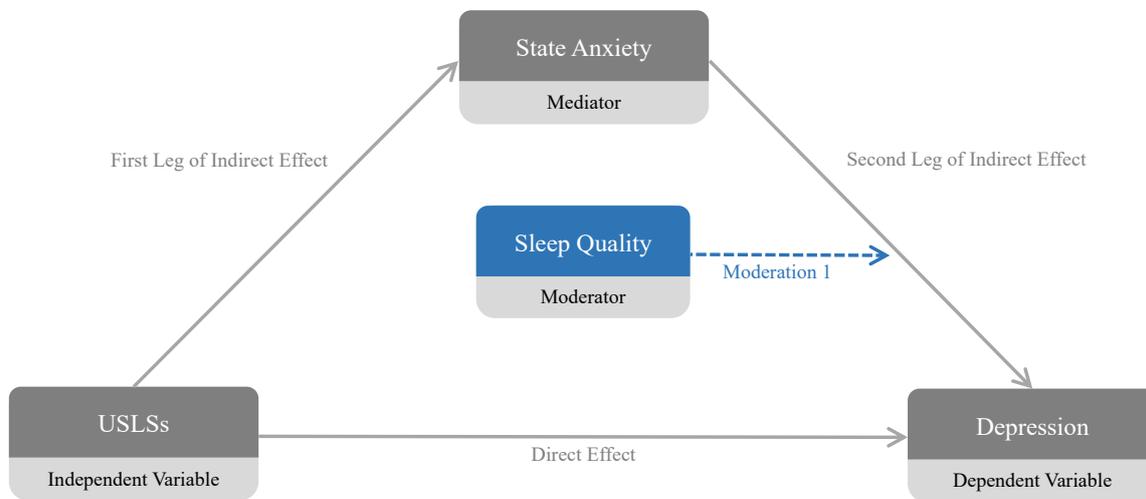


These findings suggest that sleep quality is a primary vulnerability factor for SLE-related anxiety and depression. However, they are restricted to the moderation of single relationships, as the effect of sleep quality on the combined conditional direct and indirect associations between SLEs, anxiety, and depression was not considered. When considering sleep quality in isolation (moderating a single relationship), its impact may be overemphasized.

One possibility is to explore the impact of sleep quality on the direct and indirect relationships between SLEs, anxiety, and depression in a moderated mediation model, with SLEs as the predictor variable, depression as the outcome variable, and anxiety as the mediator. Only one study thus far has explored the moderating effect of sleep quality in such a model (see Figure 5-2; Ho, 2021).

Figure 5-2

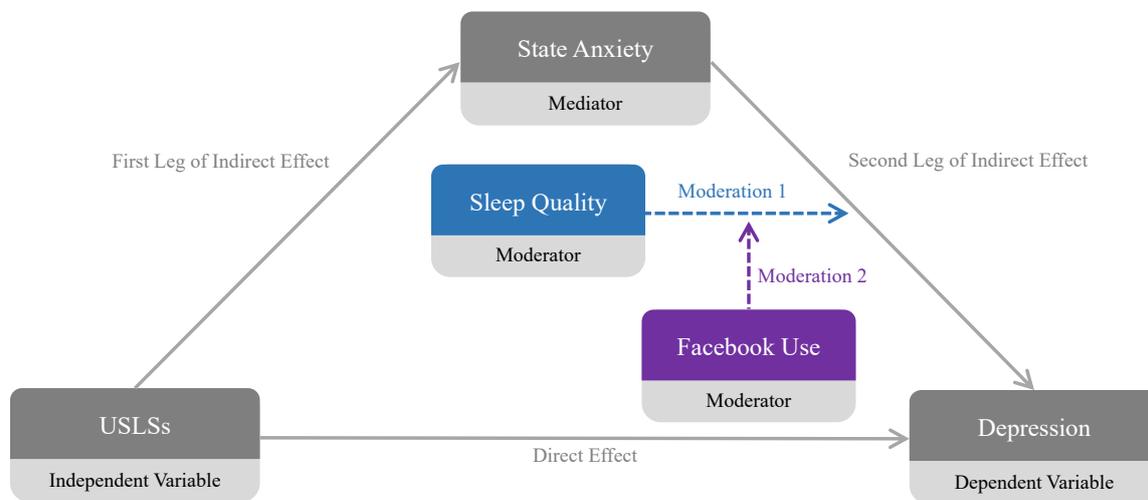
Moderated Mediation Model as Suggested by Ho (2021)



Ho (2021) postulated that Facebook users who reported poor sleep quality and SLE-related anxiety (the second leg of the indirect path) were at an increased risk of experiencing depression. These findings suggest that Facebook users with elevated stress-induced anxiety are at an increased risk of presenting with comorbid depressive symptoms. However, the proposition by Ho (2021) may need to be interpreted carefully for the following two reasons. First, the study design did not include a control group of non-Facebook users. Therefore, their findings may not be unique to Facebook users. Second, although the authors assessed the prevalence of Facebook use, they did not include this variable in the model selected (see Figure 5-3). The use of a double moderated mediation model with sleep quality as the first moderator and amount of facebook use as the second moderator may be a superior approach to address the hypothesis tested by Ho (2021).

Figure 5-3

Simple Mediation Including a Moderated Moderation: PROCESS Model 18



Note. Adapted from Hayes.

Furthermore, the model suggested by Ho (2021) may be limited since it only investigates the moderating role of sleep quality on the second path of the indirect effect. Given that earlier studies demonstrated a moderating effect of sleep quality on SLE-related anxiety and depression in their single moderation models, it could have been beneficial to determine if the direct and the first leg of the indirect path would also have been moderated and where the moderation effect was strongest.

Overall, studies investigating sleep quality as a potential risk factor in SLE-related anxiety and depression are limited in two ways. First, they investigate single relationships between variables (Kalmbach et al., 2015; Leggett et al., 2016). Second, they explore a moderating role of sleep quality on the second leg of the indirect path in a moderated mediation model with SLEs as the independent variable, depression as the outcome variable, and anxiety as the mediator (Ho, 2021), thus neglecting the effect on the first leg of the indirect path and the direct relationship of the model.

Consequently, investigating the role of sleep quality on the direct and both legs of the indirect path may be a superior approach to test the moderating effect on stress-related anxiety

and depression. In such a model, it may become evident where sleep quality has the most significant impact as a moderating variable. In some cases, moderation of a direct relationship between two variables may no longer be significant when considering the indirect effect between the two variables.

The previous two chapters explored personality traits as potential risk factors for USLS-related state anxiety and depression in a mediation model, with state anxiety as the mediator. Trait anxiety and trait anhedonia were identified as potential risk factors in this model. Sleep quality may be another factor placing students at an increased risk of USLS-related anxiety and depression during their first year of studies. No study has examined whether sleep quality is a vulnerability factor underlying USLS-related state anxiety and depression in first-year university students.

Chapter 4 investigated a moderating role of sleep quality in first-year university students' USLS-related anxiety and depression in a path model, with USLSs as the independent variable, state anxiety as the mediator, and depression as the outcome variable. Based on the literature review and findings from Study 1, state anxiety mediates the relationship between USLSs and depression and poor sleep quality promotes the negative effect of USLSs on the manifestation of depression directly and indirectly over state anxiety. The primary aims of Study 3 were to (a) assess and confirm the prevalence of poor sleep quality among first-year university students; (b) investigate associations between sleep quality, USLSs, state anxiety, and depression; (c) confirm a mediating role of state anxiety in USLS-related depressive symptoms; and (d) explore whether poor sleep quality was a risk factor for USLS-related state anxiety and depression. The hypotheses for this study were as follows:

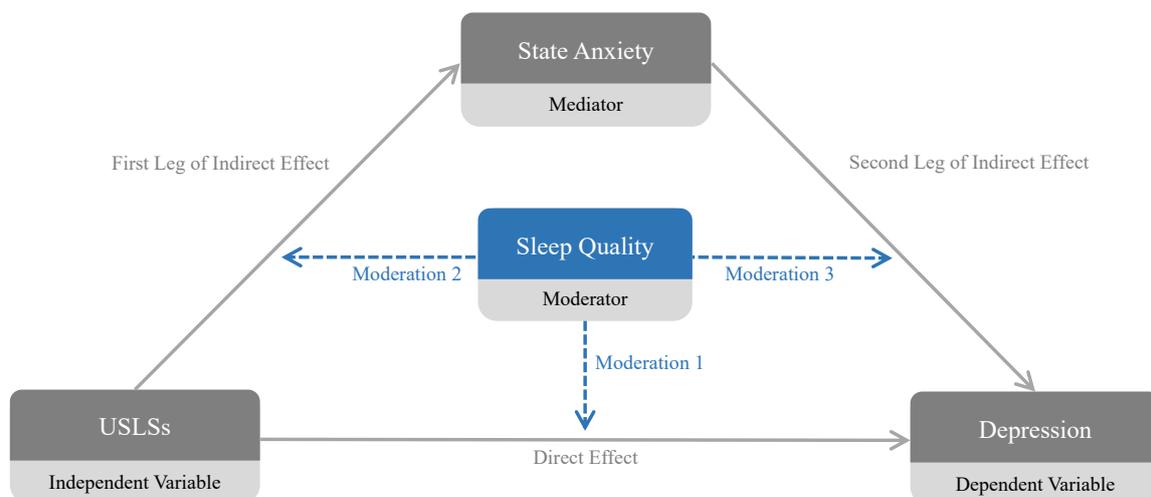
1. There is a high prevalence of poor sleep quality in first-year undergraduate students.
2. Poor sleep quality is positively associated with USLSs, state anxiety, and depressive symptoms.

3. The relationship between USLSs and depression is mediated by state anxiety.
4. SQ moderates the association between:
 - a. USLSs and state anxiety (the first leg of the indirect relationship between USLSs and depressive symptoms)
 - b. State anxiety and levels of depression (the second leg of the indirect effect between USLSs and depressive symptoms)
 - c. USLSs and depression (direct path)

A moderated mediation model was tested with USLSs as the predictor variable, depression as the outcome variable, state anxiety as the mediator, and sleep quality as the moderator of the direct and both legs of the indirect path (see Figure 5-4).

Figure 5-4

Hypothesized Moderated Mediation Model: PROCESS Model 59



Note. Adapted from Hayes Model 59.

5.2 Materials and methods

5.2.1 Participants

A total of 102 first-year undergraduate students from the University of Westminster (79 female; 23 male) participated in this study. Details about participant recruitment, the

provision of informed consent, and procedures are similar across studies and described in the framework of this thesis (see pp. 44–45).

5.2.2 Measures

In addition to the stress, anxiety, and depression measures described in the framework of this thesis (for details, see pp. 35–36), students participating in Study 3 completed a questionnaire assessing general sleep quality.

The Pittsburgh Sleep Quality Inventory (PSQI)

SQ was measured by the Pittsburgh Sleep Quality Inventory (PSQI), which is a widely used retrospective self-report questionnaire that assesses sleep quality over the previous month (Backhaus et al., 2002; Buysse et al., 1989; Carpenter & Andrykowski, 1998). The PSQI consists of a combination of a Likert-type scale and open-ended questions. With an administration time of 5-10 minutes, the PSQI is a brief and practical sleep assessment tool. The PSQI provides a single global sleep quality score, representing seven clinically derived domains of sleep problems (SQ, sleep latency and duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction). A global score of more than 5 indicates poor sleep quality in undergraduate student populations (Dietch et al., 2016). The PSQI has been used in healthy (Buysse et al., 1991) and clinical populations (Hsu et al., 2021) and in undergraduate student populations (Dietch et al., 2016; Guo et al., 2016). Psychometric evaluations of the PSQI suggest good internal consistency (Buysse et al., 1989; Carpenter & Andrykowski, 1998), high test-retest reliability, and good construct validity (Backhaus et al., 2002).

5.3 Statistical analysis

The first hypothesis was tested by comparing the distribution of sleep quality scores in the study sample to previously reported levels of poor sleep quality in other studies. To test the second hypothesis, Spearman's rank-order correlations were calculated for associations

between sleep quality and (a) USLSs, (b) state anxiety, and (c) depression. The remaining two hypotheses were tested using the PROCESS macro by Hayes (Version 4.0) running in SPSS 28. The same inference parameters (10,000 bootstraps, confidence interval of 95%, Davidson-MacKinnon HC3 bias correction) were applied. PROCESS Model 4 was used to verify the mediation model underlying the third hypothesis. To validate the fourth hypothesis, the moderated mediation PROCESS Model 59 was employed. When it became evident that the interaction effects between sleep quality and USLSs and sleep quality and state anxiety were not significant if simultaneously included in a single model, PROCESS Models 5, 7, and 14 were also tested to isolate the moderation effects on individual path legs.

Given that the dataset differed from previous chapters, potential covariates were reassessed. Due to the non-normal distribution of depression, Spearman's correlations for age, nicotine consumption, and caffeine intake with depression were calculated. A Mann-Whitney test was performed for sex. Locally estimated scatterplot smoothing (LOESS) lines in bivariate scatterplots generated in SPSS were generated to verify the linearity of the relationships between (a) USLSs and state anxiety, (b) state anxiety and depression, and (c) USLSs and depression. To verify all other assumptions required for OLS-type path analysis, the arguments made in Chapter 3 hold for the dataset in this chapter.

5.4 Results

The study sample consisted of 102 students from the University of Westminster. The mean age was 19.7 years (min = 18, max = 25, $SD = 1.76$), and 77.5% of participants were female.

5.4.1 Hypothesis 1: There is a high prevalence of poor sleep quality in first-year undergraduate students

Participants reported a mean level of sleep quality of 7.08 ($SD = 3.62$). The distribution of sleep quality scores skewed to the right (standardized skewness = 3.42) with normal

kurtosis; 61.8% reported a sleep quality score above the previously reported poor sleep cutoff score of 5. Of this percentage, 76.9% were female, which corresponds to the sex distribution in the sample.

