

**Exploring the Associations Between Problematic Smartphone Use and Academic Stress,  
Depression, Emotion Regulation, and Self-Regulation among University Students**

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### **Abstract**

University students spend up to six hours daily on their phones and are most affected by problematic smartphone use (PSU). Existing literature is contradictory in terms of which constructs are associated with PSU and how those constructs are interrelated. This study aims to investigate associations between the constructs of perceived academic stress, self-regulation, depressive symptoms, emotional regulation difficulties, and PSU among Dutch and German university students. Further, the present paper examines if self-regulation moderates the relationship between perceived academic stress and PSU. A cross-sectional, quantitative study design was used, and research data was gathered via online self-reports from a sample of 71 university students (aged 18-35; 61.97 % female, 33.80 % male, and 4.23% non-binary). Four linear regression analyses were conducted to investigate the associations with PSU. Additionally, a moderation analysis was conducted to investigate a moderating effect of self-regulation on the relationship between perceived academic stress and PSU. The results of the four linear regressions reveal significant individual associations between all constructs and PSU, in line with prior research findings. A moderation effect of self-regulation is not detected. The results of this study replicate previous research findings by confirming significant individual associations between the psychological constructs and PSU, suggesting the importance of addressing these factors when dealing with PSU. Further, the insignificant moderation analysis suggests that self-regulation does not buffer the effects of perceived academic stress on PSU in German and Dutch students. Future longitudinal studies are needed to establish causal relationships and to further investigate the role of self-regulation in the relationship between academic stress and PSU.

*Keywords:* Problematic Smartphone Use (PSU), Perceived Academic Stress, Mental Well-being, Depressive Symptoms, Self-regulation, Emotion Regulation, University Students

## **Exploring the Associations Between Problematic Smartphone Use and Academic Stress, Depression, Emotion Regulation, and Self-Regulation among University Students**

A widespread increase in smartphone use has brought about positive and negative implications for individuals of every generation. Over the last decade, smartphone use has grown terrifyingly in all age groups, including younger and older users (e.g., Busch et al. 2021). According to Statista, in 2023, the current number of smartphone users in the world is 6.92 billion, meaning 86.11 per cent of the world's population owns a smartphone (Statista, 2023). On the one side, using a smartphone is convenient and offers access to countless forms of entertainment, online shopping, virtual socialising, and others. Conversely, with all the possibilities the device offers, there is growing evidence of several adverse effects of excessive smartphone use on mental health and well-being (e.g., Billieux et al. 2015). Consequently, excessive use of digital media, particularly smartphone use, has been linked to various mental health problems, highlighting the need for further research and intervention in this area.

With an overwhelming prevalence of smartphone ownership among university students, this group emerges as a particularly vulnerable population to the adverse effects of smartphone use. Even though all age groups are now increasingly using smartphones, one of the most significant proportions of users consists of university students whose majority use their smartphones four up to six hours a day (Ataş & Çelik, 2019; Forster et al., 2021; Parent et al., 2022; Roberts et al., 2014). According to the research literature, excessive use of digital media has been associated with an increase in mental health problems, particularly among university students (e.g., Lattie et al., 2019). On top, a large-scale epidemiological study shows that diagnoses of psychopathology in university students increased from 22% to 36% between 2007 and 2017 when the first smartphone and social media were gaining popularity (Reuter, 2007;

Lipson et al., 2019). These findings highlight the need to further explore the relationship between PSU and mental health problems among university students and point the way toward a comprehensive understanding of PSU. The subsequent section focuses on the definition of PSU and its key characteristics.

### **Problematic Smartphone Use**

PSU has recently become a focus of attention in the scientific literature and is related to and used interchangeably with smartphone addiction and problematic internet use (e.g., Busch & McCarthy, 2021, for a systematic review; Fu et al., 2020; Kuss et al., 2014; Rozgonjuk et al., 2021; Wacks & Weinstein, 2021; Wang et al., 2015). The terms commonly capture excessive smartphone use, which becomes problematic if the behaviour results in compulsive or dependent maladaptive overuse (Bush et al., 2021; Chen et al., 2017; Horwood & Anglim, 2018). PSU can be associated with impairments in work, academic or social life (e.g., Billieux et al., 2015; Horwood & Anglim, 2018). The concept of problematic smartphone usage is an acute and concerning issue for the public as problematic internet usage has an estimated prevalence of more than 2 % in the world's adult population, and PSU continues to increase in this context (Kuss et al., 2014). Studies have shown various links between smartphone usage and negative consequences related to symptoms of the consumer's daily life (Busch & McCarthy, 2021; Horwood & Anglim, 2018). These include social withdrawal, loss of productivity, poor academic performance, poor social relationships, physical health problems, and emotional distress (e.g., Horwood & Anglim, 2018; Soror et al., 2012; Wacks & Weinstein, 2021). Given the diverse negative consequences associated with PSU and its increasing prevalence, understanding the underlying factors and the impact on individuals' daily functioning is crucial for addressing this emerging phenomenon.

### **Explanatory Approaches of Problematic Smartphone Use**

Although definitions and theories of the PSU concept are still evolving (Horwood & Anglim, 2018), PSU can be understood as a mechanism of behavioural addictions. Researchers recently debated the similarities between addiction disorders and PSU and how this may function as an explanatory approach for PSU. On the one side, authors investigated PSU behaviour without a clinical assessment of whether the person has a mental disorder or addiction (Wang et al., 2015). Further, PSU is still not included in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) (American Psychiatric Association, 2013). On the other side, many researchers explained PSU in the context of addiction disorders and conceptualised it as a behavioural addiction (Busch & McCarthy, 2021; Billieux et al., 2015). In recent years it has become clear that excessive and problematic smartphone use can be associated with symptoms similar to those of behavioural addictions, e.g. gambling and gaming addiction (e.g., Derevensky & Haymann, 2019; Panova & Carbonell, 2018). An Internet gaming disorder has already been included as a diagnosis in the (DSM-V) (American Psychiatric Association, 2013). Further, several studies showed that PSU has core components of addictive behaviour, such as cognitive salience, loss of control, mood change, tolerance, withdrawal, conflict, and relapse (Billieux et al., 2015; Parent et al., 2022). In conclusion, the growing evidence linking PSU to addictive behaviours underscores the importance of exploring PSU through the lens of behavioural addiction research.

Looking at PSU as a behavioural addiction, one can think of the phenomenon of operant conditioning proposed by the behavioural psychologist B. F. Skinner (1948). The paradigms of operant conditioning, which can be observed in many behavioural addictions (Chakraborty et al., 2010), might be promising to explain the mechanisms of the construct of PSU as well (Bolle,

2014; Yin et al., 2019). Generally, operant conditioning is a psychological concept that explains how behaviour is learned and influenced by its consequences (e.g., McLeod, 2015). Most psychological models of behavioural addiction assume that compulsive behaviour develops from a process of positive and negative reinforcement (Robinson & Berridge, 2003).

Positive and negative reinforcement play crucial roles in understanding the development and perpetuation of PSU. Positive reinforcement provides a desirable stimulus, such as praise or rewards, to strengthen a behaviour which produces pleasure or satisfaction (Yin et al., 2019). Negative reinforcement reduces an aversive stimulus, such as taking away an unpleasant task. Both positive and negative reinforcement crave positive emotion and try to decline negative emotion and increase the likelihood that the behaviour is being repeated (Baker et al., 2004; Wanigaratne, 2006). Operant conditioning may explain the phenomenon of PSU and suggests how positive reinforcement can lead to and promote PSU. Positive reinforcement, such as the immediate gratification and rewards provided by online activities, may create a reinforcing cycle to strengthen PSU (Lee & Kim, 2022). Addiction motivated by negative reinforcement is often referred to as avoidance conditioning, affect regulation, or even self-medication, as the user tries to alleviate negative feelings (Baker et al., 2004; Chakraborty et al., 2010; McCarthy et al., 2010; Parent et al., 2022; Robinson & Berridge, 2003). By examining the influence of positive reinforcement in creating a reinforcing cycle and the role of negative reinforcement in alleviating negative feelings, operant conditioning provides valuable insights into the mechanisms underlying PSU.

Another approach to explain the development and maintenance of PSU involves a theory proposed by Kardefelt-Winther (2014), which assumes similar emotionally motivated smartphone use that may eventually become problematic, as assumed in the operant conditioning

model of addiction. The theory, called Compensatory Internet Use Theory, can be considered as a coping strategy in which negative life situations, such as experiencing stress or depressive symptoms, can be a motivator to spend time online to alleviate negative feelings (Elhai et al., 2019; Kardefelt-Winther, 2014; Kim et al., 2015). According to the theory, the origin of the problem is the reaction to negative life situations and unmet needs, which are compensated by excessive internet use, such as PSU (Elhai et al., 2019). Users are motivated to consume online media to relieve negative feelings (Kim et al., 2015). This behaviour can, in due course, become habitual. Eventually, it might lead to negative consequences and addiction-like symptoms, as a high level of compensation is needed to relieve the negative feelings. For people with persistent problems, the need for compensation may be constant, and problematic internet use (like PSU) is likely to occur (Kardefelt-Winther, 2014). In conclusion, compensatory internet use, as well as operant conditioning models, can be referred to as self-medication or affect regulation models, emphasising PSU as a means of alleviating negative emotion, which eventually can be seen as a behavioural addiction (Baker et al., 2004; Elhai et al., 2019; Robinson & Berridge, 2003).

### **Previous Research on Various Constructs Associated with PSU**

#### *Perceived Academic Stress, Depressive Symptoms, and PSU*

Previous studies have found that psychological phenomena such as perceived academic stress and depressive symptoms can be associated with PSU. According to a recent systematic literature review by Busch and McCarthy (2021), factors related to emotional health constitute one of the primary reasons for smartphone use, suggesting that an individual's mental well-being may affect the degree of smartphone use. PSU occurs together with emotional health problems of university students, such as perceiving depressive symptoms or stress, which can thus be predictive factors as well as consequences for PSU (Fu et al., 2020; Haug et al., 2015; Xu et al.,

2018). Studying at a university can be very stressful for some students, and using a smartphone can be a method to escape reality temporarily (Soror et al., 2012). Experiencing stress is related to behavioural addictions (Rhodes & Jason, 1990), and indeed, academic stress was shown in several studies to be associated with PSU (e.g., Akinci, 2021; Vahedi & Saiphoo, 2018; Wang et al., 2015; Xu et al., 2018). Xu et al. (2018) also found that academic stress was associated with depressive symptoms, and depressive symptoms partially mediated the relationship between academic stress and PSU.

