Plants providing more than just oxygen: Searching for affective and cognitive restoration.

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A research report submitted in partial fulfilment of the requirements for the degree of Masters of Organisational Psychology in the Faculty of Humanities at the University of the Witwatersrand, Johannesburg.

DECLARATION

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Abstract

The current study implemented an experimental design to investigate whether in-door plants would have affective and cognitive restorative effects on students following a vigilance task. Specifically, the current study investigated the effects of in-door plants, guided relaxation, and a control condition on affect, psychological stress, and cognitive functioning. Drawing from Attention Restoration Theory, it is argued that individuals who deplete their cognitive resources during demanding interactions have the tendency to experience increased stress and mental fatigue which can have detrimental implications on their physical and psychological well-being. The theory further suggests that following exposure to nature these cognitive resources can be replenished and have beneficial effects on individual mood, stress, and cognitive ability. Reducing stress and promoting cognitive functioning is a critical area across many domains and to date only a few studies have been conducted that empirically investigate the restorative effects of in-door plants in isolation following a mentally fatiguing task. This study was one of the first South African studies that attempted to induce mental fatigue and empirically investigate the restorative effects of in-door plants on affect, psychological stress, and working memory; as well as compare these effects to an established method of restoration and a control condition. This experimental study used a sample of 60 students from the university of Witwatersrand who were randomly assigned to one of three conditions: (1) presence of in-door plants (two large foliage plants and one medium non-flowering bonsai tree); (2) no plants passive break (control); (3) a six-minute guided relaxation activity. All participants experienced the same procedure apart from their respective treatment interventions; namely: participants completed a baseline affective and cognitive assessment made up of: Positive Affect And Negative Affect Schedule (PANAS), Dundee Stress State Questionnaire (DSSQ), and backward Digit-span task. After which participants engaged in the Temple et al (2000) vigilance task and directly after completed the affective and cognitive assessments for a second time. Following this, participants were asked to engage in a break for six-minutes where they were exposed to their relevant treatment conditions, followed by a final affective and cognitive assessment. The results obtained from an inferential analysis of standardised change Z-scores indicated that participants who were exposed to in-door plants experienced significant improvement in distress and working memory span following the vigilance task. The guided relaxation treatment had a significant beneficial effect on distress and engagement within the relevant participants. Finally, no significant improvements were found with respect to participants in the control condition. Notably, the results of this study suggest evidence that being in the presence of two in-door plants had led to a significant decrease in distress that was statistically similar to participants in the guided relaxation condition. The conclusions drawn within the current study suggest that exposure to in-door plants can lead to improved working memory and reduced distress, however as the current study was conducted in a laboratory setting the generalisability of these findings is restricted. As individuals face many activities in life that are mentally fatiguing and stressful, this research suggests that breaks in areas with in-door plants may lead to significant beneficial impacts, with respect to distress and working memory.

Key words: Indoor Plants, Affect, Psychological Stress, Working Memory, Attention Restoration Theory, Fatigue, Restoration

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Contents

Chapter One

Introduction

The impact of the work environment on employees has been a fundamental research area for decades within the discipline of organisational psychology (Knight & Haslam, 2010; Raanaas, Evensen, Rich, Sjøstrøm, & Patil, 2011). Within the field, various authors advocate that there is substantial association between environmental characteristics, such as noise, lighting, air quality and presence of nature and performance, employee engagement, and job satisfaction (Nieuwenhuis, Knight, Postmes & Haslam, 2014; Raanaas et al., 2011). With work tasks becoming increasingly complex, stressful, and cognitively demanding, organisations have recognised the vitality of conducive workspaces (Bringslimark, Hartig & Patil, 2007). Acknowledging research from Northern and European contexts, modern organisations are progressively adopting greener workspaces to combat the adverse effects associated with detrimental working environments (Musango, Brent & Bassi, 2014).

Reducing mental fatigue and stress resulting from continued cognitive effort is a critical issue across many domains extending beyond the occupational context and academic settings (Demerouti, Bakker, & Leiter, 2014). Whilst the physical and psychological consequences of increased stress have been established historically, mental fatigue has become an increasing area of focus (Berto, 2014; Bringslimark et al., 2009). Mental fatigue refers to a negative psychological state that has been associated with maladaptive behaviour, increased error rates or stress-related illnesses (Berto, 2014l; Colligan & Higgins, 2006), and reduced well-being (Berto, 2014; Stevenson, Schilhab & Bentsen, 2018). Concerns surrounding mental fatigue are becoming increasingly prevalent within occupations with high workloads that increase susceptibility to mental fatigue such as critical occupations like security, aviation controllers, transportation managers and medical professionals (Rupp, Sweetman, Sosa, Smither, & McConnel, 2017).

According to the attention restoration theory, contact with nature is argued to be a simplistic and effective method of addressing the dangers associated with increased cognitive demands typical of modern life (Berman et al., 2008; Berto, 2014; Stevenson et al., 2018). Researchers argue that work places that include plants and or natural views buffer against the negative impact of mental fatigue by promoting feelings of relaxation, positive affect, cognitive restoration and employee well-being (Berman, Jonides, Kaplan, 2008; Berto, 2014; Kaplan, 2007; Knight & Haslam, 2010; Shibata & Suzuki, 2004; Shoemaker, Randall, Relf & Geller, 1992). Increasing evidence from studies conducted abroad have indicated support for the beneficial impacts of nature on human emotional and psychological functioning (Berto, 2014; Bringslimark, Hartig & Patil, 2009; Dijkstra, Pieterse & Pruyn, 2008; Evensen et al., 2013; Field, 2000; Knight & Haslam, 2010).

Rationale for the current study

Facing increasing fears of job insecurity and economic instability, South Africans potentially experience enhanced self-perceived environmental demands leading to increased risks of stress or mental fatigue. Eriksson (2012) argues that organisations may lose billions of Rands a year due to issues associated with workplace stress in South Africa. Furthermore, research within the field argues that mental fatigue has critical consequences on individual emotional and cognitive functioning, as such identifying empirically valid methods of resolving its onset are vital (Berto, 2014). Previous research has examined the effects of nature via passive and active methods on emotional and cognitive functioning extensively within European and North American settings (Berto, 2014; Keniger, Gaston, Irvine & Fuller, 2013; Stevenson et al., 2018). Studies that have empirically investigated the effects of in-door plants have centered on performance, well-being, and stress (Stevenson et al., 2018). Despite the notable contributions made by these studies, the restorative effects of in-door plants from a South African perspective is limited due to few studies have being conducted (Stevenson et al., 2018). As in-door plants may represent a simple method of reducing the effects of mental fatigue (Berto, 2014), this study investigated the effects of in-door plants following a vigilance task using an experimental design. This allowed for the empirical investigation of the effects of in-door plants on individuals who exhibited evidence of mental fatigue. Accordingly, the current study's findings contribute to the understanding of the restorative effects of in-door plants and applicability of attention restoration theory within a South African setting.

Chapter Organisation

Chapter one of this report serves to provide an introduction into the study conducted. It begins by providing a brief overview of previous work conducted in the field. This is followed by a discussion of the rationale and chapter overview of the current study.

Chapter two contains a literature review of previous research that provides an overview of the background theories and studies conducted within the field. It focuses on the following topics: theories relating to beneficial effects of plants; research relating to in-door plants and affect, stress and cognitive function. The chapter concludes with a discussion of the aim and proposed research hypotheses of the current study.

Chapter three provides a detailed description of the methods used to conduct the current study. It proceeds by discussing the research design, sample, research procedure implemented, materials and instruments used, data analysis conducted, and ethical considerations adhered to within the current study.

Chapter four provides an overview of the results obtained from the data analyses conducted within the study. It includes an overview of the descriptive statistics, summary of the data obtained, the reliability of the instruments used, and results of the manipulation check conducted are provided. Finally, the section concludes with an overview of the results of the statistical methods used to investigate the research hypotheses proposed within the study.

Chapter five of the report contains a discussion of the results of this study in relation to previous research conducted in the field. It provides a discussion and interpretation of the results obtained in relation to the proposed research questions. Additionally, the chapter highlights the theoretical and practical implications of the study, study limitations and recommendations for future research, and strengths of the current study. It concludes with a discussion of the conclusions drawn by the researcher.

Chapter Two: Literature Review

This chapter provides an overview of the theoretical framework, concepts of interest and previous research conducted in the field that are relevant to the current research study. The primary aim of this chapter is to elaborate on literature that is available within the field regarding in-door plants, affect, stress, and cognitive functioning. It begins by first discussing theories concerned with the beneficial effects of nature; namely, stress reduction theory and attention restoration theory. This is followed by a discussion of research focused on in-door plants in relation to affect, stress, and cognitive functioning. Subsequently, a discussion of the current study in relation to previous research is provided and the research aims and hypothesises stated.

Theoretical background.

Of the various theoretical approaches that have been employed to understand the beneficial impact of nature on humans two theories have dominated contemporary research. The first being Ulrich's (1983) theory of stress reduction which adopts a psycho-evolutionary perspective; and the second is the Attention restoration theory that reflects a more cognitive perspective (Kaplan, 1993, 1995). In the following section, these two theories will be discussed briefly, which will be followed by an overview of research specifically relating to affect/mood, stress, and cognitive functioning.

Stress reduction theory

Within the field many studies that have investigated the impact of nature on human functioning have drawn on Ulrich's (1983) theory concerning environmental influences on psychophysiological stress-reduction (Berto, 2014; Bringslimark at al., 2009). Adopting a psycho-evolutionary approach to understanding nature-human interactions, this theory focuses on the unconscious affective and aesthetic reactions caused by interactions with natural environments (Berto, 2014; Bringslimark et al., 2009; Evensen et al., 2013; Ulrich, 1984) It advocates that natural environments or images of natural settings which embody specific traits may evoke positive emotions, restrict negative feelings or thoughts, and reduce physiological arousal (Berto, 2014; Bringslimark et al., 2009). Ulrich (1983) argues that environments which embody moderate depth, contain natural content (plants, water, or mountains), and are simplistic in nature stimulate subconscious evolutionary instincts that result in feelings of relaxation, happiness, and comfort. As such, when presented with visual stimuli depicting nature, individuals experience enhanced positive emotions which may distract or buffer against negative environmental influences and the accompanying detrimental psychophysiological consequences (Berto, 2014; Bringslimark et al., 2009;).

According to the theory, the positive emotions elicited through exposure to natural environments can block negative affect caused by stressful situations and lead to a restorative effect during demanding situations (Bringslimark et al., 2009; Evensen et al., 2013; Ulrich, 1984). Accordingly, it is argued that workspaces which contain elements of nature or simulate natural settings may positively impact individual stress levels, promote well-being, and increase feelings of satisfaction or comfort (Berto, 2014; Bringslimark et al.,, 2009; Evensen et al., 2013; Ulrich, 1984). Research within the field has led to mixed conclusions regarding the validity of the theory; with the results of some studies indicating little or no significant effect on mood within participants after being exposed to natural elements such as indoor plants or pictures of plants (Berto, 2014; Bringslimark et al.,, 2009; Larsen et al., 1998; Shibata & Suzuki, 2001, 2002). Conversely, studies that have investigated the impact of nature on pain and recovery time have suggested supportive results (Lohr & Pearson-Mims, 2000; Park & Mattson, 2008, 2009). These studies argued that the natural qualities of plants may serve to distract or buffer against the negative emotions caused by experiences of pain (Dijkstra et al., 2008; Lohr & Pearson-Mims, 2000; Park et al., 2004). Accordingly, researchers within the field argue that the restorative effects of nature may be mediated by the need for restoration (Berto, 2014; Berman et al., 2008; Bringslimark et al., 2009), or how appealing the individual finds the environment or stimuli (e.g. plants, pictures of plants, etc) (Dijkstra et al., 2008; Kim & Mattson, 2002;).

Attention restoration theory

The attention restoration theory adopts a cognitive perspective when conceptualising human-nature interactions (Berman et al., 2008; Berto, 2014). According to attention restoration theory nature exerts a beneficial impact on human cognitive functioning by restoring depleted cognitive resources used during demanding tasks (Berman et al., 2008; Berto, 2014). Attention restoration theory states that an individual's attentional capacity exists as two distinct mechanisms; namely directed attention and fascination (Kaplan, 1993, 1995). Directed attention is argued to be employed when individuals focus on cognitively demanding tasks (Berman et al., 2008; Berto, 2014). This focus is achieved through the conscious effort on the part of the individual to inhibit or ignore other more appealing environmental stimuli (Kaplan, 1993, 1995). Through this process individuals can consistently direct their attention towards completing or engaging in important tasks, such as work, studying, or general life interactions (Kaplan, 1993, 1995; Raanaas et al., 2011). Fascination is described as an involuntary form of focus which may occur when exposed to appealing or attractive environmental stimuli (Kaplan, 1993, 1995). Fascination requires little conscious effort and is therefore not cognitively demanding on the individual (Berman et al., 2008; Berto, 2014; Kaplan, 1993, 1995). Additionally, researchers argue that the cognitive effort expended during fascination is derived from a separate cognitive reservoir; as such when exposed to fascinating stimuli a shift occurs within the individual (Berman et al., 2008; Berto, 2014; Kaplan, 1993).

According to the theory an individual's directed attention span is finite and can be depleted when engaging in cognitively demanding tasks for long periods of time (Berman et al., 2008; Berto, 2014; Raanaas et al., 2011). Additionally, if an individual's directed attention span is completely depleted during or after a demanding task the individual may enter a state of mental fatigue (Berman et al., 2008; Berto, 2014; Kaplan, 1993). Kaplan (1995) describes mental or cognitive fatigue as a detrimental psychological state characterized by irritability, impulsiveness, reduced attention span, and reduced decision-making ability (Berman et al., 2008; Berto, 2014). Research in the field has consistently linked indications of mental fatigue to increased instances of human error, reduced cognitive flexibility, reduced working memory, and reduced self-control (Bringslimark et al., 2009; Berto, 2014; Han, 2017; Ohly et al., 2016). Kaplan (1993, 1995) argues that by interacting with nature both actively (being in a natural environment) or passively (viewing natural scenes or being in the presence of plants) an individual's directed attention reserves can be restored.

According to the theory, the process of attention restoration is fostered when one is exposed to nature or plants, as they stimulate fascination owing to their naturally compelling designs and patterns which evoke a temporary distance between the individual and their current stressor (Kaplan, 1993; Berman et al., 2008; Berto, 2014). Through this redirection of an individual`s directed attention capacity towards fascination plants provide the opportunity for directed attention reserves to replenish as they are no longer being used (Berman et al., 2008; Berto, 2014; Kaplan, 1993; Raanaas et al., 2011). Based on the attention restoration theory, nature may act as a psychological escape from fatiguing environmental demands that enhances self-reflection and relaxation (Kaplan, 1993; Berman et al., 2008; Berto, 2014). Research findings within the field have provided increasing support of the validity of the attention restoration theory, with results indicating reduced attentional fatigue, increased creativity and productivity following contact with nature (Berto, 2014; Bringslimark et al., 2009; Han, 2017; Ohly et al., 2016).

Drawing from the tenets of attention restoration theory, it may be argued that in-door plants may offer a simple, appealing, and effective means of avoiding mental fatigue that can result from the increasingly stressful and cognitively draining situations that characterize modern life (Berman et al., 2008; Berto, 2014;; Bringslimark et al., 2009; Field, 2000; Knight & Haslam, 2010). Indoor plants refer to potted plants of various sizes and require little to no direct exposure to sunlight, weekly watering, and little or no fertilizer (Knight & Haslam, 2010). Research in North American and European contexts have indicated that indoor plants in work environments are associated with increased employee performance (Bringslimark, et al., 2009; Knight & Haslam, 2010), physiological and psychological health (Bjørnstad, Patil & Raanaas, 2016; Cruz, Christensen, Thomsen & Müller, 2014; Field, 2000; Shibata & Suzuki, 2004), and improved physical environmental quality (air, humidity, aesthetic) (Cruz et al., 2014; Knight & Haslam, 2010).

Previous research has indicated that offices containing indoor plants were associated with increased employee reports of comfort, job satisfaction, and cohesion (Berto, 2014; Bringslimark et al., 2009; Ohly et al., 2016). Field studies have found that green workspaces or offices with plants are preferred by employees over lean or no plant offices (Dravigne, Waliczek, Lineberger & Zajicek's, 2008; Qin, Sun, Zhou, Leng & Lian, 2014). A study by Thatcher and Milner (2014) reported that green building workspaces are associated with increased self-perceived performance and employee well-being. Past research suggests that short term exposure to indoor plants for as little as 10-15 minutes can lead to increased performance, reduced reaction time and blood pressure, and increased attention span (Lohr, Pearson-Mims, & Goodwin, 1996).

Thomson, Sønderstrup-Andersen, and Muller (2011) conducted a qualitative study to provide an in-depth investigation of the indoor plant-human interaction. It was found that indoor plants were viewed by employees as a natural element of the work environment (Thomsen et al., 2011). The results indicated that indoor plants served various purposes, such as coping with job demands, promoting social interaction and promoting individual wellbeing (Thomsenet al., 2011). Another qualitative study's findings suggested that employees preferred natural plants in comparison to artificial plants (Thomson, Moles, Auld and Kingsford, 2011). Research trends within the field suggests that exposure to natural stimuli improved emotional and cognitive functioning (Berto, 2014; Bringslimark, Hartig & Patil, 2009; Ohly et al., 2016). The following section provides an overview of research focused on the main variables of interest within the current study.

In-door plants and Affect (Mood)

Research trends within the field suggest that contact with nature is typically beneficially to an individual's well-being (Berto, 2014; Bringslimark et al., 2009; Han, 2017; Ohly et al., 2016).Studies within the field have employed various measures to investigate the impact of nature contact on individual, such as stress indicators, cognitive assessments, and mood assessments (Berto, 2014; Bringslimark et al., 2009; Ohly et al., 2016).Changes in mood states are of particular importance as an individual's mood influences behaviour, social interactions, stress recovery, and cognitive functioning (Berto, 2014). As affect is a multifaceted construct, researchers within the field have operationalised the concept using various psychological definitions (Berto, 2014); however, the current study operationalised affect as two independent constructs; namely: positive affect and negative affect. High positive affect (PA) reflects feelings of activity, vitality, alertness, satisfaction, and enthusiasm, whereas low PA refers to feelings of sadness, boredom, or lethargy (Watson et al., 1988). High negative affect (NA) represents feelings of irritability, distress, hostility, shame, and nervousness, with low NA referring to feelings of calmness, tranquillity, and relaxation (Watson et al., 1988).

Researchers in the field describe environments which enable high levels of nature contact as restorative environments (Berto, 2014; Bringslimark et al., 2009; Ohly et al., 2016). Environments which have windows with views of natural environments, contain indoor plants or have images of natural settings, sufficient lighting, and natural sounds are argued to foster positive emotions and mood states, reduce stress and enhance cognitive abilities (Berto, 2014; Bringslimark et al., 2009; Ohly et al., 2016). Drawing from the stress reduction theory it is suggested that humans have an evolutionary link to nature and environments that which simulate natural settings produce an unconscious autonomic reaction resulting in reduced physiological arousal, diminished negative affect, and increased positive affect (Berto, 2014). As such, from an evolutionary standpoint, contact with nature is argued to lead to increased positive emotions, reduced stress reactions, and decreased negative affect (Bringslimark et al., 2009; Evensen et al., 2013; Ulrich, 1984). Within the field various comprehensive reviews have indicated that exposure to plants can lead to improved mood within women and men (Berto, 2014; McMahan & Estes, 2015). However, this relationship is still inconclusive as some studies have indicated no significant change in mood within participants following exposure to nature (Shibata & Suzuki, 2001, 2002). The results of a meta-review by McMahan and Estes (2015) using 32 studies found that positive affect was positively associated with nature contact, and negatively associated with negative affect. They argue that previous non-significant effects of nature contact on mood may have been due to other factors such as sample size, the operationalisation of mood or extraneous such as nature identity (McMahan & Estes, 2015).

Other studies have found mixed results using neuro-biological indicators of changes in mood. A 2014 study by Ikei, Komatsu, Song, Himoro and Miyazaki, (2014) using both a physiological measure of mood and a self-report method tested the impact of being exposed to unscented pink roses for four minutes on a sample of 31 male office works from Tokyo. The results of the indicated that participants experienced greater experiences of positive affect indicated by higher reports of comfort and relaxation compared to a control group not exposed flowers (Ikei et al., 2014). Additionally, the group exposed to the flowers had significantly higher heart rate variability than the control condition indicating reduced physiological arousal (Ikei et al., 2014). Their findings suggest that flowers had relaxing effects on participants at both a physiological and psychological level. Similar results were found in a study by Haviland-Jones et al. (2005) which argued that flowers can promote positive emotions in both women and men.

Another study by Park, Song, Choi, Son and Miyazaki, (2016) investigated the relaxation effects of indoor foliage plants using an experimental design. They measured changes in prefrontal cortex activity and self-reported measures of mood following exposure for three minutes to in-door foliage plants in 24 university students. They found that subjects exposed to plants were significantly more relaxed than a control group. They concluded that foliage plants had both psychological and physiological relaxation effect within participants after a short-term exposure. Research conducted in the work context found similar results indicating that indoor plants were associated with improved mood in participants, compared to offices with no plants (Adachi et al., 2000). A study by Dravigne et al. (2008) found that job satisfaction was positively associated with the presence of indoor plants and window views of nature. In a large survey by Smith and Pitt (2009) it was found that in offices with plants, occupants felt more self-reported comfort and self-perceived performance. In a study by Ryan, Weinstein, Bernstein, Brown, Mistretta, and Gagne (2009) it was found that after viewing images of natural outdoor settings self-reported vitality was increased within participants and that participants who viewed urban settings experienced a drop in self-reported vitality.

Similar support for the beneficially impact of indoor plants on mood was demonstrated in a study by Jumeno, Desto and Matsumoto (2015). They conducted a repeated measure experiment on 18 participants with an average age of 23.5 years (Jumeno et al., 2015). The results of their experiment found that in a room containing small to medium indoor foliage plants participants exhibited the highest positive mood, lowest reaction time, highest productivity, and greatest perceived air quality compared to rooms with less to no plants (Jumeno et al., 2015). They argued that indoor plants proved beneficial to the participants' mood and that greater amounts of plants would lead to a more pronounced impact on individuals' mood. Additionally, a study by Lohr and Pearson-Mims (2000) reported that individuals were willing to withstand discomfort (hand in ice) for longer periods of time, when in the presence of plants.

In-door plants and Stress

Research on the negative impact of stress has been investigated within numerous contexts; for example: the organisational environment, academic domain, and global populations (Berto, 2014; Rupp et al., 2018). Within the literature, stress is commonly described as a negative psychological-physiological state resulting from prolonged strain that may result from an individual's prolonged inability to meet perceived environmental demands (work or personal) (Cohen, Janicki-Deverts, & Gregory, 2007; Temple, Warm, Dember, Jones, LaGrange, & Matthews, 2000). Previous research has commonly suggested that high stress levels are associated with various negative individual and organisational outcomes (Berto, 2014; Rupp et al., 2018). Examples include reduced employee engagement, increased absenteeism, negative affect, burnout, reduced well-being, increased human error and other stress related issues (headaches, heart disease, smoking, hostility, insomnia) (Berto, 2014; Cohen, Janicki-Deverts, & Gregory, 2007; Rup et al., 2018; Stanhope, Owens, and Elliott, 2016.).

Researchers argue that indoor plants and contact with nature act to reduce both physiological and psychological effects of stress by promoting positive mood reactions and or restoring depleted cognitive resources (Berman et al., 2008; Berto, 2014; Bringslimark et al., 2009; Rup et al., 2018; Ulrich, 1983). Drawing from stress reduction theory, it is argued that interactions with nature either actively or passively serve to enhance feelings of positive emotions, which starve of the impact of negative emotional states caused by fatiguing tasks (Lohr & Pearson-Mims, 2000; Park & Mattson, 2008, 2009; Ulrich, 1983;). From a more cognitive orientation, the attention restoration theory suggests that stress recovery is fostered in environments with plants owing to their inherently fascinating characteristics which promote cognitive restoration (Berto, 2014; McMahan & Estes, 2015).

Within the literature, environments with natural elements (views of nature and indoor plants) have been found to beneficially reduce stress levels, promote individual health, and foster cognitive ability (Berto, 2014; Bjørnstad et al., 2016 McMahan & Estes, 2015). Studies that have investigated the relationship between nature contact and stress have been conducted using various methods to assess stress responses; such as: neuro-physiological indicators, self-report measures, and behavioural measures of stress (Berto, 2014; Bringslimark et al., 2009; McMahan & Estes, 2015). Additionally, researchers have investigated a broad range different types of nature contact; commonly, these includes window views of nature, active walks in natural environments, passive exposure to indoor plants or pictures of plants or nature (Berto, 2014; Bringslimark et al., 2009; McMahan & Estes, 2015).

Within the available literature, the impact of nature contact on individual stress levels has commonly suggested a beneficial relationship (Berto, 2014; Bringslimarket al., 2009; Stevenson, Schilhab & Bentsen, 2018). Bringslimark, Hartig, and Patil (2009) conducted a critical review of previous research and found that increased nature contact commonly has a beneficial relationship on individual stress levels and promotes psychological health, and physiological wellbeing. This relationship is further supported by the results of a recent workplace study conducted using a web based survey method, which indicated a negative association between indoor and outdoor nature contact and employee absenteeism, self-reported job stress, and employee health complaints (Bjørnstadet al., 2016). Another study using a survey method and sample consisting of 5503 participants found similar results; indicating a negative association between various forms of nature contact and self-reported stress (Largo-Wight, Chen, Dodd & Weiler, 2011). Similarly, in a survey-based study by Kweon et al., (2008) using a sample of 210 participants it was found that participants reported lower levels of anger and stress when exposed to paintings of plants and nature (Kweon et al., 2008). A 2017 study by Korpela, Bloom, Sianoia, Pasanen, and Kinnunen suggested that within a work context, windows with natural views are associated with greater self-reports of job satisfaction, performance, and stress recovery time. Similar results have been proposed using biological indicators of stress in a laboratory context (Berto, 2014; Bringslimark et al., 2009; Stevenson et al., 2018). A study by Chang and Chen (2005) using 38 college students compared psychophysiological reactions to slides depicting indoor offices containing plants and window views of nature, cities and urban settings, and offices with no plants. Using data from an EEG to measure blood volume pulse, and a state-anxiety questionnaire they found that participants were more relaxed and less anxious when exposed to visual stimuli containing plants and natural views in comparison to participants exposed to visual stimuli containing no nature images (Chang & Chen, 2005). The results of a study by Lottrup, Grahn and Stigsdotter, (2013) suggested that both physical and visual access to nature were associated with greater participant reports of positive attitudes and reduced stress levels. This suggests that the stress relieving properties of natural environments may be provided by indoor plants as they represent and depict various elements of nature (Berto, 2014; Bringslimark et al., 2009; Stevenson et al., 2018). Studies that investigated the isolated impact of indoor plants suggest that even passive interaction leads to reduced indications of stress (Berto, 2014). A study by Dijkstra, Pieterse and Pruyn (2008), using a sample of 77 participants found that self-reported levels of perceived stress were lower in a room with indoor plants as compared to a control room with no plants. The results of a longitudinal field study by Han (2018) using 35 Taiwanese high school students indicated that both passive and active interaction with plants was associated with increased self-reported attention restoration and self-perceived stress restoration (compared to baseline no plants).

Research using physiological indicators of stress have also found similar results; a study by Kim, Cha, Koo, and Tang, (2018) investigated the effects of indoor plants on participants physiological stress responses, task response time, and room attractiveness. Using a sample of 66 university students from the Hong Kong Polytechnic University, an electrodermal activity measure (to indicate stress), self-made room assessment measure, and response time task they compared the effects of indoor plants and artificial windows to a control condition (no indoor plants or artificial windows) (Kim, Cha, Koo, & Tang, 2018). The results of their study suggested that indoor plants in an underground room were associated with reduced reaction times, more positive room assessments, and reduced physiological arousal indicating lower stress reactions (Kim, Cha, Koo, & Tang, 2018). Similarly, Kim and Mattson (2002) used a stress induction method to compare the impact of indoor plants on stress relief; they found that participants exhibited reduced electrodermal activity and EEG beta activity (indicators of stress relief) following exposure to indoor plants (geraniums). Additionally, they found that the stress relief effect of indoor plants was greater in participants with relatively high levels of induced stress (Kim & Mattson, 2002).

Similar supportive results were found in a study by Han (2009) that investigated the impact of indoor plants on two groups (total participants were 76) high school students from Taiwan. Using a quasi-experimental design, the effects of indoor plants on student’s mood, punishment records, and sick leave were investigated. The results of a self-report survey suggested that following the introduction of six indoor plants within the intervention group’s classroom students reported greater feelings of comfort, preference and friendless compared to the control group (Han, 2009). Additionally, the intervention group had significantly lower hours of sick leave and reports of misbehavior when compared to the control group (Han, 2009). Conversely, a study by Bringslimark, Hartig and Patil (2007) found no significant association between self-reported perceived stress and the presence of indoor plants. Although after statistically controlling for extraneous variables their results indicated a negative association between indoor plants and absenteeism as well as a positive association to self-perceived performance (Bringslimarket al., 2007). They argued that participants only reported moderate levels of stress and that this may have not provided sufficient opportunity for the restorative effects of indoor plants to occur.

Indoor plants and cognitive functioning

Increasingly within modern society, greater cognitive demands are being placed on individuals, stemming from fatiguing work tasks, navigating chaotic urban environments and dealing with various life stressors (Stevenson et al., 2018). Accordingly, researchers within the field suggest that individuals face greater susceptibility to experiencing mental fatigue owing to the continued need to direct cognitive effort to focus on tasks they face (Berman et al., 2008; Stevenson et al., 2018). Mental fatigue is described as a negative state of mind characterised by experiences of cognitive exhaustion, reduced ability to focus or sustain attention, reduced working memory, increased experiences of negative mood states, or reduced task performance (Berman et al., 2008; Kaplan, 1995; Stevenson et al., 2018). Drawing from attention restoration, mental fatigue is argued to occur as a result of depleted directed attentional reserves used by individuals to focus on specific elements for prolonged periods of time or to suppress potential distractions that may be more appealing than the current task (Berman et al., 2008; Kaplan, 1995; Stevenson et al., 2018).

Researchers suggest that mental fatigue has numerous detrimental consequences within individuals, such as reduced levels of self-control, poorer decision making, heightened stress levels, feelings of negative affect, and reduced task engagement (Berman et al., 2008; Kaplan, 1995; Ohly et al., 2016; Stevenson et al., 2018). Accordingly, ways of reducing mental fatigue have become an increasingly vital aspect of research (Berman et al., 2008;

Berto, 2014; Ohly et al., 2016; Stevenson et al., 2018). Drawing from attention restoration theory, researchers argue that nature contact, and natural environments can buffer against mental fatigue by fostering restoration of directed attentional reserves; that are fundamental requirements for successful emotional and cognitive functioning (Berman et al., 2008; Berto, 2014; Ohly et al., 2016; Stevenson, Schilhab & Bentsen, 2018). Previous research suggests nature contact promotes cognitive functioning (Berman et al., 2008; Berto, 2014; Ohly et al., 2016; Stevenson et al., 2018; Taylor & Kuo, 2009) enhances working-memory span and is beneficial to individual mood (Berman et al., 2008).

Attention restoration theory suggests that nature contact acts to invoke involuntary attention owing to their inherently fascinating traits; which allows the directed attention mechanisms the opportunity to recharge (this is discussed in greater detail above) (Berman et al., 2008; Berto, 2014; Ohly et al., 2016). As such it is argued that following contact with nature, individuals will perform better during cognitively demanding tasks (Berman et al., 2008; Berto, 2014; Ohly et al., 2016; Stevenson et al., 2018; Taylor and Kuo, 2009). Within the field, various studies have attempted to investigate this relationship by using various indicators of cognitive ability (Berman et al., 2008; Berto, 2014; Ohly et al., 2016; Stevenson et al., 2018; Taylor and Kuo, 2009). A recent meta review conducted by Stevenson, Schilhab and Bentsen (2018) investigated the relationship between various objective indicators of cognitive functioning and nature contact (most commonly walking) in nature across 42 studies that were published since July 2013 (Stevenson et al., 2018). The results of their meta-analysis suggested following exposure to natural environments, or a similar stimuli improvement were found in participant’s attentional control, working memory, and cognitive flexibility compared to a suitable control condition, with low to moderate effect sizes being observed (Stevenson et al., 2018). Additionally, they found significant differences in cases where participants restoration potential was higher compared to cases where no method of fatigue induction was evident.