5.4.2 Hypothesis 2: Poor sleep quality is positively associated with USLSs, state anxiety, and depressive symptoms

USLSs, state anxiety, and depression showed a similar distribution as in the dataset from the first two studies, with USLSs skewed to the right (standardized skewness = 2.46) with normal kurtosis, state anxiety normally distributed, and depression skewed to the right (standardized skewness = 5.6) and heavy-tailed (standardized kurtosis = 4.30). As hypothesized, sleep quality scores correlated positively with USLSs ($r = 0.418$, $p < .01$), state anxiety ($r = 0.462$; $p < .01$), and depression ($r = 0.441$, $p < .01$).

5.4.3 Hypothesis 3: The relationship between USLSs and depression is mediated by state anxiety

Age did not show significant correlations with depression and were therefore not included as covariates. As opposed to the dataset used in Chapter 3, sex did not qualify as a covariate. While the Mann-Whitney test revealed that the female category ($N = 79$, sum of ranks = 4,246) had a higher mean rank than the male category ($N = 23$, sum of ranks = 1,007), the difference was not statistically significant ($p = .05$).

Using the same PROCESS Model 4 specifications as in Chapter 3, the associations in this model (direct, indirect, and each indirect path leg) were also statistically significant. Similarly, the total effect of USLSs on depression was 0.385, of which 0.157 was attributable to the direct (USLSs-depression relationship) and 0.278 to the indirect (USLSs-state anxiety-depression relationship).

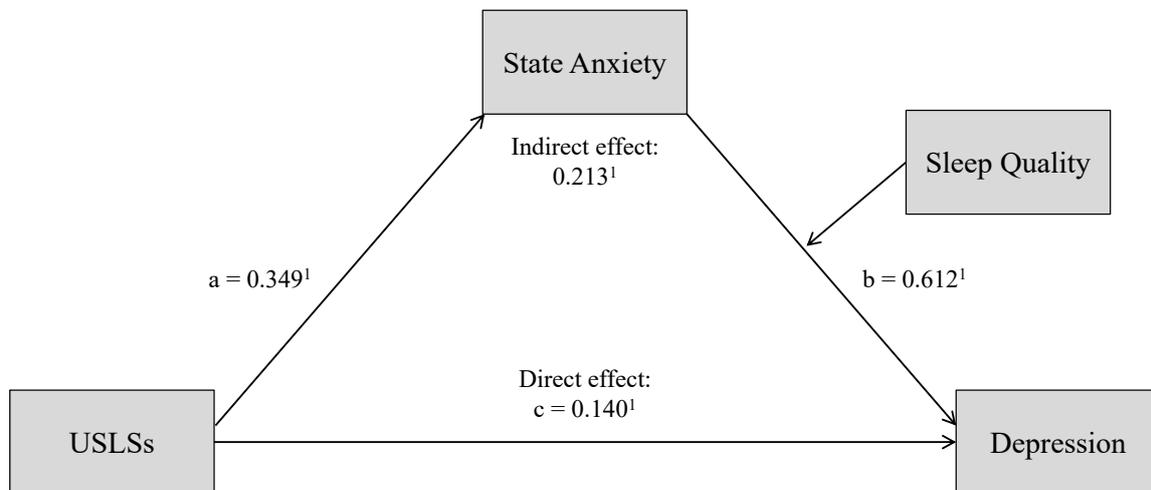
5.4.4 Hypothesis 4: Sleep quality moderates the associations between USLSs and state anxiety, state anxiety and levels of depression, and USLSs and depression

PROCESS Model 59 revealed that sleep quality did not significantly interact with (a) USLSs to affect depression (direct effect); (b) USLSs to affect state anxiety (the first leg of the indirect effect); or (c) state anxiety to affect depression (the second leg of the indirect effect) when all three hypothesized moderations were included in a single model. There were no regions of significance for the different levels of sleep quality evaluated ($-1 SD$, mean, $+1 SD$). This outcome could be due to the sample size ($N = 102$) relative to the number of factors included in the regression model (independent variable, mediator, moderator, and three interaction terms). Therefore, the moderations were tested individually in three distinct models. PROCESS Model 5 stipulates that sleep quality has a moderating role in the direct association between USLSs and the occurrence of depressive symptoms.

While the unmoderated indirect association between the variables remained significant at 0.220, the conditional direct association remained nonsignificant, and there were no levels of sleep quality where the relationship showed significance. In PROCESS Model 7, the first component of the indirect path was assumed to be moderated by sleep quality. Like the results in Model 5, sleep quality was not a significant moderator, and there were no regions of significance. The unmoderated direct effect remained significant at 0.157. In PROCESS Model 14, sleep quality was hypothesized to interact with state anxiety to affect symptoms of depression. In contrast to PROCESS Models 5 and 7, sleep quality had a strong and statistically significant moderation effect for all levels investigated. The interaction effect was 0.037, with a conditional indirect effect of 0.213 for mean levels of sleep quality (0.167 for levels of sleep quality at $-1 SD$ and 0.260 for levels of sleep quality at $+1 SD$). The unmoderated direct effect remained significant at 0.140 (see Figures 5-5 and 5-6).

Figure 5-5

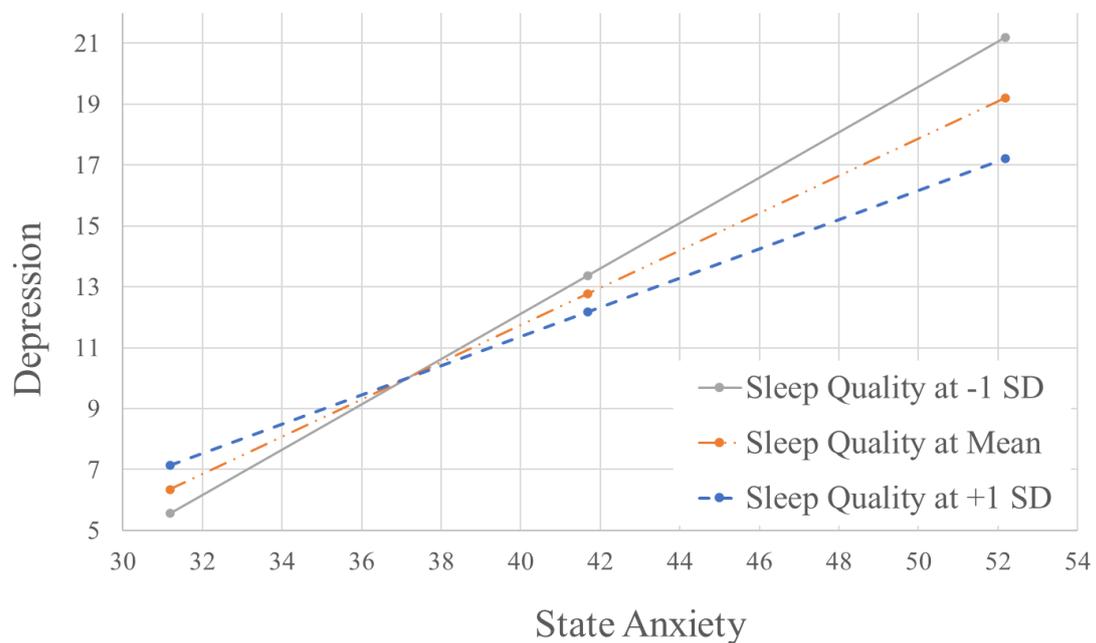
Moderated Mediation Model: Process Model 14



¹ Effect size shown at the mean level of sleep quality.

Figure 5-6

Interaction Effect Between State Anxiety and Sleep Quality on Depression



5.5 Discussion

5.5.1 Statement of major findings

Adequate and efficient sleep plays a critical role in physical and mental health across the lifespan, specifically during stages of adolescence when the brain is still under development (Garbarino, 2020). Sleep quality is generally poor in undergraduate students, associated with mental health problems such as stress, anxiety, and depression (Dinis & Bragança, 2018; Manzar et al., 2021). The primary aims of this study were to (a) assess and confirm the prevalence of poor sleep quality among first-year university students; (b) investigate associations between sleep quality, USLSs, state anxiety, and depression; (c) confirm a mediating role of state anxiety in USLS-related depressive symptoms; and (d) explore whether poor sleep quality was a risk factor for USLS-related state anxiety and depression.

5.5.1.1 Hypothesis 1

The PSQI was used to determine if there is a high prevalence of poor sleep quality in first-year undergraduate students. In concordance with the first hypothesis, results showed that the majority of students (61.75%) reported poor sleep quality (PSQI > 5). These results align with previous studies investigating sleep quality in student populations (Al-Khani et al., 2019; Attal et al., 2021). Supporting the second hypothesis and in line with previous work (Dinis & Bragança, 2018; Li et al., 2019; Manzar et al., 2021), first-year students with poorer sleep quality reported (a) to have experienced a higher number of USLSs, (b) elevated state anxiety, and (c) elevated depression levels.

5.5.1.2 Hypothesis 2

Consistent with the third hypothesis that poor sleep quality is positively associated with USLSs, state anxiety, and depressive symptoms and in concordance with findings from Studies 1 and 2, students' state anxiety significantly mediated the relationship between USLSs exposure and depressive symptoms in this smaller sample (for an interpretation of these results,

see Study 1 on p. 60). Thus, these findings further support a mediating role of state anxiety in the relationship between USLSs and depression in first-year undergraduate students.

5.5.1.3 Hypothesis 3

The third hypothesis focused on the mediating role of state anxiety in the USLSs-depression relationship. It was found that sleep quality moderates the single relationships between SLEs and depression (Leggett et al., 2016), SLEs and anxiety (Kalmbach et al., 2015), and SLE-related anxiety and depression (Ho, 2021). However, these findings do not provide insight into (a) whether sleep quality still moderates these relationships in a more complex model that includes the conditional indirect effect between these variables; and (b) were in such a model (direct effect or indirect effect) sleep quality has the most impact. A moderated mediation model—with USLSs as the independent variable, depression as the outcome variable, state anxiety as the mediator, and sleep quality as the moderator of the direct and both legs of the indirect path—was used to explore if and on which paths sleep quality has the most impact as a moderator. Contrasting Hypothesis 4, this model did not reveal significant moderation effects of sleep quality on either the direct or any leg of the indirect path.

Considering that this non-finding may be due to a relatively small sample size, the data was further explored using three distinct moderated mediation models. In particular, (a) PROCESS Model 5 was applied to explore a possible moderating role of sleep quality on the direct path; (b) PROCESS Model 7 was used to establish a moderation effect of sleep quality on the first leg of the indirect effect; and (c) PROCESS Model 14 was used to explore a moderation effect of sleep quality on the second leg of the indirect path.

There was no moderation effect of sleep quality on the direct path (PROCESS Model 5), suggesting that poor sleep quality does not moderate students' USLS-related depressive symptoms when ignoring the mediated indirect effect. Furthermore, sleep quality levels did not moderate the first leg of the indirect path between USLSs and state anxiety (PROCESS Model 7), suggesting that poor sleep quality also did not negatively affect students' USLS-related state anxiety. Thus, these findings somewhat contradict earlier work proposing that poor sleep

quality moderated stress-related depression (Leggett et al., 2016) and stress-related anxiety (Kalmbach et al., 2015).

Several explanations exist for the discrepancies between findings. First, Kalmbach et al. (2015) and Leggett et al. (2016) investigated the role of sleep quality in stress-related anxiety and depression in simple moderation models. Therefore, their findings may not hold in more complex models that include conditional indirect effects. Furthermore, while the present study investigated the role of sleep quality in stress-related anxiety and depression cross-sectionally, both studies used a longitudinal design. Thus, assessing the role of sleep quality in stress related-anxiety and depression changes over time may have yielded different results. Finally, differences in sample characteristics (e.g., participants' mean age) may have contributed to the differences in study results. While the mean age in this study was 21 years, the mean age in Leggett et al. (2016) was 47 years. It is plausible that compared to older people, younger individuals have more resources to cope with SLEs, thus making the potential negative impact of poor sleep less profound. In other words, poor sleep quality may have a lesser effect on stress-related depression in younger participants. However, these are only speculations that future studies could further explore.

5.5.1.4 Hypothesis 4

The fourth hypothesis tested whether sleep quality moderates the following associations: USLSs and state anxiety, state anxiety and levels of depression, and USLSs and depression. In support of this hypothesis, the analysis revealed that sleep quality is a factor that, when combined with USLS-induced state anxiety, increases the risk of depression in first-year university students. These findings suggest that intervening in a risk factor, such as poor sleep quality, may positively impact the indirect pathway of USLSs to state anxiety and depressive symptoms. Although specific USLSs (e.g., losing a relative or having exams) may not be preventable, it may be possible to change and improve sleep quality, affording anxious students

the time and restoration to recover from their stress-related anxiety and prevent anxiety-induced depression. These results align with Ho (2021), who reported a similar effect in a sample of Facebook users. The findings in the present study extend this work to a first-year undergraduate population.

5.5.2 Suggestions for interventions

Study results suggest that poor sleep quality is pervasive and constitutes a critical risk factor for depression in students with elevated USLS-induced state anxiety. Thus, these findings validate the benefits of intervention and treatment strategies to improve students' sleep quality. Educational institutions can utilize many interventions to help students improve their sleep quality. Sleep hygiene education can help manage problems by changing beliefs and habits. Cognitive behavioral training can be effectively used to target rumination and sleep issues through a training method called "Studieren wie im Schlaf" (SWIS; studying in your sleep; Schlarb et al., 2017). SWIS combines cognitive behavioral training and hypnotherapy to treat insomnia, nightmares, and irregular sleep-wake cycles in university students.

Another option is mindfulness-based cognitive therapy with a sleep focus. Mindfulness is practiced through meditation techniques focused on directing a person's attention toward an object or their breath, body, feeling, or thoughts (Garland et al., 2017). Mindfulness-based interventions regulate pre-sleep arousal, allowing for enhanced sleep quality (Hassirim et al., 2019). Fu et al. (2022) found significant intervention effects of mindfulness training on sleep quality in university students.