Further, according to a recent systematic review, many studies have explored a direct link between mood disorders, such as anxiety or depression, and PSU (Geng et al., 2021; Kim et al., 2015; Yang et al., 2020). As already suggested, through compensatory internet use, it can be inferred that students try to cope with the perceived stress and depressive emotions (Kardefelt-Winther, 2014) and distract themselves from these feelings, which can lead them to use their smartphones more excessively (Parent et al., 2022). Indeed, according to recent research, depressed people tend to use their smartphones to escape negative feelings (e.g., Elhai et al., 2017; Fu et al., 2020). For instance, Yen et al. (2009) examined 10,191 adolescents to investigate the relationship between depressive symptoms and PSU and discovered that those with severe depressive symptoms were more likely to engage in PSU to alleviate bad feelings (e.g., depressive symptoms) in daily life. In summary, the evidence of previous research indicates a strong association between emotional health factors, such as perceived stress and depressive symptoms, and PSU among university students. The findings suggest that students may turn to smartphones as a means to cope with stress and escape negative emotions. This underscores the need to address students' psychological well-being and promotes healthier coping mechanisms to mitigate the risk of PSU.



*Emotion Regulation Difficulties and PSU*

Emotion regulation also plays an essential role in the mechanisms of PSU. In the context that depressive symptoms are related to PSU, further research articles found that PSU is also closely related to another relevant psychological construct, namely reduced emotional self-control or emotional dysregulation (e.g., Elhai et al., 2016; Fu et al., 2020). Depressive symptoms are often defined by an inability to adapt and regulate emotions in response to the demands of a situation, which results in the maintenance of a negative mood (Davidson et al., 2002). Thus, emotion regulation appears to be important in mood disorders (Aldao et al., 2010). Emotion regulation is the ability to achieve changes in activated emotions and respond to emotional experiences in a socially acceptable manner rather than reacting spontaneously (Cole et al., 2004).

Consequently, emotion regulation helps people better adapt to personal and environmental changes (Gross & John, 2003). Deficits in emotion regulation can manifest as expressive suppression, which is the suppression of expressive emotional behaviour (Gross & John, 2003). Expressive suppression is a feature of several mental disorders, such as depression and anxiety, as well as behavioural addictions (e.g., Aldao et al. 2010). Behavioural addictions may develop as a means of coping with negative emotions (Baker et al., 2004). Recent research suggests that poor emotion regulation, specifically the suppression of emotions, may explain several addictive behaviours, including PSU, as users go online to quickly regulate their negative emotions (Van Deursen et al., 2015). This would align with Kardefelt-Winther's (2014) theory of compensatory internet use. Fu et al. (2020) found similar results in an adolescent sample, where difficulties in emotion regulation were associated with PSU. In summary, the relationship between emotional health, including factors such as perceived stress, depressive symptoms, and

emotion regulation difficulties, appears to be closely intertwined with PSU, supporting its complex nature. Further, addressing emotion regulation difficulties in university students might also be beneficial in dealing with PSU.

### *Self-Regulation and PSU*

Finally, self-regulation also appears to play a central role in developing PSU (Busch & McCarthy, 2021). Self-regulation enables a person to control goal-directed activities over time and in response to changing circumstances (Karoly, 1993). Self-regulation is closely related to impulsivity (Tangney et al., 2004). Impulsivity is a personality factor explained by preferring a smaller reward that can be obtained instantly to a larger reward that can only be obtained later. Choosing the large, delayed reward while refusing the small, instant reward has been explained as a self-regulatory skill (Reynolds et al., 2006). Research shows that individuals who are impulsive and disinhibited are more likely to engage in substance abuse and other behavioural disorders (Bornovalova et al., 2005). Billieux et al. (2015) suggest that impulsivity can lead to PSU. Furthermore, poor self-regulation has been shown to predict problematic video game behaviour (Yau et al., 2012), while several studies suggest that deficits in self-regulation may contribute to higher levels of PSU (e.g., Akinci, 2012; Lee et al., 2014; Soror et al., 2012; Yang et al., 2019). In conclusion, people with higher levels of impulsivity are more likely to engage in PSU and other behavioural disorders. As a contributing factor in PSU, self-regulation may be essential for possible interventions.

Further, previous research found that self-regulation has moderating and mediating effects on the relationship between several factors and PSU. For instance, low self-regulation appeared to increase the prevalence of negative consequences such as increased stress, anxiety, and depression (Soror et al., 2012), which were further associated with PSU (e.g., Geng et al.,

2021; Xu et al., 2018). According to Kim and Shin (2016), self-regulation moderated and thus reduced the relationship between academic stress and PSU. Students with higher levels of self-regulation tended to be less affected by academic stress and smartphone addiction than students with lower levels of self-regulation. Similar results were found by Cho et al. (2017). However, they discovered a mediation effect of self-regulation. According to Cho et al. (2017), increased stress levels led to decreased self-regulation, further increasing the likelihood of PSU. As there is disagreement in research about the exact interaction effects of self-regulation, this should be further investigated in upcoming studies. Nevertheless, what remains evident is that self-regulation skills continue to be relevant in the context of PSU.

### **The Present Study**

Research about problematic smartphone use is constantly evolving, and new studies provide insight into complex relationships between PSU and various constructs. Due to its increasing prevalence, PSU is a relevant concern for public health. Despite incremental research in this field, essential questions about the associations and mechanisms behind PSU remain unanswered. Moreover, the conceptualisation of PSU is still developing, and there are ambiguities and inconsistencies in the literature about the relationships between some factors, for instance, the moderating or mediating role of self-regulation. Further, previous research examined the relationship between various factors and PSU mostly among Chinese, South Korean, and North American students (e.g., Cho et al., 2017; Fu et al., 2020; Parent et al., 2020; Xu et al., 2018; Roberts et al., 2014; Yang et al., 2019). Only a few studies so far have examined the factors related to PSU among European students (e.g., Bolle, 2014; Brailovskaia & Margraf, 2023; Van Deursen et al., 2015). To address this research gap, this research tried to extend these findings and examine a study among Dutch and German students. Based on the theoretical and

empirical literature mentioned above, the following research question was posed: *What is the relationship between perceived academic stress, self-regulation, depressive symptoms, emotion regulation difficulties, and problematic smartphone use among Dutch and German university students?*

### **Aims and Hypotheses**

This study aimed to investigate different associations with PSU among Dutch and German university students to replicate recent findings conceptually and to uncover other possible relationships between psychological constructs in this context. More specifically, the present paper wanted to demonstrate a direct link between high levels of perceived academic stress and PSU. Then, self-regulation was anticipated to show a negative relationship with PSU. Next, it was expected that depressive symptoms to have a significant positive relationship with PSU and difficulties in emotion regulation to show a positive relationship with PSU. Furthermore, this research tried to conceptually replicate a moderation effect of self-regulation on the relationship between perceived academic stress and PSU. This led to the following hypotheses:

(H1): There is a significant relationship between perceived academic stress and PSU.

(H2): There is a significant relationship between depressive symptoms and PSU.

(H3): There is a significant relationship between self-regulation and PSU.

(H4): There is a significant relationship between emotion regulation difficulties and PSU.

(H5): The relationship between perceived academic stress and PSU is moderated by self-regulation.

### **Methods**

## **Participants**

A total of 90 university students were recruited. A detailed description of the sample can be seen in Table 1. Participants' inclusion criteria were sufficient English language proficiency and the possession of a smartphone, as well as being registered in a German or Dutch university. The removal of partial data resulted in a total of  $N = 71$  participants.

## **Materials**

The gathering of data was done using the online test environment Qualtrics. The first part of the online study included a consent form and a question battery with questions on demographic data, proficiency in understanding written English, and whether the participant actively uses a smartphone. Subsequently, five questionnaires were then completed to obtain data on the constructs below.

### *Problematic Smartphone Use*

The Smartphone Addiction Scale Short Version (SAS-SV) was used to measure PSU in participants (Kwon et al., 2013) (Appendix A). The SAS-SV indicates the amount of risk but does not diagnose an addiction. The SAS-SV captures four of the six components of the broadly used six-component model of addiction, namely, conflict, withdrawal, tolerance, and salience (Griffiths, 2005). The questionnaire contains a ten-item scale, each assessed on a six-point Likert scale. The participants rated themselves from one (strongly disagree) to six (strongly agree). Some scale items were changed to the first-person format to make it easier for participants to use the Likert scale. For example, "Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use" was rephrased as "I have a hard time concentrating in class, while doing assignments, or while working due to smartphone use". Furthermore, the item "I constantly check my smartphone so as not to miss conversations

between other people on WhatsApp, Instagram, or Facebook” was adjusted to account for newer social media platforms and messenger apps. Kwon et al. (2013) confirmed the SAS-SV's internal consistency with a Cronbach's alpha of .96. Moreover, the original SAS-SV showed concurrent and content validity (Kwon et al., 2013). In this research, Cronbach's alpha was .80.

### *Perceived Academic Stress*

To measure the level of perceived academic stress among participants, the Perception of Academic Stress Scale (PASS) was used, which was developed by Bedewy and Gabriele (2015) (Appendix A). The scale consists of 18 items measuring perceived sources of stress, where participants needed to respond from one (strongly disagree) to five (strongly agree) on a five-point Likert scale. A representative item is “My teachers are critical of my academic performance”. Bedewy and Gabriele (2015) determined the instrument's face, content, and convergent validity. The internal consistency reliability was confirmed with a Cronbach's alpha of 0.70 (Bedewy & Gabriel, 2015). This study computed a Cronbach's alpha of .79.