A study by Berto, Baroni, Zainaghi, and Bettella (2009) investigated the impact of high fascination environments on performance during attention-orienting task during a mentally fatigued state. Using a sustained attention test on 31 participants to induce mental fatigue and images of natural environments deemed fascinating; they found that participants in the high fascination condition had a reduced reaction time in a attention-orienting task (shift between trails) (Berto et al.,, 2008). Similar results were found in a study by Nieuwenhuis, Knight, Postmes, and Haslam (2014) who conducted three field experiments in a work environment to investigate the impact of green workspaces on self-reported perceptions of air quality, perceived concentration, and job satisfaction. The results of all three experiments suggested beneficial outcomes for work spaces enriched by plants as opposed to offices with lean (no plant) designs (Nieuwenhuis, Knight, Postmes, & Haslam, 2014).

In a study investigating the impact of micro-breaks spent viewing natural environments (a flowering meadow) on sustained attention ability conducted by Lee, Williams, Sargent, Williams, and Johnson (2015) it was found that 40 second breaks with natural views led to participants making less task errors as compared to those who viewed a concrete roof in a sample of 150 university students (Lee, Williams, Sargent, Williams, & Johnson, 2015).

Another study by Berman et al., (2012) investigated the impact of walking in nature during breaks on positive and negative affect and working memory within individuals with major depression. They assessed 20 participants' mood and working memory at a baseline, after which they attempted to induce negative emotions (Berman et al., 2012). This was followed by a 50-minute walk either in a natural setting or an urban one, after which they re-measured the participants' mood and working memory (Berman et al., 2012). The results of their study suggested that participants exhibited improved working memory and mood following the nature walk relative to the urban setting. Similar results were found in a previous study by Berman, Jonides, and Kaplan (2008) who, following two experimental trials, found that walking in nature (experiment one) and viewing pictures of nature (experiment two) led to improved directed attention abilities as measured by a backward digit span task and attention network task when compared to walks in an urban setting and pictures of urban environments respectively (Berman et al., 2008). Additionally, they found no significant changes in positive and negative affect in both experiments (Berman et al., 2008).

Research relating specifically to indoor plants and indicators of cognitive ability have found inconclusive results. For example, Rich (2008) investigated changes in working memory between three experimental conditions: a room with plants; a room with magazines, and a room with plants and other common office objects (Rich, 2008). The results of the study found no significant changes or differences in working memory as measured by a backward digit span task across all of the experimental conditions (Rich, 2008). Additionally, no differences in mood were observed between the experimental conditions (Rich, 2008). However, the sample size used within this study was alarmingly small being below 40 (Rich, 2008). Contrary results were found within another study by Raanaas, Evensen, Rich, Sjøstrøm and Patil (2011) who conducted in a controlled laboratory setting using a small sample of 34 students the restorative potential of indoor plants were investigated using a reading span task to measure attention capacity. The researchers randomly assigned the participants to either an intervention condition (office setting that contained indoor plants) or a control condition (same office setting with no plants). They assessed attention capacity at a baseline (immediately entering the laboratory), following the completion of a mentally fatiguing task, and after a five-minute break period. The results of their study indicated an increase in attention capacity in the plant condition following the mentally fatiguing task and no change within the control condition (Raanaas et al., 2011). Notably, there was no improvement in attention capacity within both groups following the break period (Raanaas et al.,, 2011). Similarly, studies conducted using measures of task performance to indicate cognitive ability suggest that indoor plants have a positive relationship with cognitive function. A study by Knight and Haslam (2010) measured indicators of cognitive ability via measures of performance on a card sorting task, following a vigilance task within an indoor plant condition (including art) and control no plant condition (only art). Their results suggested that participants had faster task completion rates with no detriment in accuracy on both the card sorting tasks and vigilance tasks in the indoor plant condition, as compared to the control condition (Knight & Haslam, 2010).

Further support for the restorative effect of plants was provided in a South African study by Adamson (2018). Using an experimental design consisting of 120 participants, the study found that participants exposed to plants demonstrated significantly fewer task errors, and reduced task completion time; in comparison to a lean condition (no plants or pictures of plants) and pictures of plants condition (Adamson, 2018). This study is one of the few South African studies to empirically link plants to increased task performance and reduced human error. Similar results were found in a study conducted by Shibata and Suzuki (2002) who found that participants exposed to indoor plants performed better on a creative task than the control no plant condition.

Research objectives and hypothesises

Based on insight from research within the field, the current study aimed to investigate the restorative effects on in-door plants on both affective and cognitive functioning by using a vigilance task to induce cognitive fatigue. Furthermore, the current study used a repeated measures methodology to compare changes in the variables of interest over three measurement periods. The following hypotheses were constructed to investigate the restoration potential of in-door plants as well as compare these effects to an established method of restoration.

Primary hypotheses

1. The presence of in-door plants has a significant beneficial impact on positive affect within participants following a vigilance task.
2. The presence of in-door plants has a significant beneficial impact on negative affect within participants following a vigilance task
3. The presence of in-door plants has a significant beneficial impact on distress within participants following a vigilance task.
4. The presence of in-door plants has a significant beneficial impact on worry within participants following a vigilance task.
5. The presence of in-door plants has a significant beneficial impact on engagement within participants following a vigilance task.
6. The presence of in-door plants has a significant beneficial impact on working memory within participants following a vigilance task.
7. Significant effects on positive and negative affect attributed to in-door plants will be equal to or greater than a guided relaxation condition following the vigilance task.

8. Significant effects on distress, worry, and engagement attributed to in-door plants will be equal to or greater than a guided relaxation condition following a vigilance task.

9. Significant effects on working memory attributed to in-door plants will be equal to or greater than a guided relaxation condition following a vigilance task.

Chapter Three: Methodology

Introduction

The first section of this chapter provides an overview of the methods used to investigate the effect of indoor plants on positive and negative affect, psychological indicators of stress and cognitive functioning. This chapter consists of a detailed description of the research design and method used within the current study; after which a description of the sample strategy and sample obtained is outlined. Next an overview of the research procedure and data collection methods implemented by the researcher to achieve the study objectives is provided. The latter part of this chapter contains detailed descriptions of the instruments and materials used, as well as the statistical analyses conducted to address the proposed research hypothesises. This chapter concludes by highlighting the ethical considerations undertaken throughout the duration of the study.

Research Design

To investigate the research hypotheses of the study, an experimental repeated measures design was used (Babbie, 2013). Specifically, the design was a cross-sectional, true experiment, with a contrast and control group (Babbie, 2013). The design is characterised as true experimental due to the use of a control condition and manipulation of the three independent variables; namely: 1) the control condition, passive break with no plants; 2) presence of in-door plants; 3) guided relaxation intervention (Howell, 2013). Additionally, within the current study, participants were randomly distributed into three independent groups; namely: in-door plants, control and contrast and experienced the same conditions with the exception of different treatment interventions (Babbie, 2013; Field, 2005). The study used a repeated measure approach for data collection. With respect to the dependent variables; namely: positive affect; negative affect; distress; worry; engagement; and working memory, these were measured prior to the vigilance task, post vigilance task, and post intervention (Howell, 2013). This method enabled the researcher to examine whether participants had experienced similar changes in the main variables prior to the treatment periods (Field, 2005). This promoted non-spuriousness within the study and enabled a more accurate comparison of the participants' scores (Babbie, 2013; Field, 2005).

The use of the vigilance task and investigation of the pre-vigilance task scores promoted temporal precedence as participants were randomly assigned and only exposed to one of the three study conditions (Howell, 2013). The study was characterized as cross-sectional, as data of each participant was collected at one sitting over three intervals (Babbie, 2013; Howell, 2013).

Within the study, the in-plant condition acted as the primary intervention of interest, and the results were compared to the relaxation group, and passive break group. The relaxation technique was used to enable a contrast of the restorative effects of plants to an established restorative condition; and the passive break condition acted as a control condition. The use of these comparisons enabled the researcher to isolate the restorative effects of indoor plants, if any (through the control); as well as compare these results to other well - established measures of restoration (relaxation). The quantitative method and experimental design used allows for enhanced validity of the research conclusions by promoting experimental rigor and control (Babbie, 2013; Howell, 2013). This allowed the researcher to investigate the restorative role of indoor plants within the South African context, and compare the potential effects while enabling maximum control of possible confounding variables (Babbie, 2013; Howell, 2013). This type of design tends to increase assumptions of causality (internal validity); however, it limits generalizability of the study conclusions towards other settings (Howell, 2013).

Sample and Sampling Strategy

The sample used comprised of undergraduate and postgraduate students from the University of Witwatersrand, Johannesburg, South Africa. A final sample size of 60 students was obtained through the use of a non-probability, convenience sampling strategy (Field, 2005; Howell, 2013; Babbie, 2013). The sample participants were “selected” on a volunteer basis through the distribution of information sheets via email and posters on campus notice boards. The benefit of this sampling method was that it was convenient and economical;

however a disadvantage is the concerns of volunteer bias (Howell, 2013; Field, 2005). This sample was deemed appropriate as the primary aim of the study is to investigate the restorative effects of plants as well as compare them. Accordingly, the nature of the research questions within the study are primarily comparison and contrast based in nature suggesting no additional requirements (Field, 2005).

A sample of males and females ranging in age from 18 to 50 with a mean age of 21.80 (See table 1 below) was gathered, ensuring all participants were able to legally give consent for participation. Participants were invited through the use of an information sheet (Appendix 1) presented to part time and full-time psychology students from the University of Witwatersrand, Johannesburg, South Africa. In addition, posters were placed on campus notice boards throughout the university and snowball sampling was used upon first contact with participants.

Table 1: demographic statistics age

	N	Range	Minimum	Maximum	Mean
Age	59	32	18	50	21.80

The sample was randomly divided into three groups consisting of 20 participants each; namely: (1) no plants (control); (2) plants; (3) guided relaxation. The total sample was skewed with regards to gender (See table 2 below) as there were fewer males (35,6%) than females (64.4%). However, as depicted in Table 3 below a diverse sample with regards to race was obtained. Specifically, the entire sample contained of 22 African participants (36.7%), 25 White participants (41.7%), 2 Colored participants (3.3%), 7 Indian participants (11.7%) and 4 participants who preferred not to answer or belonged to other racial groupings (6.7%).

Table 2 Demographic statistics: Gender

			Gender		
			Male	Female	Total
Enter your group number	Control	N	9	11	20
		% Gender	42.9%	28.9%	33.9%
		% of Total	15.3%	18.6%	33.9%
	Guided Relaxation	N	7	13	20
		% Gender	33.3%	34.2%	33.9%
		% of Total	11.9%	22.0%	33.9%
	In-door plants	N	5	14	19
		% Gender	23.8%	36.8%	32.2%
		% of Total	8.5%	23.7%	32.2%
Total		N	21	38	59
		% Gender	100.0%	100.0%	100.0%
		% of Total	35.6%	64.4%	100.0%

Table 3 Demographic statistics: Race

Racial category

			Racial category					Total
			White □	African □	Coloured □	Indian □	Other □	
Group number	Control	N	7	7	2	3	1	20
		% within Racial category	28.0%	31.8%	100.0%	42.9%	25.0%	33.3%
		% of Total	11.7%	11.7%	3.3%	5.0%	1.7%	33.3%
	Guided relaxation	N	7	7	0	4	2	20
		% within Racial category	28.0%	31.8%	0.0%	57.1%	50.0%	33.3%
		% of Total	11.7%	11.7%	0.0%	6.7%	3.3%	33.3%
	In-door Plants	N	11	8	0	0	1	20
		% within Racial category	44.0%	36.4%	0.0%	0.0%	25.0%	33.3%
		% of Total	18.3%	13.3%	0.0%	0.0%	1.7%	33.3%
Total		N	25	22	2	7	4	60
		% within Racial category	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	41.7%	36.7%	3.3%	11.7%	6.7%	100.0%

The sample characteristics reflect the common skewed distribution of racial and gender traits inherent of the South African population. As such, moderate external validity was indicated by the varied nature of the sample. Conversely, the laboratory setting used within the study raises concerns of compromised ecological validity as it could not be easily generalised to broader settings (Babbie, 2013).

Materials and Instruments

Experimental setting

The laboratory at the University of Witwatersrand was used to conduct the experiment. It was equipped with fluorescent lights on the ceiling, an ergonomically designed chair and desk, and no windows. These conditions were exactly the same for each of the trial conditions with the exception of the plant condition (as indoor plants were added). To ensure that the desk and chair were placed in the same spot for each of the trails, tape was used to mark their positions on the floor. The workstation was equipped with a computer running windows 7 to conduct the trails. Finally, the experimental tasks were presented using E-prime, v2.10 and the experimental instruments were administered via electronic means (using SurveyMonkey).

Biographical Questionnaire ***(See Appendix F)*** *A* self-made demographic questionnaire was administered to collect the biographical information of the participants. It consisted of questions regarding the participants gender, age, current university level, subscribed racial category, and recent caffeine intake. Additionally, 11 close ended questions were added to inquire about the participant's perception of the work environment that ranged from 1 to 7. The 7-point scale ranges from 1: completely disagree to 7: completely agree; and explores the participants perceptions of the rooms lighting levels, temperature and general comfort.

Vigilance task

The Temple et al (2000) abbreviated vigilance task was used to induce cognitive fatigue within participants. The task induces cognitive fatigue by directing a participant's attention and emulating a cognitively demanding task, through the use of electronic displays. Fatigue is induced by rapidly presenting targets to the participant to be selected. Three targets are presented, and only one is the desired target (participant will be informed of the correct target). The targets include the letter O (correct target), and two possible distractor targets in the form of a backwards, and forwards letter D. The letters were displayed as 8 x 6 millimetre light grey capital letters in Avant Grade font at the centre of the screen, behind a visual mask (so the letter appears behind). This mask is constructed through 1 millimeter diameter dark grey circles on a white background. The circles are outlined by a 0.25mm thick black line.

During the task participants must focus on the center of the display and press the space bar when they believe the target stimulus appears (letter O); and not respond to the distractor targets. The procedure begins with a 5-minute practice period; that has verbal feedback (hit, miss, incorrect) to familiarize participants with the task. This is followed by six 2.5-minute trials with no feedback. The proportion of target signals was set at a ratio of 2:8 for all the trail conditions in the study.

Positive and Negative affect schedule (PANAS) (See Appendix I)

The 20-item Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) was used to measure positive and negative affect within participants. The scale items consist of several words which describe various feelings and emotions. Participants were asked to rate the extent to which they experience each item on the scale at the present moment; using a 5-point Likert type scale (very slightly or not at all, a little, moderately, quite a bit, extremely, respectively). Examples of items that indicates positive affect are “Interested”, “Excited”, “Enthusiastic”; and example items that indicate negative affect are “Distressed”, “Upset”, “Hostile”. Higher scores on the scale represent higher levels of both positive and negative affect. Previous reliability statistics using Cronbach alpha statistics ranged between 0.86 to 0.90 regarding the Positive Affect (PA) scale and 0.84 to 0.87 with respect to the Negative Affect (NA) Scale (Abramson, & Peterson, 2009; Crawford & Henry, 2004; Watson, 1988). According to Watson (1988), the test-retest correlations were found to be 0.47-0.68 for the PA and 0.39-0.71 for the NA.

Backward digit-span task (BDS)

In order to measure each participant's working memory span, a computerized version of the backwards digit-span task was administered. The task proceeds using a staircase procedure that presents a series of numbers verbally that range from 3 to 9. Following the presentation of the number series, each participant is instructed to type in the series in reverse order. The task begins with a number three digits long and increases in length by one digit each time the participant answers correctly twice consecutively. If the participant answers incorrectly, the digit number decreases in length by one digit. Following 14 trials, the participants digit-span is recorded as the final two correctly answered consecutive trials. This method has been established within previous research in the field, as an accurate measure of working memory (Berman et al., 2008; Berto, 2014; Rupp et al., 2017). The backward digit span procedure was conducted using a pair of noise cancelling headphones to prevent external interference during the trial period.

Dundee stress state questionnaire (See Appendix J)

The 30-item version of the Dundee Stress State Questionnaire (Matthews, Emo, & Funke, 2005) was used to assess three aspects of participant's stress: task engagement, distress, and worry. The scale uses a 4-point Likert type scale to access the participants self-reported experiences of task engagement, distress and worry. Items range from 0-4, with 0 representing "definitely false" and 4 representing "definitely true". An example item of the task engagement subscale is "My attention will be directed towards the task". Additionally, an example of the distress subscale is "I expect that the task will be too difficult for me"; and an example of the worry subscale is "I am worried about what other people think of me". The scale was adapted for each of the measurement conditions, namely: pre-task, post task, and post break.

Previous Cronbach alpha statistics for engagement was found to be .84, distress reported a Cronbach alpha statistic of .85, and worry reported a Cronbach alpha of .82 (Matthews et al., 2005).

Relaxation technique

Guided relaxation is a widely accepted method for reducing stress (Rupp et al., 2017 (Souders, Yordon, Hamilton, & Charness, 2010; Stanhope, Owens, and Elliott, 2016); as such it stands to reason that guided relaxation techniques would serve as a suitable contrast intervention. The guided relaxation intervention lasted 6 minutes and was developed by TheHonestGuys (2011). This video has been verified previously by other researchers in the field (Souders, Yordon, Hamilton, & Charness, 2010; Stanhope et al., 2016).

Guided meditation videos such as this have been shown to be effective in reducing self-reported and physiological indicators of stress (Stanhope et al., 2016; Rupp et al., 2017). The activity consisted of an audio recording of a man's voice that instructs participants through a deep breathing meditation; and body awareness exercise that directs attention to individual body parts in a sequential fashion.

Passive break condition

Participants within this condition were instructed to partake in a quiet break period within the room. This condition had no plants or other potential stimuli present within it. The researcher was however present in the room but made no contact with participants during this period. Additionally, participants within this condition were instructed not to use their phones or leave the lab room during this time (See figure 1 below)

Figure 1: experimental setting for guided relaxation and control conditions

In-door plant condition

The plant condition took place in the same room as the other conditions on a different day; with the addition of indoor plants throughout the duration of the trial period. The plants for this condition were supplied and positioned by a representative from Execuflora South Africa. Execuflora is an established organisation that supplies and maintains indoor plants within organisations. Accordingly, they provide expert advice regarding indoor office plants. The representative decided to use two large in-door foliage plants and one medium desk plant depicted in figure 2 below.

Figure 2: showing plants used within the in-door plant condition

Procedure

The following procedure was used to obtain the intended sample, collect the relevant data, and investigate the proposed research questions. The researcher began by first obtaining the necessary ethical clearance to conduct the research from the University of the Witwatersrand Human Research Ethics Committee (See appendix A). Following ethical clearance confirmation (Ethics clearance number: MORG/18/001 IH), the researcher approached various psychology course coordinators to obtain permission to approach and recruit students for the purposes of the study (See Appendix B). Once permission was obtained, the researcher put up posters on campus notice boards and sent out notifications via the university electronic student notification portal (Sakai). Information sheets were attached to the notices that contained the relevant information regarding the experiment trail period, implications, procedure, and purposes of the research. Additionally, the information sheets contained the researchers contact details and indicated that interested students should contact the researcher for further information and to schedule a participation meeting.

Participants who had volunteered were informed that participation was strictly voluntarily and that they could with draw at any point prior to completion of the trial with no negative consequences. Following continued interest to participate, participants were provided with an information sheet and asked to provide a signature signalling informed consent on a detachable page attached at the back. The Participant information sheet contained a broad overview of the scope of the study to avoid potential response biases and indicated that participation was strictly voluntary once again.

Data collection begun with the construction of the experiment room which was equipped with relevant materials for each trial to be conducted as mentioned above. As one experimental lab was used for the entire study, the trails were conducted on separate days with the plants being moved during non-relevant sessions. The in-door plants were supplied and maintained by a specialist company; namely: Execuflora. The trials were conducted at a time chosen by the participants in the allocated lab within the psychology department, which had no external windows or natural light. To promote standardisation of when conducting the trials the researcher engaged in minimal contact with participants and used the same equipment throughout the duration of the study.

Each trail begun with the researcher providing the participant with a copy of the information sheets and explaining that participants were free to leave at any point (See Appendix A). Additionally, it was explained upon completion of the trail, informed consent would be assumed. If the participant was within the relaxation condition, the researcher provided a brief over view of the relaxation tape. The researcher than explained that a six-minute break would occur after the vigilance task. Participants were also asked not to use their cell phones during the break conditions or leave the experimental room.

Participants were randomly assigned to one of the three conditions and briefed about the procedure of the trail, specifically they were asked not to leave their work station throughout the trail and not to use their cell phone following entry. The exact same procedure was implemented for all of the trials; which begun with an introductory period in which participants were seated at the work space where they were asked to begin by completing the demographic questionnaire (See Appendix C). After which participants were asked to complete a baseline (pre-vigilance task) measure of the PANAS, DSSQ-S and BDS task. Following the pre-vigilance task measures, participants were introduced to the vigilance task and asked to complete it. Upon completion of the vigilance task participants were instructed to complete the PANAS, DSSQ-S, and BDS once again as honestly as possible. This was followed by exposure to their assigned treatment condition during a six-minute break; after which participants were asked to complete the PANAS, DSSQ-S and BDS for a third and final time. Each trial took seventy-five to ninety minutes to complete. The trial session concluded with a debriefing session conducted by the researcher to answer potential questions the participant had. During and after the data collection period the recorded data was stored electronically on a password protected Excel spread sheet which only the researcher and his supervisor had access to. The researcher was present throughout the trial session to answer any potential questions and clarify instructions required by participants. Following the data collection period, all the data was extracted, cleaned, and sorted by the researcher into an excel spreadsheet for analysis to begin via SPSS.

Data Analysis

As the study employed a quantitative methodology, data in the form of a coded Excel spreadsheet was imported into SPSS version 25 for statistical analysis. Analysis begun with descriptive statistics to investigate normality and ensure no missing data points were present. The researcher conducted analyses of frequencies, standard deviation, skewness, kurtosis, histogram plots, box and whisker plots, and reliability checks where necessary, to gather information about the nature of the data and sample (Howell, 2011). Additionally, normality checks and reliability scores in the form of Cronbach's alpha coefficients for the relevant instruments were calculated. To address the research hypothesises; 1, 2, 3, 4, 5, 6 inferential statistics and standardised change z-scores were employed (Babbie, 2013; Field, 2005). One mixed ANOVA was used to conduct a manipulation check, and One-way ANOVAs and independent sample T-tests were used to compare significant differences to address research hypothesises: 7, 8, and 9 were applicable (Babbie, 2013; Field, 2005).

Descriptive Statistics. These types of statistical analyses are primarily used to describe and summarise data in a meaningful way (Howell, 2011). The current study used frequencies, mean transformations and standard deviations in order to describe the sample characteristics (Babbie, 2013; Field, 2005). Additionally, summary statistics and mean transformations were conducted to address missing data points in the main variables of interest (Babbie, 2013; Field, 2005).This was followed by the use of histograms, box and whiskey plots, and skewness and kurtosis coefficients to investigate concerns of normality (Babbie, 2013; Field, 2005) (discussed in chapter 4).

Reliability

Reliability refers to the dependability and stability of an instrument that measures particular constructs (Babbie, 2013; Field, 2005). The current study investigated reliability of the relevant instruments by calculating Cronbach's alpha coefficients which assesses the extent to which the different facets of an instrument measure the same concept (Huck, 2004). According to Howell (2011) Cronbach alpha values above 0.7 are acceptable, and values of 0.4 or below are unacceptable.

Standardised change Z-scores

Within the current study, standardised change Z-scores refer to a statistical method of quantifying the degree change that occurred within participants between points of measure (Babbie, 2013; Field, 2005).The standardised change Z-score reflects a simple method of assessing the degree of difference between two scores or two groups (Babbie, 2013; Field, 2005).This method of investigating difference is often favoured within research owing to its emphasis on the degree of effect caused by a particular intervention rather than statistical significance with regards to difference (Babbie, 2013; Field, 2005).Using a standardised Z-score transformation limits the potential influence of individual differences and sample size as the scores reflect changes with respect to each individual participant (Babbie, 2013; Field, 2005).The current study constructed standardised change Z-scores by using the following formulae : $\frac{\text{Precondition} - \text{Post condition}}{Standard\ deviation\ of\ Precondition}$. The baseline score of each participant as a precondition for the post vigilance score, and the post-vigilance score as the precondition for the post- intervention score for each group respectively. This method was established as a valid method of transformation by previous research conducted within the field (Rupp et al, 2017).

Inferential statistics

In order to investigate whether significant change had occurred within participants between the successive periods of measurement, error bar graphs were constructed using the calculated change Z-score (Babbie, 2013; Field, 2005).The error bar graphs were calculated using 95% confidence intervals of the mean scores of each of the variables against a hypothesis of no change (Babbie, 2013; Field, 2005).The error bars within the graph indicate evidence of statistically significant non-zero change occurring between the two relevant periods of measure if they do not overlap zero (Babbie, 2013; Field, 2005). As such this method of analysis was used to address the three primary research questions concerned with whether in-door plants would impact on participants levels of affect, stress, and working memory (Field, 2005; Babbie, 2013).

Mixed analysis of variance (Mixed-ANOVA)

Within the current study one 3 (conditions) X 6 (interval of watch) mixed ANOVA was conducted on the percentage of correct target detections as a manipulation check (Babbie, 2013; Field, 2005).The mixed-ANOVAs compared the mean differences in performance on the vigilance task between the different group conditions (IVs) across six time periods and between the six time periods to each other (Babbie, 2013; Field, 2005). The primary purpose of this ANOVA was to observe whether there were statistical differences in the response percentage over the duration of the vigilance task within the participants to investigate whether the vigilance task had induced the desired mental fatigue within the participants (Babbie, 2013; Field, 2005). Evidence of successful fatigue induction was defined in terms of a vigilance decrement, indicated by a decline in correct detections over time (Field, 2005; Babbie, 2013).

In order to conduct the mixed-ANOVA the following statistical assumptions are required to be met (Field, 2005; Babbie, 2013):

- The measurement of the dependant variable should be at least interval level.
- The independent variable should contain at least two categorical groups that are related to each other.
- The independent variable should contain two or more categorical independent groups.
- No significant outliers should be present within the relevant data.
- The dependent variable must be normally distributed for each combination of the groups across the independent variables.

- The data of interest should reflect homogeneity of variance.
- There must be sphericity within the relevant data, meaning the variances of the differences between groups within the data must be equal.

Independent sample t-tests and one-way ANOVAs

Independent sample t-tests and one-way ANOVAs were chosen to address the research hypotheses 7; 8; 9 (Howell, 2013). Both tests require that the relevant dependant variable is at least interval or ratios level of measurement (Howell, 2013). Additionally the tests require that a random sampling strategy was utilised (Howell, 2013). The tests also require that the observations are independent of each other; meaning that one value in the relevant variable does not influence any other (Howell, 2013). The next requirement is that the relevant data must be normally distributed (Howell, 2013). The final requirement is that there is homogeneity of variance within the relevant data (the variability of the scores within each group must be fairly similar) (Field, 2005). Independent sample t-tests are used to investigate mean differences of a variable within two distinct groups (Field, 2005). Whilst one-way ANOVAs may be utilised to investigate mean differences within a variable between three or more groups (Howell, 2013). Within this study statistically significant differences were assumed by alpha values (p) that are below 0.05 (Howell, 2013). The meaningfulness of possible differences will be interpreted by calculating the appropriate effect size (Field, 2005). An effect size in relation to independent sample t-tests and one-way ANOVAs refers to the degree of difference observed between the relevant variables (Howell, 2013). The assumptions regarding independent sample t-test and one-way ANOVAs will be discussed in chapter four.

Additional analyses

In addition to the aforementioned analyses, frequencies were used to describe information regarding the participants reaction to the task setting; as well as three more one-way ANOVA's to compare mean differences in standardised change Z-scores following the vigilance between the three conditions regarding affect, stress, and working memory. This was conducted to investigate whether the effects of the vigilance task on participants affective and cognitive functioning was statistically similar before exposure to the treatment interventions.

Ethical considerations

Ethical clearance was obtained for this research from the Witwatersrand's Human Research Ethics Committee (HREC) before the study commences. All participants were briefed regarding the purpose of the research, expected duration and procedures. There were no expected risks or benefits involved in participating in the study. An information sheet was provided to all participants who took part in the study, which contained the researchers contact details, and other relevant information regarding the study. Additionally, the information sheet (See Appendix A) informed participants that they may withdraw at any point before completion of the trial, after which informed consent will be assumed. Anonymity could not be maintained as the researcher interacted with the participants in person. Confidentiality was maintained as no data was shared and no identifying information was asked. The completed trial data was only be seen by the researcher and his supervisor. The data was not viewed in isolation as all data was viewed through an output provided by Survey Monkey. All data collected was stored on a password protected computer in the supervisor's office where no one else had access. Finally, a non-vulnerable sample of participants over the age of 18 was obtained and no students were advantaged or disadvantaged through participating or not participating in the study.

Chapter Four: Results

Introduction

This chapter provides an overview of the statistical results obtained following the analysis of collected data using SPSS version 26. The chapter begins by describing the descriptive statistics conducted within the current study to examine the nature of the data obtained; after which the results of the reliability analysis are provided. This is followed a description of the results of the frequency analyses conducted on items that enquired about the participants reaction to the task setting, and the results of the mixed-ANOVA conducted as a manipulation check. Finally, the results of the statistical analyses performed to address the main research hypotheses of the current study are provided.

Please note that significance within the following analyses is represented by p <a, where alpha represents .05. All post hoc tests were based on the Bonferroni tests, and Games Howell tests when homogeneity of variance was not met (Howell, 2013).

Descriptive statistics

To provide additional information regarding the observed levels of positive and negative affect, distress, worry, and engagement following the respective measurement points within the current study, participant responses on the PANAS and DSSQ were scored and calculated according to the original author's methodology. Descriptive statistics in the form of means, standard deviations, minimums, maximums, and ranges were than used to summarise the results for each of the study conditions are depicted in tables 4, 5, and 6 below. According, to the original methodology, high scores on the PANAS represent enhanced positive affect and negative affect respectively and low scores indicate low positive affect and negative affect. With respect to the DSSQ, high scores on each of the subscales indicate enhanced worry, distress, and engagement and low scores suggest reduced worry, distress, and engagement.

Table 4: Descriptive Statistics In-door plants

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
avgBaseNegAfft	20	1.50	1.00	2.50	1.5750	.43392
avgPreNegAfft	20	1.60	1.00	2.60	1.4200	.48406
avgPostNeg	20	1.20	1.00	2.20	1.3894	.41211
avgBasePosAfft	20	3.40	1.10	4.50	2.9150	.85179
avgPrePosAfft	20	3.50	1.10	4.60	2.4600	1.05051
avgPostPos	20	3.70	1.00	4.70	2.5272	1.14426
avgBaseDistress	20	2.88	1.13	4.00	2.4125	.75666
avgPreDistress	20	3.00	1.13	4.13	2.9375	.85983
avgPostDistress	20	2.88	1.38	4.25	2.5625	.85311
avgBaseEng	20	2.50	2.50	5.00	3.7188	.61888
avgPreEng	20	3.38	1.25	4.63	3.1188	.89908
avgPostEng	20	3.25	1.50	4.75	3.0688	.95238
avgBaseWorry	20	3.29	1.07	4.36	3.0750	.83250
avgPreWorry	20	3.50	1.21	4.71	2.7250	1.00061
avgPostWorry	20	2.86	1.29	4.14	2.7679	.91352
Valid N (listwise)	20					

Table 5: Descriptive Statistics Guided relaxation

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
BaseNegative affect	20	1.90	1.10	3.00	1.7650	.49340
Post-vigilanceNegative affect	20	1.80	1.00	2.80	1.6900	.49300
PostvigilanceNegative affect	20	1.70	1.00	2.70	1.5950	.53161
avgBasePosAfft	20	2.60	1.90	4.50	3.0250	.79926
avgPrePosAfft	20	2.90	1.10	4.00	2.5450	.81659
avgPostPos	20	3.10	1.40	4.50	2.5550	.73662
avgBaseDistress	20	2.00	1.25	3.25	2.3938	.60599
avgPreDistress	20	3.00	1.50	4.50	2.8187	.84922
avgPostDistress	20	2.13	1.50	3.63	2.3875	.70232
avgBaseEng	20	2.13	2.50	4.63	3.7937	.61140
avgPreEng	20	2.63	1.63	4.25	3.0875	.72785
avgPostEng	20	2.13	2.13	4.25	3.4000	.64456
avgBaseWorry	20	2.00	2.00	4.00	3.0321	.51948
avgPreWorry	20	3.50	1.00	4.50	2.5357	.85980
avgPostWorry	20	2.64	1.14	3.79	2.4107	.73170
Valid N (listwise)	20					

Table 6: Descriptive Statistics control group

Descriptive Statistics	N	Range	Minimum	Maximum	Mean	Std. Deviation
avgBaseNegAfft	20	1.60	1.00	2.60	1.5900	.51596
avgPreNegAfft	20	2.20	1.00	3.20	1.6750	.58117
avgPostNeg	20	1.90	1.00	2.90	1.6100	.56466
avgBasePosAfft	20	3.20	1.50	4.70	2.8650	.85856
avgPrePosAfft	20	3.60	1.20	4.80	2.5900	.96240
avgPostPos	20	3.60	1.20	4.80	2.5050	.99709
avgBaseDistress	20	2.13	1.75	3.88	2.6295	.52290
avgPreDistress	20	2.88	1.50	4.38	2.7875	.70606
avgPostDistress	20	2.75	1.50	4.25	2.6000	.62117
avgBaseEng	20	1.88	2.50	4.38	3.5938	.59310
avgPreEng	20	2.75	2.13	4.88	3.2375	.69526
avgPostEng	20	3.38	1.63	5.00	3.2125	.85079
avgBaseWorry	20	2.43	2.00	4.43	3.2643	.59405
avgPreWorry	20	3.21	1.07	4.29	3.0036	.86447
avgPostWorry	20	3.36	1.21	4.57	3.0929	.87669
Valid N (listwise)	20					

As the current study was interested in investigating restorative effects the scores depicted above are listed for descriptive purposes and were not used within subsequent analyses.