Furthermore, cognitive behavioral training often incorporates progressive muscle relaxation to reduce stress and anxiety and relieve insomnia (Arianti & Novera, 2019; Dolbier & Rush, 2012; Liu et al., 2019). Progressive muscle relaxation is based on voluntarily tensing one muscle group at a time followed by a relaxation phase, leading to a release of tension

throughout the body. Progressive muscle relaxation is simple to learn and does not require tools such as audio devices or mats, making it easy to integrate into everyday life.

Future studies could investigate whether these interventions improve sleep quality and lower the risk of comorbid depressive symptoms in students with stress-related state anxiety.

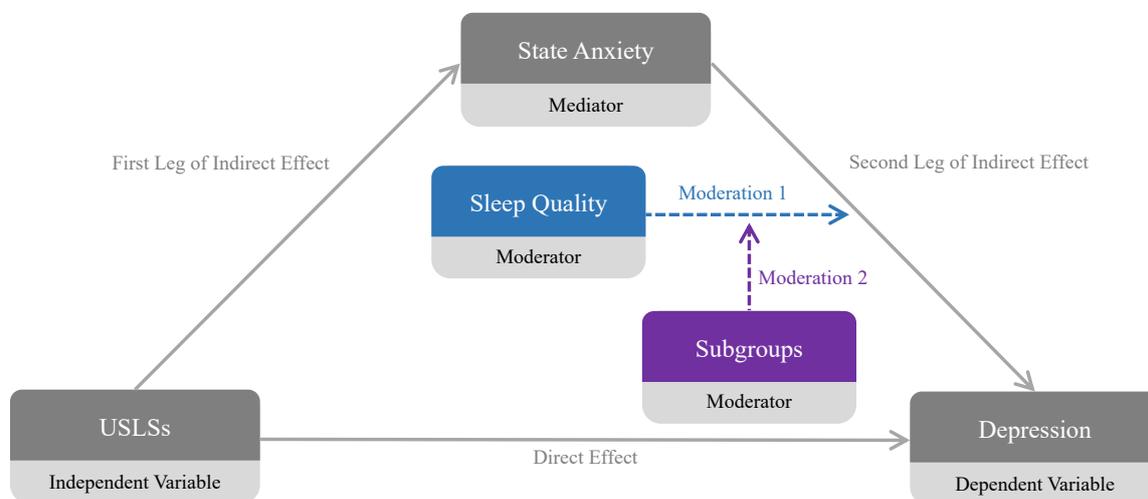
5.5.3 Limitations and future directions

Although study findings suggest that when exposed to life stress, poor sleep quality is associated with depression in students with elevated state anxiety, there are potential other interpretations. For example, poor sleep quality may result from feelings of anxiety and depressed mood related to the occurrence of SLEs. Future studies using longitudinal designs are needed to support the model proposed here.

Furthermore, the current study and Ho (2021) are limited by the lack of control groups. Control groups would allow for testing and concluding whether the study findings apply to the general population or are unique to specific subgroups, such as first-year students or Facebook users. An enhanced dataset including different population subgroups could be analyzed using PROCESS Model 18 (see Figure 5-7), including subgroups as a second moderator. Overall, future studies exploring such a model are needed.

Figure 5-7

Proposed Enhanced Moderated Mediation Model: PROCESS Model 18



Note. Adapted from Hayes Model 18.

5.5.4 Conclusion

This study extended findings from Studies 1 and 2 by exploring the role of sleep quality in first-year university students' USLS-related state anxiety and depression in a moderated mediation model (PROCESS Model 59) with state anxiety as a mediator in the direct relationship between USLSs and depression and sleep quality as a moderator of the direct and both legs of the indirect path. This model did not provide significant results, which may be attributable to the small sample size in this study. Further exploration of the data using PROCESS Models 5, 7, and 14 revealed a moderation effect of sleep quality on the association between USLS-related state anxiety and depression (PROCESS Model 14). In this study, students who experienced elevated USLS-related state anxiety and poor sleep were at an increased risk of depression. Study findings have critical implications for depression intervention and therapy in students with USLS-related state anxiety. Intervention methods such as SWIS or mindfulness-based training might be beneficial.

Thus far, the studies in this thesis have demonstrated that certain personality traits and sleep quality can increase the risk for USLS-related state anxiety and depression. Another factor which may put first-year students at an increased risk for USLS-related state anxiety and depression is their cognitive profile. Study 4 investigates if first-year students are at an increased risk of state anxiety and depression due to their EF abilities.

6 Executive functioning: A risk factor in USLS-related anxiety and depression in first-year university students (Study 4)

6.1 Introduction

Individual differences in effectively responding to SLEs may help explain who can cope and who is prone to experience negative emotional states such as anxiety and depression (Aldao et al., 2010). The previous three thesis studies demonstrated that USLSs, state anxiety, and depression are strongly associated. Furthermore, they showed that first-year university students who report USLS-induced state anxiety are at an increased risk of depression depending on corresponding elevated trait anxiety, trait anhedonia, or poor sleep quality.

EF is another construct that may regulate the impact of SLEs on anxiety and depression. EF is the brain's management system and describes a set of higher-order cognitive skills that help a person plan, focus attention, recall instructions, manage multiple tasks, and attain goals. EF skills develop early during childhood, into the teenage years, and continue to progress into late adolescence. When students enter university, their EF skills are still under construction. Dealing with everyday tasks can be challenging for students who struggle with EF, pervading nearly every aspect of their student life. Poor EF skills can inhibit accomplishing basic tasks such as paying bills, preparing meals, or arriving at lectures on time. These skills are also crucial to learning, decision-making, and academic success. EF skills such as working memory, cognitive flexibility, inhibitory control, and sustained attention are strongly associated with emotion regulation, as intense emotions can result in emotional disorganization.

Chronic and acute stress have been associated with EF performance. While acute stress may worsen working memory (Gagnon & Wagner, 2016; Qin et al., 2009; Schoofs et al., 2009), sustained attention (Roos et al., 2019), and cognitive flexibility (Alexander et al., 2007; Schoofs et al., 2009), acute and chronic stress can improve EF in some individuals (Booth,

2019; Chang et al., 2020). However, on average, EF performance declines after stress exposure (Plessow et al., 2012).

In addition, there is a connection between EF task performance and symptoms of anxiety and depression. Deficits in the inhibition of negative material, attentional deficits, low working memory storage, and poor cognitive flexibility are linked to elevated anxiety (Forster et al., 2015; Kircanski et al., 2016; Lukasik et al., 2019; Wilson et al., 2018) and depression (Dai et al., 2011; Maramis et al., 2021; Nikolin et al., 2021; Piani et al., 2022; Stange et al., 2017). Longitudinal studies have demonstrated that the associations between these variables are complex and bidirectionally impair each other across time (e.g., Petkus et al., 2017; Zainal & Newman, 2021). Most studies investigated associations between EF and negative emotional states (e.g., anxiety and depression) in the clinical population. Although few have explored these associations in the subclinical population, improved EF capacity in tasks requiring sustained attention and cognitive flexibility can contribute to rumination and depressive symptoms in healthy individuals (Genet et al., 2013; Shimony et al., 2021).

EF skills are essential for coping during high-stress periods. Emotion regulation and associated problem-solving strategies are particularly crucial in allowing a person to manage SLEs. Failure to implement such strategies when exposed to SLEs can lead to an elevated risk of low mood. A lack of EF skills may contribute to ineffective coping with SLEs, facilitating depressive symptoms (Joormann & Gotlib, 2010). Quinn and Joormann (2015) confirmed this notion using the Trier Social Stress Test (TSST), which assesses social evaluation and perceived negative evaluation, to induce acute stress and assess subsequent changes in working memory and depressive symptoms in non-clinical individuals. Findings revealed that inducing acute stress resulted in changes in working memory performance and that these changes were associated with depressive symptoms. Based on these findings, EF may mitigate the adverse

effects of SLEs on the manifestation of physical and mental health symptoms after acute stress induction.

Shields et al. (2017) assessed whether EF performance based on the Berg Card Sorting Test—a sensitive measure to an inability to shift set—moderated the association between SLEs and physical and mental health after acute stress induction via the TSST in a healthy young adult sample. Results indicated that higher performance on EF buffers the adverse effects of SLEs on a person’s physical and mental health. These findings suggest that high EF after acute stress induction may constitute a resilience factor for SLE-related physical and mental health. However, they are limited as they rely on a global EF score. As such, they do not allow for concluding the extent to which distinct EF skills contributed to this effect. Studying the role of specific EFs in SLE-related mental and physical health symptoms may permit such conclusions. Furthermore, the findings relied on the induction of acute stress. Chronic stress may also have an attenuating effect on SLE-related health complaints, but such a hypothesis has not yet been tested.

First-year undergraduate students often display high or medium levels of chronic stress (Pozos-Radillo et al., 2015). No study thus far has examined the relationship between first-year undergraduate students’ USLSs, state anxiety, and depression while accounting for EF performance. This study investigated the interplay between negative emotional states and first-year students’ EF performance on specific EF tasks in the core model of this thesis to address this gap. This study aimed to answer the following research questions:

- Are distinct EF skills (Working Memory, Cognitive Flexibility, and Inhibitory Control) associated with students’ self-reported USLSs, state anxiety, and depressive symptoms?

- Does the extent of USLSs combine with EF performance to predict (a) depression (direct effect); (b) state anxiety (i.e., first leg of indirect effect); and (c) USLS-induced state anxiety-related depression (i.e., second leg of indirect effect)?

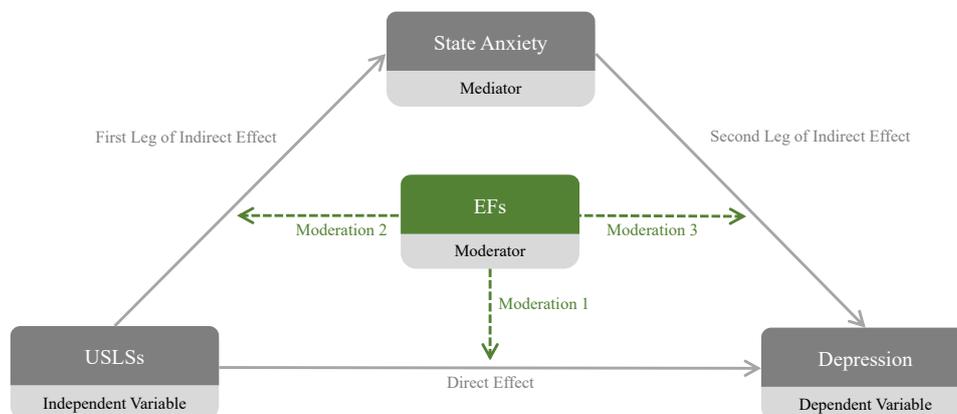
Furthermore, the following hypotheses were tested:

1. Performance on distinct EF skills is associated with first-year university students' self-reported USLSs, state anxiety, and depression.
2. State anxiety mediates the association between USLSs and depression.
3. Performance on each distinct EF skill moderates the association between USLSs and state anxiety (i.e., the first leg of the indirect effect in the core model).
4. Performance on each distinct EF skill moderates the association between state anxiety and levels of depression (i.e., the second leg of the indirect effect in the core model).
5. Performance on each distinct EF skill moderates the direct effect between USLSs and depression.

Twelve moderated mediation models were tested, with USLSs as the predictor variable, depression as the outcome variable, state anxiety as the mediator, and performance on each distinct EF skill as moderators of the direct and both legs of the indirect path (see Figure 6-1).

Figure 6-1

Hypothesized Moderated Mediation Models: PROCESS Models 5, 7, and 14



Note. EFs cover; sustained attention, inhibitory control, cognitive flexibility and working memory

6.2 Materials and methods

6.2.1 Participants

A total of 70 first-year undergraduate students from the University of Westminster (56 female; 14 male) participated in this study. Details about participant recruitment, informed consent, and procedures are similar across studies and described in the framework of this thesis (see pp. 44–45).

6.2.2 Measures

In addition to the stress, anxiety, and depression measures described in the framework of this thesis (for details, see pp. 35–36), students participating in the current study completed three EF tasks assessing working memory, cognitive flexibility, inhibitory control, and sustained attention.

6.2.2.1 Cognitive measures

The Cambridge Neurological Test Battery (CANTAB) was developed at the University of Cambridge and is based on cognitive paradigms on neural cognition and behavior. The CANTAB has proven to be sensitive to neuropsychological impairment associated with mood disorders and schizophrenia spectrum disorders. In this study, three of the most administered CANTAB subtests were applied to explore associations between first-year students' EF capacity and their USLS-related anxiety and depression.

Rapid Visual Information Processing

The Rapid Visual Information Processing (RVP) task, a component of the Cambridge Neuropsychological Test Automated Battery (CANTAB), assesses an individual's ability to maintain prolonged attention, offering valuable insight into their attention span and processing speed (Sahakian et al., 1989). Additionally, its false alarm measure serves as a tool to evaluate inhibitory control capacity and impulsivity (Fan et al., 2017; Gau & Huang, 2014; Teisen et al., 2019). With a brief administration time of 7 minutes, the RVP is a practical choice for quick

yet comprehensive assessment. Particularly capable of detecting cognitive issues related to attention and processing speed, the RVP has proven effective with clinical and subclinical populations (Gau & Huang, 2014; Vestergaard et al., 2022). Its computerized format assures standardized administration and scoring, minimizing potential human error and facilitating the comparison of results across studies and populations. Moreover, as a non-verbal task, the RVP is suitable for populations where language or cultural factors could impact performance on traditional neuropsychological tests. For University of Westminster, characterized by its multicultural and multilingual student demographic, this aspect offers significant benefits, allowing for the inclusive participation of students with various linguistic backgrounds and differing levels of English proficiency in cognitive evaluations.