### *Depressive Symptoms*

To measure depressive symptoms in participants, the Patient Health Questionnaire 9 (PHQ-9) was used (Appendix A). This self-report instrument consists of nine items used to assess the severity of depression (Kroenke et al., 2001). The items are based on the DSM-IV diagnostic criteria for a major depressive disorder. For each of the nine items, the respondents are asked to rate on a four-point Likert scale how often they have experienced the specified symptoms of depression in the past two weeks ranging from zero (not at all) to three (nearly every day). A representative item is "Over the last two weeks, how often have you been bothered by little interest or pleasure in doing things? The internal consistency of the PHQ-9 was excellent, with a Cronbach's alpha of .89 in the PHQ Primary Care Study with over 3,000

patients. The test-retest reliability of the PHQ-9 was also excellent (Spitzer et al., 1999). In this research, Cronbach's alpha was .84.

### *Self-Regulation*

The construct of self-regulation of university students was measured using the Self-Regulation Scale (SRS) designed by Diehl et al. (2006) (Appendix A). This scale consists of 10 items scored on a four-point Likert scale with responses ranging from one (not at all true) to four (completely true). A representative item is: "I stay focused on my goal and don't allow anything to distract me from my plan of action". Questions five, seven, and nine are scored reversely. The scale showed good criterion validity and adequate test-retest reliability (Diehl et al., 2006). In the study by Diehl et al. (2006), Cronbach's alpha of the scale was reported as .84. The Cronbach alpha coefficient computed for this study was .78.

### *Emotion Regulation Difficulties*

The participants' emotion regulation difficulties were measured with the Difficulties in Emotion Regulation Scale (DERS-SF) (Kaufman et al., 2016) (Appendix A). This practical self-report scale for assessing emotion regulation problems in adolescents and adults that have been widely used in previous studies. The scale consists of 18 items rated on a five-point Likert ranging from one (almost never) to five (almost always). A representative item is "When I'm upset, I become out of control". Kaufman et al. (2016) confirmed the internal consistency of the DERS-SF with a Cronbach's alpha of .92. In this study, a Cronbach's alpha of .86 was computed.

### **Procedure**

Ethical approval by the ethical committee of the BMS Faculty of the University of Twente (Approval code 230266) was obtained before recruiting the participants. The participants were recruited using convenience sampling, a non-probability sampling that involved reaching

out to participants via multiple channels (e.g., Peterson & Merunka, 2014). At first, the study was shared with acquaintances and friends through personal networks via WhatsApp. In addition, the study was uploaded to the University of Twente's intern subject pool Sona-systems, a platform specifically designed for psychology students to recruit participants for their studies. To participate in this study, respondents needed access to a computer or smartphone and an internet connection. Subjects could participate in the online study either via the website of Sona-systems or via a direct and anonymous Qualtrics link. This link was forwarded to the participants via WhatsApp. Participants who took part in the survey via Sona-systems received 0.25 virtual credit points as compensation. The other participants did not receive any compensation.

After clicking on the link, participants were first given a brief description of the study, which also included information on the anonymity and confidentiality of the data and the purpose of the study. In addition, the participants were asked to agree to the informed consent form. If participants denied consent, they were not forwarded to the questionnaires. Participation in the study was voluntary, and withdrawal was possible at any moment. When the participants decided to take part in the study, they needed to complete the demographic questions. For this, participants were asked to provide their age in a categorical manner (18-24, 25-35, >35 years old), select their gender (male, female, non-binary), indicate whether they were currently enrolled in a university, specify their highest level of education completed (e.g., high school, bachelor's degree), and if they can read and understand English proficiently. In addition, they were asked if they own a smartphone that they use regularly. Subsequently, the participants filled in specific items to measure the described questionnaires. After completing the questionnaires, the subjects were thanked for participating and informed that their responses had been collected.



The gathered data of the participants were anonymised, and it was assured that the data would be erased six months after completing the survey.

### **Data Analysis**

A quantitative, cross-sectional online study was conducted to investigate the relations between the five constructs. Participants' data were gathered in March and April 2023. To process the data, the statistical software Excel was used. The data were analysed using R software version 4.3.0 (R Core Team, 2023). Initially, pre-processing was done on the raw data derived from Qualtrics. 19 Participants had to be excluded as they did not complete all five questionnaires or were not enrolled at a university in Germany or the Netherlands. The total scores per participant were calculated for each questionnaire, which were subsequently used for the analysis. No outliers were identified. Finally, data from 71 participants were included for analysis.

Descriptive statistics were obtained for all five questionnaires used in the study, including each construct's means and standard deviations. To test the research hypotheses, inferential statistics were performed. Initially, four univariate linear regression models were conducted to investigate a significant direct relationship between the independent variables and PSU. Then, a moderation analysis was performed to examine a moderating effect of self-regulation on the relationship between perceived academic stress and PSU.

Before conducting all regression analyses, several parametric assumptions were to be checked to ensure the validity of the models (Appendix B & C). For each model, at first, the linearity assumption needed to be checked by looking at the residual plots. Secondly, the normality assumption was tested by examining the distribution of the residuals. The third step was evaluating the assumption of homogeneity of variance by examining a scatter plot of the

residuals against the fitted values (Fox, 2015). Finally, the multicollinearity assumption was checked for the multivariable moderation model (Appendix C). To assess the presence of multicollinearity between the independent variables, the variance inflation factor (VIF) was calculated. The VIF values were all below 5, which indicated that multicollinearity was significant (Fox, 2015) (Appendix A).

## Results

### Descriptive Statistics

The final sample included 71 respondents (see Table 1). The sample consisted of 44 (61.97%) females, 24 (33.80%) male participants, and 3 (4.23%) participants who identified as non-binary. 64 (90.14%) of participants reported being between the ages of 18 and 24, while 7 (9.86%) reported being between the ages of 25 and 35. Regarding the highest level of education completed, 55 participants (77.46%) stated having a high school diploma or equivalent. In contrast, 11 (15.49%) said they had a bachelor's degree. 2 (2.82%) participants reported having a Master's degree and 1 (1.40%) reported having a PhD or professional degree.

**Table 1**

*Demographic profile of the final sample*

Demographics	Categories	N	%
Gender	Male	24	33.80
	Female	44	61.97
	Non-binary	3	4.23
Age	18-24	64	90.14
	25-35	7	9.86

Highest level of education completed	High school diploma or equivalent	55	77.46
	College or associate degree	2	2.82
	Bachelor's degree	11	15.49
	Master's degree	2	2.82
	PhD or professional degree	1	1.40

*Note.* N = Number of participants for each category. % = Percentage of participants.

Descriptive statistics for the five questionnaires are presented in Table 2. To provide an overview of the distribution of the scores for each questionnaire, the table shows the minimum and maximum scores, mean scores, and standard deviation.

**Table 2**

*Descriptive Statistics of the Five Questionnaires*

Questionnaires	Number of Items	Answering Likert Scale	Min. – Max.	Mean (SD)
SAS-SV (PSU)	10	1 - 6	19.00 - 55.00	33.93 (8.05)
PASS (Perceived academic stress)	18	1 - 5	20.00 - 65.00	46.97 (9.83)
PHQ9 (Depressive symptoms)	9	0 - 3	0.00 - 23.00	9.014 (5.70)
SRS (Self-regulation)	10	1 - 4	14.00 - 37.00	26.10 (4.51)
DERS-SF (Emotion regulation difficulties)	18	1 - 5	29.00 - 77.00	48.30 (11.37)

*Note.* Min. = Minimum scores. Max = Maximum scored. SD = Standard deviation scores.

To further examine the individual relationships between the dependent variable PSU and

the four independent variables, four univariate regression models were analysed (see Table 3). Each model explained a significant proportion of the variance in PSU, ranging from 13% to 15% (Table 3). The results showed significant relationships between PSU and each of the independent variables. The parametric assumptions for each linear model were checked, namely: the linearity of the relationship between predictor and dependent variable, homoscedasticity of the variance of residuals, and normality distribution of residuals. No violations of the assumptions were found (Appendix B).

First, the simple linear regression with perceived academic stress as an independent variable showed a significant positive relationship with PSU,  $R^2 = .13$ ,  $F(1, 68) = 10.57$ ,  $p < .01$ , confirming Hypothesis 1. Second, depressive symptoms showed a significant positive relationship with PSU,  $R^2 = .15$ ,  $F(1, 68) = 11.61$ ,  $p < .01$ . Therefore, Hypothesis 2 could be confirmed. Third, self-regulation showed a significant negative relationship with PSU,  $R^2 = .15$ ,  $F(1, 68) = 11.91$ ,  $p < .01$ , which means Hypothesis 3 could be confirmed. Finally, emotion regulation difficulties also showed a significant positive relationship with PSU,  $R^2 = 0.15$ ,  $F(1, 68) = 11.88$ ,  $p < .01$ , which supports Hypothesis 4.

**Table 3**

*Results of Univariate Regression Models Predicting Problematic Smartphone Use*

Predictor Variable	Intercept	Coefficient Estimate	SE	t-value	p-value	R <sup>2</sup>	Adjusted R <sup>2</sup>	F-statistic
Perceived academic stress	20.20	0.29	0.09	3.25	< <b>0.01</b>	0.13	0.12	<b>10.57</b>

Depressive symptoms	29.34	0.53	0.15	3.40	< <b>0.01</b>	0.15	0.13	<b>11.61</b>
Self-regulation	51.83	-0.67	0.19	-3.45	< <b>0.01</b>	0.15	0.14	<b>11.91</b>
Emotion regulation difficulties	21.17	0.27	0.07	3.44	< <b>0.01</b>	0.15	0.13	<b>11.88</b>

*Note.* SE = Standard Error.  $R^2$  = R-squared. Bold numbers mean the p-value is less than 0.01, indicating statistical significance at the 1% level ( $p < .01$ ).