Normality

As the current study utilised a quantitative methodology to achieve the main research objectives the distribution for each of the main variables were examined to determine normality (Howell, 2013). Descriptive statics in the form of skewness coefficients and kurtosis coefficients, means and standard deviations were calculated (See table 7). Skewness and kurtosis coefficients that fall between the ranges of -2 and 2, and -3 and 3 respectively, suggest evidence of normality and a normal distribution (Field, 2009). Histograms and box plots were also constructed to assist in determining normality and identifying potentially influential outliers within the data (See Appendix K).

The skewness and kurtosis coefficients obtained for the main variables indicated evidence of the main variables being normally distributed, as the calculated coefficients fell within acceptable ranges of – 2 and 2, and -3 and 3 respectively (Field, 2009). The results are provided in Table 7.

Table 7: Descriptive Statistics standardised change scores

Descriptive Statistics							
	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*	*Skewness*	*Kurtosis*
ChangeNeg1	*60.00*	*-2.07*	*2.33*	*-.11*	*1.02*	*.30*	*.30*
ChangeNeg2	*60.00*	*-1.62*	*1.83*	*-.12*	*.64*	*.02*	*1.41*
ChangePos1	*57.00*	*-2.00*	*1.29*	*-.44*	*.63*	*.24*	*1.00*
ChangePost2	*60.00*	*-1.56*	*1.84*	*.00*	*.62*	*.30*	*1.05*
Chane1Distress	*59.00*	*-1.86*	*2.87*	*.63*	*1.03*	*-.13*	*-.35*
Change2Distress	*59.00*	*-2.65*	*1.03*	*-.45*	*.77*	*-.23*	*-.09*
Change1Eng	*60.00*	*-2.74*	*1.69*	*-.91*	*1.03*	*.55*	*-.14*
Change2Eng	*59.00*	*-1.11*	*1.80*	*.07*	*.69*	*.41*	*-.38*
Change1Worry	*60.00*	*-3.58*	*1.08*	*-.60*	*.96*	*-.81*	*.52*
Change2Worry	*60.00*	*-1.25*	*1.16*	*.00*	*.50*	*.14*	*.20*
Change2Digit	*55.00*	*-1.79*	*1.89*	*.15*	*.74*	*-.01*	*.06*
Change1Digit	*59.00*	*-1.01*	*2.02*	*.25*	*.76*	*.19*	*-.38*

The histograms constructed (See Appendix K further suggested evidence of a normal distribution; however, upon interpretation of the box plots several outliers were identified (Howell, 2013). Outliers refer to data points which contain values which are more than 2 standard deviations away from the mean value and may severely influence the results of statistical analyses conducted (Howell, 2013). As such, the researcher decided to exclude these data points during the relevant analysis process following consultation with his supervisor. This decision was supported by concerns of sample size and the sensitivity of the primary method of analysis to outliers. Following the removal of these data points normality was assumed to be met based indications from the histograms, skewness and kurtosis coefficients which suggested evidence of normality (Howell, 2013).

Reliability Analysis

The results of the reliability of the scales used in this study was accessed by calculating Cronbach alpha statistics for the subscales of the PANAS and DSSQ using data obtained at each of the three measurement points. The table below depicts the results of the reliability analysis for the positive affect, negative affect, distress, worry, and engagement scales at the baseline measurement period (Time 1), following the vigilance task (Time 2), and after the intervention period (Time 3). The Cronbach alpha values obtained within the current study suggest that all of the scales used were acceptable as all of the Cronbach alpha values were above 0.7 (Howell, 2013), depicted in table 8. The backward digit-span task that was used to operationalise working memory in this study was a behavioural task and a Cronbach alpha statistic could not be calculated, however, this instrument has been validated within previous research (Rupp et al 2007; Berman et al., 2008; Berman et al., 2012)

Table 8: Reliability Cronbach Alphas

Variable	Items	Cronbach's Alpha Time 1	Cronbach's Alpha Time 2	Cronbach's Alpha Time 3
Positive Affect	10	0.89	0.93	0.93
Negative Affect	10	0.73	0.78	0.78
Distress	8	0.73	0.82	0.78
Worry	14	0.76	0.90	0.88
Engagement	8	0.73	0.84	0.86

Frequency analyses of reaction to task setting

To gather additional information about participant impressions of the room in which the experimental trials took place, 11 items were included within the demographic section of the questionnaire. These items enquired about participant's perceptions of the task setting as a working environment and items assessed feelings of pleasantness, comfort, concentration, air quality, temperature, and lighting. The researcher conducted a several frequency analyses on these items to examine and gain a greater understanding of participants experiences of the task setting (See Appendix H). In the section below, the results of these analyses on items the researcher decided were valuable are elaborated on.

Across all three conditions most participants agreed that the room was a pleasant space to work in (Appendix H). Two of the items enquired about how comfortable and uncomfortable participants felt within the room, the results suggested that across the three interventions participants reported that they felt comfortable within the room (Appendix H). Interestingly with regards to whether participants felt that they could concentrate within the room, more participants agreed within the control condition as compared to the other two conditions, however overall most participants agreed that they could concentrate within all of the conditions (See appendix H). Two of the items enquired about participants thoughts of how stuffy and stale they perceived the air to be within the room. Based on the results, it was suggested that more participants disagreed that the air within the room was either stuffy or stale in the in-door plant condition comparison to the control and meditation conditions (See appendix H).

Manipulation check

To examine whether the desired mental fatigue was successfully induced within participants the researcher quantified participants performance throughout the duration of the vigilance task (See figure 3). In the current study evidence of mental fatigue was taken by a significant a decline in the percentage of correct target detections made by participants over the course of the vigilance task. Six continuous variables depicting independent intervals of measure were constructed by dividing each participant's performance during the 15-minute vigilance task into 2.5-minute intervals of watch.

To determine a statistically significant effect a 3 (intervention IV1) x 6 (interval of watch IV2) mixed ANOVA was conducted on the percentage of the rate of correct target detections (DV) made by participants in the study. The mixed ANOVAs primary purpose is to investigate mean differences when the DV has one within subject factor and there are two or more between subject factors (IVs) with two or more conditions (Babbie, 2013; Field, 2005).This statistical analysis was chosen as it allowed the researcher to investigate mean differences in performance (DV) across the three intervention conditions (IVs) and six intervals of watch (IV2) separately as well as in conjunction with each other (Field, 2005; Babbie, 2013).

The common assumptions required to conduct a mixed ANOVA that were met within the current study are (Field, 2005; Babbie, 2013):

- The DV should be measured at a continuous level; this was assumed to be met as the DV of interest percentage of correct answers reflected an interval level of measure (Babbie, 2013).
- The within subjects IV (interval of watch) must contain at least two related categorical groups; this was assumed to be met as interval of watch factor was constructed by dividing each participant's overall performance into six related conditions (Field, 2005; Babbie, 2013).
- The between-subjects IV (intervention) should contain at least two or more categorical independent groups; this was assumed to be met as participants within the

study were only exposed to a single intervention condition (Field, 2005; Babbie, 2013).

- There should be influential outliers and the data within each of combined IV/DV groups should be normally distributed.

To assist in determining the degree of normality reflected by the data, skewness and kurtosis coefficients were calculated for each IV/DV combination. As depicted by tables 9, 10, 11 below, the skewness and kurtosis coefficients for all of the IV/DV group combinations were found to be within the acceptable ranges of -2 and 2 and -3 and 3 suggesting evidence of normality (Babbie, 2013; Field, 2005). Further evidence of normality was suggested by histograms constructed by the researcher (See Appendix G) as such it was assumed that normality had been met. With regards to identifying significant outliers a box and whisker plot was constructed (See Appendix G), which depicted several potentially influential outliers within the data that were excluded from the proceeding analysis (Field, 2005; Babbie, 2013).

Table 9: Descriptive Statistics control condition

		percentB1	percentB2	percentB3	percentB4	percentB5	percentB6	Valid N (listwise)
N	Statistic	18	19	19	19	19	18	17
Minimum	Statistic	93.33	81.67	73.33	72.50	74.17	82.50	
Maximum	Statistic	100.00	100.00	97.50	100.00	98.33	98.33	
Mean	Statistic	97.4074	94.2982	90.6579	91.7105	91.4912	93.2407	
Std. Deviation	Statistic	1.91504	5.46639	7.67079	7.28326	7.19857	4.85819	
Skewness	Statistic	-.698	-1.119	-1.130	-1.129	-1.129	-1.016	
	Std. Error	.536	.524	.524	.524	.524	.536	
Kurtosis	Statistic	-.359	.454	.210	.997	.358	.218	
	Std. Error	1.038	1.014	1.014	1.014	1.014	1.038	

Table 10: Descriptive Statistics guided relaxation condition

		percentB 1	percentB 2	percentB 3	percentB 4	percentB 5	percentB 6	Valid N (listwise)
N	Statistic	19	20	20	20	20	20	19
Minimum	Statistic	90.00	84.17	71.67	74.17	75.83	69.17	
Maximum	Statistic	100.00	98.33	99.17	99.17	100.00	98.33	
Mean	Statistic	96.6667	94.5417	91.2500	90.4167	90.7500	88.1667	
Std. Deviation	Statistic	2.76385	3.95955	6.79428	6.94327	6.90844	7.84350	
Skewness	Statistic	-.950	-1.201	-1.383	-.571	-.730	-.793	
	Std. Error	.524	.512	.512	.512	.512	.512	
Kurtosis	Statistic	.487	1.055	2.331	-.082	-.181	.320	
	Std. Error	1.014	.992	.992	.992	.992	.992	

Table 11: Descriptive Statistics In-door plants condition

		percentB 1	percentB 2	percentB 3	percentB 4	percentB 5	percentB 6	Valid N (listwise)
N	Statistic	19	20	20	20	20	20	19
Minimum	Statistic	90.00	76.67	75.83	74.17	78.33	80.83	
Maximum	Statistic	99.17	100.00	98.33	97.50	99.17	97.50	
Mean	Statistic	96.3596	91.6250	89.8750	89.5417	90.0417	90.2083	
Std. Deviation	Statistic	2.78070	6.99036	7.58131	6.54201	6.48590	5.70905	
Skewness	Statistic	-.984	-.636	-.506	-1.140	-.071	-.263	
	Std. Error	.524	.512	.512	.512	.512	.512	
Kurtosis	Statistic	-.005	-.567	-1.269	.648	-1.295	-1.407	
	Std. Error	1.014	.992	.992	.992	.992	.992	

- The next assumption associated with the mixed ANOVA is that there should be homogeneity of variance for each IV/DV combination. This was addressed by conducting a Levene’s test which indicates homogeneity with a non-significant result at an alpha level of .05. The results of the Levene’s test of homogeneity of variance was met (See table 14 below).

- The final assumption of the mixed ANOVA is that there should be sphericity of variance, meaning that the variances of differences between the within subjects’ factor should be equal for all of the groups across the between subjects’ factor. In order to investigate whether the assumption of sphericity was met, the researcher conducted a Mauchly’s test of sphericity which indicates sphericity with a non-significant result at an alpha level of <.05. The results of the Mauchly’s test depicted in table 12 below suggested that the assumption of sphericity had been violated (W (14) = 44.10, p < 0.001); as such in order to corrections were applied using the Huynh-Feldt estimate to obtain a valid F ratio.

Table 12: Mauchly's test of Sphericity

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.415	44.102	14	.000	.793	.900	.200

Table 13: mixed ANOVA

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
factor1	Pillai's Trace	.652	17.988[b]	5.000	48.000	.000	.652
	Wilks' Lambda	.348	17.988[b]	5.000	48.000	.000	.652
	Hotelling's Trace	1.874	17.988[b]	5.000	48.000	.000	.652
	Roy's Largest Root	1.874	17.988[b]	5.000	48.000	.000	.652
factor1 * group	Pillai's Trace	.233	1.289	10.000	98.000	.247	.116
	Wilks' Lambda	.775	1.305[b]	10.000	96.000	.239	.120
	Hotelling's Trace	.281	1.319	10.000	94.000	.232	.123
	Roy's Largest Root	.240	2.355[c]	5.000	49.000	.054	.194

Table 14: Levene's Test of Homogeneity

Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
percentB1	Based on Mean	.815	2	52	.448
	Based on Median	.483	2	52	.620
	Based on Median and with adjusted df	.483	2	42.679	.620
	Based on trimmed mean	.742	2	52	.481
percentB2	Based on Mean	2.581	2	52	.085
	Based on Median	1.413	2	52	.253
	Based on Median and with adjusted df	1.413	2	49.477	.253
	Based on trimmed mean	2.405	2	52	.100
percentB3	Based on Mean	1.927	2	52	.156
	Based on Median	.811	2	52	.450
	Based on Median and with adjusted df	.811	2	38.911	.452
	Based on trimmed mean	1.643	2	52	.203
percentB4	Based on Mean	.861	2	52	.429
	Based on Median	.245	2	52	.784
	Based on Median and with adjusted df	.245	2	36.882	.784
	Based on trimmed mean	.659	2	52	.522
percentB5	Based on Mean	.100	2	52	.905
	Based on Median	.252	2	52	.778
	Based on Median and with adjusted df	.252	2	41.652	.778
	Based on trimmed mean	.153	2	52	.858
percentB6	Based on Mean	1.734	2	52	.187
	Based on Median	1.602	2	52	.211
	Based on Median and with adjusted df	1.602	2	49.937	.212
	Based on trimmed mean	1.734	2	52	.187

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Table 15: Bonferoni Pairwise Comparisons

Pairwise Comparisons

Measure: MEASURE_1

(I) factor1	(J) factor1	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	2.923*	.614	.000	1.034	4.812
	3	5.476*	.807	.000	2.994	7.959
	4	5.484*	.735	.000	3.222	7.747
	5	5.271*	.713	.000	3.077	7.465
	6	5.712*	.666	.000	3.663	7.761
2	1	-2.923*	.614	.000	-4.812	-1.034
	3	2.553*	.540	.000	.893	4.214
	4	2.561*	.702	.009	.401	4.721
	5	2.348*	.737	.037	.080	4.615
	6	2.789*	.701	.003	.633	4.945
3	1	-5.476*	.807	.000	-7.959	-2.994
	2	-2.553*	.540	.000	-4.214	-.893
	4	.008	.587	1.000	-1.798	1.814
	5	-.206	.789	1.000	-2.633	2.222
	6	.236	.753	1.000	-2.083	2.554
4	1	-5.484*	.735	.000	-7.747	-3.222
	2	-2.561*	.702	.009	-4.721	-.401
	3	-.008	.587	1.000	-1.814	1.798
	5	-.213	.557	1.000	-1.927	1.500
	6	.228	.780	1.000	-2.173	2.629
5	1	-5.271*	.713	.000	-7.465	-3.077
	2	-2.348*	.737	.037	-4.615	-.080
	3	.206	.789	1.000	-2.222	2.633
	4	.213	.557	1.000	-1.500	1.927
	6	.441	.748	1.000	-1.861	2.743
6	1	-5.712*	.666	.000	-7.761	-3.663
	2	-2.789*	.701	.003	-4.945	-.633
	3	-.236	.753	1.000	-2.554	2.083
	4	-.228	.780	1.000	-2.629	2.173
	5	-.441	.748	1.000	-2.743	1.861

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.
b. Adjustment for multiple comparisons: Bonferroni.

Table 16: Mixed ANOVA Between subject Effects

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	2824870.006	1	2824870.006	21878.335	.000	.998
group	191.481	2	95.740	.741	.481	.028
Error	6714.096	52	129.117			

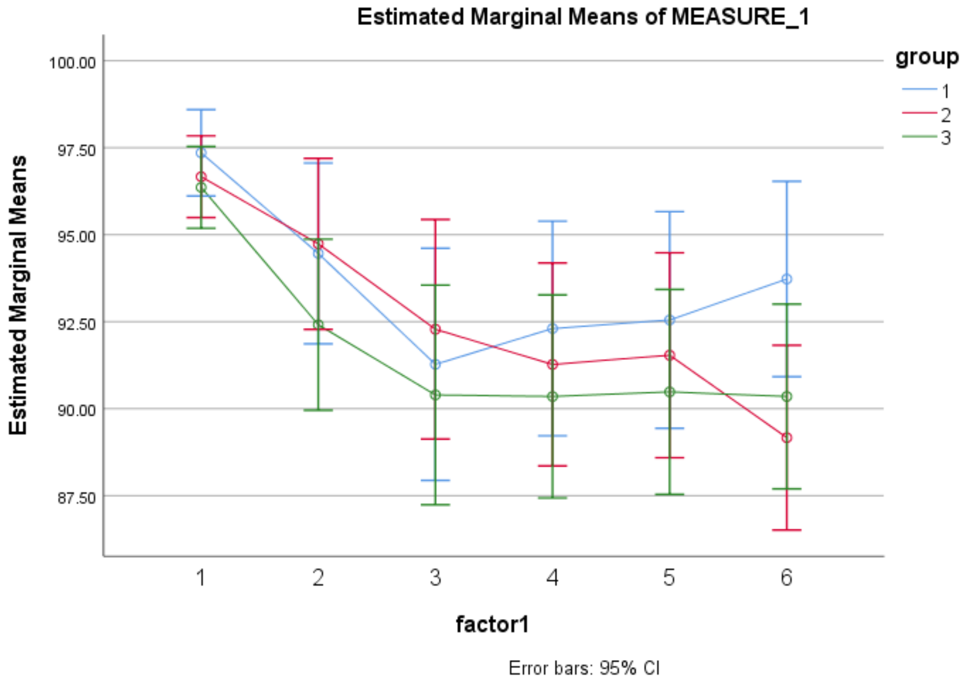

Figure 3: Differences in correct target detections over time

The results of the 3 (intervention) by 6 (interval of watch) mixed ANOVA on percentage of correct target detections indicated a significant effect on interval of watch, *F* (4.5) = 21.20, p<0.05. Since the assumption of sphericity was violated as indicated Mauchly's test of sphericity, the Greenhouse-Geisser correction was utilised (See table 13 above). The Eta effect size indicated that the effect of period of watch on percentage of correct detections was large to moderate (ETA= 0.65). Post- hoc analyses were conducted using Bonferroni tests to compare the percentage of correct detections observed at the first interval of measure to each proceeding block to examine changes in correct target detections over time. The results of the Bonferroni analysis suggested that the percentage of correct target detections observed at interval of watch 1 (M=96.80, $p < 0.05$) was significantly larger in comparison to the proceeding intervals of watch; specifically, interval of watch 2 (M=93.88, $p < 0.05$), interval of watch 3 (M=91.32, $p < 0.05$), interval of watch 4 (M=91.30, $p < 0.05$), interval of watch 5 (M=91.52, $p < 0.05$), and interval of watch 6 (M=91.01, $p < 0.05$). These results indicated that the percentage of correct target detections made by participants within the sample had significantly declined over the duration of the vigilance task (See figure 3). Conversely, there was no evidence of the three interventions conditions having any statistically significant effects on the percentage of correct target detections made by participants (See table 16). Additionally, the results indicated no evidence of a statistically significant effect attributed to an interval of watch by intervention interaction (see table See table 13). These results suggest that the intervention condition participants belonged to did not significantly affect the percentage of correct target detection and that all participants within the sample experienced statistically similar levels of mental fatigue.

Post-vigilance Change

In order to investigate whether participant levels positive affect, negative affect, distress, worry, engagement, and working memory had significantly changed from the baseline measurement period to the post-vigilance task measurement across the control, guided relaxation, and in-door plants conditions. Standardized change Z-scores were calculated using the aforementioned method (See chapter 3) and examined against a hypothesis of no change using 95% confidence intervals. The results of this analysis are depicted in figure 4 below, evidence of a significant non-zero change is indicated when the error bars do not overlap zero.

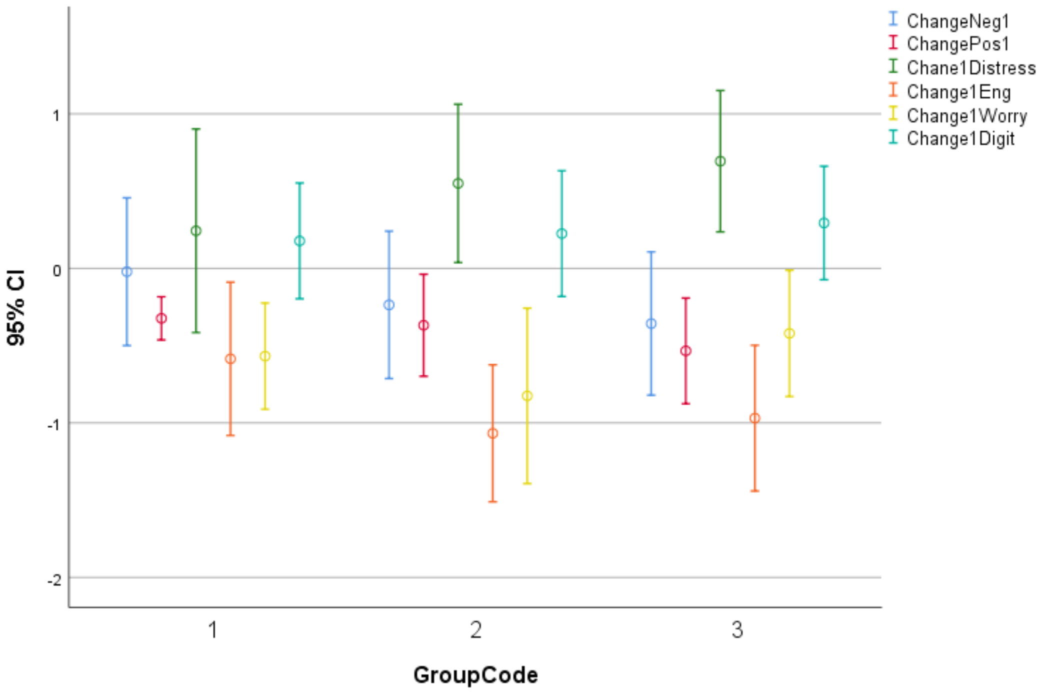

Figure 4: Standardised change Z-scores

Changes in Positive and Negative Affect following the vigilance task

The results depicted in figure 4 above suggest that based on 95% confidence intervals, there was a statistically significant decline in positive affect (*M* = -0.32, 95%, CI [−0.46, -0.18]) and no statistically significant change in negative affect (*M* = 0,16, 95% CI [-0,34,0,67]) with respect to the control group. Similarly, the results regarding the guided relaxation group indicated that there was significant decline positive affect (*M* = -0.45, 95%, CI [-0.81, -0.09]) and no significant change in negative affect (*M* = -0,15, 95% CI [-0.61,0.31]) within participants. Finally, participants in the presence of in-door plants were suggested to have experienced a statistically significant decline in positive affect (*M* = −0.44, 95%, CI [-0.61, -0.28]) and no statistically significant change negative affect (*M* = -0.36, 95% CI [-0.82, 0.11]) following the vigilance task. This suggests that following the vigilance task, participants in all three of the conditions had experienced a statistically significant decrease in positive affect and not significant change in negative affect based on average confidence intervals. As participants in all three study conditions had experienced a significant change in positive affect, a one-way ANOVA was conducted to investigate these potential differences.

One Way ANOVA for Conditions and Positive affect

In order to compare the significant decreases in positive affect observed within the in-door plant condition, guided relaxation condition, and control condition. A one-way ANOVA was conducted using the study conditions as the independent variable and standardised change Z-score in positive affect following the vigilance task as the dependant variable.

Table 17: Descriptive statistics Positive Affect

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Control	18	-.3235	.28123	.06629	-.4634	-.1837	-.93	.23
Guided relaxation	19	-.4544	.74629	.17121	-.8141	-.0947	-2.00	1.25
In-door plants	20	-.5342	.73016	.16327	-.8759	-.1924	-1.29	1.29
Total	57	-.4411	.62571	.08288	-.6071	-.2750	-2.00	1.29

Table 18: Levene's test of Homogeneity

		Levene Statistic	df1	df2	Sig.
Positive Affect	Based on Mean	5.377	2	54	.007
	Based on Median	3.252	2	54	.046
	Based on Median and with adjusted df	3.252	2	41.325	.049
	Based on trimmed mean	4.992	2	54	.010

Table 19: Welch test for equality of means

Robust Tests of Equality of Means
ChangePos1

	Statistic[a]	df1	df2	Sig.
Welch	.850	2	30.566	.437

a. Asymptotically F distributed.

Table 20: One-way ANOVA standardised change in Positive affect

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.425	2	.213	.534	.589
Within Groups	21.499	54	.398		
Total	21.925	56			

Upon interpretation of the Levene's test of homogeneity of variance, it was found that homogeneity of variance could not be assumed for the standardised change in positive affect variable ($F(2,54) = 5.38$, $p < 0.05$). As such a Welch test for equality of means was conduct as an alternative to interpret the subsequent results obtained (See table 19). The results of the Welch test suggested that the degree of standardised change in positive affect across the study conditions did not differ significantly statistically ($F(2, 30.57) = 0.85$, $p = 0.44$). These results participants within each of the study conditions had experienced a statistically similar degree of detriment in positive affect following the vigilance task (See table 20).

Standardised change in distress, worry, and engagement following the vigilance task.

The average standardised change scores of distress, worry, and engagement for the study conditions were examined using error bar graphs using 95% confidence intervals to examine instances of significant change within participants following the vigilance task (See figure 4).

The results as depicted in figure 3 above suggested that participants within the control group had reported a statistically significant decrease in worry (*M* = -0.44, 95% CI [-0.80, -0.08]) and engagement (*M* = -0.60, 95% CI [-1.14, -0.06]) following the vigilance task. The results obtained with respect to distress (*M* = 0.49, 95% CI [-0.01,1.00]) suggested evidence of no statistically significant change from baseline to post- vigilance measurement. Conversely, the results suggested that participants in the guided relaxation condition reported a statistically significant decline in worry (*M* = -0.96, 95% CI [-1.50, -0.42]) and engagement (*M* = -1.16, 95% CI [-1.58, -0.73]) and a statistically significant increase in distress (*M* = 0.70, 95% CI [0.19, 1.22]). Finally, the results suggested that participants in the in-door plant condition had reported a statistically significant decline in worry (*M* = -0.42, 95% CI [-0.83, -0.01]) and engagement (*M* = -0.97, 95% CI [-1.44, -0.50]), and a statistically significant increase in distress (*M* = 0.70, 95% CI [0.24, 1.15]). These results suggested that the vigilance task had led to a significant decrease in distress, worry, and engagement within participants in the in-door plant condition and the guided relaxation conditions. However, the vigilance task had only had a significant detriment effect on engagement and worry with respect to participants in the control condition. As there was evidence that participants in all three study conditions had experienced significant detrimental effects with respect to worry, and engagement, a one-way ANOVA was conducted to examine potential differences. Additionally, as the results suggested that participants in the control condition had not experienced a significant change in distress level, an independent sample t-test was conducted to investigate potential differences between standardised change in distress with respect to the in-door plant condition and the guided relaxation condition.

One-way ANOVA worry and engagement.

A one-way between groups ANOVA was conducted to compare the significant standardised change scores with respect to worry, and engagement across the study conditions; namely: control condition, guided relaxation condition, and in-door plant condition.

Upon interpretation of the Levene's test; homogeneity of variance was assumed (see table 22)

Table 21: Descriptive Statistics worry and engagement following the vigilance task

Descriptives

						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Change1Eng	1	20	-.6007	1.14680	.25643	-1.1374	-.0639	-2.74	1.69
	2	20	-1.1551	.90045	.20135	-1.5766	-.7337	-2.66	.82
	3	20	-.9695	1.00797	.22539	-1.4412	-.4977	-2.22	1.21
	Total	60	-.9084	1.03238	.13328	-1.1751	-.6417	-2.74	1.69
Change1Worry	1	20	-.4389	.77363	.17299	-.8009	-.0768	-1.80	1.08
	2	20	-.9556	1.15428	.25810	-1.4958	-.4154	-3.58	.96
	3	20	-.4204	.87317	.19525	-.8291	-.0118	-2.66	.77
	Total	60	-.6050	.96432	.12449	-.8541	-.3559	-3.58	1.08

Table 22: Levenes' test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Change1Eng	Based on Mean	.366	2	57	.695
	Based on Median	.340	2	57	.713
	Based on Median and with adjusted df	.340	2	53.757	.713
	Based on trimmed mean	.354	2	57	.703
Change1Worry	Based on Mean	1.913	2	57	.157
	Based on Median	1.886	2	57	.161
	Based on Median and with adjusted df	1.886	2	52.233	.162
	Based on trimmed mean	1.951	2	57	.152

Table 23: One-way ANOVA engagement and worry following vigilance task

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Change1Eng	Between Groups	3.186	2	1.593	1.521	.227
	Within Groups	59.697	57	1.047		
	Total	62.883	59			
Change1Worry	Between Groups	3.692	2	1.846	2.056	.137
	Within Groups	51.173	57	.898		
	Total	54.865	59			

The results of the Levene's test of homogeneity of variance suggested that homogeneity of variance could be assumed for the degree of standardised change in worry and engagement (See table 18). Accordingly, the results of the one-way ANOVA suggested that there was no statistically significant difference the degree of change in worry (F (2, 59) = 2.06, p = 0.14), engagement (F (2, 59) = 1.52, p = 0.23) between the two intervention conditions. These results indicate that the degree of change in worry, and engagement that occurred following the vigilance task were statistically the same for the two intervention conditions.

Independent sample T-test: Standardised change differences in distress

As the resulted obtained indicated that distress had significantly changed within two of the three study conditions; name: guided relaxation condition and in-door plant condition. An independent sample T-test was conducted in order to investigate possible differences in the standardised change of self-reported distress following the vigilance task between participants in the guided relaxation condition and the in-door plant condition (See table 24 below).

Table 24: Descriptive statistics for guided relaxation condition and in-door plant condition

Group Statistics

	GroupCode	N	Mean	Std. Deviation	Std. Error Mean
Chane1Distress	2	20	.7013	1.09845	.24562
	3	20	.6938	.97748	.21857

Table 25: Independent sample T-test on Distress following vigilance task

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Chane1Distress	Equal variances assumed	.020	.889	.023	38	.982	.00749	.32879	-.65811	.67309
	Equal variances not assumed			.023	37.494	.982	.00749	.32879	-.65841	.67338

The results of the Levenes test suggested that equality of variance could be assumed (See table 25). The results obtained from the independent sample T-test indicated that there was no significant difference (t (38) =0.023, p = 0.98) the degree of standardised change in distress between participants in the guided relaxation condition (M=.70, SD=1.10) and the in-door plant condition (M=, SD=1.00). These results indicate that the degree of standardised change that had occurred within participants in the guided relaxation condition and in-door plant condition following the vigilance was statistically similar (See table 25).

Standardised change in Working memory following the vigilance task

In order to investigate whether working memory spans had been significantly affected by the vigilance task, standardised change scores representing baseline-post-vigilance task changes were examined using 95% confidence intervals against a hypothesis of no change. The results depicted in figure 4 above suggest that there was no evidence of a statistically significant change in working memory following the vigilance task across all three study conditions, control (*M* = 0.24, 95% CI [-0.11, 0.59]), guided relaxation (*M* = 0.21, 95% CI [-

0.17, 0.60]), and plants (*M* =0.29, 95% CI [-0.07, 0.66]). As such these results suggest that working memory spans within participants across all three study conditions were not significantly impacted by the vigilance task.