When performing this task, participants must memorize three different target sequences, each consisting of three digits (“2-4-6,” “3-5-7,” and “4-6-8”). A white box then appears in the center of the screen, with digits 2-9 presented at a speed of 100 digits per minute. Participants must detect the three target sequences and respond as quickly as possible after the last number of a specific target sequence. The number of correctly detected target sequences in a response window of 1,800 ms is measured and recorded. Although the RVP is primarily a measure of visual sustained attention, it also depends on selective attention (specific predefined targets must be selected), inhibition (responses to the non-targets must be inhibited), and working memory (three different target sequences must be memorized; Coull et al., 1996). RVP probability of hits, RVP false alarms, RVP mean latencies, and RVP Sensitivity A are recorded. In this study, students’ sustained attention and inhibitory control were assessed. Therefore, students’ RVP probability of hits scores were used to determine their sustained attention capacity, and the RVP false alarms scores were used to evaluate their inhibitory control capacity.

Intra-Extra Dimensional Shift

The Intra-Extra Dimensional Shift (IED) task, a component of the Cambridge Neurological Test Battery (CANTAB), probes cognitive flexibility by assessing rule acquisition, visual discrimination, abstract reasoning, and set-shifting abilities. Building on the foundation of the traditional Wisconsin Card Sorting Test, the IED provides a computerized platform for evaluation, ensuring standardized administration and scoring, reducing the risk of researcher error, and facilitating the comparison of results across diverse studies and populations. Similar to the RVP, this task is non-verbal and designed to minimize cultural and educational biases, making it an ideal tool in environments where language or cultural factors may impact performance on conventional neuropsychological assessments.

This task uses two artificial dimensions: pink shapes and white lines. Participants must use feedback to figure out a rule that determines which of the above four stimuli is correct. After six correct responses, a new stimulus, rule, or both are introduced. Initially, the task involves simple stimuli consisting of one of the two dimensions (only the pink figures are relevant). As the IED progresses, compound stimuli become the dominant dimension (white lines overlaying the pink figures). Participants must correctly and consecutively predict the defined rules to pass each step. The task automatically ends when participants fail to predict the rule after 50 attempts during any one step. The dependent variables in the IED are the number of trials completed, the number of stages completed, and the number of errors made. In this study, the IED number of errors made measured cognitive flexibility performance.

Paired-Associate Learning

Paired-associate learning (PAL) is a traditional method in memory studies to explore how individuals create and recall newly formed connections between various stimuli (Arndt, 2012). PAL tests, renowned for their sensitivity in detecting memory problems (Kapur, 1988), hold notable advantages, as they represent an intersection of PAL and working memory, two

intertwined cognitive processes that are fundamental to everyday learning tasks (Baddeley, 2010; Kurtz et al., 2013). Primarily assessing visual memory and new learning, the PAL paradigm requires learners to memorize pairs of items or concepts, such as words and their definitions, effectively emulating real-world academic scenarios. Incorporated into this thesis for its critical role in shaping students' memory function, PAL is a pivotal part of the learning process. Proficiency in PAL is instrumental for academic performance—a deficiency can elevate stress levels, potentially fostering anxiety and depression and profoundly impacting a student's overall well-being.

Like the previously described RVP and IED tasks, PAL is part of the CANTAB suite of tests. This non-verbal, computerized, and standardized test, similar to its counterparts, ensures uniform administration and scoring, rendering it a powerful tool for examining cognitive functions across a broad range of populations. This consistent format solidifies its reliability and applicability, regardless of cultural or linguistic differences among participants.

In the application of the CANTAB- PAL task in this thesis, participants are required to recognize and recall the locations of various visual patterns presented on a computer screen. In the initial stage, identical boxes open at different locations on the screen one at a time, revealing distinct patterns inside. In the second stage (i.e., recall), each pattern reappears individually in the center of the screen, and participants must select the matching box in the periphery containing the same pattern. Once they have successfully identified the pattern location, the task gradually becomes more challenging with larger pattern sets. PAL ends with the presentation and localization of eight items in eight boxes. If participants make a mistake, the position of each pattern is re-presented, giving another opportunity to indicate the correct location. The session automatically ends if participants fail to identify the location of a pattern after 10 trials. The outcome measure is the total number of errors adjusted.

6.3 Primary statistical analysis

The first hypothesis was tested by calculating Spearman's rank-order correlations for the associations between the distinct EF skills (working memory, sustained attention, inhibitory control, and cognitive flexibility) and students' self-reported USLSs, state anxiety, and depression. The subsequent hypotheses (and the secondary hypotheses) were assessed using PROCESS by Hayes (version 4.0) running in SPSS 28 with the aforementioned model parameters. Hypothesis 2 was tested with PROCESS model 4, while hypotheses 3, 4, and 5 were assessed with PROCESS models 7, 14, and 5, respectively. The distinct EF skills were probed as moderators of the association between either (a) USLSs and depression, (b) USLSs and state anxiety, and (c) state anxiety and depression. Thus, a total of 12 moderated mediations were performed. Due to the lumped distribution of the EF variables, the sample was divided into three groups using equal percentiles. The two secondary hypotheses were analyzed with PROCESS model 1. Since the composition of the dataset in this chapter was different, Spearman's correlations of age with depression and the Mann-Whitney test for sex with depression were carried out to determine whether these variables had to be included as covariates. All assumptions needed as a precondition to conduct OLS-type path analysis were reconfirmed as described in Chapter 3.

6.4 Results

The sample consisted of 70 students from the University of Westminster. The mean age was 19.6 years (min = 18, max = 25, $SD = 1.57$) and 80% of the students were female.

6.4.1 Hypothesis 1: Performance on the distinct EF skills is associated with first-year university students' self-reported USLSs, state anxiety, and depression

Participants reported a working memory mean score of 7.17 ($SD = 7.56$). The distribution was skewed to the right (standardized skewness = 6.71) and heavy-tailed (standardized kurtosis = 6.60). The mean score for sustained attention was 0.59 ($SD = 0.18$).

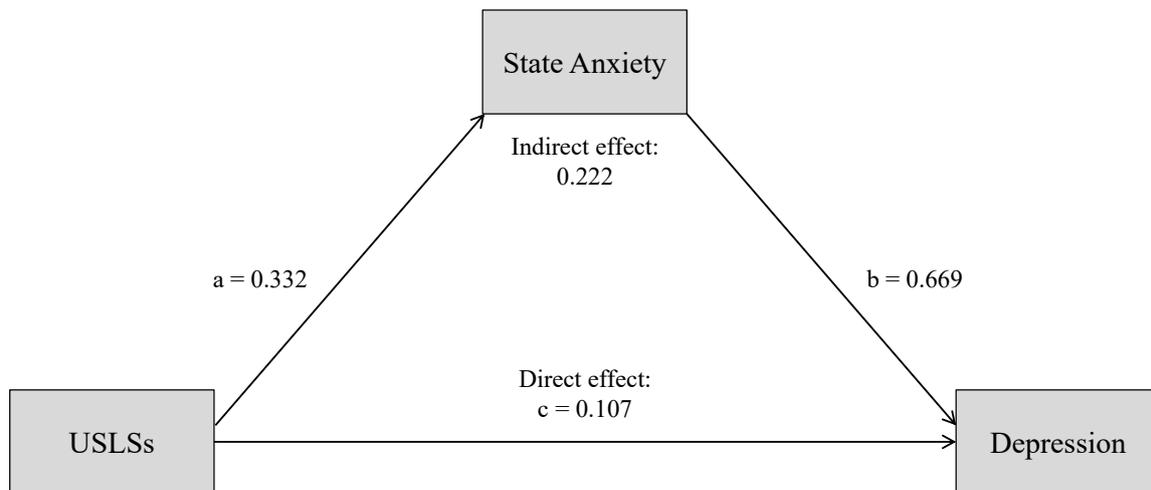
Frequency analysis showed a normal distribution within acceptable levels (standardized skewness = -0.78; standardized kurtosis = -1.01). The sample showed a mean inhibitory control score of 3.24 ($SD = 3.99$), with a strong skew to the right (standardized skewness = 8.40) and heavy tails (standardized kurtosis = 13.59). The mean score for cognitive flexibility was 25.34 ($SD = 19.48$), with a standardized skewness of 2.85 and a standardized kurtosis of -1.72. While both statistics are below the cutoff for non-normality, the inspection of the histogram revealed a non-normal distribution. The analysis of Spearman's Rho showed only two significant correlations among the investigated associations. Sustained attention performance showed a positive correlation ($\rho = 0.301, p = .05$) to depression scores, and inhibitory control was positively related to state anxiety ($\rho = 0.266, p = .05$).

6.4.2 Hypothesis 2: State anxiety mediates the association between USLSs and depression

Age was not included as a covariate, as it did not show significant correlations with depression. The Mann-Whitney test ($p = .05$) revealed that the female category ($N = 56$, sum of ranks = 2053.50) did not have a significantly larger mean rank than the male category ($N = 14$, sum of ranks = 431.50). Therefore, sex did not qualify as a covariate. With this smaller sample size, the core model showed a significant total effect of 0.329, consisting of a non-significant direct effect of 0.107 and a significant indirect effect of 0.222 (see Figure 6-2). The bootstrapped confidence interval of the direct effect (lower level = -0.067; upper level = 0.281) barely straddled zero. Therefore, the sample size explains the difference in significance of the direct effect between this sample and the samples used in previous chapters.

Figure 6-2

Mediation Model: Process Model 4



Note. Adapted from Hayes (2018).

6.4.3 Hypothesis 3: Performance on each distinct EF skill moderates the association between USLSs and state anxiety (i.e., the first leg of the indirect relationship in the core model)

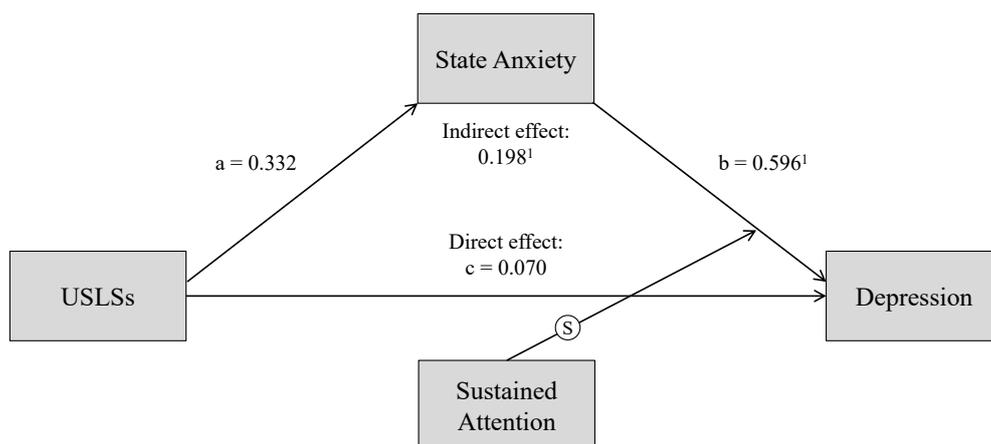
When inserting either working memory, sustained attention, inhibitory control, or cognitive flexibility as a moderator in PROCESS model 7, no distinct EF skills significantly interacted with USLSs to affect state anxiety. While the interaction effect between USLS and each moderator was not significant, the indirect effect was still significant for students whose moderator scores fell in a certain range. Specifically, the moderated indirect effect between USLSs and depression was significant for students scoring at or above mean working memory (effect sizes of 0.232 and 0.333 respectively) and sustained attention levels (effect sizes of 0.200 and 0.327 respectively). In contrast, the moderated indirect association between USLSs and depression was significant for students with cognitive flexibility scores at or below the mean (effect sizes of 0.219 and 0.349 respectively). The indirect association between USLSs and depression was also significant for students with mean inhibitory control levels (effect size of 0.195). The direct effect remained non-significant in all cases.

6.4.4 Hypothesis 4: Performance on each distinct EF skill moderates the association between state anxiety and levels of depression (i.e., the second leg of the indirect effect in the core model)

The analysis in PROCESS model 14 revealed that sustained attention and inhibitory control significantly interacted with state anxiety to affect levels of depression. The interaction coefficient for sustained attention was 0.190 ($p = .05$). The effect of sustained attention on depressive symptoms was 0.436 for participants with low levels of sustained attention ($-1 SD$ below the mean) and 0.756 for those with high levels of sustained attention ($+1 SD$ above the mean). Correspondingly, the overall indirect effect between USLSs and depression ranged from 0.145 to 0.251. For inhibitory control, the interaction was substantial, with a coefficient of 0.315. When state anxiety interacted with inhibitory control, its effect on levels of depression was equal to 0.416 for students exhibiting weak inhibitory control and 0.947 for those with strong inhibitory control. The overall indirect effect of USLSs on depressive symptoms ranged from 0.138 to 0.315 (see Figures 6-3 and 6-4).

Figure 6-3

Moderated Mediation: Process Model 14

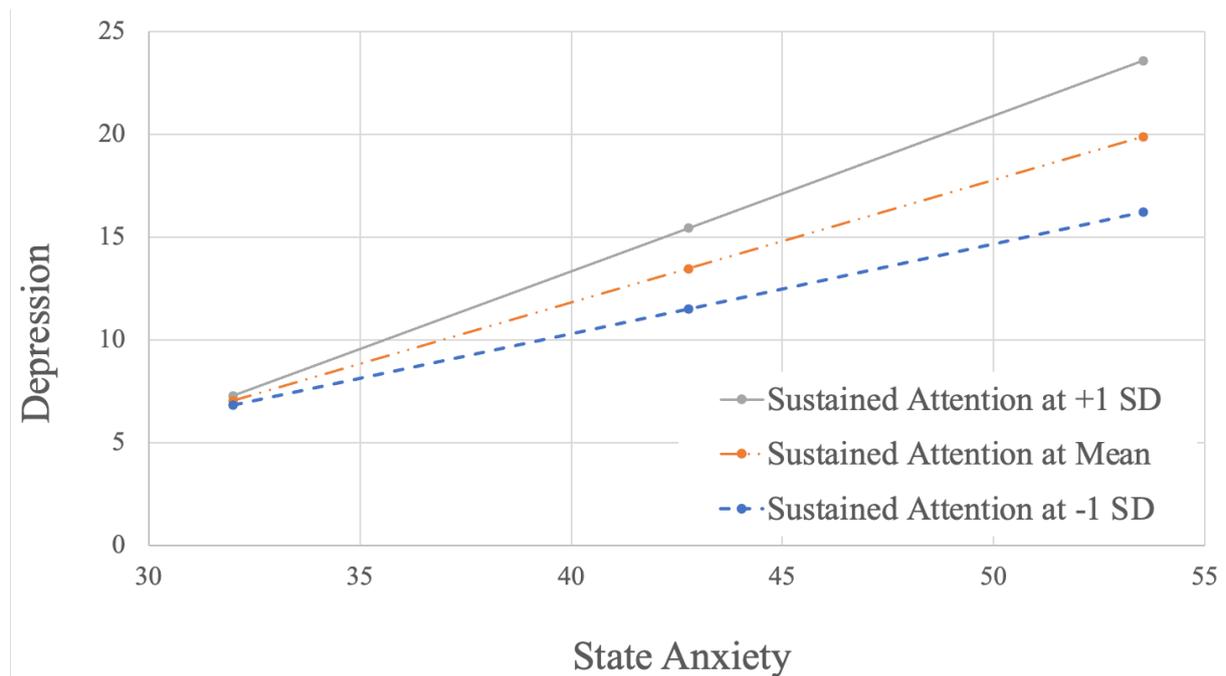


¹ Effect size shown at the mean level of sustained attention.