A moderation analysis was then conducted to analyse the potential interaction effect of self-regulation on the relationship between perceived academic stress and PSU (see Table 4). The analysis revealed that the main effects of perceived academic stress and self-regulation were not significant. The coefficient estimate of  $\beta = -.03$  ( $SE = 0.02$ ,  $t = -1.43$ ,  $p = .15$ ) for the interaction effect was insignificant, implying that hypothesis H5 could not be confirmed. The F-statistic test was significant,  $R^2 = .20$ ,  $F(3, 67) = 5.67$ ,  $p < .01$ , which suggested that the model as a whole was a good fit. Furthermore, the predictor variables accounted for 20.26% of the variance in PSU. The parametric assumptions were examined for possible violations to assess the moderation model's applicability. No assumption violations were detected, indicating that the model met the necessary conditions for further analysis (see Appendix C).

#### **Table 4**

##### *Moderation Analysis of Self-Regulation*

Coefficients	Coefficient Estimate	SE	t-value	p-value	R <sup>2</sup>	Adjusted R <sup>2</sup>	F-statistic
(Intercept)	3.77	25.23	0.15	0.88	0.20	0.17	<b>5.67</b>
Perceived academic stress	0.91	0.51	1.78	0.07			
Self-regulation	0.78	0.91	0.85	0.39			
Perceived academic stress: Self-regulation	-0.03	0.02	-1.43	0.15			

*Note.* SE = Standard Error. R<sup>2</sup> = R-squared. The bold number means that the p-value is less than 0.01, indicating statistical significance at the 1% level ( $p < .01$ ).

### Discussion

The present cross-sectional study investigated the associations between PSU and the four independent constructs of perceived academic stress (H1), depressive symptoms (H2), self-regulation (H3), and emotion regulation difficulties (H4) among Dutch and German university students. The four univariate regressions of each construct and PSU revealed that all independent constructs were significantly associated with PSU, confirming Hypotheses 1, 2, 3, and 4. Notably, all constructs explained a similar proportion of the variance of PSU (R<sup>2</sup>) (Table 3). Next, this research explored if self-regulation moderated the relationship between perceived academic stress and PSU (H5). However, no moderation effect of self-regulation was found on the association between perceived academic stress and PSU, rejecting Hypothesis 5. To come to

a coherent interpretation of these results, I will first discuss each hypothesis individually. Then, I will combine these considerations into an overall reflection concerning previous research.

Firstly, the data supported Hypothesis 1. My findings showed a significant relationship between perceived academic stress and PSU in line with relevant research by Van Deursen et al. (2015), Xu et al. (2018), and Zhao & Lapierre (2020). Combined with these prior findings, the results indicate that stressed students seem to spend more time on their smartphones to relieve their negative moods and escape stress. This aligns with the assumption of the Compensatory Internet Use Theory, which states that negative feelings like stress causes people to use the internet excessively to relieve unpleasant feelings and tension (Kardefelt-Winther, 2014). As a maladaptive coping strategy, they may engage in PSU to cope with current perceived stress. The finding that perceived academic stress is related to PSU supports the argument that PSU functions similarly to other addictions in that there is a risk factor such as perceived stress and the function of PSU is to manage this perceived stress, as also proposed in Kardefelt-Winther's theory (2014). Furthermore, as previous studies have confirmed, stressful life experiences or contexts can alter a person's stress response, increasing the likelihood of developing and maintaining addictive disorders (Del Giudice et al., 2011; Kreek et al., 2005). Consistent with prior research, this underscores the similarity of PSU with other addictive behaviours. Thus, it is advisable to consider PSU in the context of behavioural addictions and to take measures aimed at stress management and coping strategies to reduce the risk of PSU.

Secondly, the data suggested that depressive symptoms were also significantly associated with PSU, supporting Hypothesis 2. These findings are consistent with previous research on PSU (e.g., Busch & Mc Carthy, 2021; Elhai et al., 2019; Fu et al., 2020; Kim et al., 2015; Xu et al., 2018). In this context, the authors also referred to the theory by Kardefelt-Winther (2014). As

mentioned, people are more likely to use smartphones excessively when perceiving negative life situations such as depressive symptoms. The negative feelings motivate them to spend more time online compared to others with less severe depressive symptoms (Kardefelt-Winther, 2014; Kim et al., 2015). If repeated, this behaviour eventually becomes habitual, leading to negative consequences and problematic internet use (or PSU) (Fu et al., 2020; Kardefelt-Winther, 2014; Kim et al., 2015). In conclusion, the positive association between depressive symptoms and PSU observed in this study supports previous research findings and aligns with the explanations offered by Kardefelt-Winther's (2014) Compensatory Internet Use Theory.

Another explanation for why both psychological constructs, i.e. increased perceived academic stress and depressive symptoms, were positively associated with PSU could be that both seem to behave similarly regarding PSU. This may not be surprising as stress is consistently associated with depression (e.g., Van Praag, 2004). Furthermore, Zhao & Lapierre (2020) even showed a full mediation effect of perceived academic stress on the association between PSU and depression. At the same time, Xu et al. (2018) found that depressive symptoms partially mediated the association between perceived academic stress and PSU. To conclude, the similarities in the associations between perceived academic stress, depressive symptoms, and PSU underscore the intertwined nature of these psychological constructs. Additionally, the results emphasise the role of negative affect and maladaptive coping strategies as factors contributing to the development and maintenance of PSU, underpinning the conceptualisation of PSU as a behavioural addiction. Overall, these findings indicate the importance of addressing stress and depressive symptoms in interventions aimed at managing PSU.

Thirdly, my research indicated that self-regulation was significantly related to PSU, which supports Hypothesis 3. This relationship has already been shown in several studies (e.g.,



Van Deursen et al., 2015; Yang et al., 2019), suggesting that individuals with lower levels of self-regulation are more susceptible to developing PSU, as they might be less able to control impulsive actions and are more likely to act on conditioned impulses (e.g. impulsively checking messenger apps) (Elhai et al., 2017; Karoly, 1993; Soror et al., 2012; VanDeursen et al., 2015; Yang et al., 2019).

Impulsive behaviours of PSU can be explained by the positive and negative reinforcement mechanisms of operant conditioning theories (Robinson & Berridge, 2003; Yin et al., 2019). By examining PSU through the positive reinforcement paradigm, on the one hand, it is easy to explain why the smartphone functions as a stimulus for the conditioning mechanism. The smartphone provides various pleasant and stimulating experiences that potentially act as rewards and increase the likelihood that excessive use will develop into habitual use (Bian & Leung, 2015). Pleasurable experiences can cause a loss of behavioural control (Song et al., 2004). The gain in pleasure and satisfaction is the positive reinforcement for the individual to continue the smartphone use behaviour. The urge for positive reinforcement will increase over time, and eventually, addictive behaviour is likely to emerge (Yin et al., 2019).

On the other hand, the impulse to use the smartphone frequently through the negative reinforcement path can be explained similarly to the Compensatory Internet Use Theory by Kardefelt-Winther (2014). As a behaviour of avoidance conditioning, the addictive smartphone behaviour serves to cope instantly with negative feelings (Baker et al., 2004). In conclusion, the confirmation of Hypothesis 3 suggests, in line with previous research, that lower levels of self-regulation carry a higher risk of PSU, which can be explained by the fact that poor self-regulation is driven by emotions and automatic, impulse-driven processes. Based on these

findings, it can be concluded that initiatives to improve self-regulation skills among university students will be beneficial in preventing PSU.

Fourthly, the present study supported Hypothesis 4, which stated that emotion regulation difficulties were significantly related to PSU. Consistent with Elhai et al. (2016) and Fu et al. (2020), the present findings indicated that participants with higher emotion regulation difficulties were more likely to display PSU. This association could also be explained by operant conditioning mechanisms. According to Koole (2009), individuals' emotion regulation efforts serve the hedonistic urge to enhance pleasure and alleviate suffering. Thus, students might regulate their emotions by using smartphones to prevent suffering due to their own negative emotions, resulting in negative reinforcement. This explanation is in line with the Theory of Compensatory Internet Use by Kardefelt-Winther (2014), which states that the Internet is used as an emotion regulation strategy to alleviate negative moods such as depression. People with deficits in emotion regulation may try to suppress their feelings and tend to distract themselves with excessive activities (Elhai et al., 2016; Hoffner & Lee, 2015). On the other hand, due to experiencing positive emotions based on the pleasure of excessive smartphone use, they may use the smartphone intensively to maintain the pleasure of emotions which accounts for the mechanism of positive reinforcement (Yildiz, 2017). In summary, these mechanisms of operant conditioning could explain why difficulties in emotion regulation are positively associated with PSU, as people low on emotion regulation use smartphones to regulate their emotions.

Finally, my results did not support Hypothesis H5. No significant effect indicated that self-regulation moderated the association between perceived academic stress and PSU. As mentioned in the introduction, previous research by Kim and Shin (2016) was able to demonstrate a significant interaction effect of perceived academic stress and self-regulation.

According to Kim and Shin (2016), self-regulation can moderate and thus reduce the effects of academic stress and smartphone addiction. Students with higher levels of self-regulation tend to be less affected by academic stress and smartphone addiction than students with lower levels of self-regulation (Kim & Shin, 2016).

Several reasons could explain why my research did not conceptually replicate the study by Kim and Shin (2016). First of all, it should be mentioned that there were some methodological differences. First, my sample consisted of another target group, namely German and Dutch university students. In the study by Kim and Shin (2016), the sample consisted of South Korean middle school students. While my sample consisted of 71 participants, they addressed 398 students. In addition, the questionnaires to measure the constructs perceived academic stress, self-regulation, and PSU were quite different. Kim and Shin (2016) also controlled for other variables in their study, such as gender. Furthermore, it can be assumed that their result is not very informative. Although they obtained a significant interaction effect ( $\beta = -.004$ ,  $p = .014$ ), the effect was minimal and even smaller than my effect ( $\beta = -.03$ ,  $p = .15$ ) despite the sample size differences and the significant result. Lastly, it is notable that there appears to be lots of disagreement about the relationships between the variables related to PSU (Busch & McCarthy, 2021). As mentioned earlier, Cho et al. (2017) discovered a mediation effect of self-regulation. According to the results of their study, an increase in stress levels leads to a decrease in self-regulation. This decrease in self-regulation, in turn, increases the likelihood of PSU. Future research is needed to resolve the mixed results. Nonetheless, it can be concluded that participants with lower self-regulation had higher PSU, regardless of possible moderation or mediation effects with other variables (Busch & McCarthy, 2021; Elhai et al., 2017; Soror et al., 2012).