Post-intervention changes

In order to address hypotheses: 1, 2, 3, 4, 5, 6 of the current study standardized change scores were used to examine instances of significant change between the post-vigilance task measurement and the post-intervention measurement with respect to reported levels of positive affect, negative affect, distress, worry, engagement, and working memory across the three study conditions; namely: control condition, guided relaxation condition, and in-door plants condition. The standardised change scores were examined against the hypothesis of no change using 95% confidence intervals, where significant non-zero change was indicated when the respective error bars did not overlap zero, see figure 5 below.

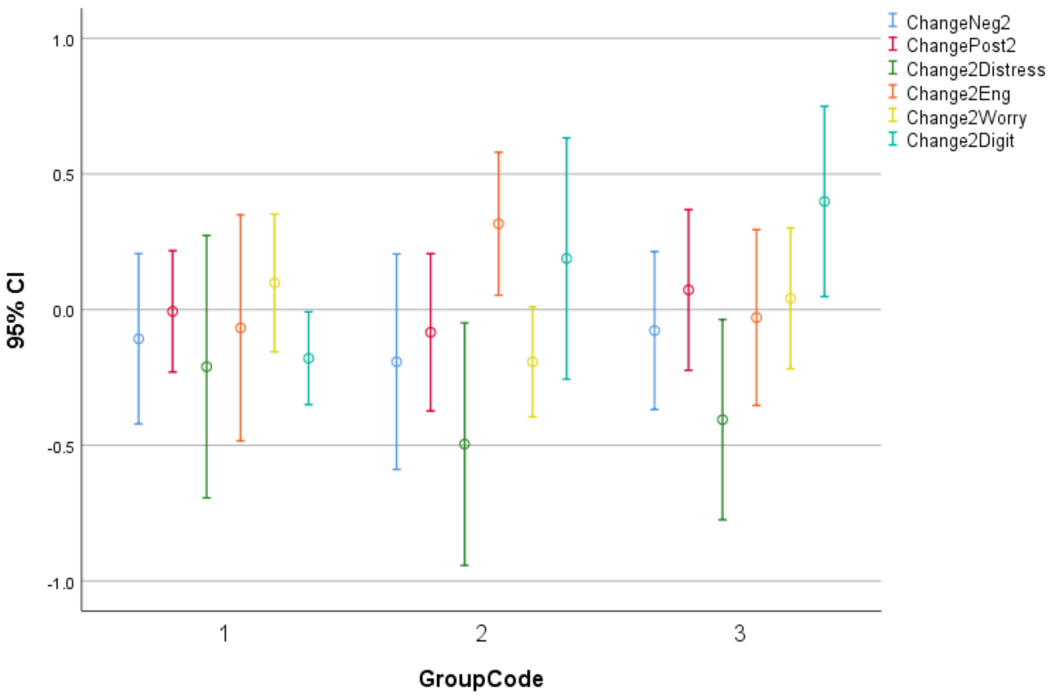

Figure 5 Standardised change Z-scores post-vigilance task-post intervention period.

Standardised change in positive and negative affect

Based on the results depicted in figure 5 above it was found that participants within the control group did not report a significant change in positive affect (*M* = −0.09, 95%, CI [−0.33, 0.16]), and negative affect (*M* = -0.11, 95% CI [-0.36,0.14]). Similarly, the results indicated that there was no evidence of a statistically significant change in reported levels of positive affect (*M* = 0.01, 95%, CI [−0.33, 0.35]) and negative affect (*M* = -0.19, 95% CI [-0.57, 0.18]) with respect to participants in the guided relaxation group. Finally, the results depicted in figure 4 suggested that participants within the in-door plant condition did not report a significant change in positive affect (*M* =0.06, 95%, CI [−0.22, 0.34]) and negative affect (*M* = -0.6, 95% CI [-0.34, 0.21) following the treatment period. These results suggest that participants within all three study conditions did not report a significant change in positive and negative affect following the intervention periods. As such based on the results obtained, the current study failed to reject the null hypotheses of no significant change with respect to hypothesis 1 and 2.

Standardised change in distress, worry, and engagement following the intervention period.

The results with respect to changes in worry (*M* = 0.10, 95% CI [-0.13, 0.34]), engagement (*M* = -0.4, 95% CI [-0.42, 0.34]), distress (*M* = -0.27, 95% CI [-0.67, 0.14]) regarding participants within the control group suggested no statistically significant change between post-vigilance task and post-intervention measurements. Similarly, within the guided relaxation group the results suggested that there was no statistically significant change in worry (*M* = −0.15, 95% CI [-0.36, 0.07]) following the intervention period. However, based on 95% confidence intervals there was a statistically significant decline in distress (*M* = -0.51, 95% CI [-0.93, -0.8]), and a statistically significant increase in engagement (*M* = 0.32, 95% CI [0.05, 0.58]). Finally, within the in-door plant group, the results suggested that there was no evidence of a statistically significant change in both worry (*M* = 0.04, 95% CI [-0.20, 0.29]) and engagement (*M* = −0.06, 95% CI [-0.37, 0.26]). However, the results did suggest that there was a statistically significant decrease in distress within participants in the in-door plant condition (*M* = -0.44, 95% CI [-0.79, -0.08]) following the intervention period. As such an independent samples T-test was conducted to investigate potential differences in standardised change between the post vigilance task and post intervention periods of measurement with respect to the guided relaxation condition and the in-door plants condition.

Independent sample T-test: differences in standardised change of distress between in-door plants and guided relaxation condition.

An independent sample T-test was conducted to compare the degree of standardised change in distress in each of the Guided relaxation and in-door plant conditions. Upon interpretation of the Levene's test; homogeneity of variance was assumed (See table 27 below)

Table 26: Descriptive Statistics guided relaxation and in-door plants condition

Group Statistics

	GroupCode	N	Mean	Std. Deviation	Std. Error Mean
Change2Distress	2	20	-.5078	.90418	.20218
	3	20	-.4361	.75761	.16941

Table 27: Independent samples T-Test on Standardised change in distress following the intervention period

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Change2Distress	Equal variances assumed	.420	.521	-.272	38	.787	-.07169	.26377	-.60567	.46229
	Equal variances not assumed			-.272	36.870	.787	-.07169	.26377	-.60620	.46283

Accordingly, the results of the independent sample T-test suggested that there was no statistically significant difference the degree of change in distress (t (38) = 0.272, p = 0.787) between guided relaxation condition (M=-0.50, SD=0.90) and In-door plants condition (M=-0.44, SD=0.76) . These results indicate that the improvements observed within self-reported distress within participants in the guided relaxation condition and the in-door plants condition were statistically similar

Standardised change in Working memory spans following the intervention period.

In order to address research hypothesis seven, the standardised change scores depicting difference in working memory span between the post-vigilance task and post-intervention periods of measurement were examined using 95% confidence intervals against the hypothesis of no significant change. Evidence of a significant none zero change was determined when error bars did not overlap zero depicted in figure 4 above.

The results depicted in figure 5 above indicated that working memory spans within participants in the control condition (M = -0.036, 95% CI [-0.37, 0.28]) and guided relaxation (M = 0.18, 95% CI [-0.24, 0.60]) did not significantly change following the intervention period. However, the results suggested that working memory spans regarding participants in the in-door plant condition had significantly increased following the treatment period (M = 0.40, 95% CI [0.05, 0.75]). These results suggested that participants in the in-door plant condition had experienced a significant improvement in working memory spans between the post-vigilance task measurement and post-intervention measurement. As such, the results obtained provided significant evidence to reject the null hypothesis of no change and accept the alternate hypothesis six.

Chapter Five: Discussion and Conclusion

Introduction

This chapter provides a discussion of the findings obtained in the current study in relation to previous research conducted in the field. The results of the current study indicated that participants in the presence of in-door plants had a significant improvement in self-reported distress that was statistically similar to the improvement within participants exposed to a guided meditation intervention. In addition, participants in the presence of in-door plants for six-minutes demonstrated significant increase in working memory following the treatment period. No other significant effects were found within the current study with respect to significant changes in positive affect, negative affect, and worry across the three study conditions. Furthermore, the results indicated that participants within the guided relaxation condition were the only ones to demonstrate a significant improvement in engagement following the treatment period. In the section below the results with respect to affect, psychological stress, and working memory are discussed in relation to previous studies conducted within the field. In addition, this chapter provides a discussion of the current study's limitations and recommendations for future research, strengths, theoretical and practical implications, and conclusions of the research overall.

Discussion of Findings

The current study aimed to investigate the restorative effects of in-door plants on positive and negative affect. The results of the study suggested that participants within all three study conditions did not report a significant improvement in positive and negative affect following the treatment conditions. These results convey contrary findings to previous research conducted within the field regarding the guided relaxation condition and in-door plant condition.

With respect to the main treatment condition of interest; namely: the presence of in-door plants, the findings of the current study are inconsistent with studies conducted of a similar nature within the field (Adachi et al., 2000). In the study by Adachi et al (2000) it was found that participants exposed to flowering plants showed greater improvements in affect as compared to those exposed to non-flowering plants foliage plants. Furthermore, in a qualitative study by Thomsen et al (2011) it was found that participants preferred different types of plants based on individual characteristics, the situation they are currently in and personal experiences. Furthermore, drawing from the stress-reduction theory, it is suggested that increases in positive mood and decreases in negative moods are produced when the individual subconsciously perceives the environment they are situated in as containing traits that are instinctually linked to survival or prosperity (Berto, 2014; McMahan & Estes, 2015). As such the insignificant results observed within the current study regarding affect may be due to the indoor-plants used in the current study not portraying the required traits to transform the task environment into a setting conducive with the principals outlined by stress-reduction theory (Berto, 2014; McMahan & Estes, 2015).

Another explanation may be that the sample within the study did not experience a sufficient need for affective restoration following the vigilance task (Berto, 2014; McMahan & Estes, 2015). The results obtained suggested that following the vigilance task, participants self-reported levels of negative affect did not significantly increase (Berto, 2014; McMahan & Estes, 2015). According to the attention restoration theory, it is argued that mental fatigue is characterised by reduced cognitive functioning and increased negative affect (Berto, 2014; McMahan & Estes, 2015), which was not observed within the results of the current study.

Therefore, it is possible that despite the vigilance decrement produced by the vigilance task, that there may have not been a substantial need for affective restoration within participants. Authors within the field have argued that the restorative affects attributed to nature contact may be moderated by the degree to which restoration is needed (Berto, 2014; McMahan & Estes, 2015).

The current study examined stress using self-reported indicators of distress, worry, and engagement. The findings of this study indicated that participants in the presence of in-door plants during a six-minute treatment period had significantly improved levels of distress following a fatiguing vigilance task. As revealed by the results of an independent sample T-test, it was found that these improvements were statistically similar to participants in a guided relaxation treatment condition. No other significant beneficial effects were found in the current study with respect to participants in the in-door plant condition. Conversely, participants in the guided relaxation condition had experienced significant improvements in engagement following the treatment period. These results suggest inconsistent findings in relation to previous research, that have argued that exposure to in-door plants can reduced stress responses (Chang & Chen, 2005; Kim & Mattson, 2002; Liu et al., 2003). An explanation for the current study's findings could be due to the instruments used. Previous studies that have found significant beneficial effects attributed to in-door plants on stress levels have often employed physiological indicators; whereas this study did not involve the use of instruments to measure physiological arousal (Berto, 2014; Chang & Chen, 2005; Kim & Mattson, 2002; Liu et al., 2003; McMahan & Estes, 2015).

Another possible explanation for the findings of the current study may be that participants were not fatigued enough to warrant restoration (Shoemaker et al.,1992). In a study by Bringslimark et al (2007) similar non-significant effects were found using a self-reported measure of perceived stress; the authors argued that this finding was due to the moderate levels of stress reported by their sample. Another study by Kim and Mattson (2002) found that in-door plants had a more pronounced non-significant effect on participants who were more stressed. These arguments align with the principals depicted by attention restoration theory and stress reduction theory, which reflect that the restorative effects of nature are more apparent when individuals experience increased negative emotions, enhanced stress, and cognitive fatigue. The results obtained within the current research indicate that there was no significant change in negative affect and working memory following the vigilance task within participants.

Another explanation regarding the findings of the current study may also be due to the perceived appeal of the task setting within participants. In a study by Dijkstra et al (2008), it was found that perceived stress was lower in a room with in-door plants and that room attractiveness mediated the effects on perceived stress. Furthermore, research has demonstrated that a participant’s nature identity can impact on the effective effects of plant on stress levels, such as engagement or worry. Researchers within the field argue that the restorative effects of plants can be impacted by demographic traits within participants, types of nature contact and nature identity of the participant. Inferences from the frequency analyses run on the participants task reactions to the room suggested that most of the participants within the three conditions had perceived the rooms as not extremely appealing, which may indicate that participants may have not found any one condition more appealing than another. Participants in the in-door plant condition did not rate the task setting as more appealing than the other two conditions.

The results in relation to working memory suggested that participants in the presence of in-door plants had demonstrated a significant improvement in working memory span following the six-minute break period. Interestingly, the findings of the current study indicated that working memory spans across the three study conditions did not significantly decrease as desired following the vigilance task. Therefore, the findings of the current study suggest the presence of a learning effect having been observed, as opposed to restoration. Nonetheless, the results of this study suggest consistent findings with previous research conducted in the field using nature walk therapy (Berman et al., 2008; Berman et al., 2012). In both of these studies using backward digit span task to access working memory, it was found that participants exposed to a nature walk therapy and visual images had demonstrated significant improvements in working memory spans in comparison to studies using urbanised stimuli as treatment conditions.

Theoretical and Practical Implications

The findings of the current study contribute to the applicability of the attention restoration theory from a South African perspective. They suggest that in-door plants may lead to improved performance in tasks that require directed attention functions such as the backward digit span task. Further, the findings of this study suggest that the beneficial effects of in-door plants on tasks that require certain directed attention functions may be independent of a participant’s mood or affect, in consistent with the stress-reduction theory. These findings additionally suggest that the cognitive functions used within vigilance task may be independent to those of tasks associated with working memory. The findings of this study lend support for the incorporation of plants into work environments by promoting the psychological benefits associated with in-door plants. Short break periods taken in environments containing in-door plants may promote working memory and decrease distress levels within individuals. However, further investigation needs to be conducted with respect to the restorative impacts of in-door plants with respect to affect and psychological stress. The findings of the current study may be applied towards the design of workspaces where working memory or reduced distress are of critical importance, such as libraries.

Study Limitations, and Recommendations for Future Research

The primary limitation of the current study relates to the laboratory setting and sample used to examine its research objectives. This experimental methodology used limits the generalisability of conclusions made in this study to South African students from the university of Witwatersrand. Furthermore, as the current study was conducted in a lab setting the observed significant effects cannot be generalised to other settings or contexts. Therefore, future research should be conducted using field experiments to examine whether in-door plants would produce similar effects.

Another limitation relates to the vigilance task used to induce fatigue, specifically, the task did not lead to significant detriments in working memory spans and negative affect as desired. This limited the extent to which instances of restoration could be examined as significant improvements with respect to working memory were not accompanied by a prior decrease. Future research could be conducted to examine restorative effects attributed to in-door plants using a wider range of cognitive tasks induce mental fatigue. Furthermore, as only one measure of cognitive function was used in the current study, future studies should be conducted using other or multiple measures to investigate the current results further.

Another limitation of the current study was the time constraints imposed by the nature of its scope, treatment periods were restricted to six-minutes and the data was obtained using a cross sectional methodology. Future studies should be conducted that use a longitudinal methodology to examine the effects of long-term exposure to indoor plants across different settings and periods (Babbie, 2013). This can lead to increased knowledge regarding the impact of indoor plants over time within the South African context. There were also concerns regarding the sample used in the study, specifically, whilst normality was indicated within the data distribution, the sample size could be considered small with only 60 participants. Future studies should be conducted using larger samples to examine the effects of in-door plants.

In addition, as the instruments used were of a self-reported in nature in this study, there may have been concerns of social desirability bias occurring (Field, 2009). The use of self-report questionnaires relies heavily on participants' truthfulness and commitment to the research (Babbie, 2013). Therefore, some of the participants may have answered questions in a socially desirable way or the way they thought would be acceptable or liked by the experimenter (Field, 2009). Thus, future research could be conducted using physiological or objective measures of stress and affect. Finally, as only two types of foliage plants were used in the current study, it study could not examine whether different types of plants would lead to different effects. Future studies should be conducted that include measures of participants attraction to the plants or different types such as flowering ones.

Strengths of the study

Despite the limitations discussed above, the current study has various merits as well. The primary strength of the study lies in the true experimental design and repeated measure quantitative methodology used. This methodology allows for wider statistical analyses to be performed on obtained data. An experimental design is objective in that all participants experience the same conditions with the exception of the treatments used in each intervention condition. Additionally, all relevant statistical analyses within the study were conducted on standardised Z-scores constructed in relation to each participant`s data measured before and after the relevant treatment exposures which reduces the influences potentially caused by individual participants' characteristics. Furthermore, the use of an experimental group and a control or contrast group enables the researcher to investigate the variables associated with the restorative effects of plants following established methods of carrying out experimental research. The use of numerical data and a behavioural measure of working memory enhanced the reliability and validity of the findings indicated. Finally, the study added to the body of knowledge relating to stress-reduction theory and attention restoration theory with respect to in-door plants, as well as adopted methods not previous used in similar research conducted in South Africa.

Conclusion

The findings of the current study indicated that indoor plants may serve as more than just aesthetically pleasing decorative elements found within work settings. This study highlighted that in addition to improving physical properties within in-door environments as established in previous research, indoor plants can have restorative properties as well. The current study used a true experimental design to investigate the effect of indoor plants in isolation on affect, stress, and working memory. Using a quantitative repeated measure methodology, the study recruited 60 participants to investigate the affective and cognitively restorative properties attributed to indoor plants following a short vigilance task. The theoretical framework used within the study was based on two complementary theories; namely: attention restoration theory and stress-reduction theory. The applications of the theories were demonstrated in the study. The theories were found applicable to the study in terms of the effect of interactions with nature and resultant human cognitive and emotional functioning. The results obtained in this study support ongoing research on cognitive restorative effect of indoor plants. Notably, the restorative effect with respect to reduced distress is statistically similar to a six-minute guided relaxation intervention. It is suggested that the results of this should be used to promote the creation of enriched green work spaces containing indoor plants owing to the beneficial effects they can have on cognitive functioning. Future studies could focus on research that addresses the effects of in-door plants of psychological stress, affect, and cognitive functioning.

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Appendix A (Participant Information Sheet)

School of Human &
Community Development
University of the Witwatersrand
Private Bag 3, Wits, 2050
Tel: 011 717 4503 Fax: 011 717 4559

Good day

My name is Preyen Archary, and I am conducting research for the purposes of obtaining a master's Degree in Organisational Psychology at the University of the Witwatersrand. As part of this degree I am required to complete a formal research project; and present a report on the information obtained. The more responses I receive, the greater the strength of my research. My research is interested in the affective and cognitive restorative benefits of plants. I would like to invite you to take part in this research.

Participation in this research will involve you completing an experimental trail process, held within the psychology department. The trial period will take approximately **30 to 45 minutes** to complete. Your participation is completely voluntary; and there are no potential advantages or disadvantages as a result of participating or not participating in the study. There are no expected risks that may occur from participation, and you will be free to withdraw from the trial at any point prior to completion; after which informed consent will be assumed.

Anonymity cannot be guaranteed as I will have to meet with you in person to conduct each trial; however, confidentiality will be maintained by removing identifying information from the final data set. Your responses to the trial measures will only been seen by my supervisor and I; and the resulting data will not be viewed in isolation.

If you would like to participate in the study, please contact me on the email address provided below, for more information on the study. Please note that the results of this study may be released in the form of a publication or however no identifying information will be included. Your participation in this study would be greatly appreciated. If you would like to enquire about any other ethical concerns please feel free to contact Doctor Colleen Bernstein.

Kind regards

Researcher: Preyen Archary
Student number: 682743
Email address: 682743@students.wits.ac.za

Supervisor: Dr Calvin Gwandure
Phone: 011 717-4519
Email address: Calvin.Gwandure@wits.ac.za

Masters course co-ordinator: Dr Colleen Bernstein
Email address: Colleen.Berstein@wits.ac.za

Appendix B (Letter Requesting Undergraduate Coordinator Consent)

School of Human &
Community Development
University of the Witwatersrand
Private Bag 3, Wits, 2050
Tel: 011 717 4503 Fax: 011 717 4559

Good Day
My name is Preyen Archary and I am conducting research for the purposes of obtaining a Masters degree in Organisational Psychology at the University of the Witwatersrand. As part of this degree I am required to complete research and present a report on the information obtained. The more responses I receive, the greater the strength of my research. My research is looking at the potential benefits plants provide, in relation to cognitive fatigue, stress and working memory. I am writing this letter in order to request permission to carry out my research in your department.

Participation in this research will involve students completing an experimental trial, which attempts to induce mental fatigue, and asses the restorative role plants provide after a break condition. The trial will be conducted using a computerised survey measure and cognitive task. Each trial period will take approximately **30 to 45 minutes** to complete. Participation is completely voluntary; and students will not be advantaged or disadvantaged as a result of participating or not. There are no expected risks associated with participation in the study, and ethical clearance will be obtained before trails begin.

The information sheets states that participation is strictly voluntary, contains information pertaining to the study; and explains how the student may contact the researcher if they wish to participate. Participants will be provided with a copy of this information sheet, if they wish to ask questions regarding the results of the study.

Anonymity cannot be guaranteed because I will have to meet with students in person to conduct the trials. However, confidentiality will be maintained by removing identifying information from the final data set. The collected data will not be seen by anyone other than my supervisor and I. Furthermore, all the responses will only be looked at in relation to all other responses.

If students choose to participate in this study, they will be asked to complete the entire trial. Completion of the trail will be regarded as their consent to participate in this study; however, students will be able to withdraw from the study at any point prior to completion. Feedback will be given in the form of a summary of the overall findings of the research to the course co-ordinator of the department.

Your support in this study would be greatly appreciated. Please contact either me or my supervisor or the organisational psychology masters course co-ordinator should you have any further questions or concerns; and if you wish to meet with me for a discussion and/or see a copy of the trail process.

Kind regards

Researcher: Preyen Archary

Student number: 682743

Email address: 682743@students.wits.ac.za

Supervisor: Dr Calvin Gwandure

Phone: 011 717-4519

Email address: Calvin.Gwandure@wits.ac.za

Masters course co-ordinator: Dr Colleen Bernstein

Email address: Colleen.Berstein@wits.ac.za

Appendix C Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (SCHOOL OF HUMAN & COMMUNITY DEVELOPMENT

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: MORG/18/001 IH**

PROJECT TITLE: Plants providing more than just oxygen: searching for effective and cognitive restoration

INVESTIGATORS Archary Preyen

DEPARTMENT Psychology

DATE CONSIDERED 28/06/18

DECISION OF COMMITTEE* Approved

This ethical clearance is valid for 2 years and may be renewed upon application

DATE: 28 June 2018

CHAIRPERSON
(Dr Colleen Bernstein)

cc Supervisor:

Dr Calvin Gwandure
Psychology

DECLARATION OF INVESTIGATOR (S)

To be completed in duplicate and **one copy** returned to the Secretary, Room 100015, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure, as approved, I/we undertake to submit a revised protocol to the Committee.

This ethical clearance will expire on 31 December 2020

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix D: Informed Consent form

School of Human &
Community Development
University of the Witwatersrand
Private Bag 3, Wits, 2050
Tel: 011 717 4503 Fax: 011 717 4559

Good day

My name is Preyen Archery, and I am conducting research for the purposes of obtaining a master's Degree in Organisational Psychology at the University of the Witwatersrand. As part of this degree I am required to complete a formal research project; and present a report on the information obtained. The more responses I receive, the greater the strength of my research. My research is interested in the affective and cognitive restorative benefits of plants. I would like to invite you to take part in this research.

Participation in this research will involve you completing an experimental trail process, held within the psychology department. The trial period will take approximately **45 to 60 minutes** to complete. Your participation is completely voluntary; and there are no potential advantages or disadvantages as a result of participating or not participating in the study. There are no expected risks that may occur from participation, and you will be free to withdraw from the trial at any point prior to completion; after which informed consent will be assumed.

Anonymity cannot be guaranteed as I will have to meet with you in person to conduct each trial; however, confidentiality will be maintained by removing identifying information from the final data set. Your responses to the trial measures will only been seen by my supervisor and I; and the resulting data will not be viewed in isolation.

If you would like to participate in the study, please contact me on the email address provided below, for more information on the study. Please note that the results of this study may be released in the form of a publication or however no identifying information will be included. Your participation in this study would be greatly appreciated. If you would like to enquire about any other ethical concerns please feel free to contact Doctor Colleen Bernstein.

Kind regards

Researcher: Preyen Archary

Student number: 682743

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CONSENT TO PARTICIPATE

I agree to participate in the aforementioned research.

Name:

Signature:

Appendix E Pictures of Conditions

Figure 6 Experimental setting control and guided relaxation

Figure 7 Experimental setting In-door plants

Appendix F Demographic questionnaire

This brief questionnaire has been designed to gather non-identifying demographic information about you and for you to express your opinions of the workstation you are currently in.

- Before you begin, please be assured that all your responses will remain **confidential**
- If you have any questions, please ask them now.

Demographics

1. What is your age?
   Please state here: years

2. What is your gender?
   Male □ Female □

3. What is your racial category?
   White □ African □ Colored □ Indian □ Other □

4. Current university level?
   First year □ Second year □ Third year □ Fourth year □ Postgraduate □

5. Approximately how many cups of caffeinated beverages have you had in the last two hours?
   0 cups □ 1 cup □ 2 cups □ 3 cups □ 4 or more cups □

Reaction to room

INSTRUCTIONS

This questionnaire consists of a number of statements each with its own scale. These scales allow for seven shades of meaning from disagree completely to agree completely. For example, if you agree quite strongly with a statement you would cross the sixth box in the scale like this

disagree completely □ □ □ □ □ ☒ □ agree completely

If on the other hand you slightly disagree with a statement, then the third box on the scale would be the one to choose, like this:

disagree completely □ □ ☒ □ □ □ □ agree completely

6. This is a pleasant room in which to work

disagree completely □ □ □ □ □ □ □ agree completely

7. I feel comfortable in the room

disagree completely □ □ □ □ □ □ □ agree completely

8. I feel uncomfortable in the room

disagree completely □ □ □ □ □ □ □ agree completely

9. I am able to concentrate in the room

disagree completely □ □ □ □ □ □ □ agree completely

10. The room has a good atmosphere in which to work

disagree completely □ □ □ □ □ □ □ agree completely

11. The air in the room is stuffy

disagree completely □ □ □ □ □ □ □ agree completely

12. The air in the room is stale

disagree completely □ □ □ □ □ □ □ agree completely

13. The room is too cold

disagree completely □ □ □ □ □ □ □ agree completely

14. The room is too hot

disagree completely □ □ □ □ □ □ □ agree completely

15. The lights are too bright

disagree completely □ □ □ □ □ □ □ agree completely

16. The lights are too dim

Disagree completely □ □ □ □ □ □ □ agree completely

Appendix I (Positive and Negative Affect Schedule)

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. **Indicate to what extent you feel this way right now, that is, at the present moment by selecting the corresponding number for each question.**

1) Very Slightly or Not at All
2) A Little
3) Moderately
4) Quite a Bit
5) Extremely

__________ 1. Interested
__________ 2. Distressed
__________ 3. Excited
__________ 4. Upset
__________ 5. Strong
__________ 6. Guilty
__________ 7. Scared
__________ 8. Hostile
__________ 9. Enthusiastic
__________ 10. Proud
__________ 11. Irritable
__________ 12. Alert
__________ 13. Ashamed
__________ 14. Inspired
__________ 15. Nervous
__________ 16. Determined
__________ 17. Attentive
__________ 18. Jittery
__________ 19. Active
__________ 20. Afraid

Appendix J (Dundee Stress State Questionnaire)

DSSQ-3 STATE QUESTIONNAIRE

PRE-TASK QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **AT THE MOMENT**.

Definitely false = 0, Somewhat false = 1, Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

1. I feel concerned about the impression I am making. 0 1 2 3 4
2. I feel relaxed. 0 1 2 3 4
3. The content of the task will be dull. 0 1 2 3 4
4. I am thinking about how other people might judge my performance. 0 1 2 3 4
5. I am determined to succeed on the task. 0 1 2 3 4
6. I feel tense. 0 1 2 3 4
7. I am worried about what other people think of me. 0 1 2 3 4
8. I am thinking about how I would feel if I were told how I performed 0 1 2 3 4
9. Generally, I feel in control of things. 0 1 2 3 4
10. I am reflecting about myself. 0 1 2 3 4
11. My attention will be directed towards the task. 0 1 2 3 4
12. I am thinking deeply about myself. 0 1 2 3 4
13. I feel energetic. 0 1 2 3 4
14. I am thinking about things that happened to me in the past 0 1 2 3 4
15. I am thinking about how other people might perform on this task 0 1 2 3 4

16. I am thinking about something that happened earlier today. 0 1 2 3 4

17. I expect that the task will be too difficult for me. 0 1 2 3 4

18. I will find it hard to keep my concentration on the task. 0 1 2 3 4

19. I am thinking about personal concerns and interests. 0 1 2 3 4

20. I feel confident about my performance. 0 1 2 3 4

21. I am examining my motives. 0 1 2 3 4

22. I can handle any difficulties I may encounter 0 1 2 3 4

23. I am thinking about how I have dealt with similar tasks in the past 0 1 2 3 4

24. I am reflecting on my reasons for doing the task 0 1 2 3 4

25. I am motivated to try hard at the task. 0 1 2 3 4

26. I am thinking about things important to me. 0 1 2 3 4

27. I feel uneasy. 0 1 2 3 4

28. I feel tired. 0 1 2 3 4

29. I feel that I cannot deal with the situation effectively. 0 1 2 3 4

30. I feel bored. 0 1 2 3 4

DSSQ-3 STATE QUESTIONNAIRE

POST-TASK QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts while you were performing the task. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **WHILE PERFORMING THE TASK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **WHILE PERFORMING THE TASK**.

Definitely false = 0, Somewhat false = 1, Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

1. I felt concerned about the impression I am making. 0 1 2 3 4
2. I felt relaxed. 0 1 2 3 4
3. The content of the task was dull. 0 1 2 3 4
4. I thought about how other people might judge my performance 0 1 2 3 4
5. I was determined to succeed on the task. 0 1 2 3 4
6. I felt tense. 0 1 2 3 4
7. I was worried about what other people think of me. 0 1 2 3 4
8. I thought about how I would felt if I were told how I performed 0 1 2 3 4
9. Generally, I felt in control of things. 0 1 2 3 4
10. I reflected about myself. 0 1 2 3 4
11. My attention was directed towards the task. 0 1 2 3 4
12. I thought deeply about myself. 0 1 2 3 4
13. I felt energetic. 0 1 2 3 4
14. I thought about things that happened to me in the past 0 1 2 3 4
15. I thought about how other people might perform on this task 0 1 2 3 4
16. I thought about something that happened earlier today. 0 1 2 3 4
17. I found the task was too difficult for me. 0 1 2 3 4

18. I found it hard to keep my concentration on the task. 0 1 2 3 4

19. I thought about personal concerns and interests. 0 1 2 3 4

20. I felt confident about my performance. 0 1 2 3 4

21. I examined my motives. 0 1 2 3 4

22. I felt like I could handle any difficulties I encountered 0 1 2 3 4

23. I thought about how I have dealt with similar tasks in the past 0 1 2 3 4

24. I reflected on my reasons for doing the task 0 1 2 3 4

25. I was motivated to try hard at the task. 0 1 2 3 4

26. I thought about things important to me. 0 1 2 3 4

27. I felt uneasy. 0 1 2 3 4

28. I felt tired. 0 1 2 3 4

29. I felt that I could not deal with the situation effectively. 0 1 2 3 4

30. I felt bored. 0 1 2 3 4

POST-INTERVENTION QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts while you were performing the task. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **DURING THE BREAK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **DURING THE BREAK**.