(S) Interaction effect is significant.

Figure 6-4

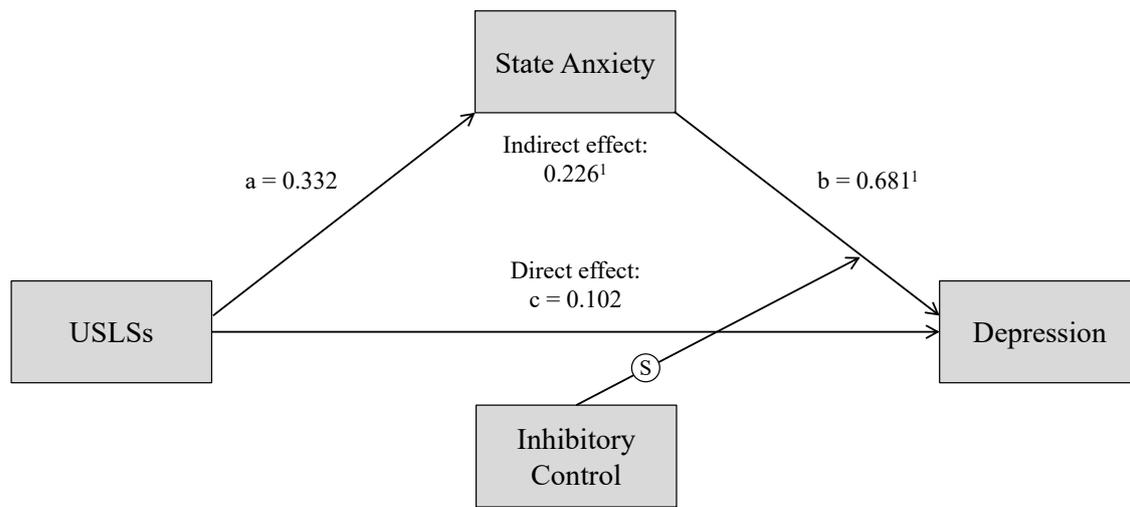
Interaction Effect Between State Anxiety and Sustained Attention on Depression



For both sustained attention and inhibitory control, the indirect effect was significant for all investigated regions of the moderator. While working memory and cognitive flexibility did not significantly interact with state anxiety to affect levels of depression, the moderated indirect effects between USLSs and depression were still significant for all investigated levels (from -1 *SD* to +1 *SD*) of the moderator with effect sizes ranging from 0.228 to 0.217 in the case of working memory and 0.243 to 0.169 in the case of cognitive flexibility. The interaction coefficients could have been significant with a larger sample size (see Figures 6-5 and 6-6). As expected from the earlier analysis of the core model, the direct effect was not significant.

Figure 6-5

Moderated Mediation: Process Model 14

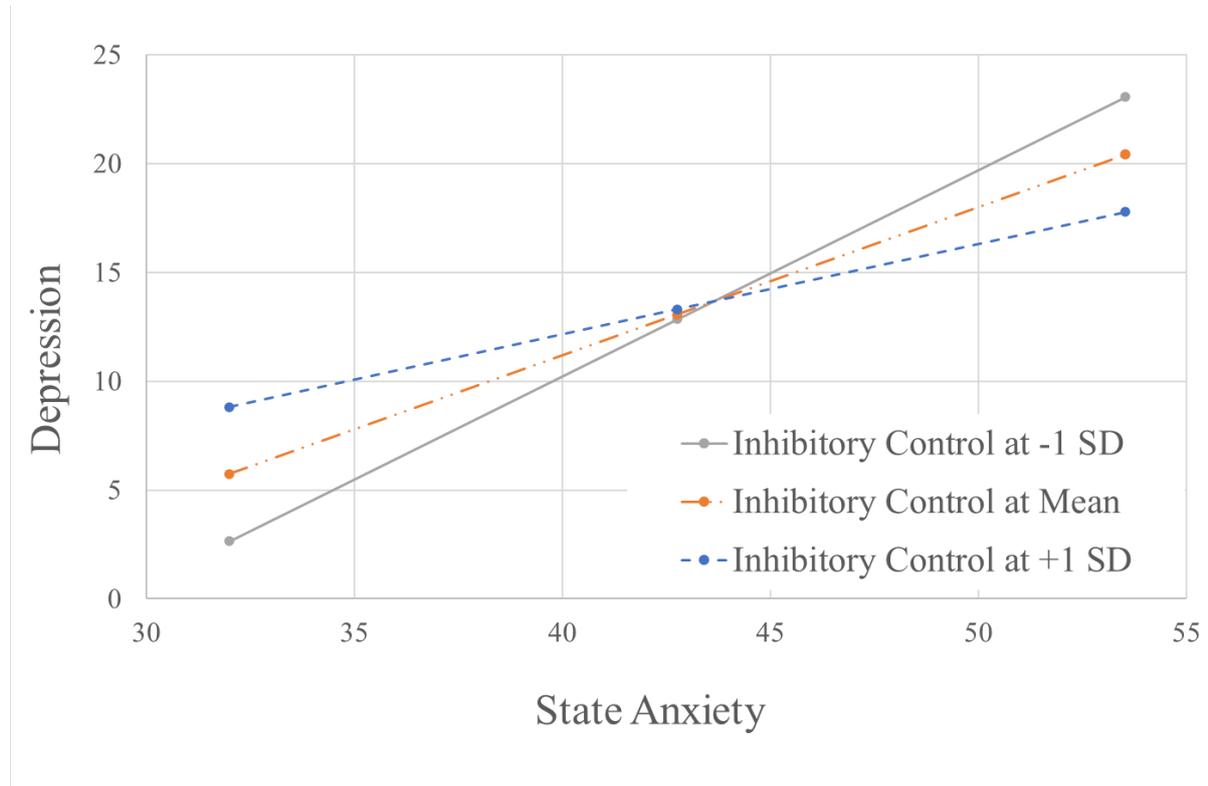


¹ Effect size shown at the mean level of inhibitory control.

(S) Interaction effect is significant.

Figure 6-6

Interaction Effect Between State Anxiety and Inhibitory Control on Depression

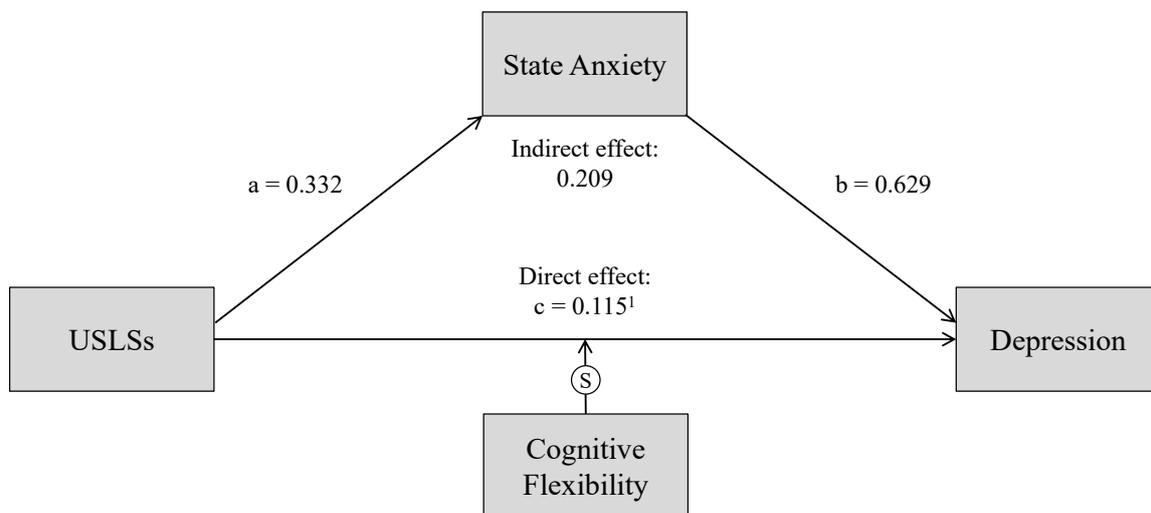


6.4.5 Hypothesis 5: Performance on each distinct EF skill moderates the direct effect between USLSs and depression

Based on an analysis of PROCESS model 5, cognitive flexibility was the only EF skill that significantly interacted with USLSs to directly affect depression (interaction coefficient = - 0.218). While the interaction was significant, the investigation into regions of significance revealed that the moderated direct effect was only significant for levels of the moderator below its sample mean (effect size of 0.300). This finding confirms a statistically relevant concentration of cognitive flexibility scores below the mean. No other EF skills showed significant interactions, and there were no regions of significance for the moderated direct effect (see Figures 6-7 and 6-8).

Figure 6-7

Moderated Mediation: Process Model 5

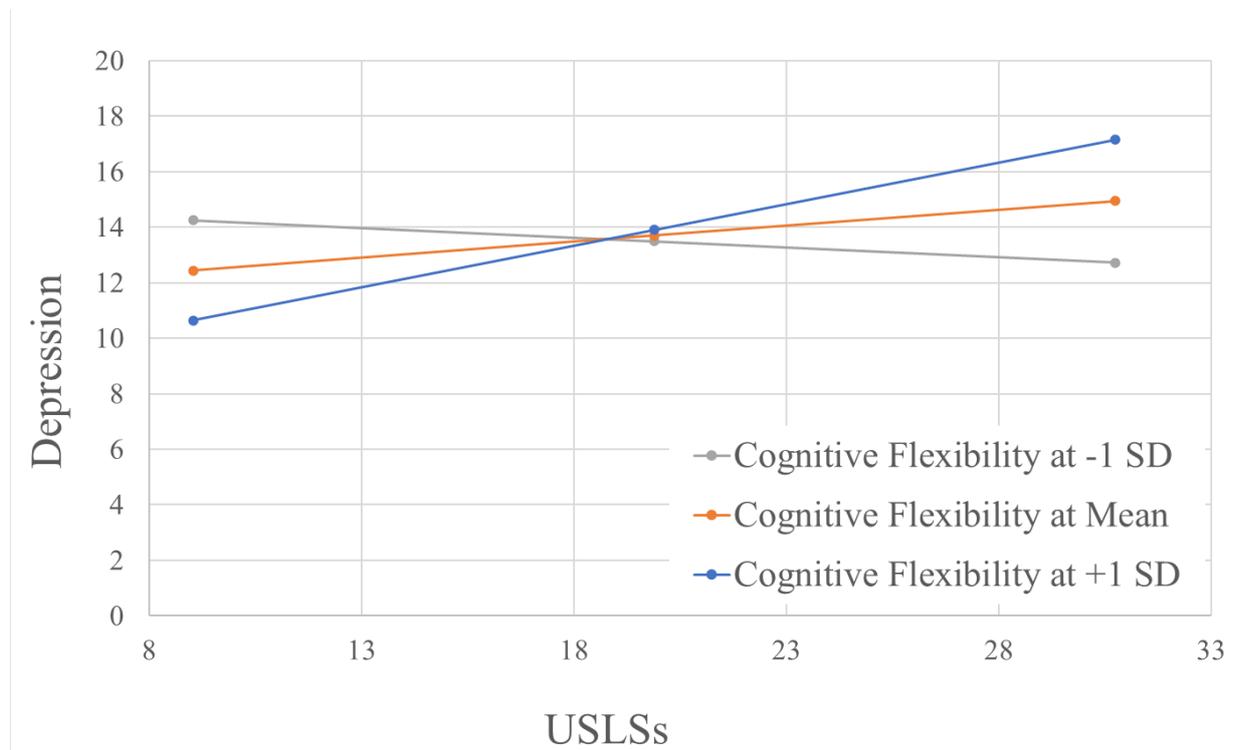


¹ Effect size shown at the mean level of sustained attention.

Ⓢ Interaction effect is significant.

Figure 6-8

Interaction Effect Between State USLSs and Cognitive Flexibility on Depression



6.5 Secondary statistical analysis

Based on the findings from the primary statistical analysis, the dataset was explored further. Two additional hypotheses were tested.