### **Strengths and Limitations**

A primary strength is the comprehensive examination of multiple psychological factors (perceived academic stress, depressive symptoms, self-regulation, and emotion regulation difficulties) in relation to PSU. By investigating the associations between these variables, this study provides a nuanced understanding of the complex psychological processes involved in PSU. Further, to the best of my knowledge, this study was one of the first to provide evidence for the associations between the constructs in a Dutch and German sample. In addition, the constructs studied were measured using validated scales verified by previous research. In this study, they showed satisfactory reliability.

Nevertheless, several limitations need to be acknowledged that may have influenced the results of this study. First, the cross-sectional study design limits the possibility of establishing causal relationships between the variables (Elhai et al., 2019). Thus, only correlations could be detected. Second, the study relied on online self-reports, which are susceptible to response bias, such as social desirability bias (Andrews et al., 2015). Participants may have supplied answers that they thought were socially acceptable, especially when dealing with sensitive topics such as smartphone addiction and depressive symptoms. Participants could have over- or underestimated themselves, which also comprised the generalizability. Thirdly, a further bias in generalisability could be caused by participation bias. Participants were recruited through convenience sampling, which could lead to disproportionality in the sample of participants with specific characteristics, affecting participation, dropout, or outcomes (Elston, 2021). Relying on online platforms could, for instance, attract participants who are more technologically competent and use the smartphone more frequently. This could lead to a bias towards a certain population group that already suffers from some of the psychological constructs under investigation, such as PSU.

Fourthly, further restriction concerns the gender distribution in the current sample. Most participants were female (62%), leading to an underrepresentation of male (34%) and non-binary (4 %) participants, which limits generalisability to the population. Lastly, a limitation that has a substantial impact on the generalizability of the results is the minimal sample size of 71 individuals. This can produce a sampling error, which leads to a more significant deviation between the sample estimate and the actual value of the population (Altman & Bland, 2014). It also diminishes the possibility of obtaining statistically significant results, which might explain the non-significant moderation effects observed in this study. Besides the small sample size, non-significant results might be attributable to other factors that were not evaluated in this study.

### **Future Research**

Based on the limitations, future research should include different measures to assess PSU (e.g., screen time apps). This could reduce potential self-report bias (Ohme et al., 2021). Further, network analysis can help better understand the relationships and underlying mediation effects between the variables associated with PSU and develop strategies and interventions against the negative impacts of PSU (Baggio et al., 2018). In addition, longitudinal studies need to be conducted to investigate causal relationships between variables. For instance, (Busch & McCarthy, 2021) stated that the same constructs (e.g., depression) appeared both as antecedents and consequences in the literature. Besides, replication studies should be conducted in future research to unravel ambiguities in the literature. As mentioned earlier, Cho et al. (2017) found a mediating effect of self-regulation, while Kim and Shin (2016) claimed that they found a moderating effect. Generally, it is essential to investigate additional moderating and mediating analyses that may influence the relationship between variables related to PSU. As all investigated

constructs were significantly associated with PSU, further mediation and interaction effects seem to be conceivable and could be investigated in future studies.

Lastly, future research could focus on conducting and evaluating intervention studies. Smartphone use education interventions could effectively treat PSU (Williams-Buratti et al., 2022). Using a smartphone does not need to be worrying. However, the positive benefits of smartphone use may only be sustained as long as the extent of use remains moderate (Brailovskaia et al., 2022). Users should be guided and informed about the risks PSU entails. In fact, what is of significant concern, app developers actively use conditioning mechanisms to reinforce user behaviour. One example is the endless scrolling technique (Montag et al., 2019). Through this technique, social media platforms are designed to be immersive, creating a flow during use that is accompanied by a sense of time distortion (Alter, 2017). This behaviour is reinforced as the user is rewarded with ever-changing and engaging information (e.g., fun or exciting content) (Montag et al., 2019). Other psychological mechanisms that social media apps use to engage users including seeking excessive validation (Billieux et al., 2015) and the reluctance to miss important information or fear of missing out (FOMO) (Elhai et al., 2016). Another successful method to increase data flow is social pressure. Messenger users are encouraged to communicate quickly and frequently through the "double checkmark" feature. Social pressure is created since both the receiver and the transmitter of a message are aware of these rules (Sha et al., 2019). By actively utilising addictive mechanisms, the smartphone has the potential to become a behavioural drug. Therefore, students should be taught how to use their phones properly in future interventions.

### **Practical Implication**

The results of the study have several implications. Firstly, the significant individual associations between all independent variables and PSU align with prior research findings. This suggests that these variables play important roles in the development and manifestation of PSU. It indicates that negative life situations, such as stress and depressive symptoms, as well as lower levels of self-regulation and difficulties in emotion regulation, are associated with higher levels of PSU. The results of this study contribute to the existing literature by confirming the individual associations between the examined variables and PSU in a German and Dutch sample.

### **Conclusion**

The present study highlighted the critical roles of the examined constructs in relation to PSU. My results showed that negative life situations, such as perceived stress and depressive symptoms, were associated with PSU. In addition, difficulties in emotion regulation were associated with PSU, and self-regulation was negatively related to PSU. Moreover, self-regulation did not moderate the association between perceived stress and PSU. However, regarding the direct associations with PSU, this study confirmed the findings from studies in other cultures, which could mean that the individual associations of the examined constructs with the PSU might be transferable to Dutch and German students. Furthermore, the results showed that the independent variables were similarly relevant in explaining the variance of PSU. Lastly, the paper provided explanations of how and why the different constructs might be related through the theories of operant conditioning and Compensatory Internet Use.

### **Disclosure Statement**

The author reported no potential conflict of interest. The research met the required ethical standards.

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## Appendix

### Appendix A

#### Smartphone Addiction Scale Short Version

The participants were asked to indicate, to what extent you agree with the following ten statements concerning their smartphone use on a Likert scale with the following format:

o Strongly Disagree o Disagree o Weakly Disagree o Weakly Agree o Agree o Strongly Agree

Questionnaire Items:

I miss planned work due to smartphone use.

I have a hard time concentrating in class, while doing assignments, or while working due to smartphone use.

I feel pain in the wrists or at the back of the neck while using a smartphone.

I won't be able to stand not having a smartphone.

I feel impatient and fretful when I am not holding my smartphone.

I have my smartphone in my mind even when I am not using it.

I will never give up using my smartphone even when my daily life is already greatly affected by it.

I constantly check my smartphone so as not to miss conversations between other people on WhatsApp, Instagram or Facebook.

I use my smartphone longer than I had intended.

The people around me tell me that I use my smartphone too much.

#### Perceptions of Academic Stress (PAS) scale.

The participants were asked to rate their perception of the following statements in contributing to academic stress on a Likert scale with the following format:

- o Strongly Disagree o Somewhat Disagree o Neither agree nor disagree o Somewhat Agree
- o Strongly Agree

Questionnaire Items:

I am confident that I will be a successful student. -

I am confident that I will be a successful in my future career. -

I think that my worry about examinations is weakness of character.

Teachers have unrealistic expectations of me.

The size of the curriculum (workload) is excessive.

I believe that the amount of work assignments is too much.

I am unable to catch up if getting behind the work.

The unrealistic expectations of my parents stresses me out. Competition with my peers for grades is quite intense.

Competition with my peers for grades is quite intense.

The examination questions are usually difficult.

Examination time is short to complete the answers.

Examination times are very stressful to me out.

Even if I pass my exams, I am worried about getting a job.

*Note.* The dash (-) indicates the item negatively correlates with the scale in general and needs to be reversed before the total score is calculated.

### **Self-Regulation Scale (SRS)**

The participants were asked to rate their perception of the following statements on a Likert scale with the following format:

- o Not at all true o Barely true o Somewhat true o Completely true

Questionnaire items:

I can concentrate on one activity for a long time, if necessary.

If I am distracted from an activity, I don't have any problem coming back to the topic quickly.

If an activity arouses my feelings too much, I can calm myself down so that I can continue with the activity soon.

If an activity requires a problem-oriented attitude, I can control my feelings.

It is difficult for me to suppress thoughts that interfere with what I need to do. -

I can control my thoughts from distracting me from the task at hand.

When I worry about something, I cannot concentrate on an activity. -

After an interruption, I don't have any problem resuming my concentrated style of working.

I usually have a whole bunch of thoughts and feelings that interfere with my ability to work in a focused way. -

I stay focused on my goal and don't allow anything to distract me from my plan of action.

*Note.* The dash (-) indicates the item negatively correlates with the scale in general and needs to be reversed before the total score is calculated.

### **Patient Health Questionnaire (PHQ-9).**

The participants were asked how often have you been bothered by any of the following problems over the last two weeks? The participants were asked to indicate the perceived severity on a Likert scale of the following format:

o Not at all o Several days o More than half the days o Nearly every day

Questionnaire items:

Little interest or pleasure in doing things?

Feeling down, depressed, or hopeless?

Trouble falling or staying asleep, or sleeping too much?

Feeling tired or having little energy?

Poor appetite or overeating?

Feeling bad about yourself - or that you are a failure or have let yourself or your family down?

Trouble concentrating on things, such as reading the newspaper or watching television?

Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual?

Thoughts that you would be better off dead, or of hurting yourself in some way?

### **Difficulties in Emotion Regulation Scale – Short Form (DERS-SF)**

The participants were asked to rate their perception of the following statements on a Likert scale of the following format:

o Almost Never o Sometimes o About Half of the Time o Most of the Time o Almost Always

Questionnaire items:

I pay attention to how I feel.

I have no idea how I am feeling.

I have difficulty making sense out of my feelings.

I care about what I am feeling.

I am confused about how I feel.

When I'm upset, I acknowledge my emotions.