Definitely false = 0, Somewhat false = 1, Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

1. I felt concerned about the impression I am making. 0 1 2 3 4
2. I felt relaxed. 0 1 2 3 4
3. The content of the task was dull. 0 1 2 3 4
4. I thought about how other people might judge my performance 0 1 2 3 4
5. I was determined to succeed on the task. 0 1 2 3 4
6. I felt tense. 0 1 2 3 4
7. I was worried about what other people think of me. 0 1 2 3 4
8. I thought about how I would felt if I were told how I performed 0 1 2 3 4
9. Generally, I felt in control of things. 0 1 2 3 4
10. I reflected about myself. 0 1 2 3 4
11. My attention was directed towards the task. 0 1 2 3 4
12. I thought deeply about myself. 0 1 2 3 4
13. I felt energetic. 0 1 2 3 4
14. I thought about things that happened to me in the past 0 1 2 3 4
15. I thought about how other people might perform on this task 0 1 2 3 4
16. I thought about something that happened earlier today. 0 1 2 3 4
17. I found the task was too difficult for me. 0 1 2 3 4
18. I found it hard to keep my concentration on the task. 0 1 2 3 4

19. I thought about personal concerns and interests. 0 1 2 3 4

20. I felt confident about my performance. 0 1 2 3 4

21. I examined my motives. 0 1 2 3 4

22. I felt like I could handle any difficulties I encountered 0 1 2 3 4

23. I thought about how I have dealt with similar tasks in the past 0 1 2 3 4

24. I reflected on my reasons for doing the task 0 1 2 3 4

25. I was motivated to try hard at the task. 0 1 2 3 4

26. I thought about things important to me. 0 1 2 3 4

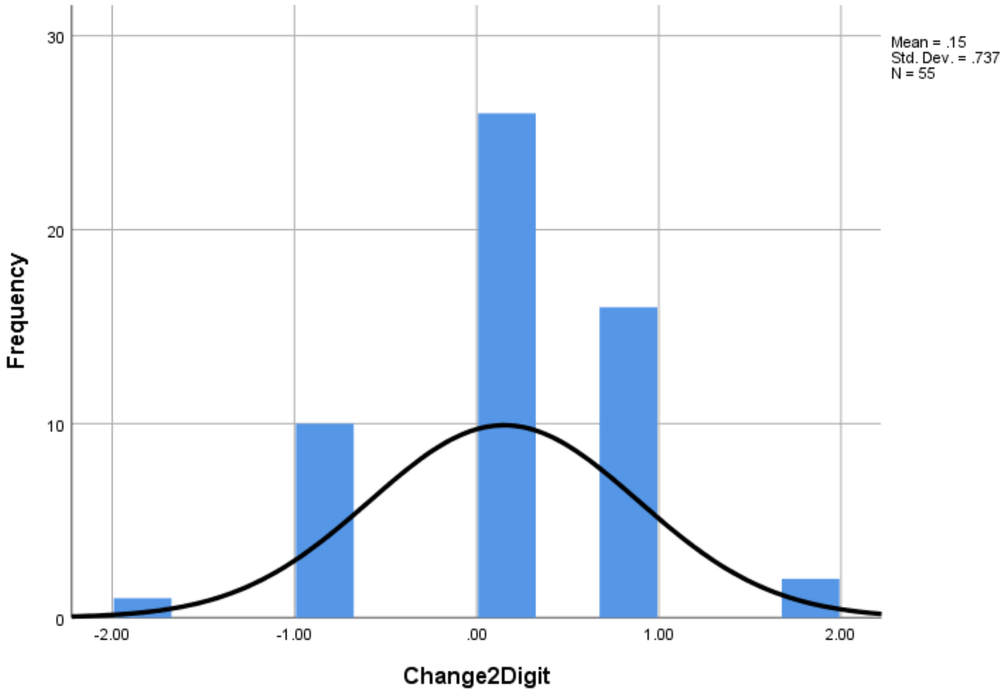
27. I felt uneasy. 0 1 2 3 4

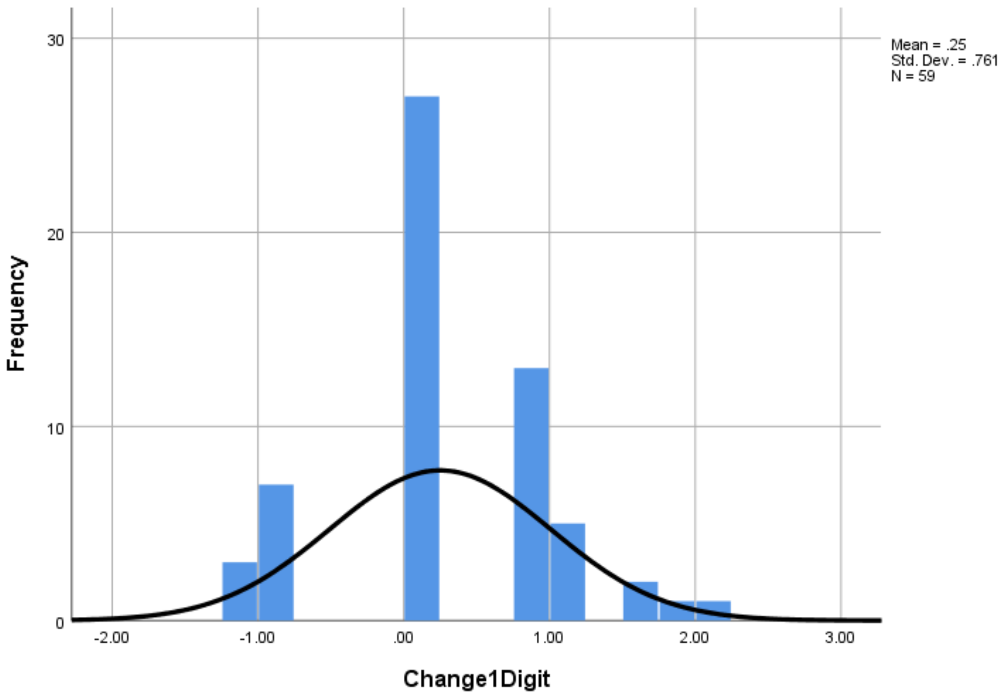
28. I felt tired. 0 1 2 3 4

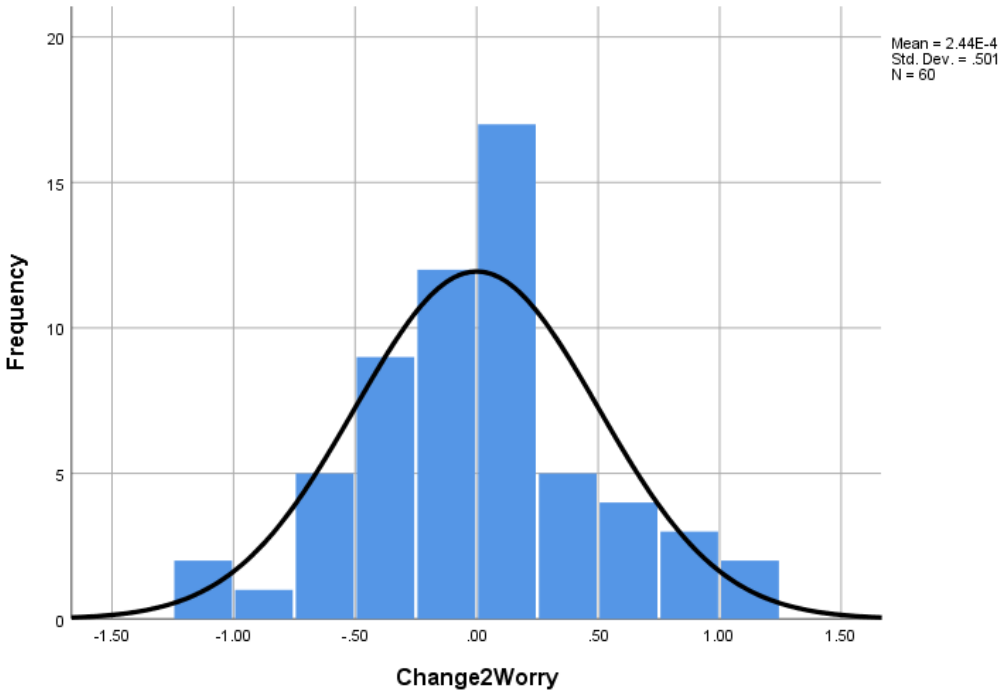
29. I felt that I could not deal with the situation effectively. 0 1 2 3 4

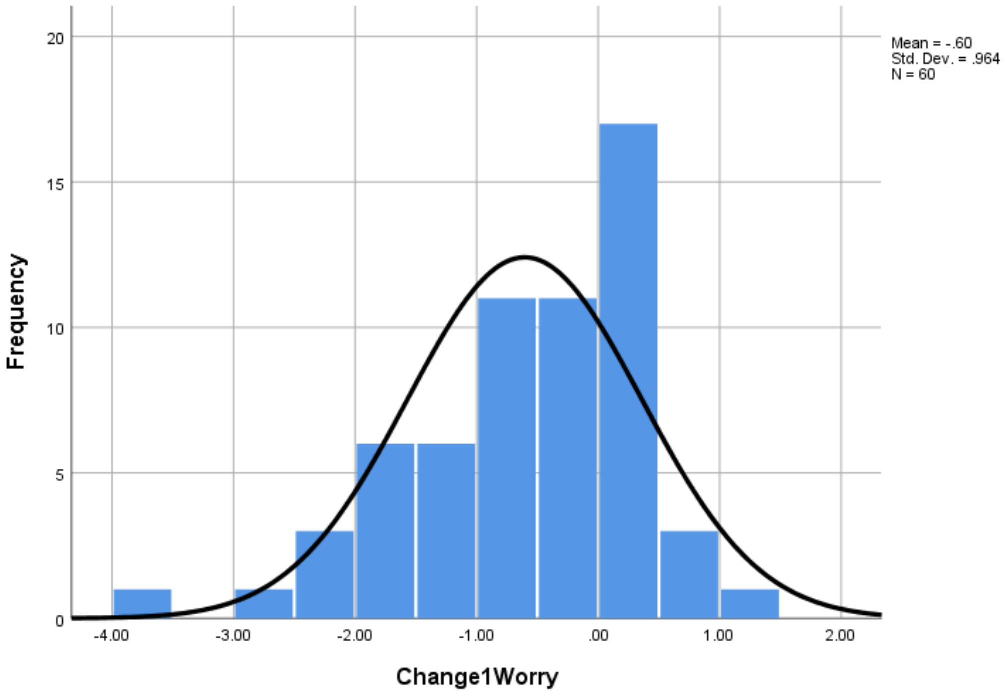
30. I felt bored. 0 1 2 3 4

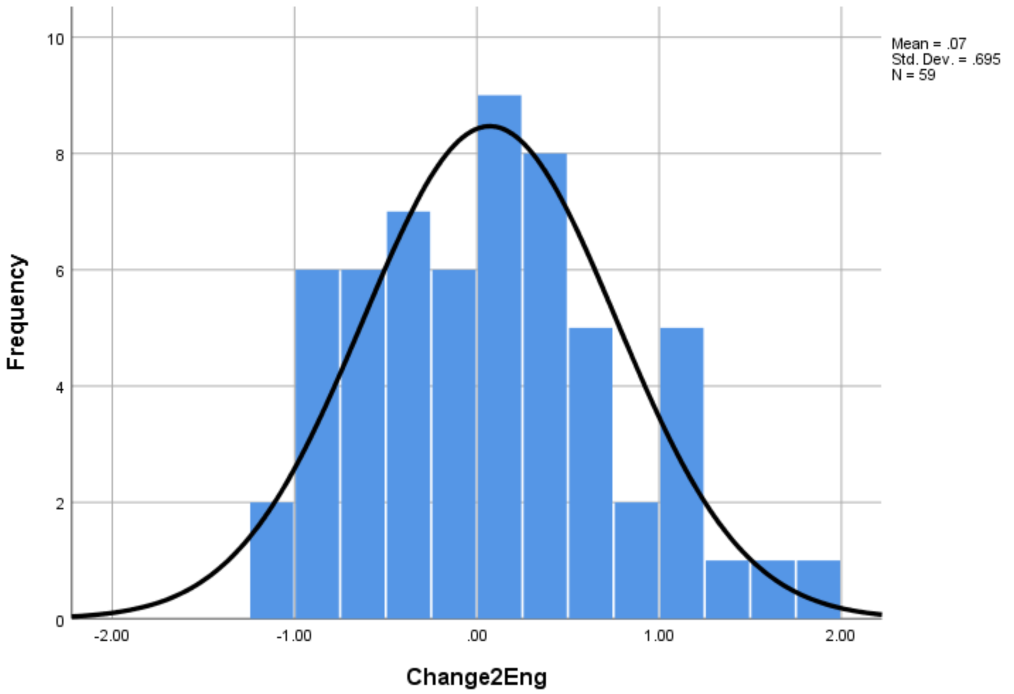
Appendix K Normality Histograms

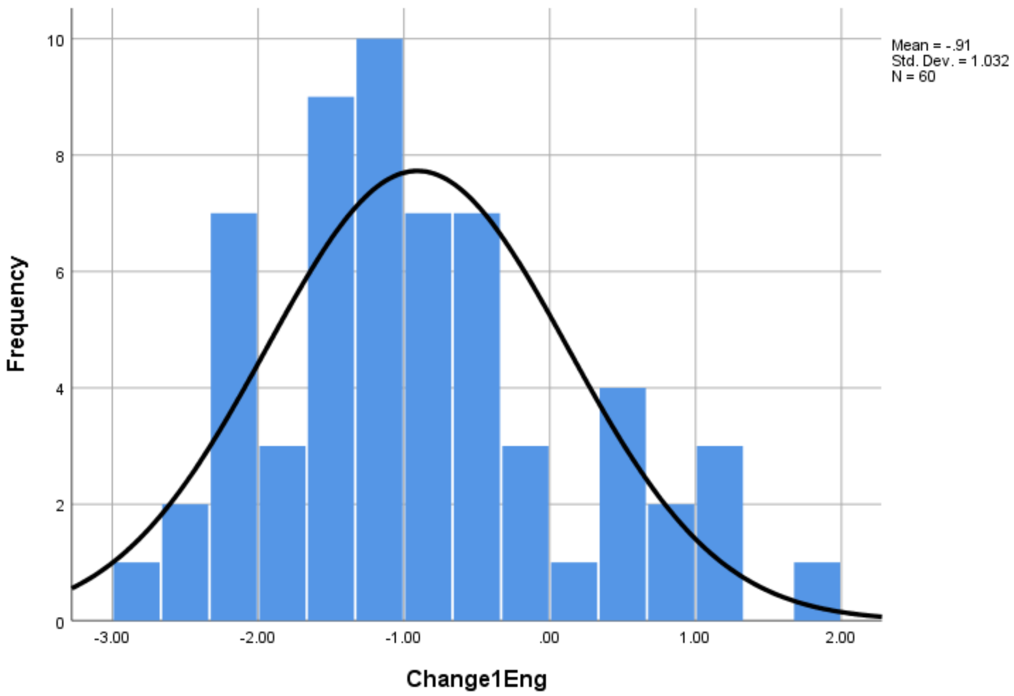


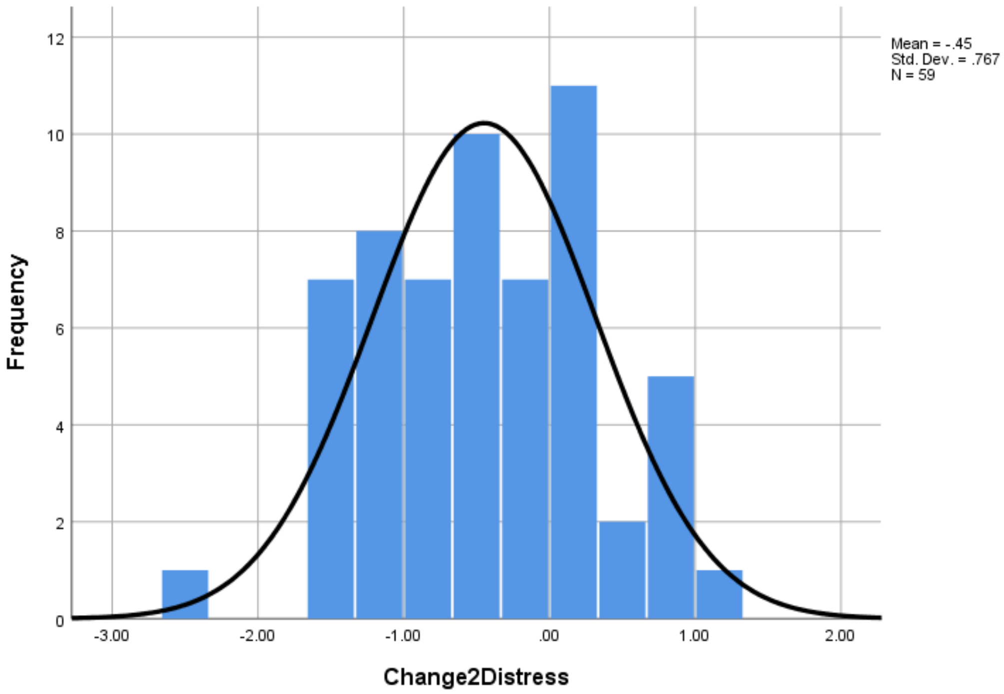



Mean = 2.44E-4
Std. Dev. = .501
N = 60
Frequency
20
15
10
5
0
-1.50
-1.00
-.50
.00
.50
1.00
1.50
Change2Worry

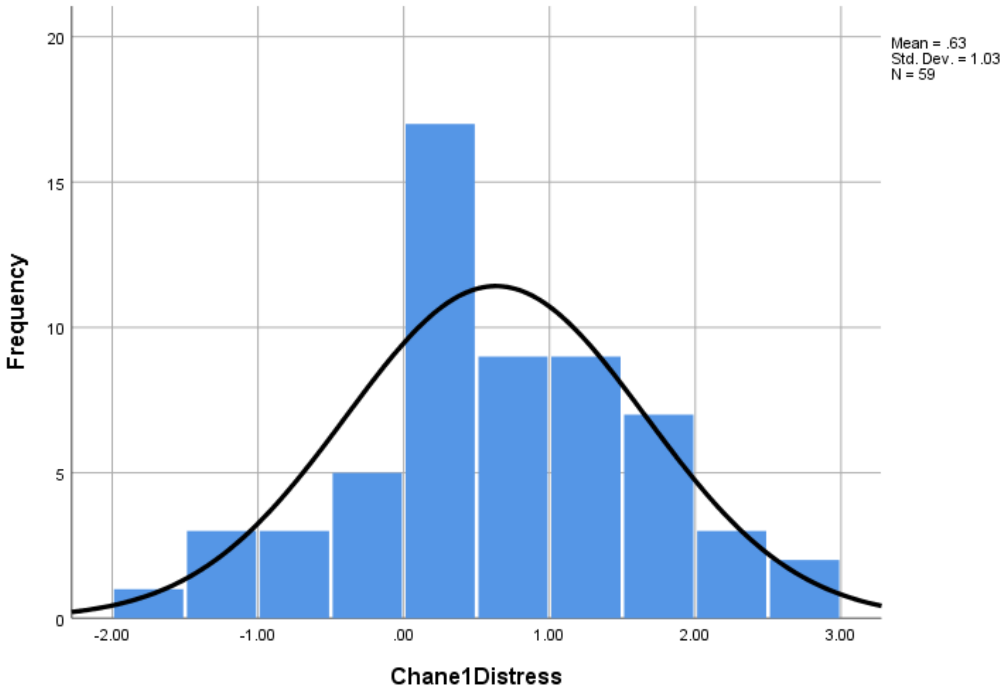

Mean = -.60
Std. Dev. = .964
N = 60
Frequency
20
15
10
5
0
-4.00
-3.00
-2.00
-1.00
.00
1.00
2.00
Change1Worry


Mean = .07
Std. Dev. = .695
N = 59
Frequency
Change2Eng

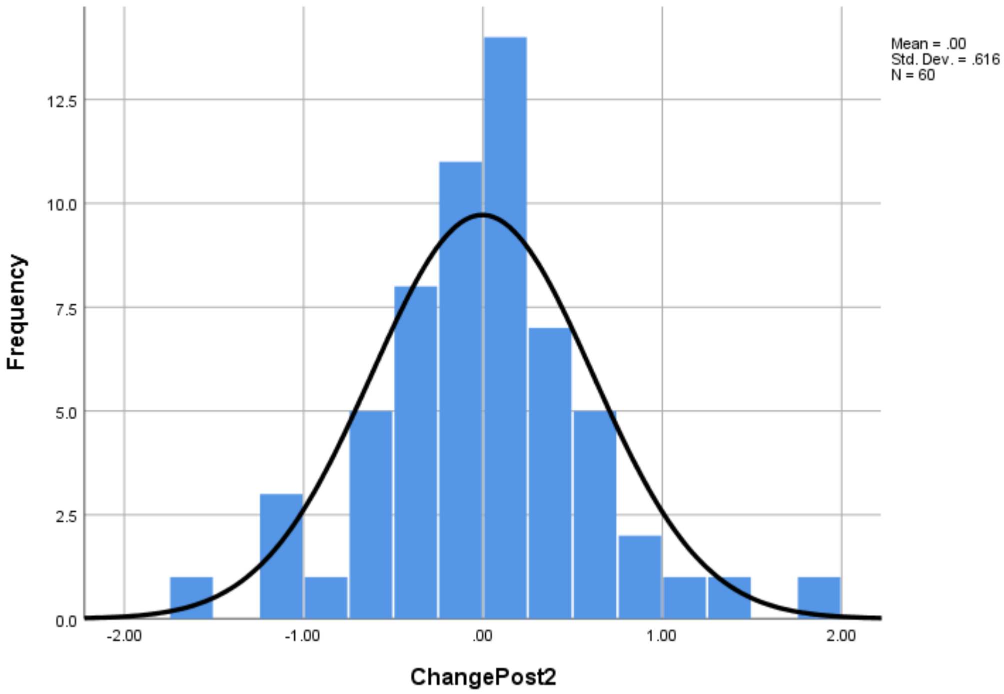

Mean = -.91
Std. Dev. = 1.032
N = 60
Frequency
Change1Eng

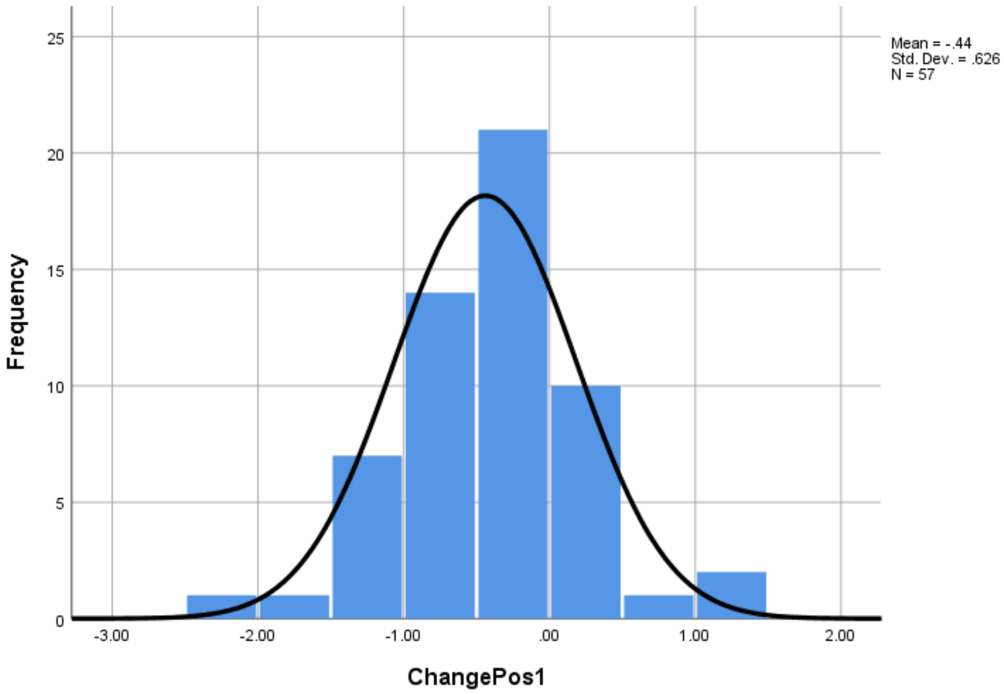


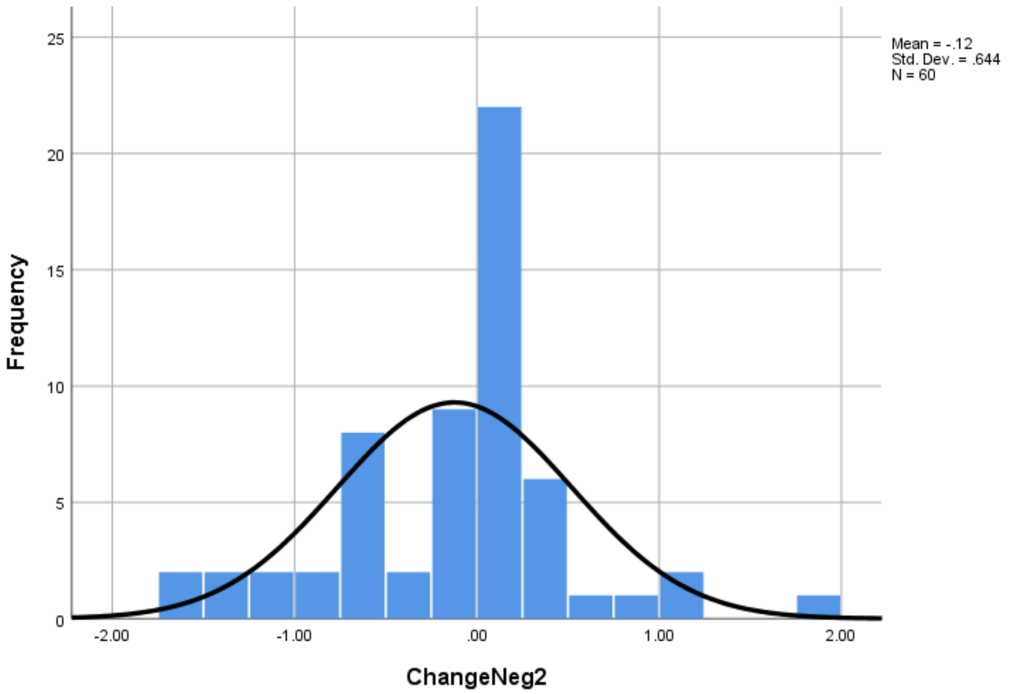
Mean = -.45
Std. Dev. = .767
N = 59
Frequency
Change2Distress

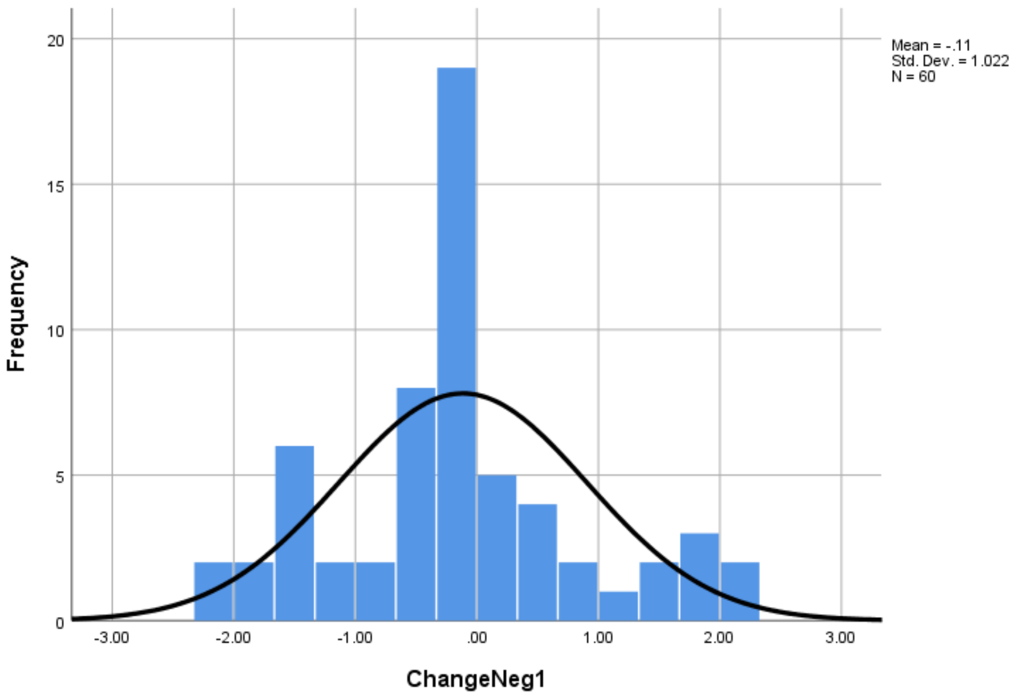


Mean = .63
Std. Dev. = 1.03
N = 59
Frequency
Chane1Distress

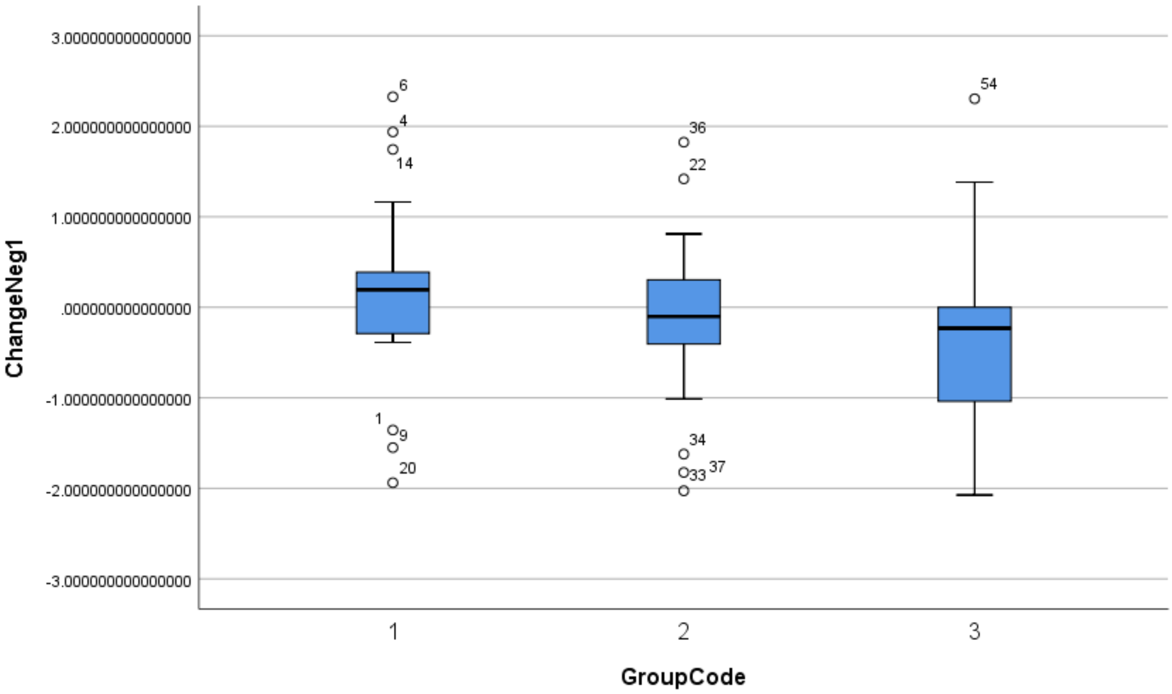

Mean = .00
Std. Dev. = .616
N = 60
Frequency
12.5
10.0
7.5
5.0
2.5
0.0
-2.00
-1.00
.00
1.00
2.00
ChangePost2