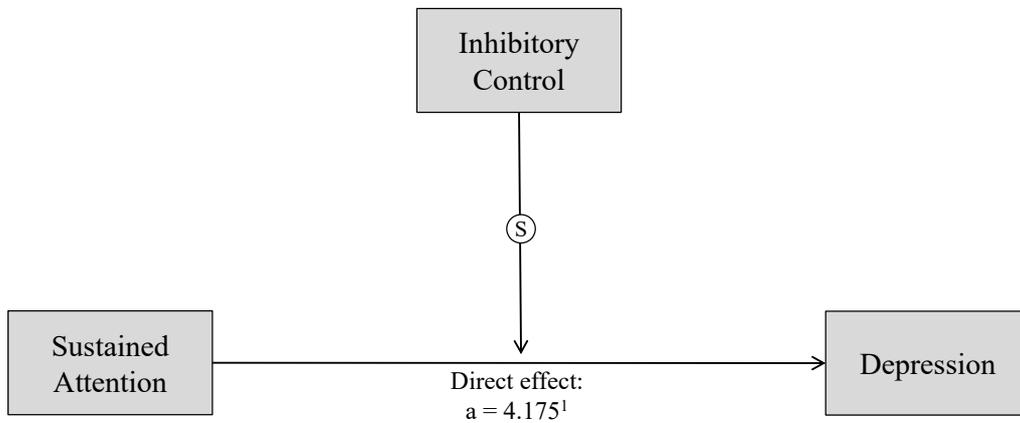
6.6 Results

6.6.1 Hypothesis 6: Inhibitory control capacity has a moderating effect on the relationship between sustained attention and depression

The analysis conducted with PROCESS Model 1 found that students' inhibitory control performance significantly influences how their sustained attention affects levels of depression (interaction coefficient = 5.597). The effect of sustained attention on depression varied from -0.546 to 8.896 for those scoring at +/-1 SD from the mean in inhibitory control performance, respectively (see Figures 6-9 and 6-10 below).

Figure 6-9

Simple Moderation: Process Model 1

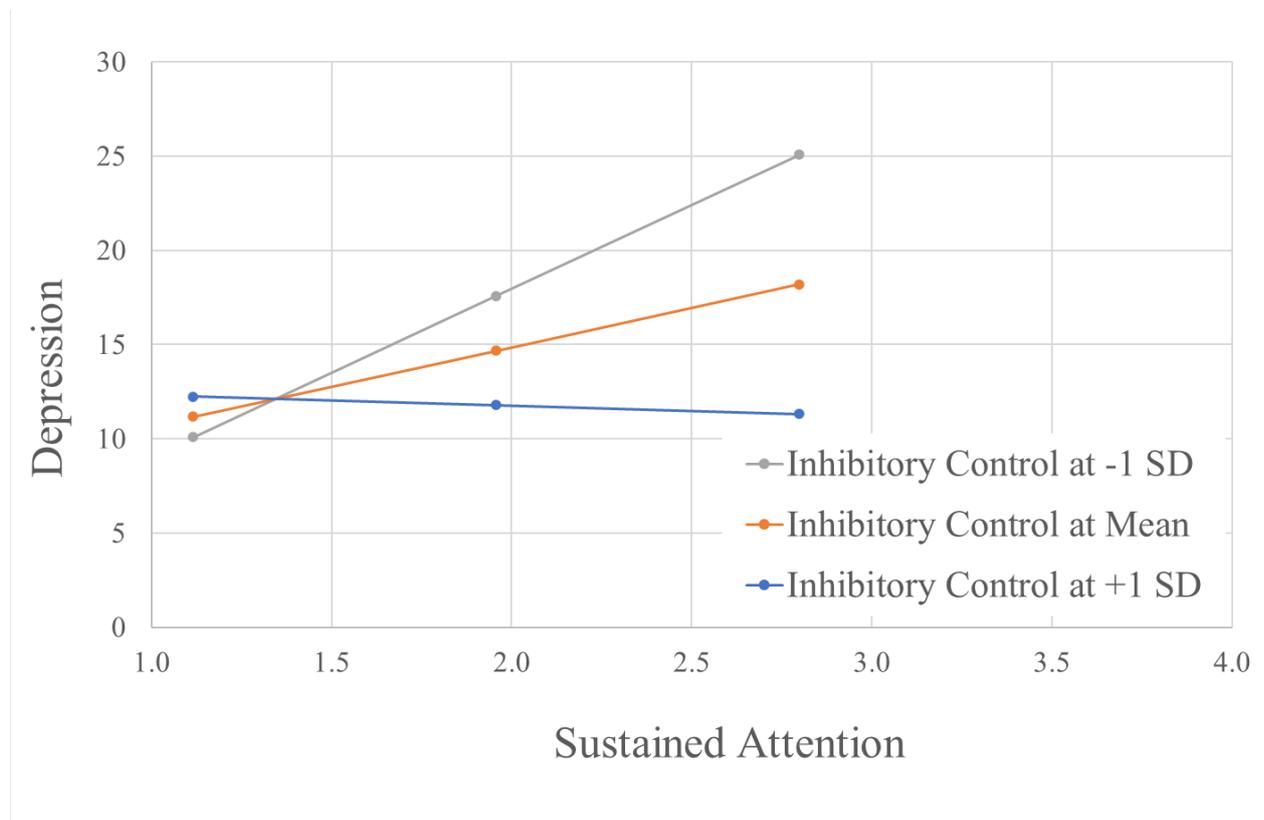


¹ Effect size shown at the mean level of inhibitory control.

Ⓢ Interaction effect is significant.

Figure 6-10

Interaction Effect Between Sustained Attention and Inhibitory Control on Depression



6.6.2 Hypothesis 7: Inhibitory control capacity has a moderating effect on the relationship between cognitive flexibility and depression.

The analysis conducted with PROCESS Model 1 did not confirm the hypothesized relationship. The interaction effect came out at -1.097, but the confidence interval boundaries were calculated at -5.390 and 3.200 respectively. As a result, this hypothesis was rejected.

6.7 Discussion

6.7.1 Statement of major findings

Study 4 extends findings of the previous three studies by exploring EF skills as risk-resilience factors in the direct and indirect relationship between USLSs and depression mediated through state anxiety. Using a moderated mediation approach, this study explored the moderating role of distinct EF skills (inhibitory control, sustained attention, working memory, and cognitive flexibility) in the direct path between USLS-related depression and both legs of the indirect path. A range of EF paradigms were used to probe a conditional effect of cognition on USLS-induced state anxiety and depression.

6.7.1.1 Hypothesis 1

EF skills are directly associated with USLSs. In contrast to the first hypothesis regarding EF skill performance and first-year university students' self-reported USLSs and findings from previous studies (Gagnon & Wagner, 2016; Qin et al., 2009; Schoofs et al., 2009), students' EF performance on tasks requiring working memory, cognitive flexibility, inhibitory control, and sustained attention were not significantly associated with their self-reported USLSs. The discrepancy in findings may be rooted in the study design. While previous studies relied on the assessment of the effect of acute stress (assessed via stress induction methods) on EF performance (Shields et al., 2017), this study assessed stress based on USLSs experienced in a chronic stress context (i.e., the first year at university). Therefore, assessing EF performance after acute stress induction may have yielded different results.

EFs are directly associated with state anxiety. Contrary to the first hypothesis and earlier work (Eysenck & Derakshan, 2011; Vytal et al., 2013), no associations were found between students' state anxiety and EF assessed by working memory and cognitive flexibility performance. The non-significance of these findings may be attributable to the non-clinical sample used in this study. The lack of associations between working memory and cognitive flexibility performance and state anxiety in a non-clinical sample suggests that working memory and cognitive flexibility are robust against normal anxiety variations and only become deficient in clinical anxiety.

Regarding the association between students' inhibitory control capacity and their state anxiety levels, results revealed significantly poorer inhibitory control in highly anxious students compared to students with low state anxiety. This finding is consistent with previous research on anxiety-linked differences in inhibitory control (Basanovic et al., 2018; Eysenck et al., 2007), supporting the presence of a reduced inhibitory control mechanism in anxious individuals. Given that inhibitory control is necessary for regulating emotions (Gil et al., 2021), anxious students with poor inhibitory control may be at particular risk for state anxiety-related mental and physical health issues.

EFs are directly associated with depression. Contrary to earlier studies suggesting a negative association between sustained attention and current acute depression (see Wagner et al., 2015 for a meta-analysis) and in line with Rifkin et al. (2021), who investigated these associations in a non-clinical sample, enhanced sustained attention was found in students with elevated depressive symptoms. These findings substantiate the proposition that in a subclinical sample, higher sustained attention levels may contribute to rumination and subsequent depressive symptoms. Furthermore, only once an individual actively experiences an episode of major depression is their attentional capacity altered (Rifkin et al., 2021).

There is evidence of a negative relationship between EF task performance requiring working memory, inhibitory control, and cognitive flexibility and depressive symptoms in depressed patients and those currently in remission (Dai et al., 2011; Maramis et al., 2021; Nikolin et al., 2021; Stange et al., 2017). However, this study did not confirm such associations. Accordingly, these EF skills may not be affected by and do not impact subclinical symptoms of depression.

6.7.1.2 Hypothesis 2

The second hypothesis looked at whether state anxiety mediates the association between USLSs and depression. The lack of evidence of a direct relationship between some emotional and EF variables does not rule out their association with conditional effects on the relationships between USLSs, state anxiety, and depression. Therefore, the data was further explored in the core model of this thesis, which proved to be significant, as evident in previous chapters.

6.7.1.3 Hypothesis 3

Contrary to the third hypothesis that EF skill performance moderates the association between USLSs and state anxiety—the first leg of the indirect relationship in the core model—no EF variables significantly interacted with USLSs to affect state anxiety (albeit only by a small margin). Yet the indirect relationship between USLSs and depressive symptoms mediated through state anxiety was significant for certain levels of each distinct moderator. However, the indirect effect may not have been significant for other moderator levels outside $\pm 1 SD$ from its mean. Overall, the differences observed in the indirect effects suggest the presence of potential interaction effects. However, these effects did not reach statistical significance in the current study, potentially due to the limited sample size. A post hoc power analysis could shed light on this issue, offering evidence that the study may have been underpowered to detect these interaction effects. The small sample size may have constrained

the ability to uncover statistically significant interaction coefficients, potentially obscuring critical relationships in the data. In future research, it would be beneficial to conduct an a priori power analysis to determine a sample size that will sufficiently increase the statistical power and sensitivity to detect significant interaction effects.

6.7.1.4 Hypothesis 4

In support of the fourth hypothesis that EF skill performance moderates the association between state anxiety and levels of depression—the second leg of the indirect effect in the core model—significant interactions were found for some EF skills.

Inhibitory control

Even though inhibitory control did not significantly correlate with depression in this sample, there was a significant moderation effect on the relationship between USLS-induced state anxiety and depressive symptoms. The moderated mediation model revealed a significant crossover interaction. Independent of inhibitory control performance, higher USLS-induced state anxiety levels were associated with higher depression rates. There was an inverse link between the size of the effect of state anxiety on depression levels and inhibitory control performance. In other words, the weaker the inhibitory control, the more pronounced the effect of USLS-induced state anxiety on depression.

At low state anxiety levels, students with lower inhibitory control reported fewer state anxiety-related depressive symptoms than those with higher inhibitory control. However, at high state anxiety levels, this relationship was reversed, suggesting that while weak inhibitory control exacerbates state anxiety-related depression, strong inhibitory control can only minimize the negative effect of state anxiety on depression. Given that elevated state anxiety is a risk factor for depression, study results support and extend earlier studies proposing a general and non-emotional inhibitory control deficit in non-clinical individuals (Shimony et al., 2021) at risk for depression (Aker et al., 2016).

Sustained attention

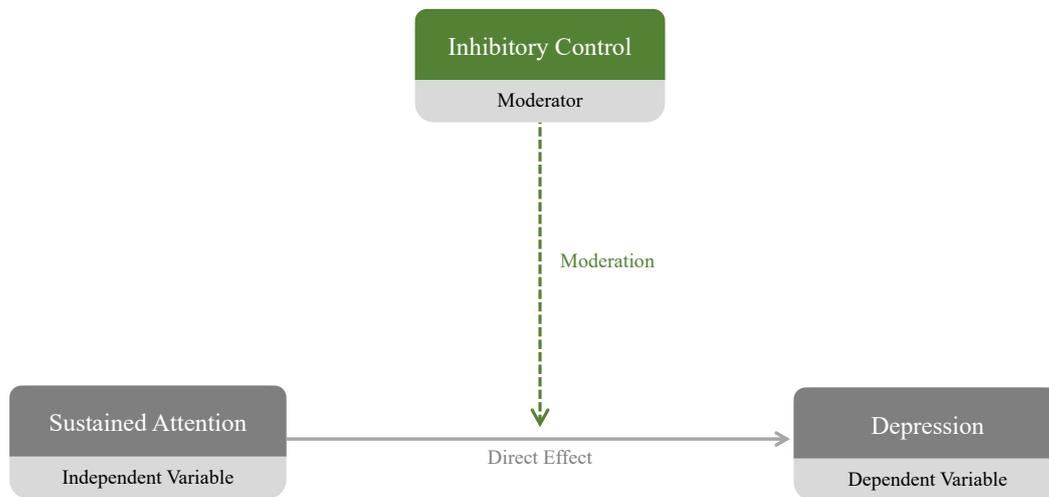
Further supporting the fourth hypothesis, a significant moderation effect of USLS-induced state anxiety and sustained attention on depression was found. For all investigated anxiety levels, students with more sustained attention were more likely to report higher depression levels than those with lower sustained attention. These findings extend previous work (Rifkin et al., 2021), suggesting a positive relationship between sustained attention and depressive symptoms by demonstrating that sustained attention has a moderating role in the USLSs-anxiety-depression relationship, which is strongest for individuals with high sustained attention.

In this study, poor inhibitory control and pronounced sustained attention increased depression risk in anxious students. Previous studies have demonstrated that rumination mediates the relationship between poor inhibitory control and depression and the relationship between high sustained attention and depression (Rifkin et al., 2021; Shimony et al., 2021). Thus, students with poor inhibitory control and strong sustained attention may have a specifically high capacity to indulge in the rumination of negative thoughts and be at greater risk for depression.

To test this secondary hypothesis, the data was further explored through a simple moderation model, with sustained attention as the independent variable, depression as the outcome variable, and inhibitory control as the moderator (see Figure 6-11 below).