When I'm upset, I become embarrassed for feeling that way.

When I'm upset, I have difficulty getting work done.

When I'm upset, I become out of control.

When I'm upset, I believe that I will end up feeling very depressed.



When I'm upset, I have difficulty focusing on other things.

When I'm upset, I feel guilty for feeling that way.

When I'm upset, I have difficulty concentrating.

When I'm upset, I have difficulty controlling my behaviors.

When I'm upset, I believe there is nothing I can do to make myself feel better.

When I'm upset, I become irritated with myself for feeling that way.

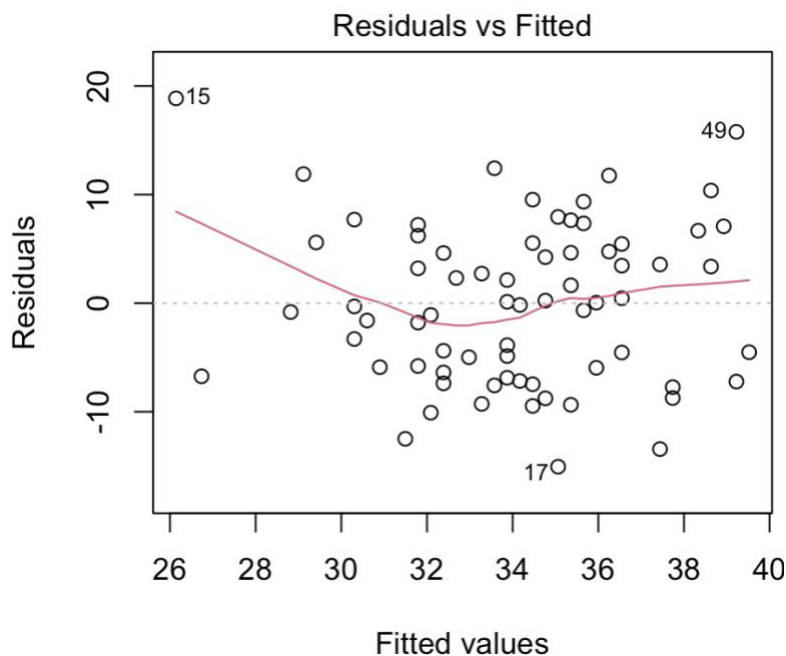
When I'm upset, I lose control over my behavior.

When I'm upset, it takes me a long time to feel better.

## Appendix B:

### Figure 1

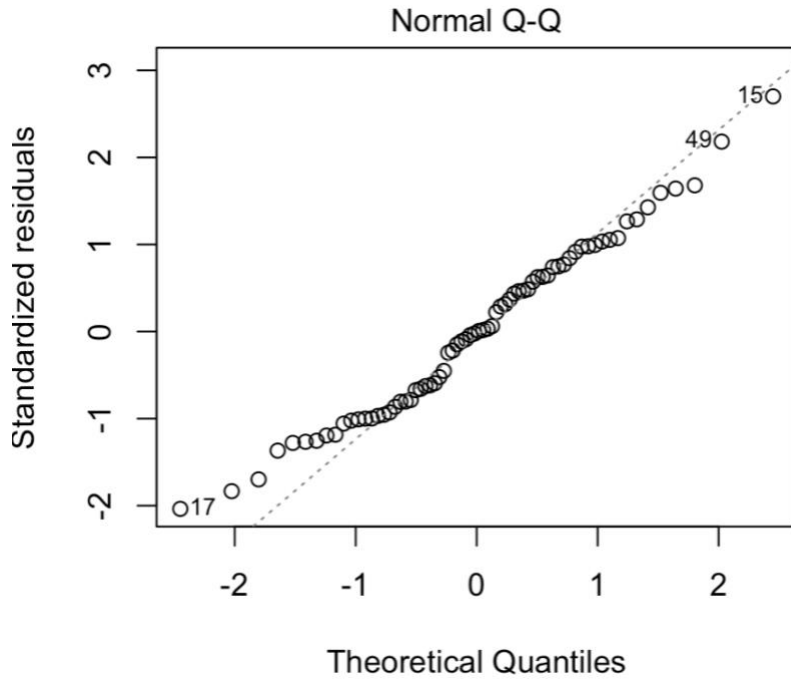
*Linearity of the data, from the linear model of perceived academic stress and PSU*



*Note.* The residual plot does not show a fitted pattern. A linear relationship can be assumed.

### Figure 2

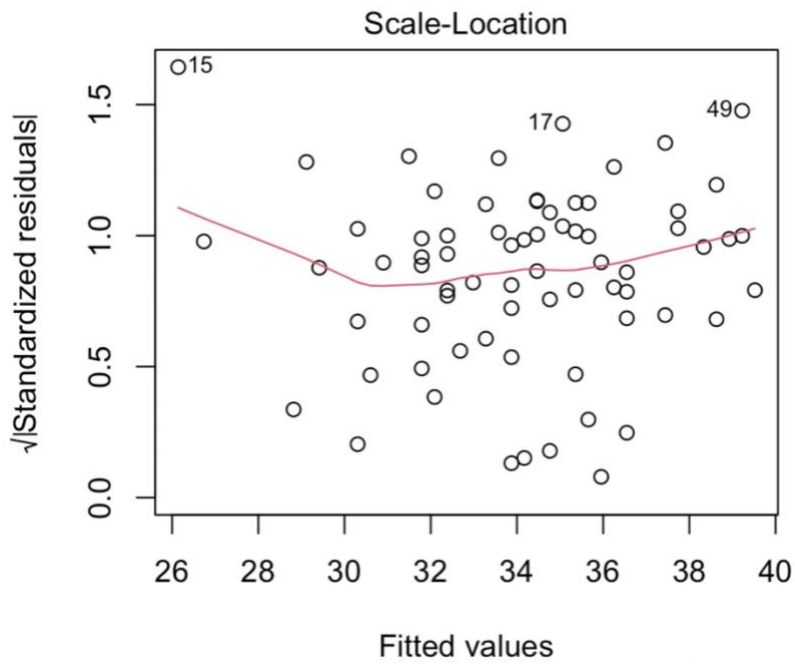
*Normality of residuals to check normality assumption*



*Note.* All the points fall approximately along this reference line, so normality can be assumed.

**Figure 3**

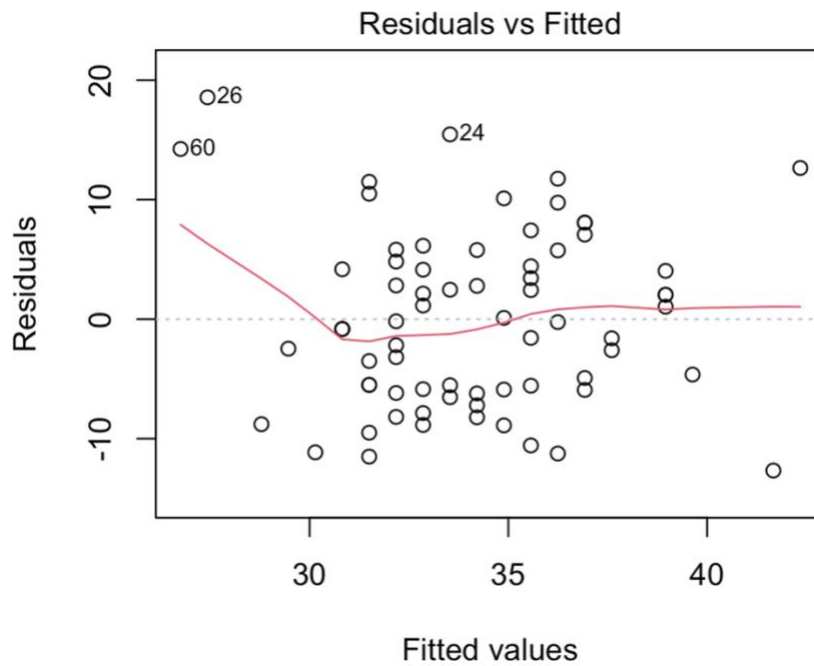
*Homogeneity of variance*



*Note.* Error variance appears to be homoscedastic.

**Figure 4**

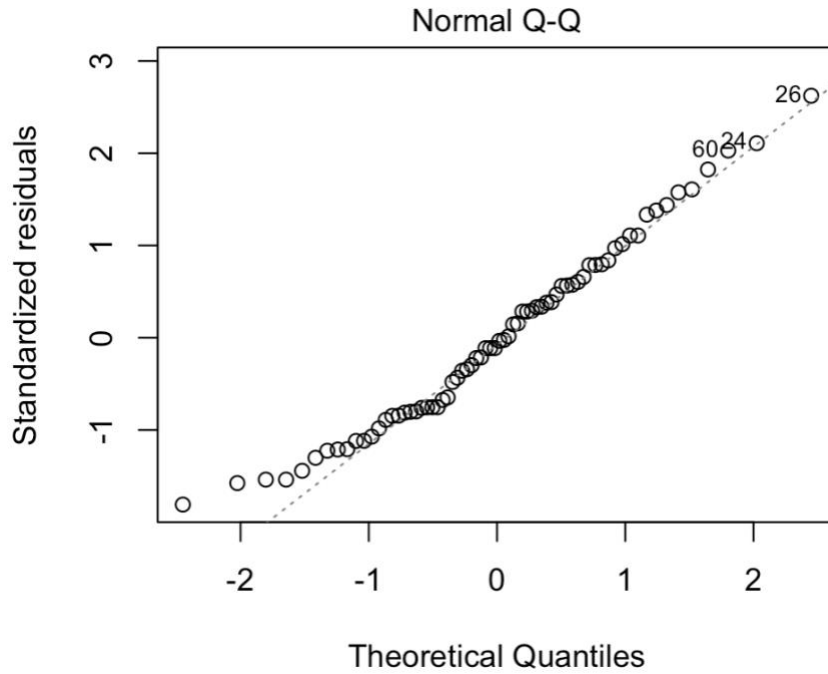
*Linearity of the data, from the linear model of self-regulation and PSU*



*Note.* The residual plot does not show a fitted pattern. A linear relationship can be assumed.