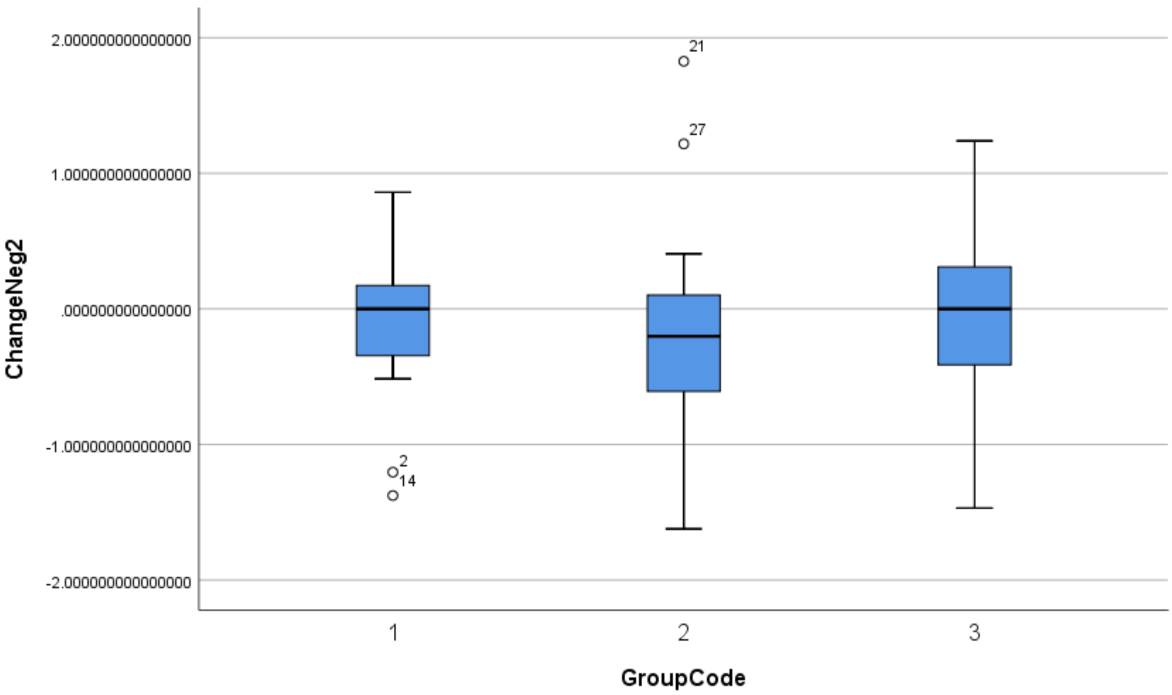

Mean = -.44
Std. Dev. = .626
N = 57
Frequency
25
20
15
10
5
0
-3.00
-2.00
-1.00
.00
1.00
2.00
ChangePos1

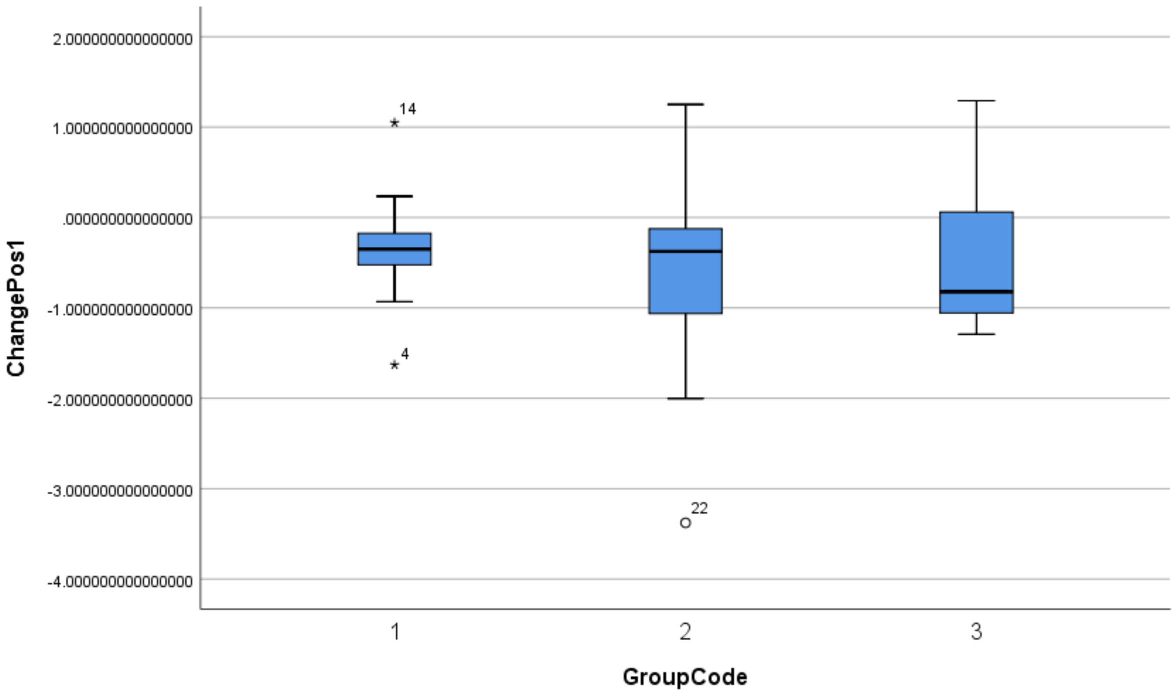

Mean = -.12
Std. Dev. = .644
N = 60
Frequency
ChangeNeg2
25
20
15
10
5
0
-2.00
-1.00
.00
1.00
2.00

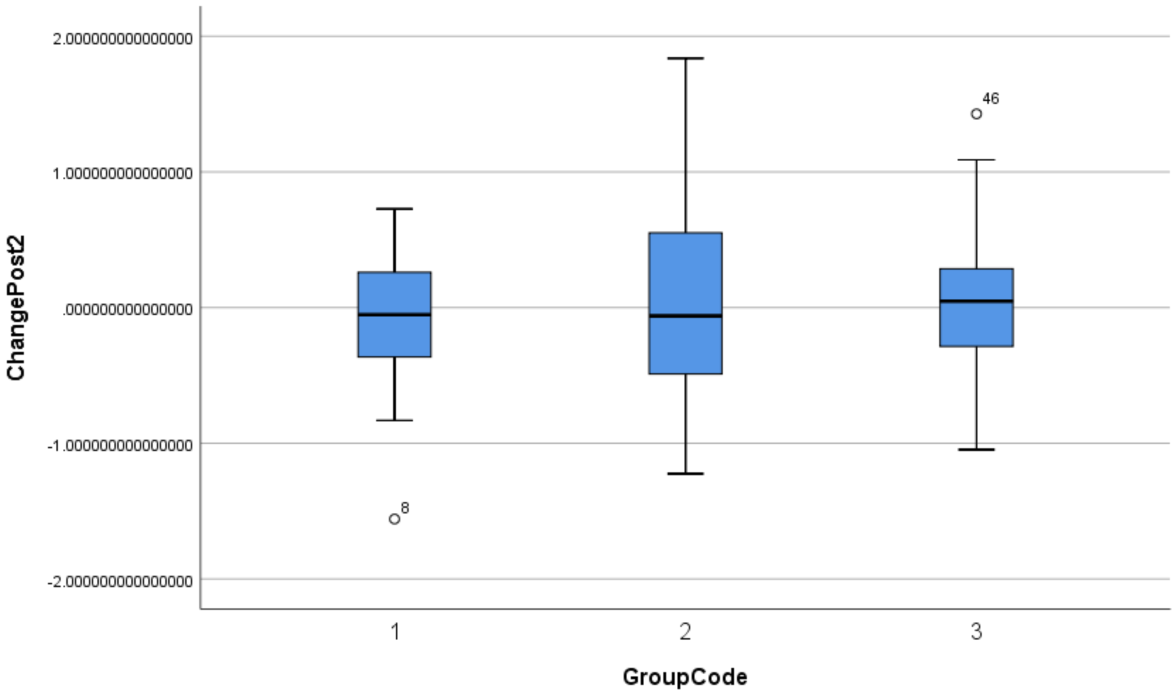

Mean = -.11
Std. Dev. = 1.022
N = 60
Frequency
ChangeNeg1
20
15
10
5
0
-3.00
-2.00
-1.00
.00
1.00
2.00
3.00

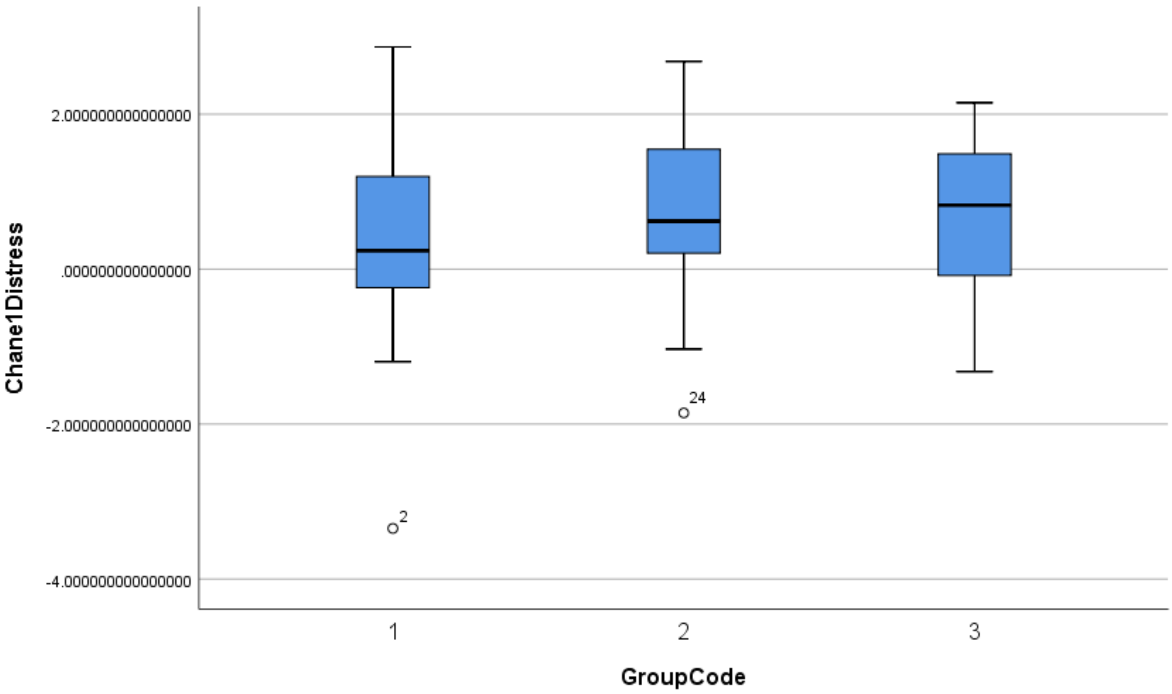
Appendix L: Box plots for significant outliers

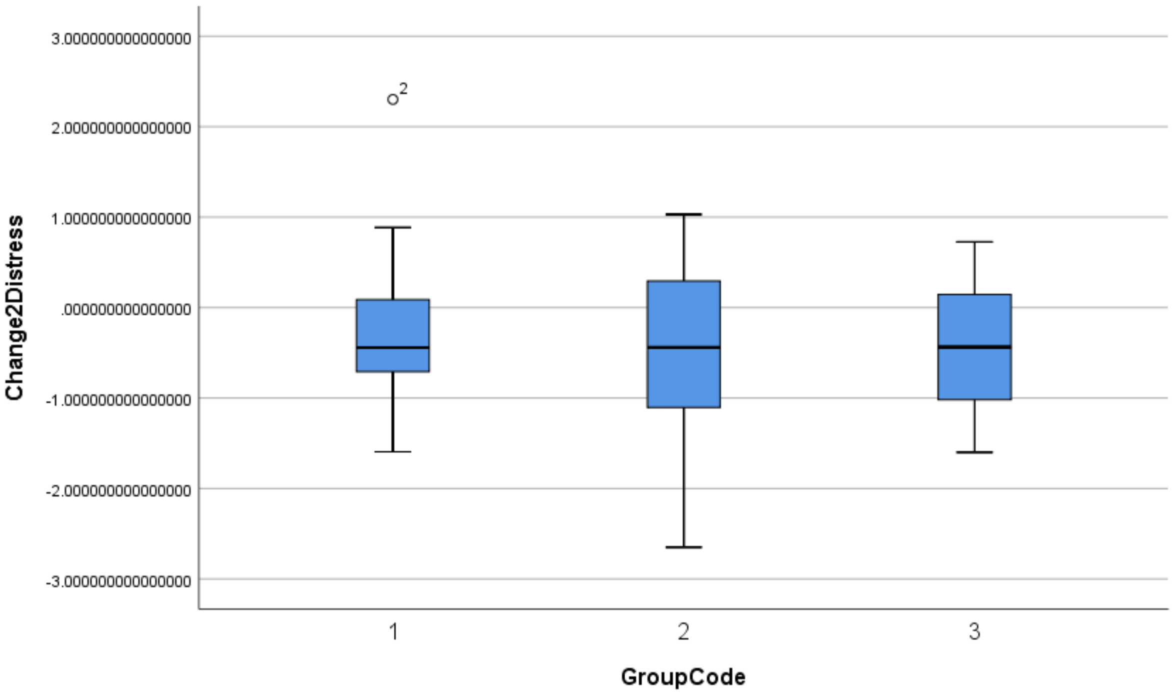


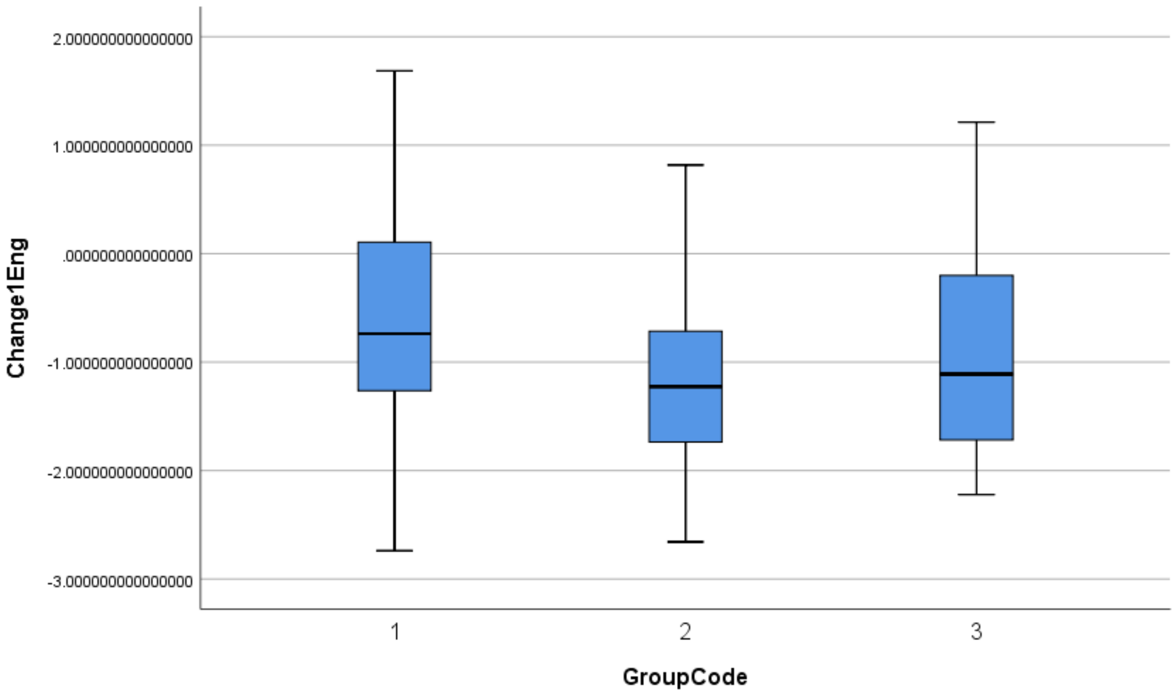



2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
-3.000000000000000
-4.000000000000000
ChangePos1
14
4
22
1
2
3
GroupCode

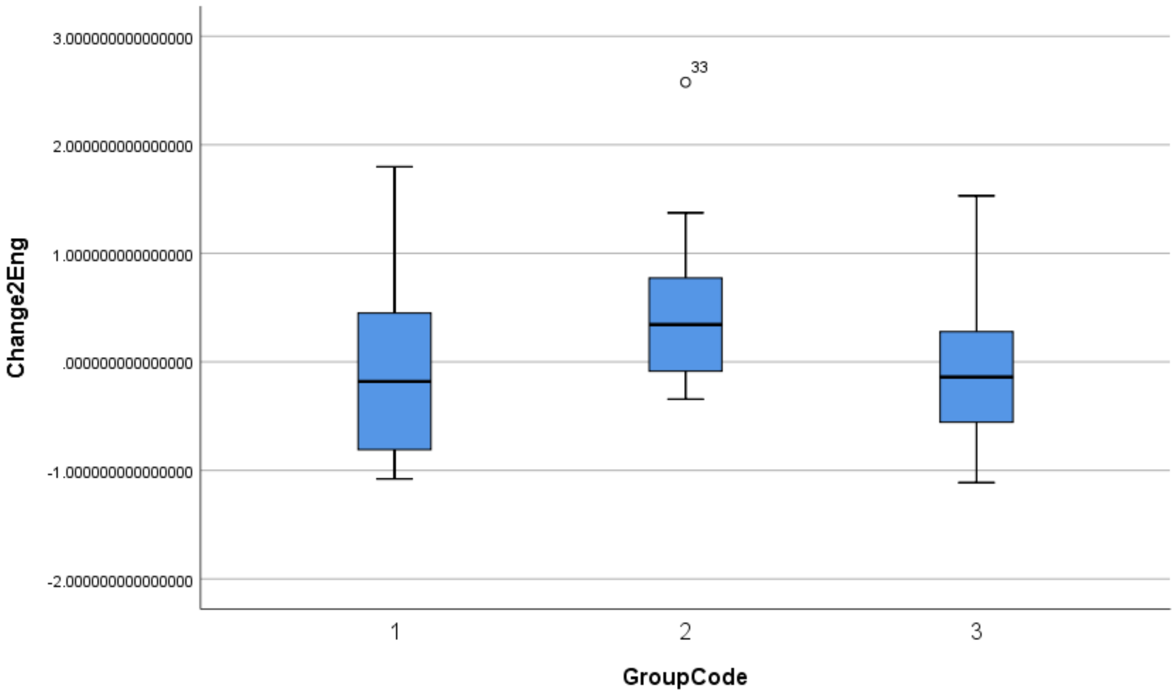

2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
ChangePost2
46
8
1
2
3
GroupCode


2.000000000000000
.000000000000000
-2.000000000000000
-4.000000000000000
Chane1Distress
24
2
1
2
3
GroupCode

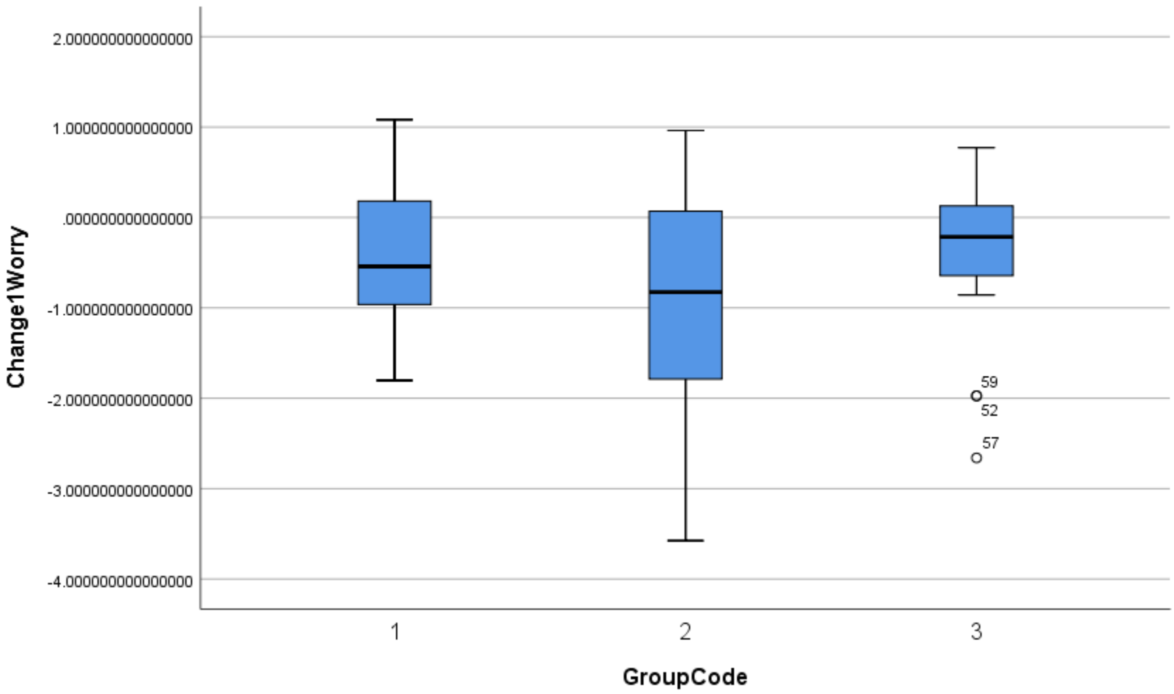

3.000000000000000
2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
-3.000000000000000
Change2Distress
2
1
2
3
GroupCode



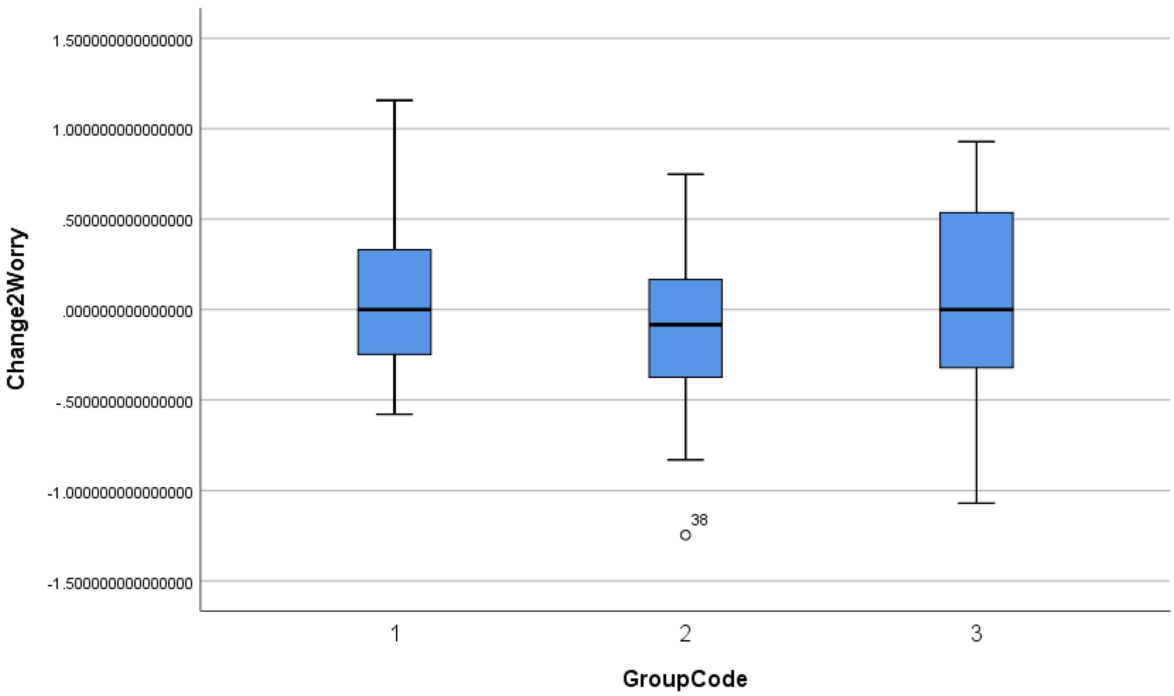
2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
-3.000000000000000
Change1Eng
1
2
3
GroupCode



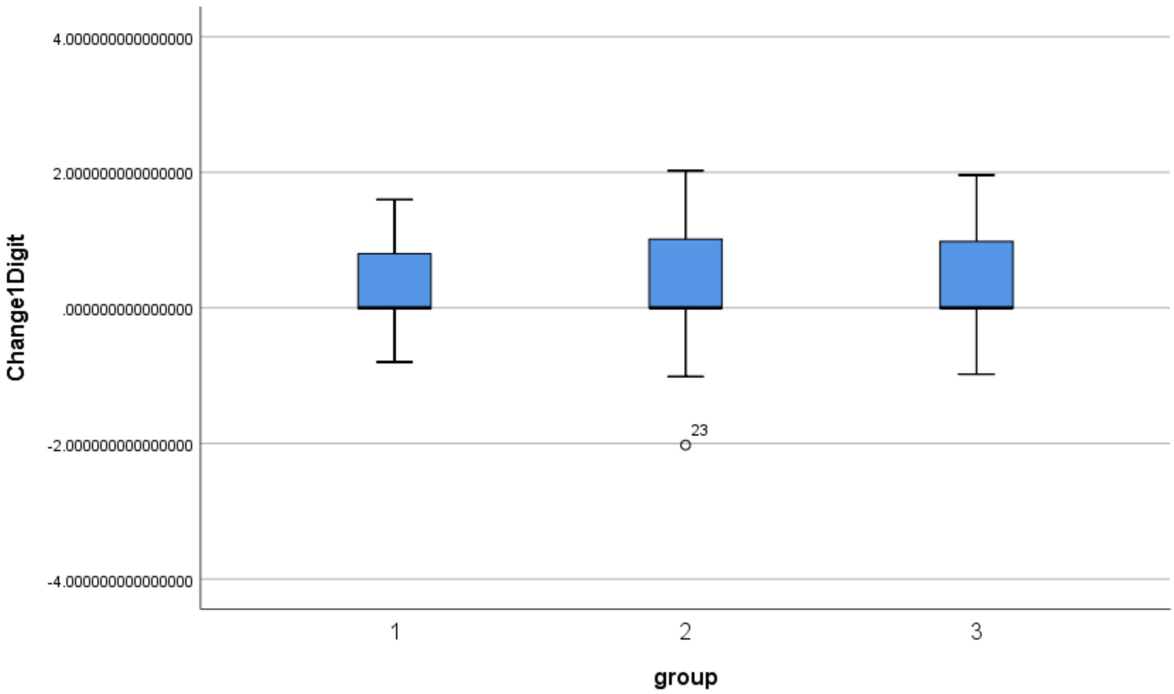
3.000000000000000
2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
33
Change2Eng
1
2
3
GroupCode

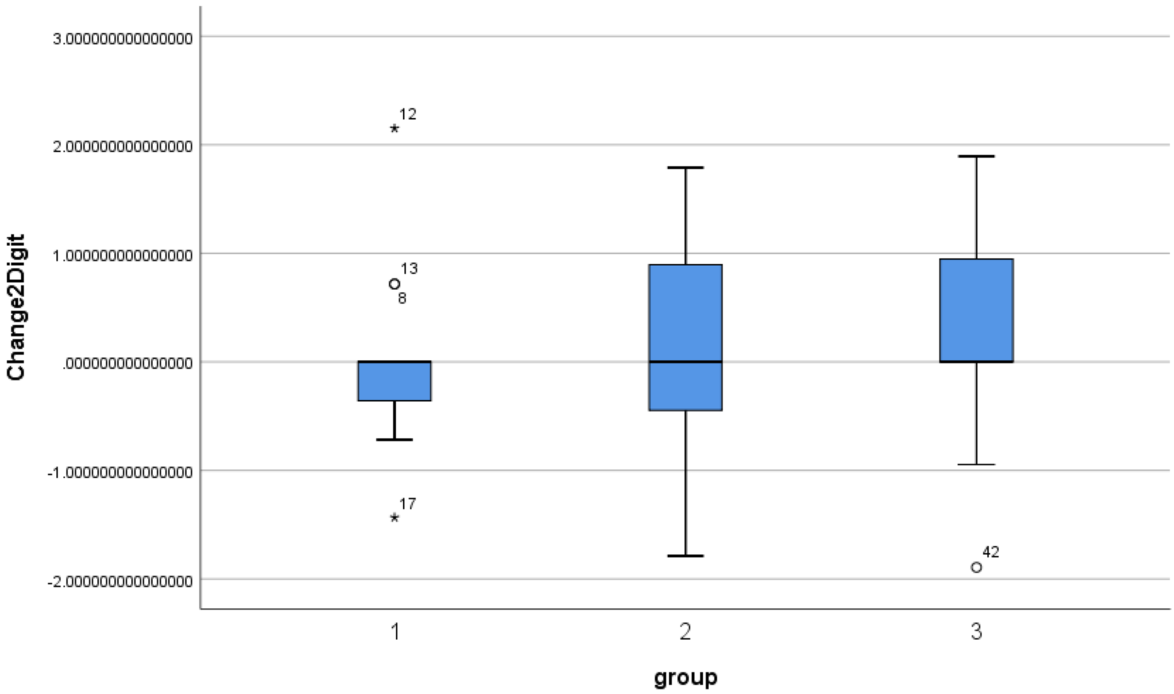


Change1Worry
2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
-3.000000000000000
-4.000000000000000
59
52
57
1
2
3
GroupCode

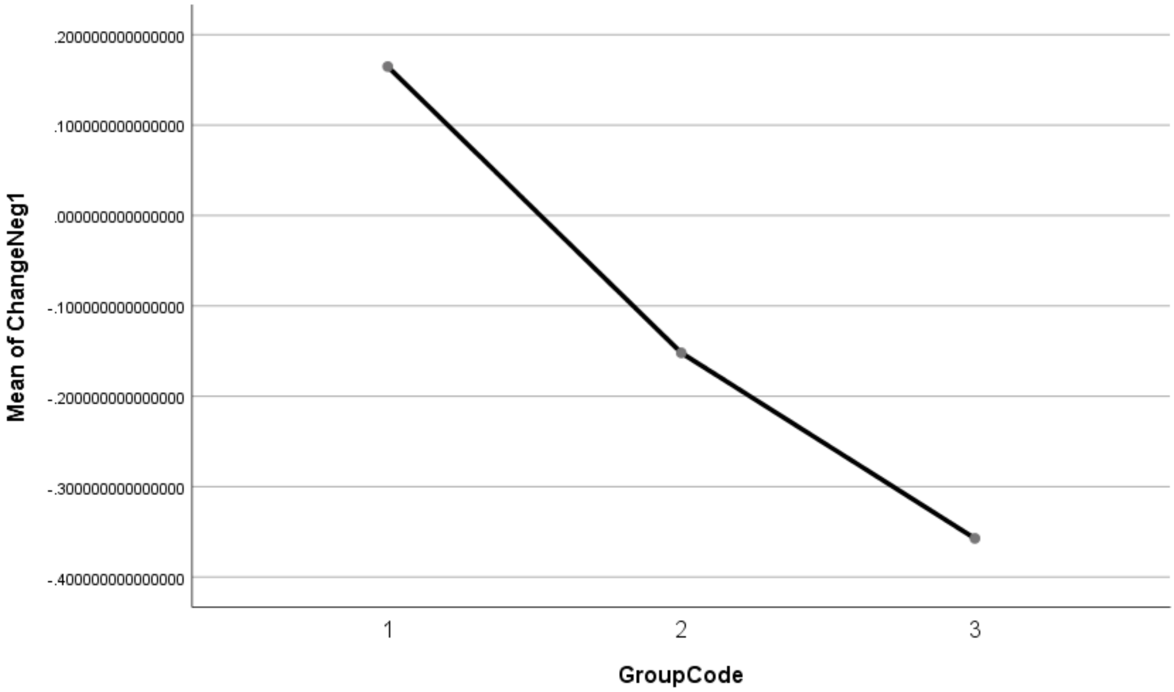


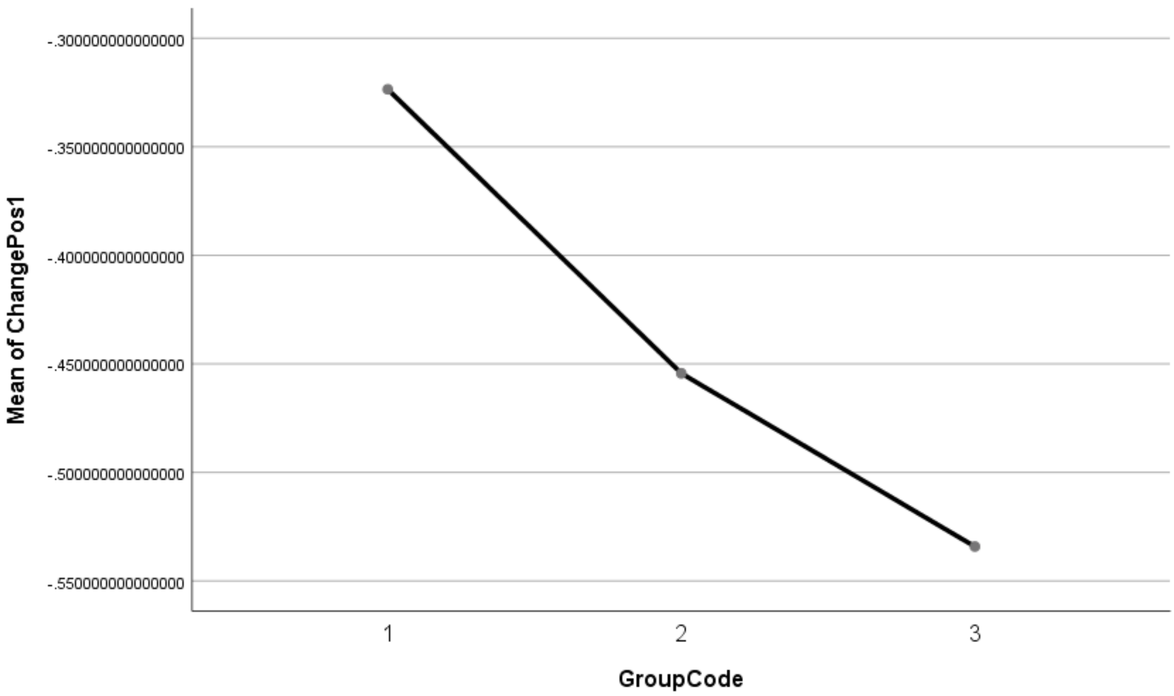
Change2Worry
1.500000000000000
1.000000000000000
.500000000000000
.000000000000000
-.500000000000000
-1.000000000000000
-1.500000000000000
38
1
2
3
GroupCode