Figure 6-11

Moderated Model: PROCESS Model 1



The analysis revealed a significant interaction effect of inhibitory control and sustained attention on depression, suggesting students with higher sustained attention are not at an increased risk for depression unless they also have poor inhibitory control. These findings suggest an interplay between inhibitory control and sustained attention in contributing to depression among students. Specifically, students who exhibit poor inhibitory control and strong sustained attention have a heightened capacity for dwelling on negative thoughts, escalating their risk for depression. The subsequent moderation model reaffirms this dynamic, indicating heightened sustained attention does not enhance the risk of depression unless paired with weakened inhibitory control. This finding highlights the complexity of the cognitive processes underlying depression, demonstrating the importance of these interactions when developing interventions. These findings underscore the crucial role of inhibitory control in moderating the influence of sustained attention on depression, shedding light on potential targets for preventive strategies and therapeutic interventions for depression among students.

Cognitive flexibility and working memory

Similar to working memory, cognitive flexibility did not significantly moderate the second leg of the indirect relationship between USLS-related state anxiety and depressive

symptoms. These findings suggest that contrary to the fourth hypothesis, neither working memory nor cognitive flexibility significantly influences the relationship between USLS-related state anxiety and depressive symptoms. In other words, the negative impact of state anxiety induced by USLSs on depression is not moderated by the capacity of students' working memory or cognitive flexibility. This result nuances the understanding of the cognitive mechanisms underpinning depression and anxiety, indicating that not all aspects of executive function play a pivotal role in this relationship.

6.7.1.5 Hypothesis 5

Working memory, sustained attention, and inhibitory control

Regarding the fifth hypothesis, which pertained to the direct moderating effect of EF skill performance on the USLSs-depression relationship, working memory, inhibitory control, and sustained attention performance did not significantly interact with USLSs to predict depression. Notably, some findings were close to significant levels. There was a strong tendency for students with poor inhibitory control and elevated sustained attention to present with increased USLS-related depressive symptoms. Therefore, poor inhibitory control and high sustained attention may also increase vulnerability for USLS-related depressive symptoms in students with low anxiety levels. This connection could not be demonstrated in this study's small dataset. However, a larger dataset may have yielded more significant results.

Cognitive flexibility

USLS-related depressive symptoms were found to hinge on first-year students' cognitive flexibility capacity. Even though cognitive flexibility was not directly related to depressive symptoms, study results revealed a significant crossover interaction effect between USLSs and cognitive flexibility on depression levels. At low USLS levels, students with high cognitive flexibility had fewer depressive symptoms than those with low cognitive flexibility. However, when exposed to many USLSs, students with enhanced cognitive flexibility showed

the highest depression rates. Thus, similar to increased depression rates in individuals with high sustained attention (Rifkin et al., 2021), enhanced cognitive flexibility may promote USLS-related depression.

This finding challenges the notion that enhanced cognitive flexibility is an adaptive skill fostering depression resilience and that poor cognitive flexibility is a vulnerability factor for depression (see Morris et al., 2014; Schmid & Hammar, 2013; Stange et al., 2016, 2017). The discrepancy in findings may be because these studies investigated the direct association between cognitive flexibility and depression rather than the moderating effect on the relationship between SLEs and depression. By demonstrating that students with enhanced cognitive flexibility who experience many USLSs are at an elevated risk for depression, this study adds further insight into the pathogenesis of USLS-related depression in the undergraduate population.

Like the effect of high sustained attention on the relationship between USLS-induced state anxiety and depression, enhanced cognitive flexibility may facilitate rumination on the consequences of experienced USLSs and thus exacerbate depressive symptoms. Therefore, to test a secondary hypothesis suggesting that inhibitory control moderates the relationship between cognitive flexibility and depression, a post hoc analysis was performed. The results did not confirm this hypothesis. Therefore, inhibitory control does not help differentiate between students with high cognitive flexibility regarding their depression vulnerability.

6.7.2 Suggestions for interventions

Study findings demonstrate that the impact of EFs on depression levels was highest for students reporting higher numbers of USLSs and those with elevated USLS-related anxiety. Therefore, interventions aimed at reducing stress and anxiety may protect those at increased risk due to their cognitive profile, representing a pattern of strength and challenges across cognitive domains.

To reduce stress and anxiety, students can seek the counsel of qualified professionals on campus who actively listen and provide coping techniques to manage negative feelings. Supervisors or student representatives may then refer students to university counselors or psychologists. However, students need to be aware of these opportunities and feel like the campus is a safe space to show their vulnerability. Events such as induction and freshers' day are examples where students can receive information about such resources. Lastly, universities can incorporate psychoeducation courses into their curricula. According to Hood et al. (2021), psychoeducation is an “approach of teaching students about the underlying causes of mental health problems and evidence-based interventions they can use to treat such issues” (p. 2). In addition, universities could add more content about well-being and mindfulness into their existing psychology courses.

Furthermore, findings revealed that high sustained attention only constituted an elevated depression risk for students with low inhibitory control levels. This finding suggests that inhibitory control training interventions may be beneficial in reducing depression risk in students with elevated stress-induced anxiety and high sustained attention.

Finally, poor inhibitory control is strongly associated with increased rumination (Shimony et al., 2021), contributing to depression in people with high sustained attention. Therefore, addressing rumination among students with poor inhibitory control may lower their risk of depression. Rumination-focused cognitive behavioral therapy, developed by Watkins et al. (2011), is one method to successfully target the rumination thought cycle and reduce anxiety and depression symptoms (Feldhaus et al., 2020; Umegaki et al., 2022). Future studies on the efficacy of such a method in students with concurrent high sustained attention and poor inhibitory control via rumination are needed.

6.7.3 Limitations and future directions

This study has several limitations. First, the study is limited by not including other variables likely to influence the relationship between better EF and students USLS related anxiety and depression. One such variable is intelligence, the ability to understand, learn and make judgements. Highly intelligent people seem to suffer more from depression than average and lower-intelligent people (Li & Kanazawa, 2016). Individual differences in intelligence have also consistently been linked with individual differences in metacognitive EF (Engelhardt et al., 2016). Consequently, the current study finding of better sustained attention and stronger cognitive flexibility in elevated stress-related depression may be indicative of higher intelligence underlying this relationship. Future studies could explore the role of EF in USLS-related state anxiety and depression, including intelligence as a control variable.

Second, the outcomes of the present study might be potentially limited due to the chosen measurement tools, specifically, the 'number of errors' metric of the PAL task and the 'false alarm' measure of the RVP. Notably, the former was implemented as measure for working memory and was not found to significantly moderate the relationship between USLSs, state anxiety, and depression. This may be attributed to PAL's characteristics, as it is not a pure measure of working memory, incorporating another cognitive process—paired associative learning. Therefore, future investigations could benefit from using tests that offer a more precise measure of working memory to potentially achieve divergent results. One option is the Digit Span Backward task, a subtest of the Wechsler Memory Scale (Wechsler, 2009). Alternatively, researchers could use the Automated Operation Span Task (AOSPAN), which is recognized for its specificity in assessing working memory capacity, providing a more refined measure of this discrete cognitive ability (Unsworth et al., 2005). Regarding the false alarm measure from the RVP task used in this study to assess inhibitory control, it is critical to consider that this task also demands sustained attention over a prolonged period, which may dilute its

effectiveness as a pure measure of inhibitory control. Thus, the application of other measurement tools specifically designed to assess inhibitory control could refine and affirm the current study's findings. Potential alternatives include the Go/No-Go task, the Stop Signal task, or the Flanker task (Diamond, 2013).

Third, regarding the study design, rumination—a variable strongly associated with inhibitory control—was not included. Regardless, the tendency to ruminate among students with concurrent poor inhibitory control and high sustained attention could make them more vulnerable to depression. Thus, future studies should explore the effect of poor inhibitory control on the relationship between sustained attention and depression and students' tendency to ruminate.

Fourth, this study was limited to a small sample size, which led to an investigation of 12 moderated mediation models and two moderation models. A larger dataset would enable models that test the impact of a distinct EF on the direct and both legs of the indirect path simultaneously (e.g., Process Model 59). Such an approach could reveal where a specific EF has the most impact. Thus, future studies could replicate this study using a larger sample and more complex conditional models.

Finally, contrary to the finding of reduced EF in the clinical population, this study demonstrated that in healthy undergraduate students (i.e., no clinical acute diagnosis of mental illness), enhanced sustained attention and inhibitory control seem to facilitate depression, leading to EF deficits in the clinical population. Because this study had a cross-sectional design, evidence of such a trajectory could not be provided. Future studies investigating longitudinal cognition and emotional interactions are needed to substantiate this idea.

6.7.4 Conclusion

This study was the first to use a moderated mediation approach to investigate the role of EF skills in first-year university students' USLS-related state anxiety and depression. The

results revealed that poor inhibitory control and high sustained attention increased depression risk in anxious students and that high cognitive flexibility increased the depression risk independent of their state anxiety. When considering the direct relationship between sustained attention and depression while including inhibitory control as a moderator, low inhibitory control promotes and high inhibitory control buffers the negative effect of sustained attention on depressive symptoms. This finding suggests that students with high sustained attention are not always at an increased depression risk, but they are if they have low inhibitory control. These findings highlight the importance of including EF as a target for prevention and intervention techniques to limit students' USLS-related depression.

7 General Discussion

7.1 Introduction

Exposure to SLEs is one of the most reliable predictors of anxiety and depression in all age groups, especially in late adolescence (Anniko et al., 2018). However, stress does not necessarily lead to anxiety and depression due to exposure to SLEs (Shin & Liberzon, 2010). In other words, individual differences in how people respond to SLEs may help explain who can cope and who is prone to experiencing symptoms of distress (Aldao et al., 2010). First-year university students find themselves in a potentially stressful situation when they initially leave home and transition to independent living and academic study. This phenomenon is due to ongoing neurodevelopmental challenges paired with a new environment in which they are exposed to an increased number of USLSs.

Accordingly, mental health problems such as anxiety and depression are prevalent among first-year university students (Duffy et al., 2020; McLafferty et al., 2017). However, little attention has been paid to why some students can manage their first year of studies while others experience serious mental health issues. It is imperative to identify factors that protect students or place them at an increased risk for USLS-related anxiety and depression. Therefore, this thesis aimed to identify specific resilience and risk factors using a moderated mediation approach to examine the association of first-year university students' USLSs with state anxiety and depression based on their personality, sleep quality, and a range of neurocognitive factors.

This chapter synthesizes the findings of this thesis, offering a comprehensive examination of theoretical and practical implications. Specifically, it draws comparisons and distinctions based on the thesis's proposition that certain factors—such as trait anxiety, trait anhedonia, sleep quality, and EF—synergize with typical stressors inherent to university life, potentially leading to heightened levels of anxiety and depression observed in first-year university students. This chapter also includes reflections on the study's limitations, providing

a critical view of the research. Lastly, it outlines prospective avenues for future research inspired by the findings and limitations of this current study. These recommendations may spur further scientific inquiry into this issue, allowing for more preventative and intervention strategies for mental health issues among university students.

7.2 Study 1 (Chapter 3)

The aims of Study 1 were to (a) confirm the presence of generally high levels of stress, anxiety, and depression in first-year university students; (b) confirm findings from previous studies suggesting that exposure to USLSs is positively associated with state anxiety and depression; (c) confirm previous findings suggesting that state anxiety mediates the relationship between SLEs and depression; and (d) explore if trait anxiety acts as a moderator of the first leg of the indirect association between USLSs and depression mediated by state anxiety.

In line with previous research, the statistical analyses revealed high stress, anxiety, and depression levels in students compared to the general population, reinforcing the importance of investigating the mechanism underlying these factors. Furthermore, the results supported earlier studies investigating the associations between life stress and mental health in undergraduate students (Doyle et al., 2021; Ramón-Arbués et al., 2020). The data revealed that exposure to a large number of USLSs was significantly associated with students' anxiety and depression levels.

The aim of this study was to clarify the role of state and trait anxiety in the relationship between life stressors and depression. As hypothesized, and in line with other studies, state anxiety partially mediates the relationship between USLSs and depression (Anyan et al., 2018; Kok et al., 2016). Notably, the direct effect between USLSs and depression remained significant, suggesting that some students experienced USLS-related depressive symptoms without feelings of unease, such as worry or fear. Thus, these findings support the proposition

that depression can be divided into two qualitatively different categories (depression with and without features of anxiety; Maes et al., 1994) and extend previous findings from the clinical population by demonstrating that this classification already exists in the subclinical population. Students with high trait anxiety were not at an increased risk for USLS-related state anxiety. However, those with elevated USLS-related state anxiety were more likely to show depressive symptoms if they also had high trait anxiety. Thus, the extent to which two students who have experienced similar levels of USLS-related state anxiety experience depressive symptoms depends on their innate anxious personality characteristics. These findings are in line with the view that state anxiety is a temporary natural human response to threat, for which a person does not need to have an underlying anxiety condition (Hutchins & Young, 2018).

This was the first study to demonstrate that like other stressors, USLSs are associated with students' state anxiety and depression, suggesting that the USQ is a valuable tool to assess USLS-related anxiety and depression. By demonstrating that those students with an anxious personality are at a specific depression risk when experiencing USLS-related state anxiety, this study clarified inconsistencies in the literature on the role of trait and state anxiety in the stress-depression relationship.

Suggestions for future research

Based on these findings, when exploring factors underlying the stress-anxiety-depression relationship, one should differentiate between the mediating and moderating role of state and trait anxiety.

7.3 Study 2 (Chapter 4)

Study 2 extended Study 1 findings by exploring the role of high trait anhedonia as another personality trait that may put students at an elevated risk for USLS-related anxiety and depression. A moderated mediation model (PROCESS model 59) was tested with USLSs as

the predictor variable, depression as the outcome variable, state anxiety as the mediator, and trait anhedonia as the moderator of the direct and both legs of the indirect path.