**Figure 5**

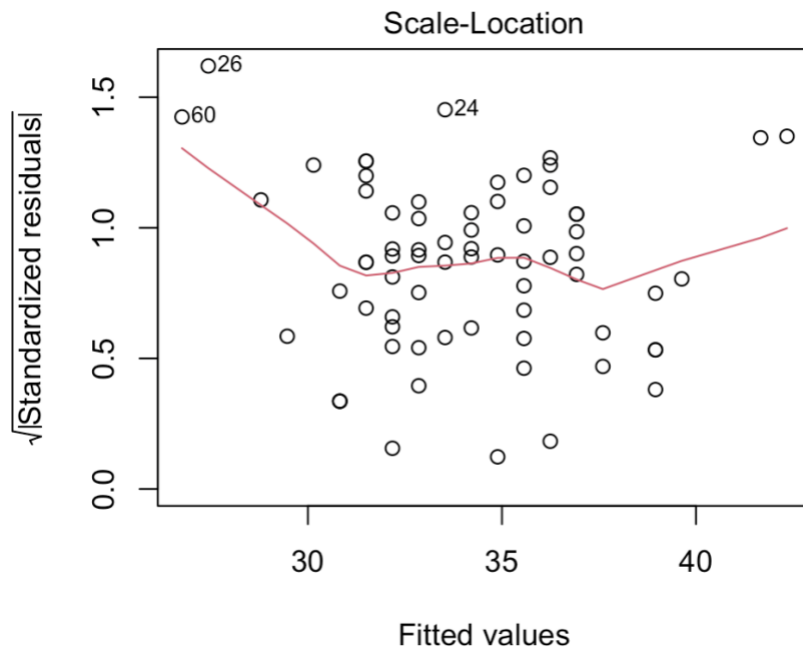
*Normality of residuals to check normality assumption*



*Note.* All the points fall approximately along this reference line, so normality can be assumed. SRS represents self-regulation scores.

**Figure 6**

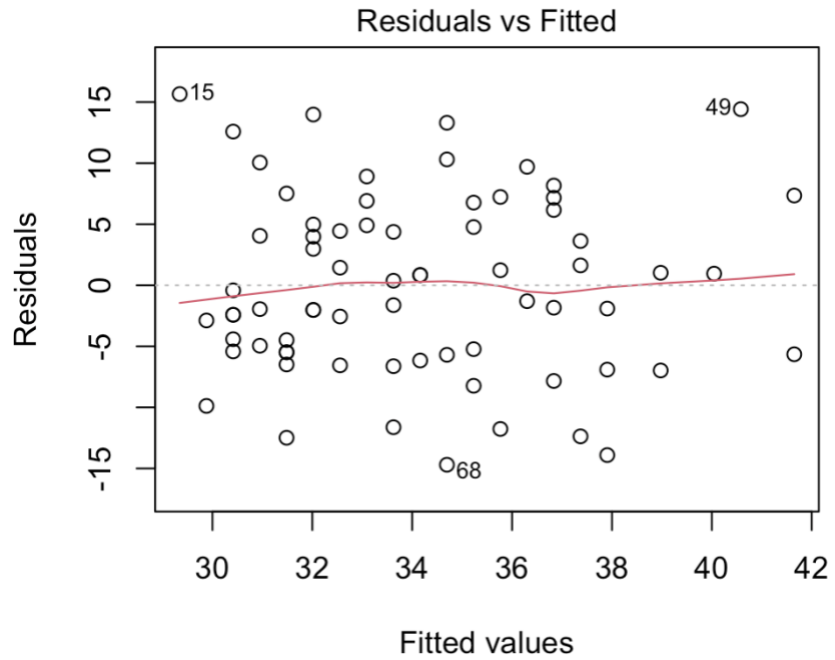
*Homogeneity of variance*



*Note.* Error variance appears to be homoscedastic.

### Figure 7

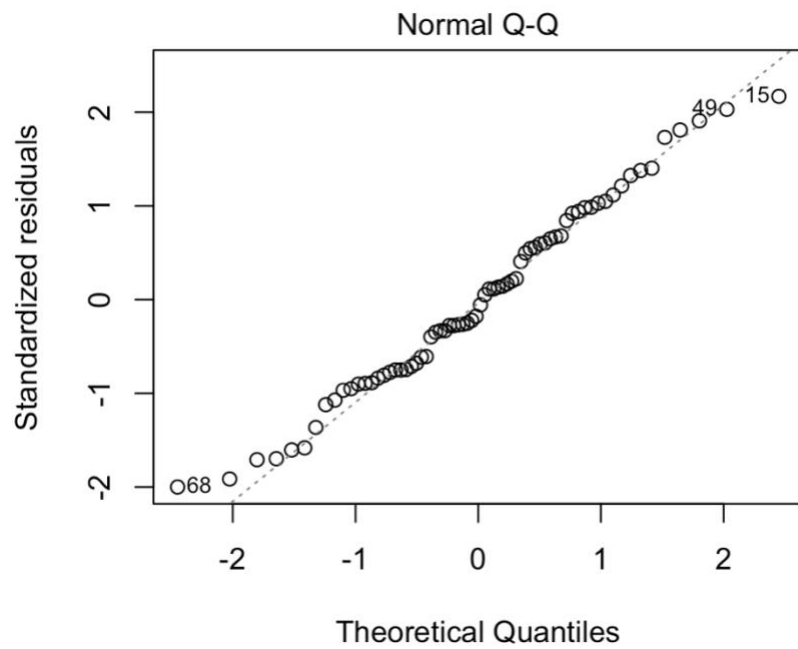
*Linearity of the data, from the linear model of depressive symptoms and PSU*



*Note.* The residual plot does not show a fitted pattern. A linear relationship can be assumed.

### Figure 8

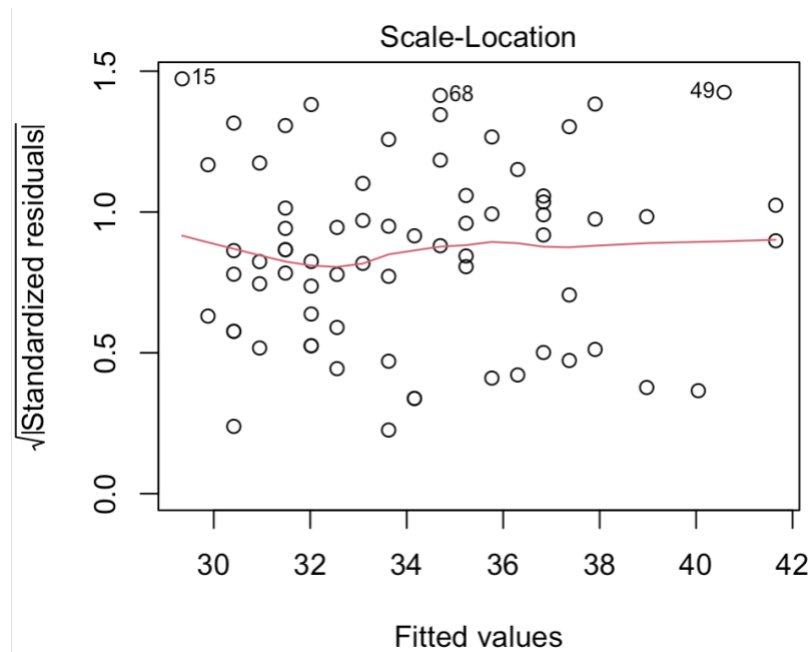
*Normality of residuals to check normality assumption*



*Note.* All the points fall approximately along this reference line, so normality can be assumed.

**Figure 9**

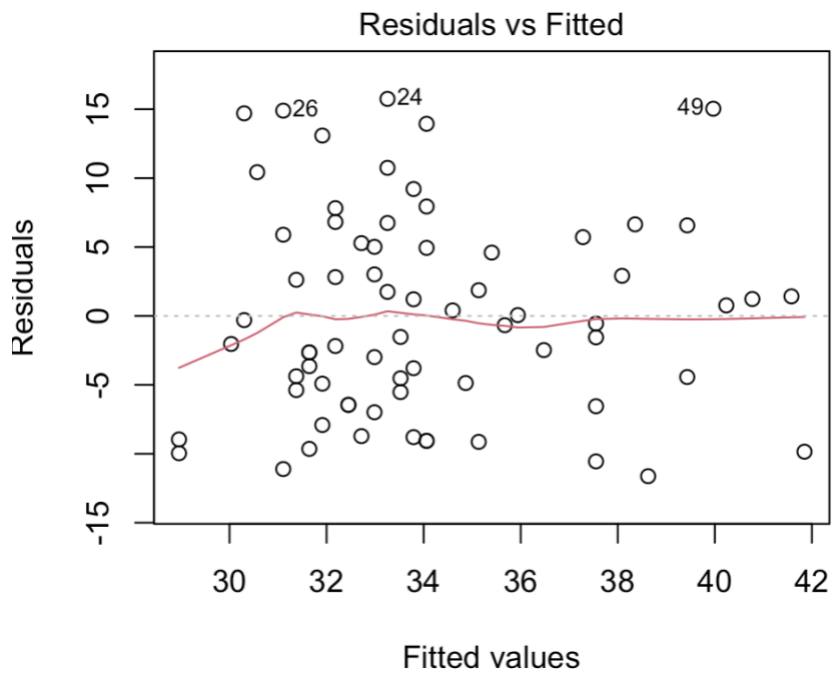
*Homogeneity of variance*



*Note.* Error variance appears to be homoscedastic.