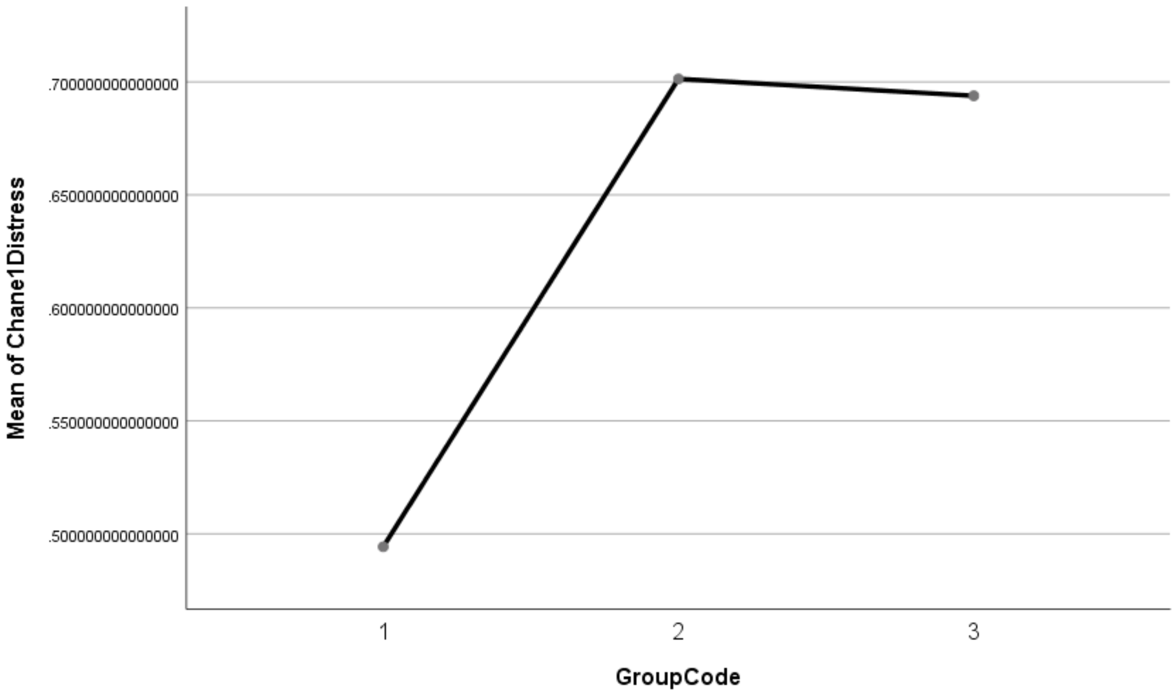

4.000000000000000
2.000000000000000
.000000000000000
-2.000000000000000
-4.000000000000000
Change1Digit
23
1
2
3
group


3.000000000000000
2.000000000000000
1.000000000000000
.000000000000000
-1.000000000000000
-2.000000000000000
Change2Digit
12
13
8
17
42
1
2
3
group

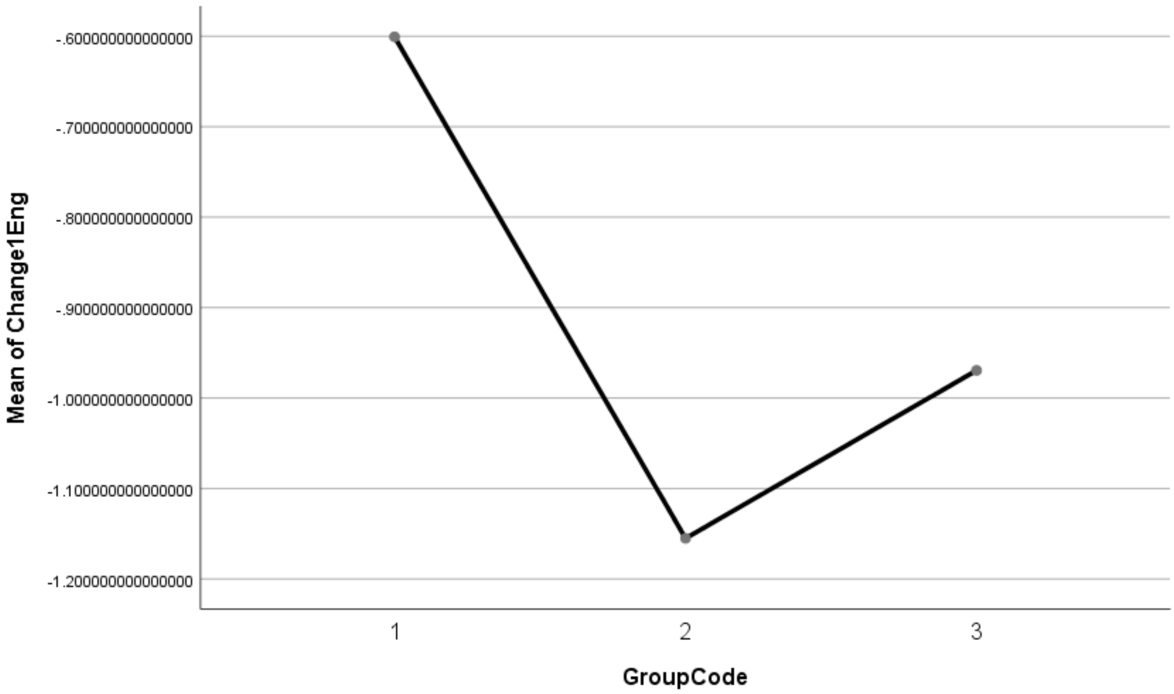
Appendix M: Mean plots of ANOVAS



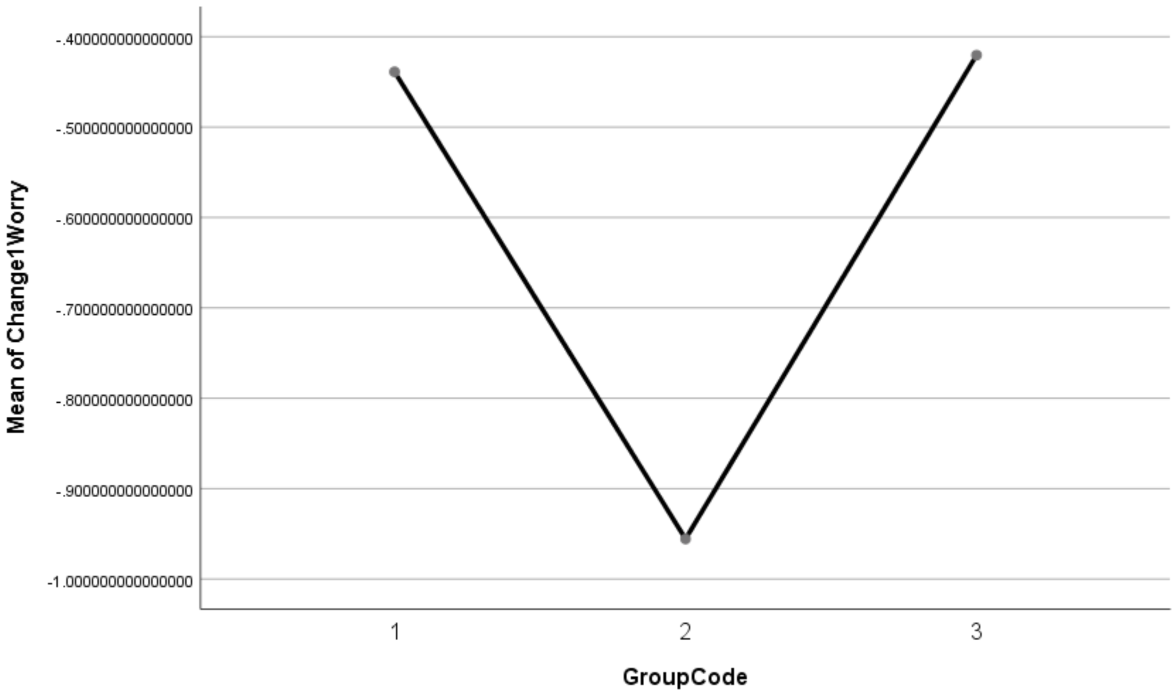




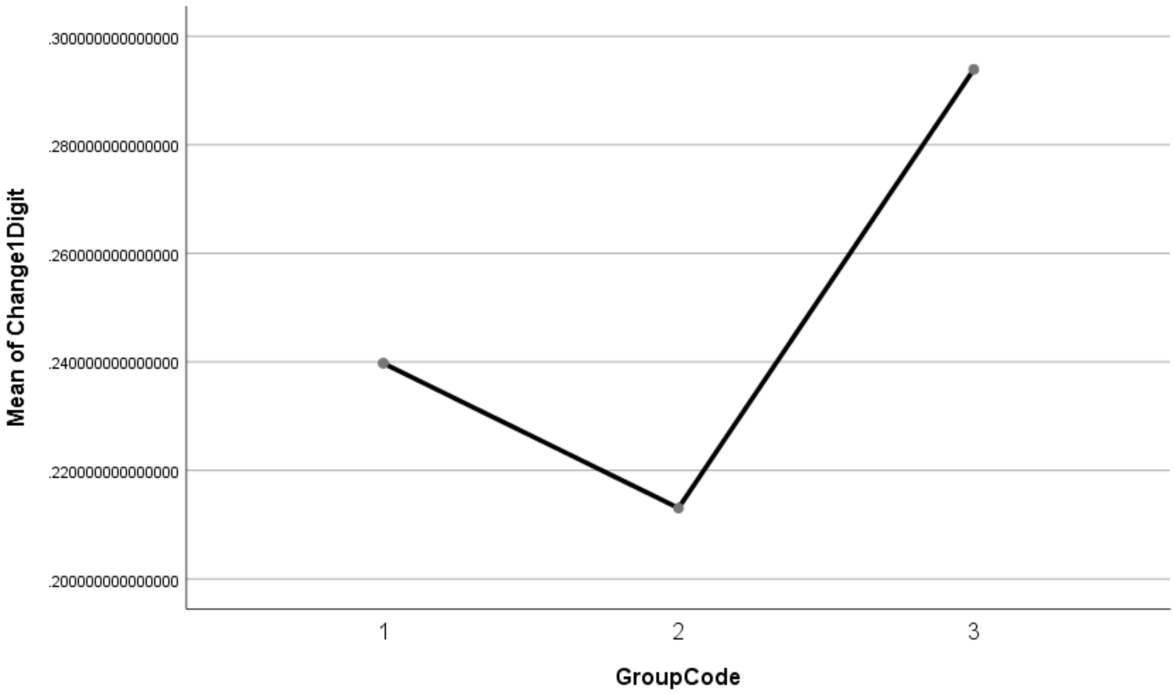
.700000000000000
.650000000000000
.600000000000000
.550000000000000
.500000000000000
Mean of Chane1Distress
1
2
3
GroupCode



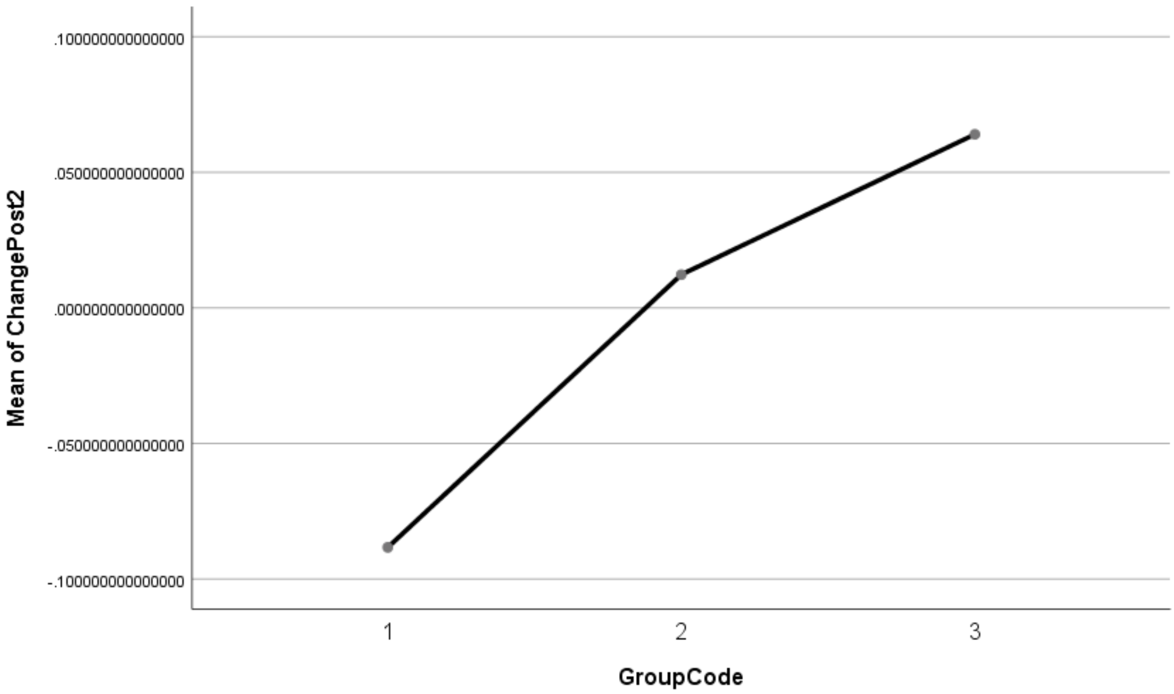
-.600000000000000
-.700000000000000
-.800000000000000
-.900000000000000
-1.000000000000000
-1.100000000000000
-1.200000000000000
Mean of Change1Eng
1
2
3
GroupCode

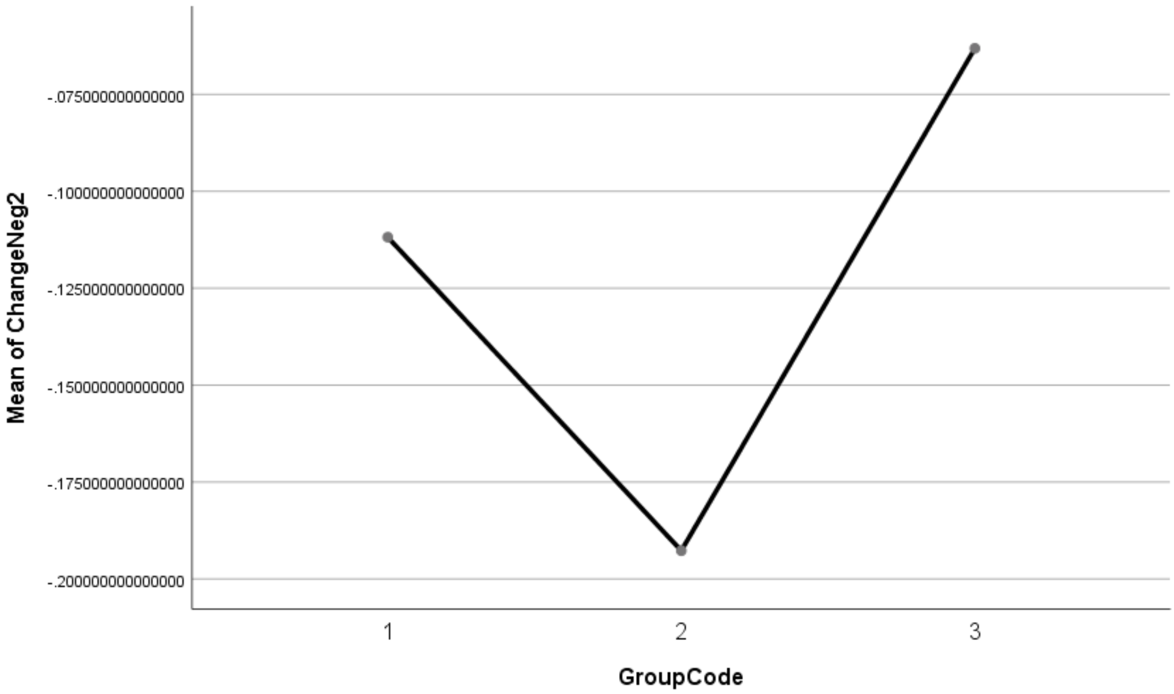


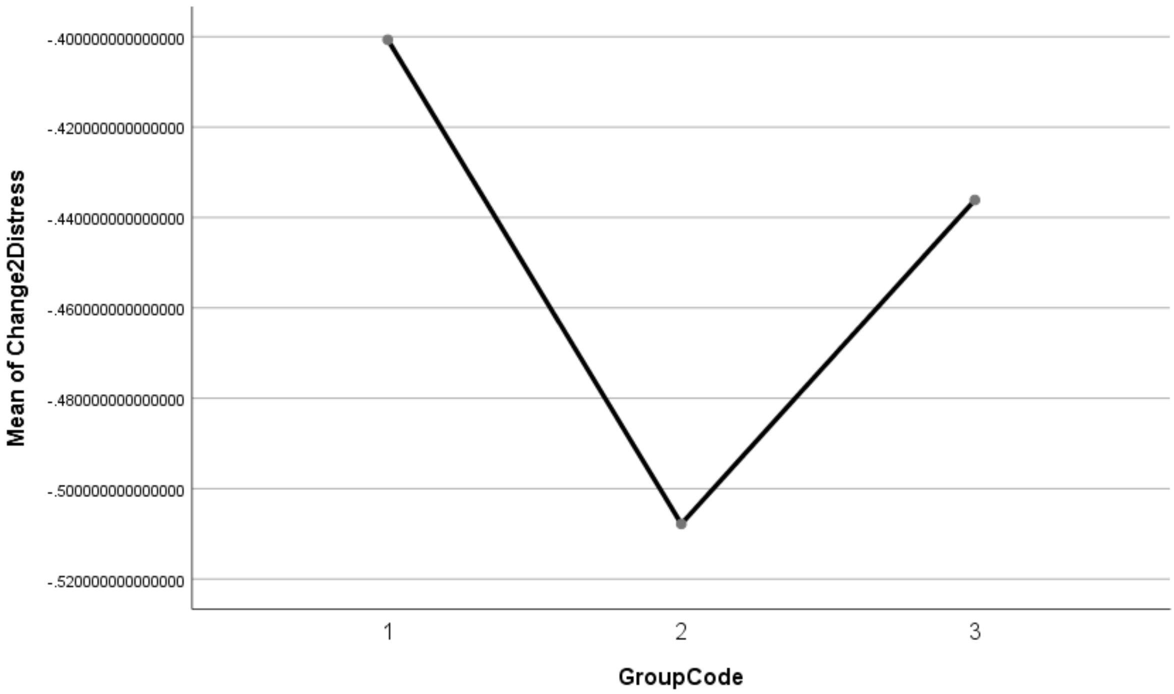
-.400000000000000
-.500000000000000
-.600000000000000
-.700000000000000
-.800000000000000
-.900000000000000
-1.000000000000000
Mean of Change1Worry
1
2
3
GroupCode



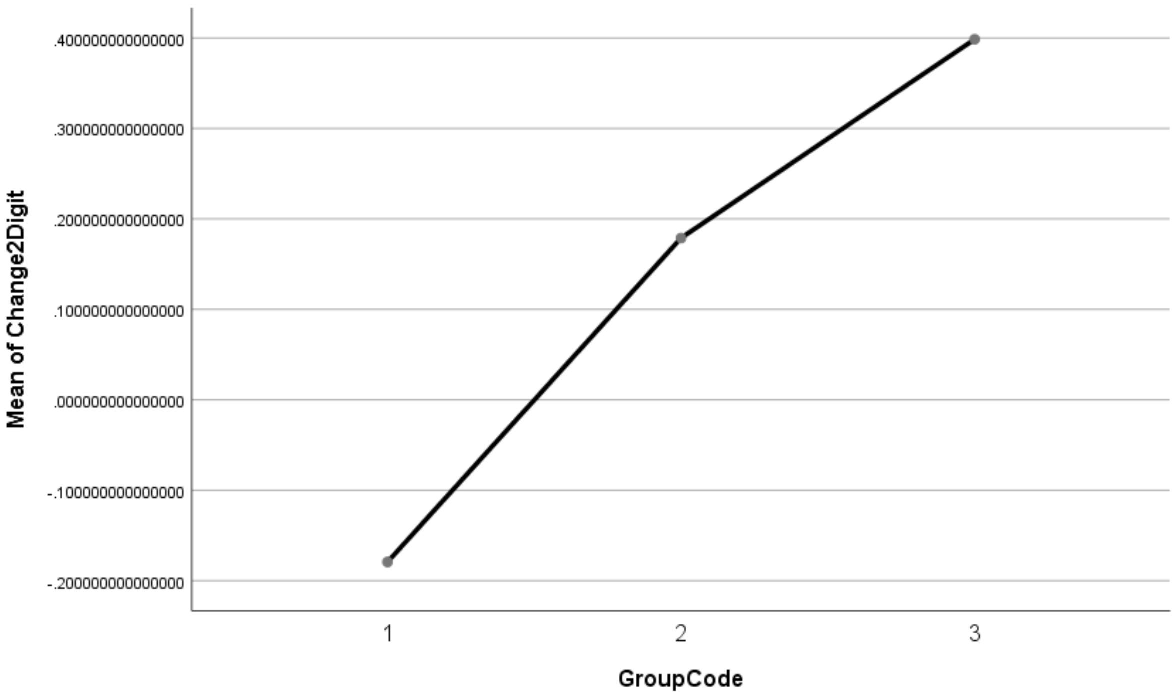
.300000000000000
.280000000000000
.260000000000000
.240000000000000
.220000000000000
.200000000000000
Mean of Change1Digit
1
2
3
GroupCode


.100000000000000
.050000000000000
.000000000000000
-.050000000000000
-.100000000000000
Mean of ChangePost2
1
2
3
GroupCode

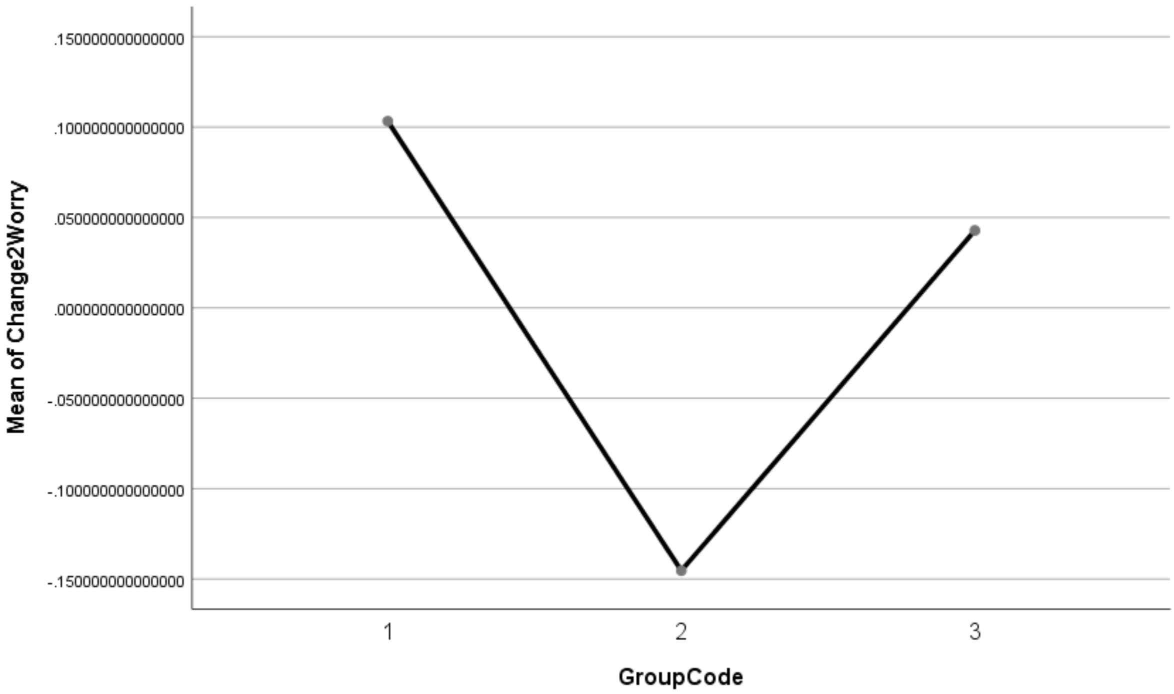

-.075000000000000
-.100000000000000
-.125000000000000
-.150000000000000
-.175000000000000
-.200000000000000
Mean of ChangeNeg2
1
2
3
GroupCode



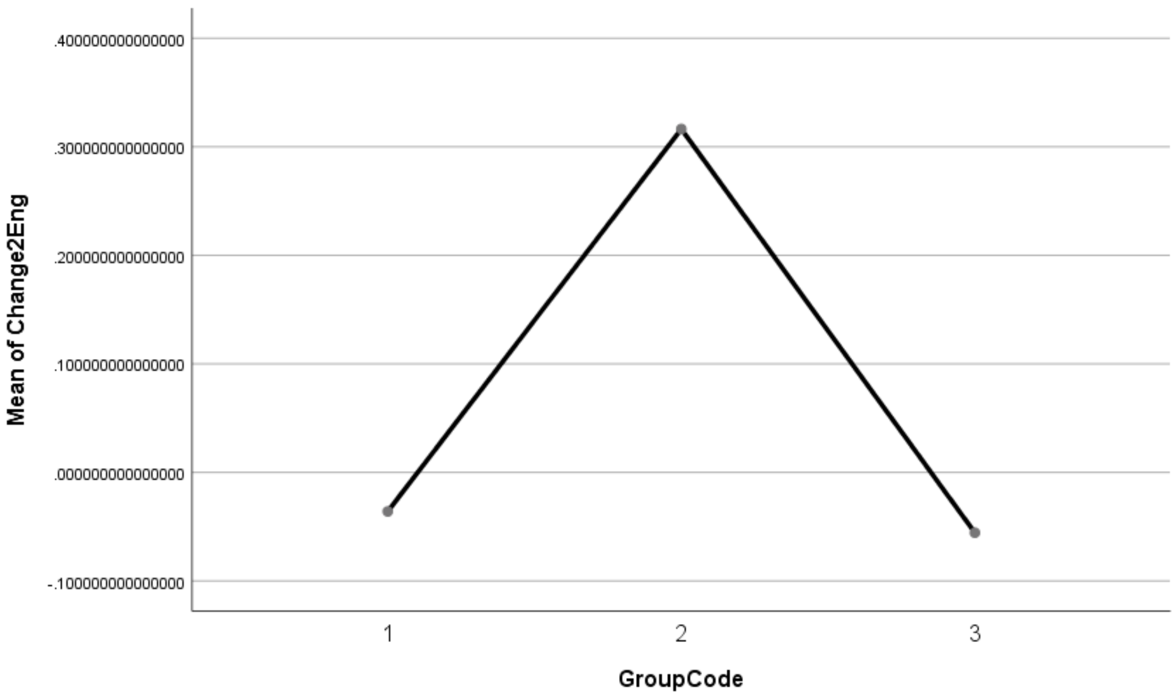
-.400000000000000
-.420000000000000
-.440000000000000
-.460000000000000
-.480000000000000
-.500000000000000
-.520000000000000
Mean of Change2Distress
1
2
3
GroupCode



.400000000000000
.300000000000000
.200000000000000
.100000000000000
.000000000000000
-.100000000000000
-.200000000000000
Mean of Change2Digit
1
2
3
GroupCode

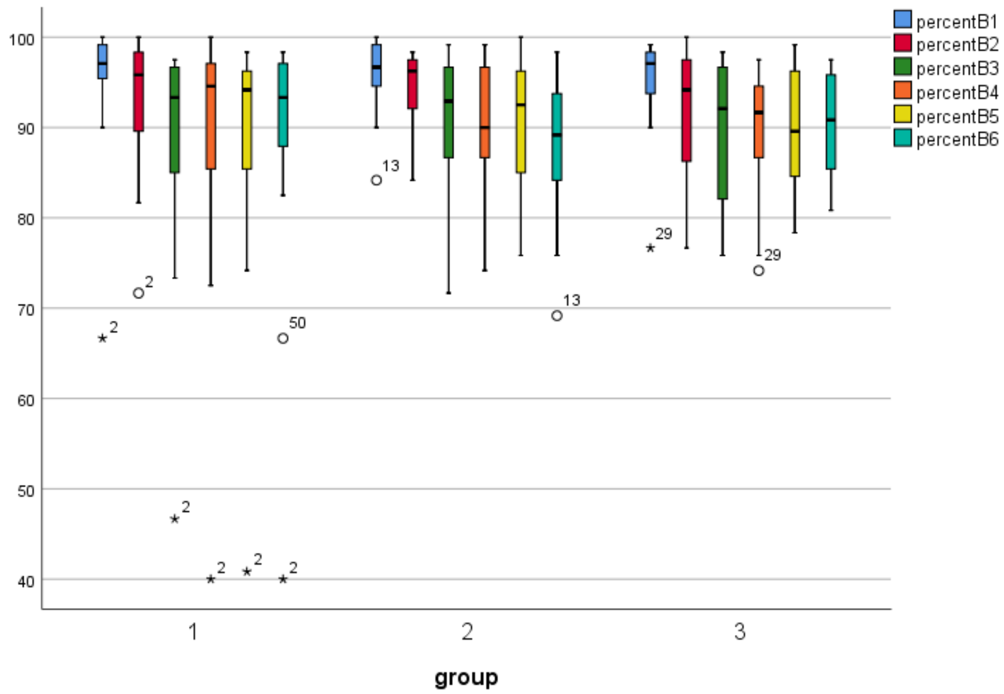


.150000000000000
.100000000000000
.050000000000000
.000000000000000
-.050000000000000
-.100000000000000
-.150000000000000
Mean of Change2Worry
1
2
3
GroupCode

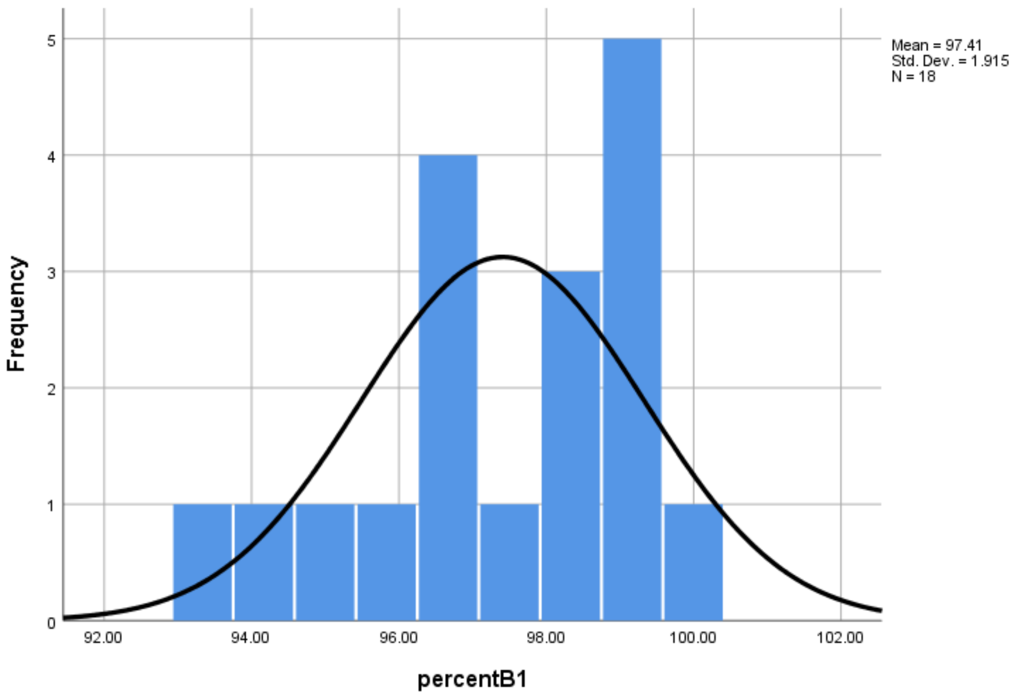


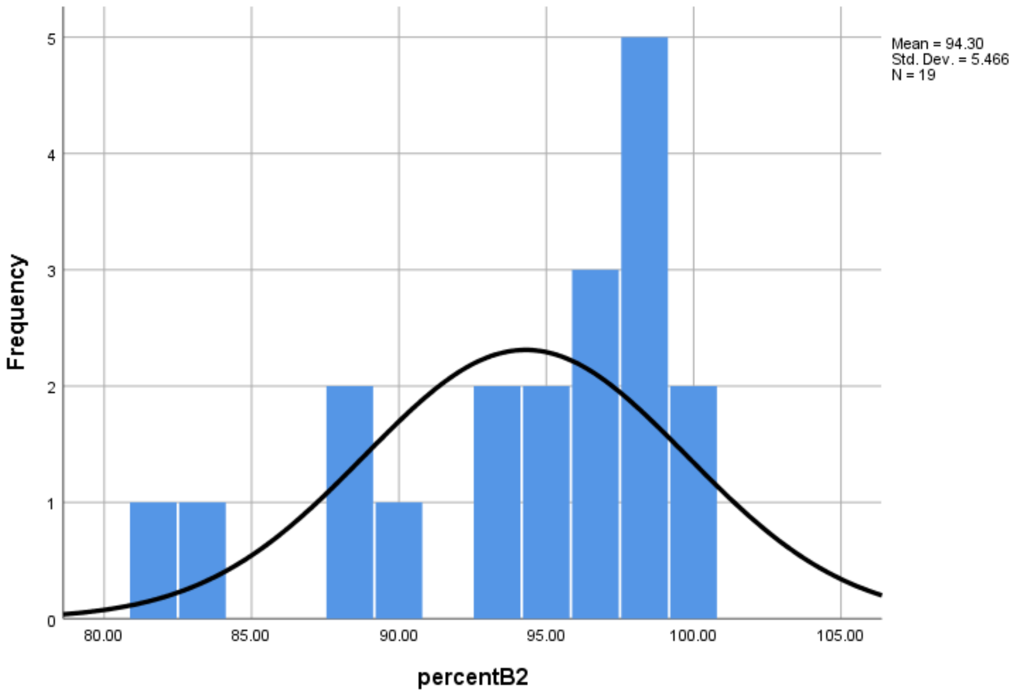
.400000000000000
.300000000000000
.200000000000000
.100000000000000
.000000000000000
-.100000000000000
Mean of Change2Eng
1
2
3
GroupCode