Students with elevated anhedonia also showed heightened state anxiety and depression. Furthermore, trait anhedonia did not have a conditional effect on the relationship between USLSs and state anxiety for students scoring at the low levels of trait anhedonia, but it had for students scoring at medium and high levels. These findings suggest that at higher levels, trait anhedonia is a factor that puts students at an increased risk for state anxiety when exposed to a large number of USLSs. Furthermore, trait anhedonia significantly moderated the effect USLS-related state anxiety had on depression and also the direct effect USLSs had on depression. The moderating effect of trait anhedonia on the indirect path between USLSs on depression (mediated through state anxiety) was stronger than its effect on the direct relationship between USLSs and depression. This suggests that when exposed to large numbers of USLSs, students with both state anxiety and trait anhedonia are at a higher depression risk compared to students who presented with anhedonia in isolation of state anxiety. These findings uncovered the role of trait anhedonia as a specific risk factor for new students' USLS-related state anxiety and depression. Notably, those students with elevated state anxiety seemed to be at a specifically high depression risk when they also showed elevated trait anhedonia.

Furthermore, Study 2 findings support the view that, by activating the affiliative and soothing drive system (Gilbert, 2009a, 2009b), social interaction may protect against the development of physical and mental health problems in a stressful context (Lienert et al., 2017; Yancy et al., 2015). Therefore, from a practical standpoint, these findings indicate that students with fewer social interactions due to their anhedonic personality may benefit to a lesser extent from the soothing and affiliation gained, which may result in a specific vulnerability to USLS-related anxiety and depression.

Suggestions for future directions

In this study, trait anhedonia was not associated with the number of USLSs experienced. This may be an artificial finding for the following reason. Typically, individuals with high trait anhedonia engage less in social interactions. However, some USQ items assess psychosocial stressors (e.g., arguments, conflicts between friends, relationship breakups). Therefore, anhedonic students may have fewer social interactions, limiting the resulting psychosocial stress. Thus, a measurement tool with a greater emphasis on psychosocial life stressors, such as financial challenges, transportation problems, or general health issues may have yielded different results. Future studies investigating the relationships between SLEs, state anxiety, and depression in students with trait anhedonia should choose a measurement tool that does not include items referring to social interactions. Such an approach may reveal a significant relationship between SLEs and trait anhedonia not found in this study.

Furthermore, Study 2 relied on the trait anhedonia subscale of the Oxford Liverpool Inventory of Feelings and experiences, which is dominated by social anhedonia items. However, anhedonia is a multifaceted construct, constituting social, physical, and consummatory anhedonia. Future studies are needed to clarify the findings reported here, exploring whether physical and consummatory anhedonia are also risk factors for first-year students' USLS-related state anxiety and depression.

7.4 Study 3 (Chapter 5)

Studies 1 and 2 identified trait anxiety and trait anhedonia as vulnerability factors for stress-related state anxiety and depression. Another factor suggested to influence the relationship between these variables is sleep quality (Kalmbach et al., 2015; Leggett et al., 2016). The aims of Study 3 were to (a) assess the prevalence of sleep quality in first-year university students; (b) assess associations between sleep quality and symptoms of anxiety and depression; (c) confirm the core model of this thesis; and (d) explore a moderating role of sleep quality in the core model of this thesis.

The majority of students in this study (61.75%) had poor sleep quality (PSQI > 5). These numbers are in line with reports from previous investigations into the prevalence of sleep quality in the student population (Al-Khani et al., 2019; Attal et al., 2021). In support of the literature, poor sleep quality was related to students' self-reported USLSs and their anxiety and depression levels (Dinis & Bragança, 2018; Li et al., 2019, 2020; Manzar et al., 2021). Furthermore, mirroring Studies 1 and 2 findings, for a significant number of students, state anxiety helped explain the association between USLSs and depression. Finally, a set of three moderated mediation models (PROCESS Model 5, 7, and 14) revealed that like trait anxiety in Study 1 and trait anhedonia in Study 2, sleep quality significantly moderated the second leg of the core model. Thus, students with elevated state anxiety and concurrent poor sleep seemed specifically vulnerable to experience high levels of depressive symptoms.

7.5 Study 4 (Chapter 6)

Studies 1, 2, and 3 identified high levels of trait anxiety, trait anhedonia, and poor sleep quality as vulnerability factors for stress-related state anxiety and depression. Cognitive functioning may also influence how students cope when exposed to USLSs and potentially foster or mitigate the ramifications of USLSs on state anxiety and depressive symptoms. The aims of Study 3 were to (a) assess associations between EFs and self-reported USLSs as well as symptoms of state anxiety and depression; (b) confirm the core model of this thesis; and (c) explore the role of EFs in the core model of this thesis.

A range of EF paradigms exists to assess associations between distinct EFs and students' self-reported USLSs, state anxiety, and depression. EF components such as inhibitory control and sustained attention are positively associated with state anxiety and depression levels, substantiating the value of investigating these relationships using individual EF scores rather than a global score.

A series of moderated mediation models were used to assess the moderating role of distinct EF components (cognitive flexibility, sustained attention, inhibitory control, and working memory) in the core model of this thesis. The study findings go beyond previous reports by demonstrating that when exposed to many USLSs: (a) students with high cognitive flexibility seem to be at an elevated depression risk; and (b) those with high USLS-induced state anxiety are at an increased risk for depression when they have concurrent poor inhibitory control and high sustained attention. These findings suggested that in a stressful context, better inhibitory control can limit the negative impact of USLSs on depression, while stronger sustained attention and better cognitive flexibility facilitate this effect.

Considering that extensive rumination (the repetitive and passive focus on causes and consequences of a person's experienced distress) in individuals with both poor inhibitory control and high sustained attention has been shown to facilitate depression, it may be that high inhibitory control could ameliorate this effect. This idea was further explored through testing if the relationship between strong sustained attention and depression was moderated by inhibitory control. The results revealed that students with strong sustained attention are not per se at an increased depression risk per se, unless their inhibitory control is poor.

Collectively, the study results suggest that (a) in a first-year undergraduate student population, higher levels of depressive symptoms in response to USLSs and USLS-induced state anxiety are promoted through certain aspects of EF (weak inhibitory control, strong sustained attention, and high cognitive flexibility); and (b) the negative effect of higher sustained attention on depressive symptoms can be compensated for through better inhibitory control.

These findings support and extend the limited literature, suggesting that strong EF is not always adaptable in the subclinical population. Furthermore, they add to a more nuanced understanding of the emotional and cognitive processes underlying the stress-anxiety-

depression relationship in a nonclinical first-year student population. Thus, the study findings inform current emotion–cognition interaction theories and hold critical implications for prevention efforts for first-year undergraduate students based on their cognitive profile—specifically cognitive flexibility, sustained attention, and inhibitory control.

7.6 Executive summary of findings and implications for interventions

First-year university students often encounter a stressful new environment. In line with the literature (Duffy et al., 2020; McLafferty et al., 2017), the study results in this thesis demonstrated that anxiety and depression are prevalent mental health problems. However, little is known about factors predisposing new students to experience USLS-related anxiety and depression. Identifying such factors is critical in developing new and informing existing preventive interventions for high-risk individuals. Accordingly, this thesis used a moderated mediation approach to identify specific risk factors, such as personality profiles, sleep quality, and cognitive profiles, for USLS-related anxiety and depression.

Overall, study findings suggest a high prevalence of USLSs, anxiety, and depression among first-year students. Study 1 clarified inconsistencies in the literature regarding the role of trait and state anxiety in the stress-depression relationship. The findings revealed that students' state anxiety levels partially explain the USLS-depression relationship. Furthermore, high-trait anxiety students were vulnerable to presenting with state anxiety-related depression. Universities should identify high trait anxiety students early and offer interventions such as muscle relaxation, mindfulness meditation, and cognitive behavioral training. This strategy could help prevent the development of depressive symptoms in students with concurrent high state and trait anxiety.

Study 2 extended Study 1 findings by demonstrating that when exposed to numerous USLSs, students with high levels of anhedonia were at an increased risk for state anxiety and depression. Thus, those with concurrent elevated state anxiety and anhedonia had the highest

depression risk. Given these findings, anhedonic students may benefit from interventions including behavioral activation and social skills training. Universities should actively offer such interventions to students who struggle with social integration when starting university.

Study 3 findings revealed that students presenting with state anxiety after exposure to many USLS are at an increased risk for state anxiety-related depression depending on sleep quality. Accordingly, students with high state anxiety and poor sleep quality are at an increased risk to show depressive symptoms, especially compared to those with low anxiety. Therefore, universities should offer prevention options and interventions that combat sleep issues for anxious students with poor sleep quality. Sleep hygiene education—alongside cognitive behavioral training, mindfulness meditation, and progressive muscle relaxation—has proven to decrease stress awareness, elevate mood, and increase sleep quality (Soleimani et al., 2016).

Finally, Study 4 findings revealed that a student's cognitive profile provides insight into those prone to experience USLS-related state anxiety and depression. The results demonstrated that anxious students with weak inhibitory control and concurrent high sustained attention (the latter of which is generally favorable) were at increased risk of depression. These results have critical implications for identifying depression vulnerability among first-year students. Furthermore, given that high-anxiety students with better inhibitory control and high sustained attention did not show increased depression rates, improving inhibitory control in those students may help prevent depression. Inhibitory control training may benefit anxious students with high sustained attention (Shanok et al., 2022). Universities could offer inhibitory control training to anxious students with high sustained attention.

Furthermore, Study 4 findings revealed that when experiencing many USLS students with high cognitive flexibility (as high sustained attention, a generally adaptable cognitive ability) were at an increased depression risk. Students with high cognitive flexibility were not at an increased depression risk per se, but this was the case when exposed to many USLSs.

Therefore, these students may be at risk for USLS-related depression and benefit from stress intervention methodologies, such as cognitive behavior therapy, mindfulness-based interventions, or progressive muscle relaxation. Universities should evaluate if these therapies and interventions positively affect students with co-occurrent high stress levels and high cognitive flexibility.

7.7 General limitations and further directions

Although this thesis has many theoretical and practical implications, several limitations highlight notable areas for future research. First, the specific thesis framework of this thesis did not allow for collecting a large amount of data for each study, resulting in smaller sample sizes. In particular, the moderating role of EF (70 participants) and sleep quality (102 participants) in the core thesis model might have revealed more significant results in a larger sample.

Second, samples were collected from one UK university; thus, findings may not be generalizable to the country or globally. Since many universities focus on student diversity and cultural representation from several countries, this setting is ideal for expanding on the foundational studies in this thesis. However, some universities may have cultural biases and limit or even exclude some populations from their student bodies. Therefore, future researchers should be mindful when replicating these thesis studies across different universities and countries.

Third, this thesis used a cross-sectional study design, which is valuable in providing a snapshot of the phenomena at a particular point in time but limits the ability to infer causal relationships among the variables examined. This limitation presents certain constraints, partially offset by replicating and extending previous longitudinal findings within the present study. However, this is not an absolute solution. To provide stronger evidence for causality and to understand how the identified risk factors may escalate USLS-related state anxiety and

depression over time, future research would benefit from adopting a longitudinal study design. Longitudinal studies would enable examining changes in these risk factors and their impact on USLS-related anxiety and depression across different time points, providing a more comprehensive and dynamic understanding of these relationships. This design would facilitate the development of more timely and effective interventions for mitigating the negative effects of USLS on student mental health.

Fourth, while PROCESS is a powerful statistical tool for exploring moderated mediation effects, it has certain limitations. Most importantly, PROCESS models often take the form of black box modeling, meaning that they generate outputs without explicitly demonstrating the intricate computations that occur within (Fairchild & McDaniel, 2017). This lack of transparency can be problematic, making it more challenging to fully understand and articulate the underlying mathematical and statistical processes involved, limiting the depth of their interpretation and discussion of results (Preacher & Hayes, 2004). Furthermore, while PROCESS provides a user-friendly interface for complex analyses, its ease of use can also be a limitation. Specifically, it offers limited flexibility compared to more complex statistical software such as SEM or multi-level models. PROCESS does not readily accommodate multi-level data structures, complex sampling designs, or missing data techniques (Hayes & Rockwood, 2019). These limitations can restrict the types of research questions and datasets that can be addressed using this tool. Thus, while PROCESS is a valuable resource, its use should be considered in the context of the research design and objectives (Muller et al., 2005).

Fifth, Cronbach's alpha values for the specific questionnaires and subscales in the studies of this thesis were not reported. This decision was based on the well-established nature of these instruments and the availability of Cronbach's alpha values in previous literature. While prior studies have supported the internal consistency of the measures, the absence of reported Cronbach's alphas in this thesis limits the direct examination of internal reliability

within the context of this research. Future studies utilizing electronic questionnaires may benefit from reporting Cronbach's alpha as it provides valuable information regarding the reliability of questionnaire scores and strengthens the validity of the findings.

Sixth, the samples of the distinct studies consisted predominantly of female students. Thus, it cannot be assumed that the results from these studies would generalize equally to both males and females. Future studies investigating the processes addressed in this research are needed to explore whether the established risk factors apply to both male and female students equally.

Finally, the studies focused on first-year psychology undergraduate students. Thus, the study design did not include control groups, such as students in different years of study, students in other faculties, students in other institutions, or non-students. Thus, the findings reported may not be unique to first-year university students. Future research should explore the processes investigated in this thesis in the overall student and general population.

7.8 Conclusion

Through a moderated mediation approach, this thesis explored risk factors for first-year university students' USLS-related state anxiety and depression. In line with previous work, high distress was found among first-year university students. By identifying trait anxiety as a moderator in the relationship between USLSs and depression mediated by state anxiety, Study 1 clarified inconsistencies in the literature on the role of trait and state anxiety in the stress-depression relationship. Studies 2 to 4 were the first to identify high trait anhedonia, poor sleep quality, and high cognitive flexibility—as well concurrent high sustained attention and poor inhibitory control—as specific risk factors for USLS-related state anxiety and depression among first-year students.

Informed by this evidence, universities must improve existing and develop new mental health strategies to proactively identify students with these risk factors. To prevent

exacerbation of risk factors and associated mental health problems, universities also must provide vulnerable students with interventions that effectively reduce stress, anxiety, and anhedonia while improving sleep quality and inhibitory control. Such a holistic approach can further enhance academic success, well-being, and mental health throughout adulthood.

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