**Figure 10**

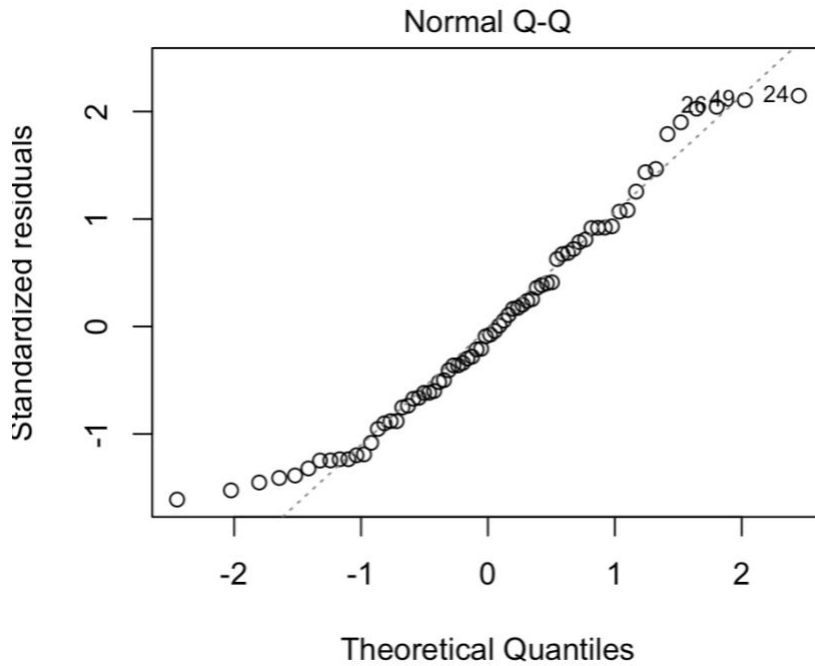
*Linearity of the data, from the linear model of emotion regulation difficulties and PSU*



*Note.* The residual plot does not show a fitted pattern. A linear relationship can be assumed.

**Figure 11**

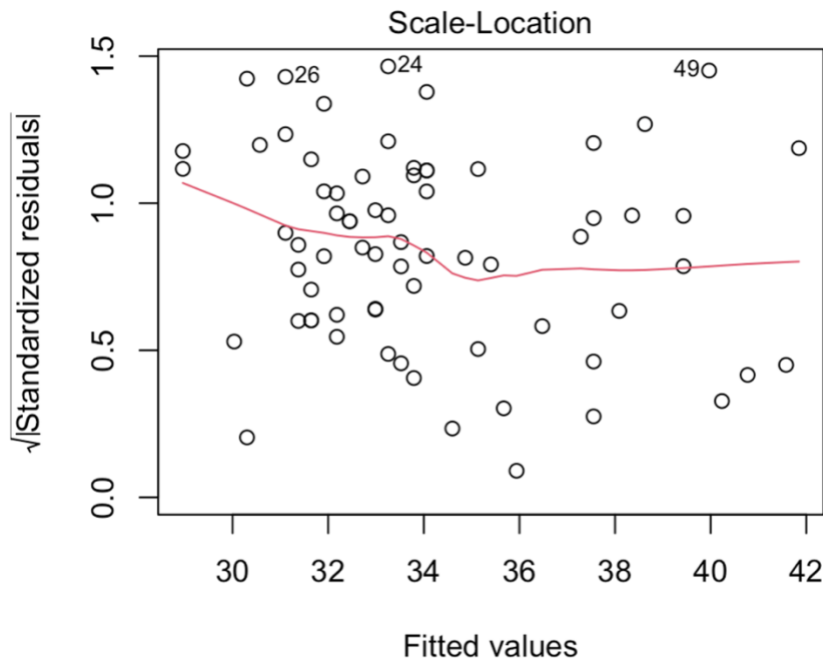
*Normality of residuals to check normality assumption*



*Note.* All the points fall approximately along this reference line, so normality can be assumed.

**Figure 12**

*Homogeneity of variance*

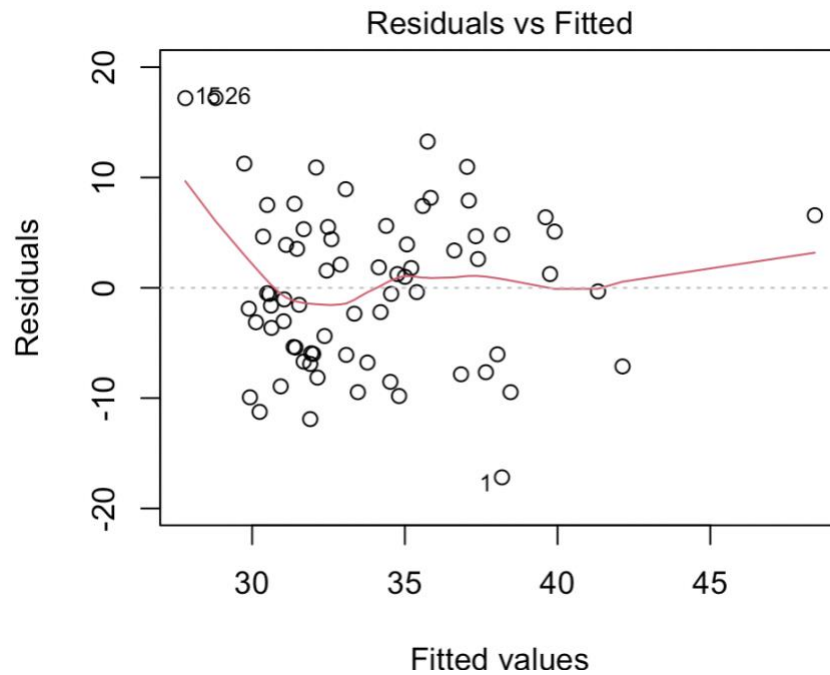


*Note.* Error variance appears to be homoscedastic.



**Appendix C****Figure 13**

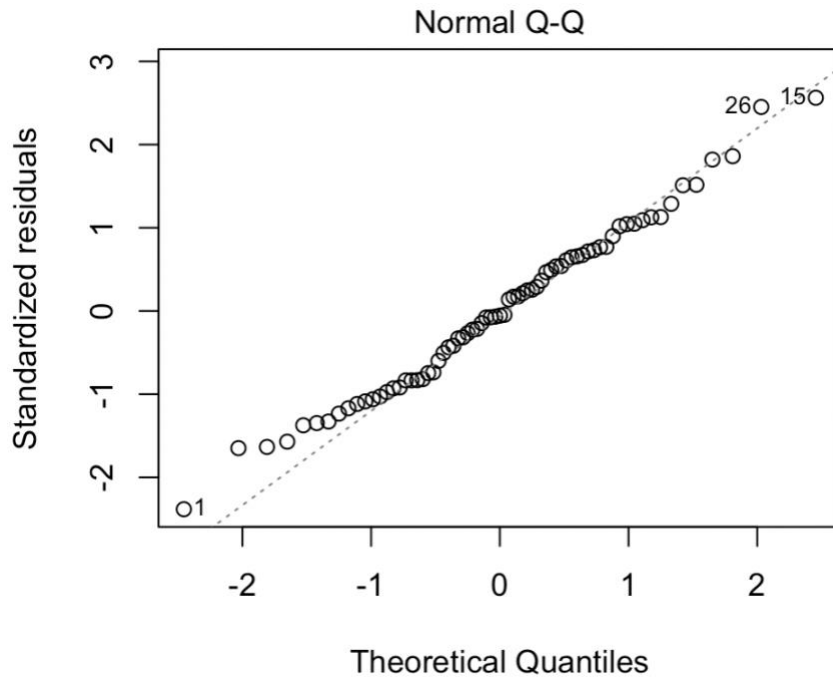
*Linearity of the data, from moderation effect of self-regulation on the relation between perceived academic stress and PSU*



*Note.* The residual plot does not show a fitted pattern. A linear relationship can be assumed.

**Figure 14**

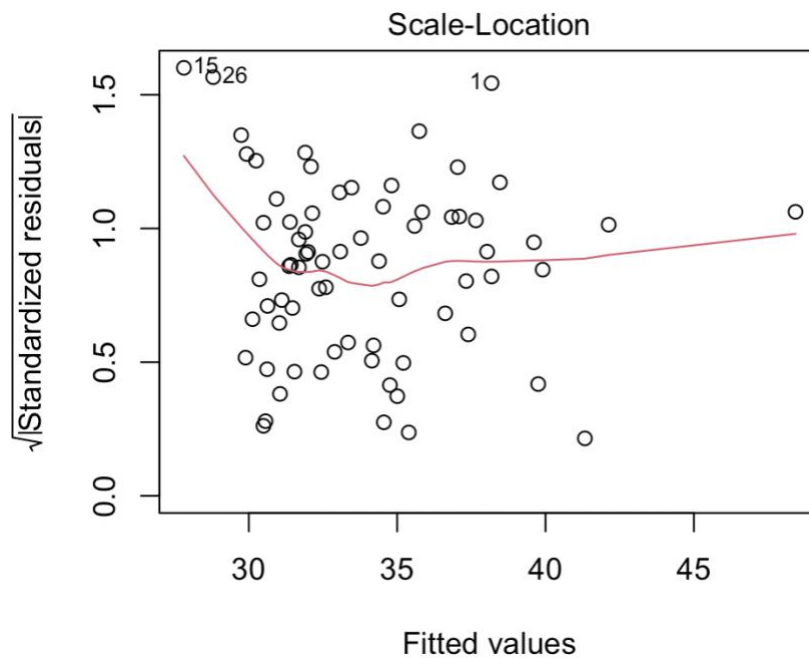
*Normality of residuals to check normality assumption*



*Note.* All the points fall approximately along this reference line, so normality can be assumed.

**Figure 15**

*Homogeneity of variance*



*Note.* Error variance appears to be homoscedastic.

**Collinearity Check Moderation Model with Self-Regulation as Moderator**

In general, high VIF values are expected if interaction terms are included in a model. This multicollinearity among the component terms of an interaction is also called "inessential ill-conditioning", which results in inflated VIF values that are often seen in models with interaction *terms* (Francoeur, 2013). Therefore, VIF values were calculated to assess multicollinearity among the independent variables in the model without interaction terms. The results showed that perceived academic stress had a VIF of 1.14 (95% CI: 1.02 to 2.00), indicating a low level of multicollinearity. Similarly, self-regulation had a VIF of 1.14 (95% CI: 1.02 to 2.00), suggesting no significant multicollinearity.