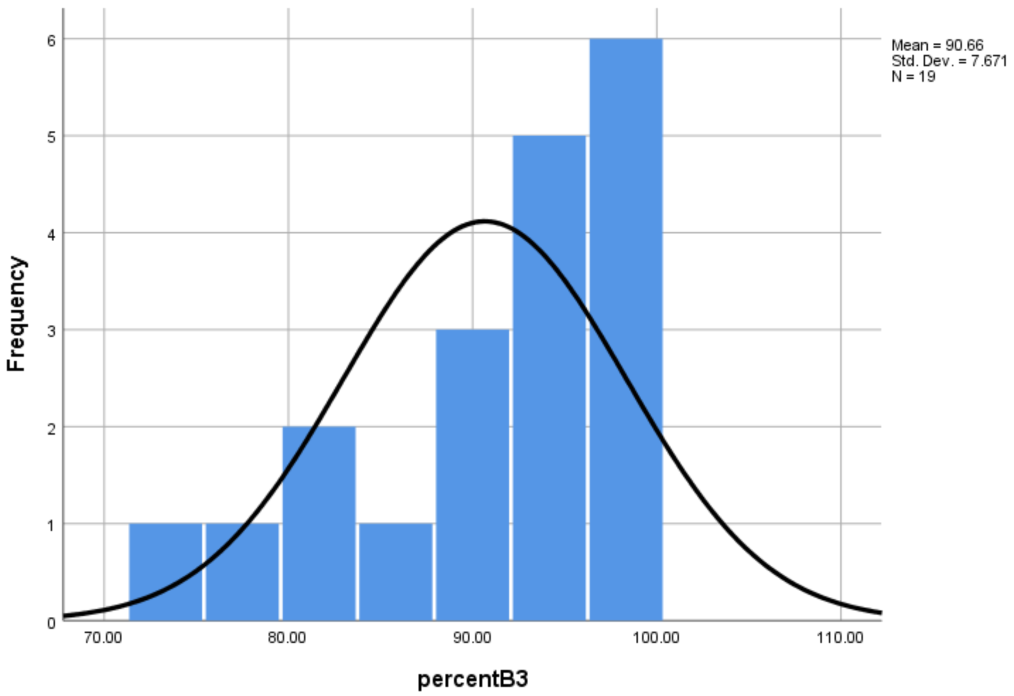
Appendix G : Mixed ANOVA figures

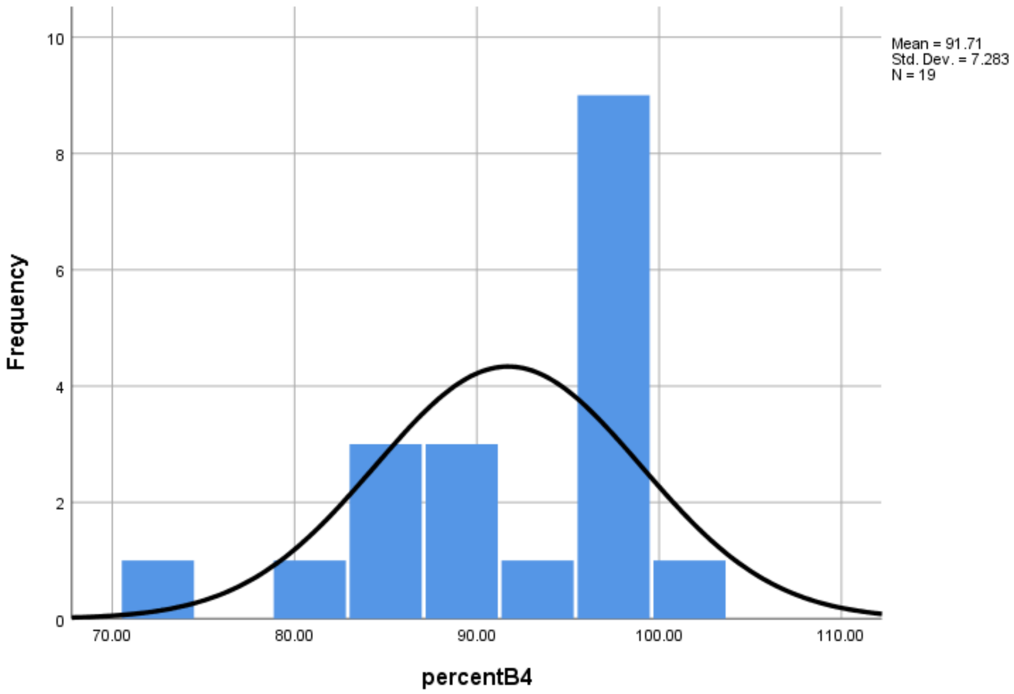


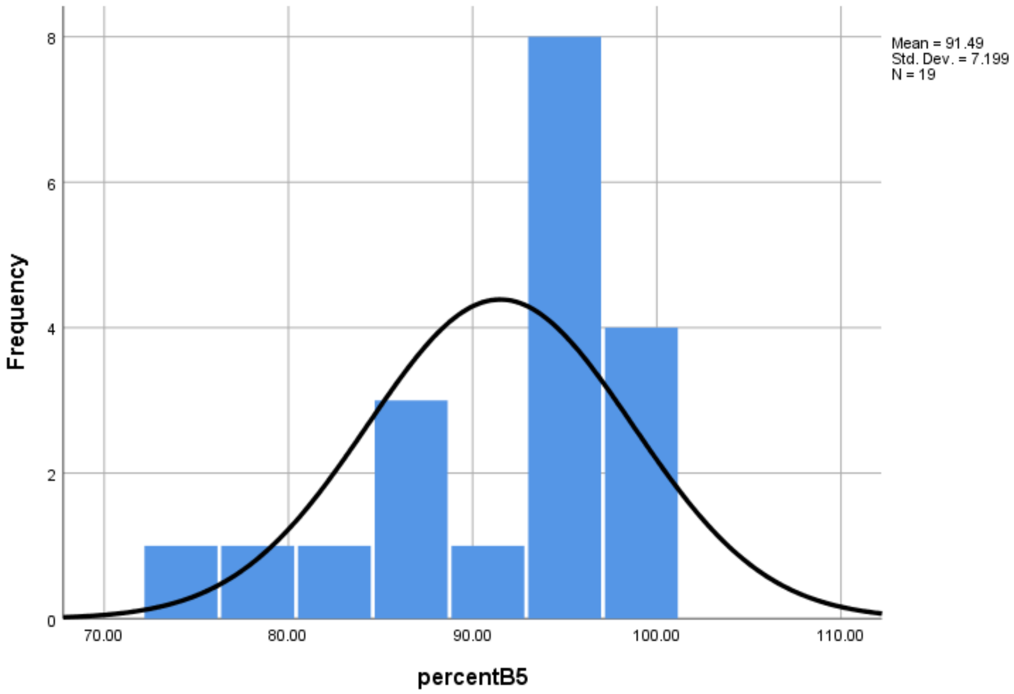
Histograms: Control Group

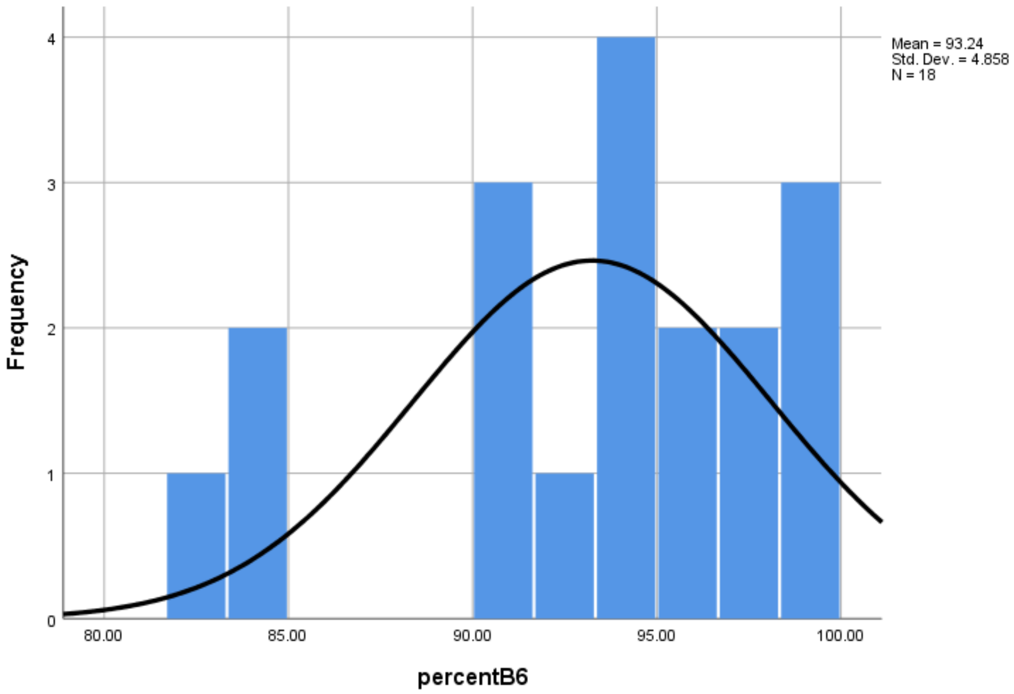



Mean = 94.30
Std. Dev. = 5.466
N = 19
Frequency
percentB2
0
1
2
3
4
5
80.00
85.00
90.00
95.00
100.00
105.00

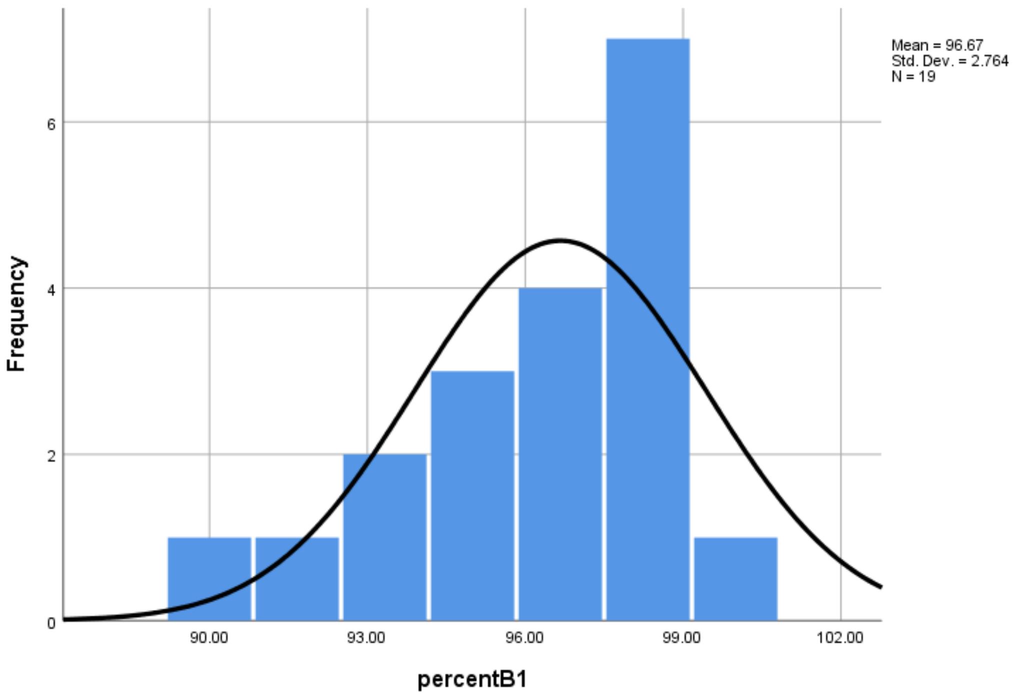

Mean = 90.66
Std. Dev. = 7.671
N = 19
Frequency
percentB3
0
1
2
3
4
5
6
70.00
80.00
90.00
100.00
110.00

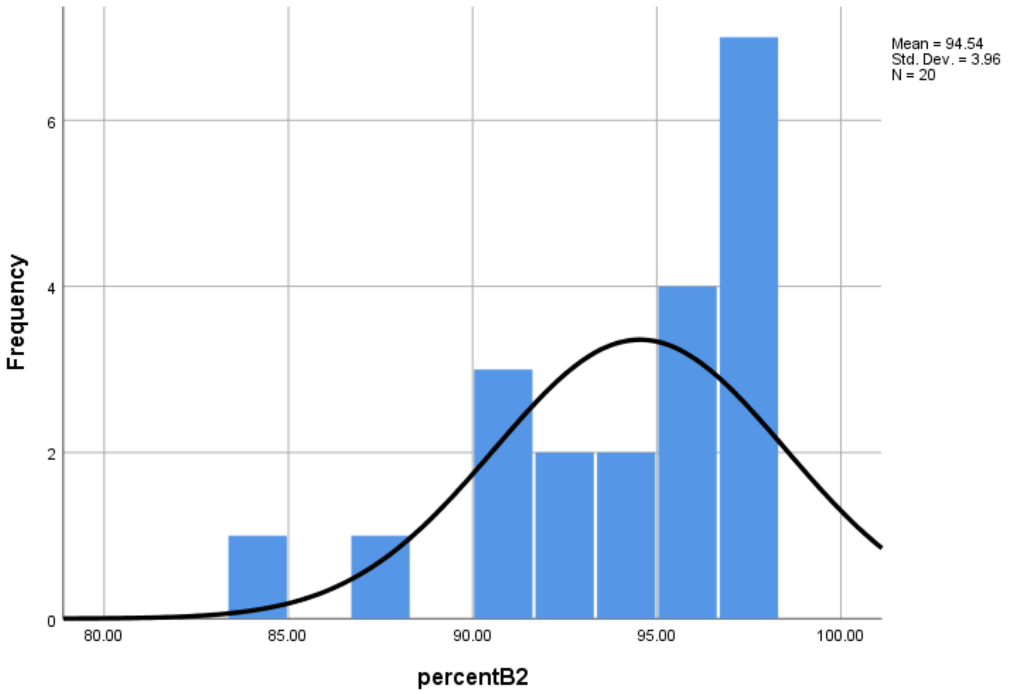

Mean = 91.71
Std. Dev. = 7.283
N = 19
Frequency
10
8
6
4
2
0
70.00
80.00
90.00
100.00
110.00
percentB4

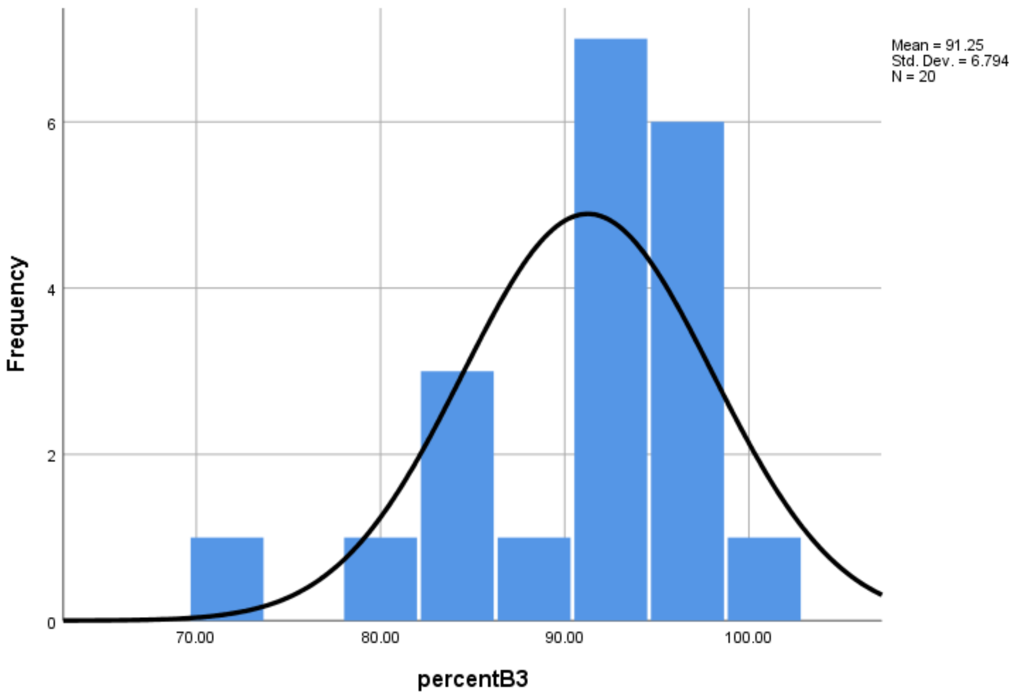

Mean = 91.49
Std. Dev. = 7.199
N = 19
Frequency
8
6
4
2
0
70.00
80.00
90.00
100.00
110.00
percentB5

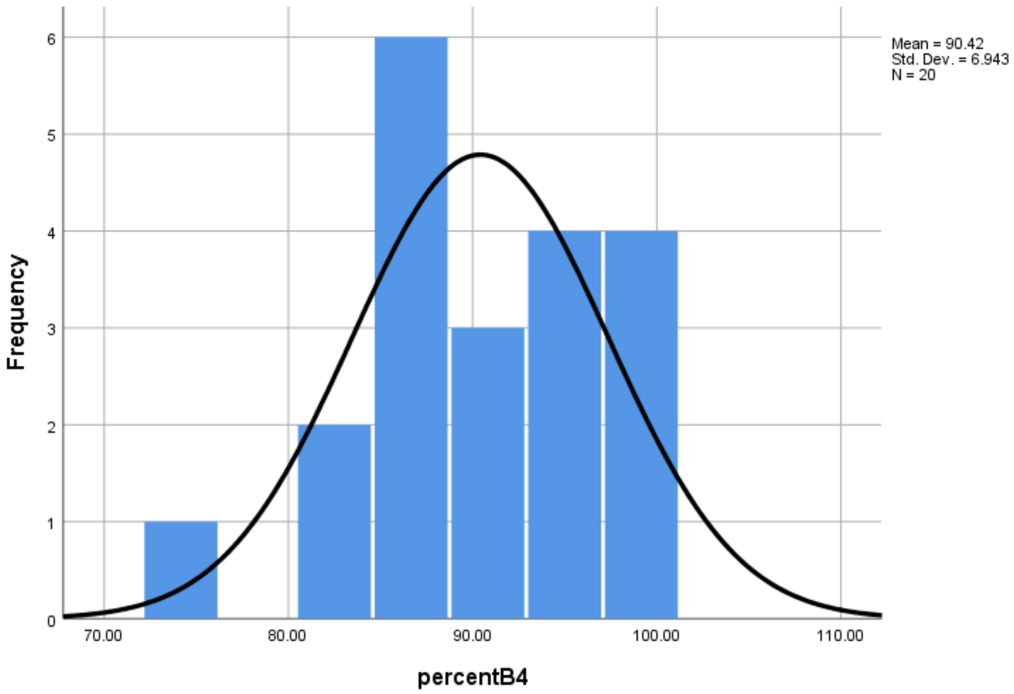


Histograms group 2

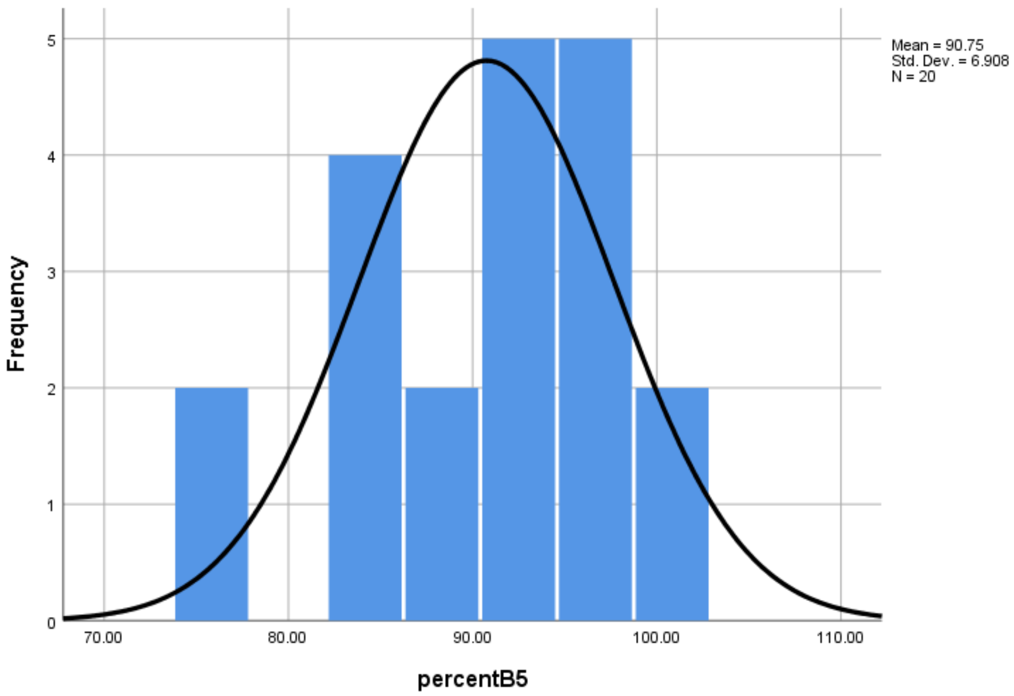



Mean = 94.54
Std. Dev. = 3.96
N = 20
Frequency
0
2
4
6
80.00
85.00
90.00
95.00
100.00
percentB2

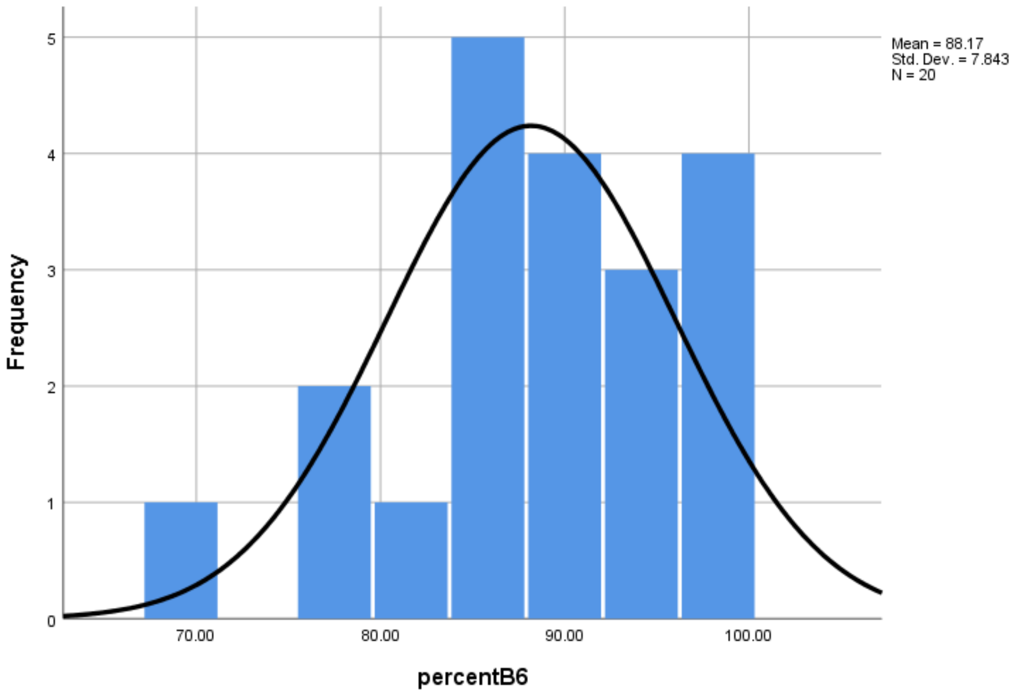

Mean = 91.25
Std. Dev. = 6.794
N = 20
Frequency
0
2
4
6
70.00
80.00
90.00
100.00
percentB3



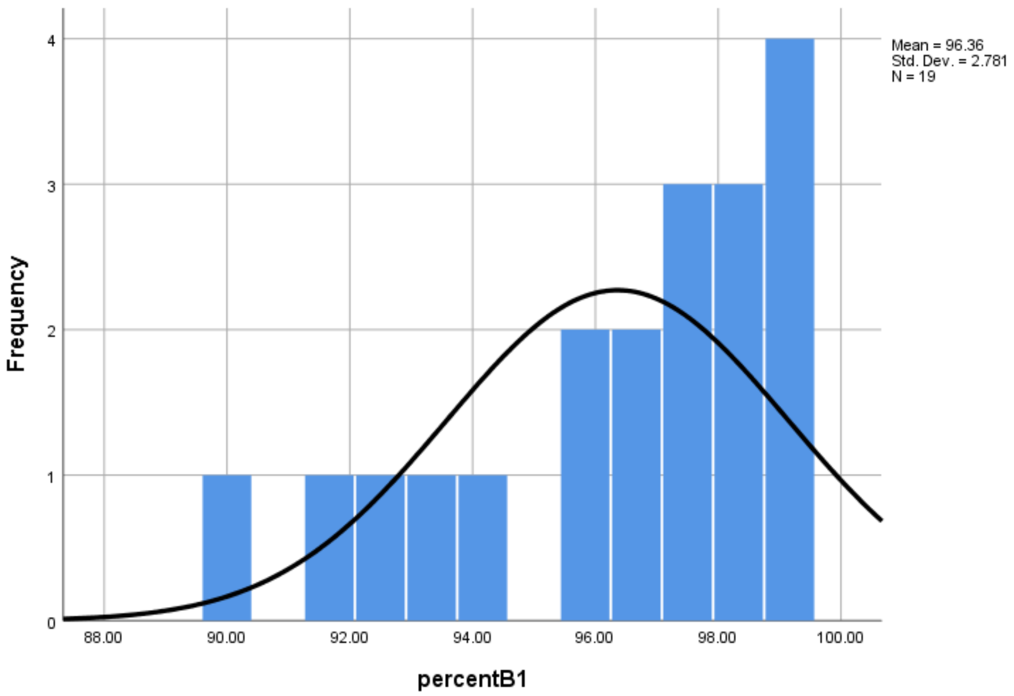
Mean = 90.42
Std. Dev. = 6.943
N = 20
Frequency
percentB4

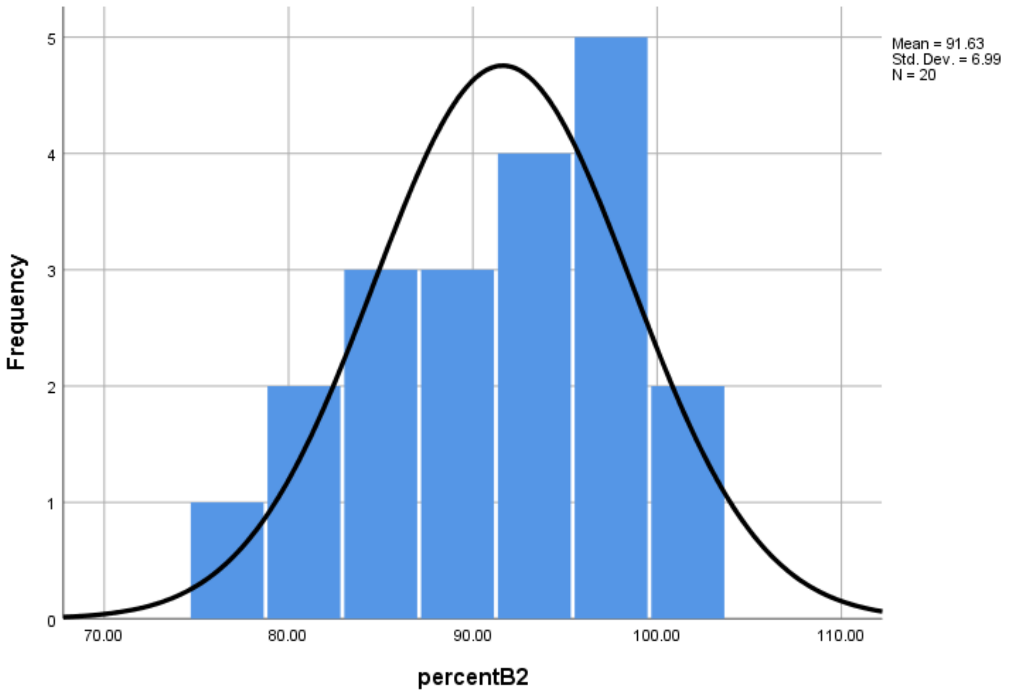


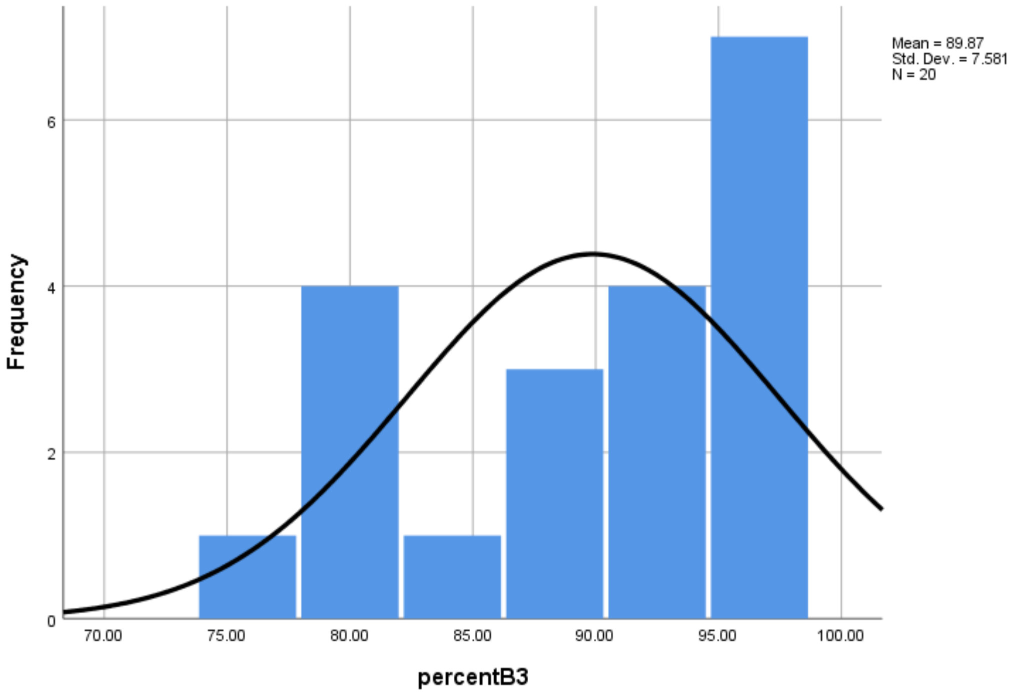
Mean = 90.75
Std. Dev. = 6.908
N = 20
Frequency
percentB5

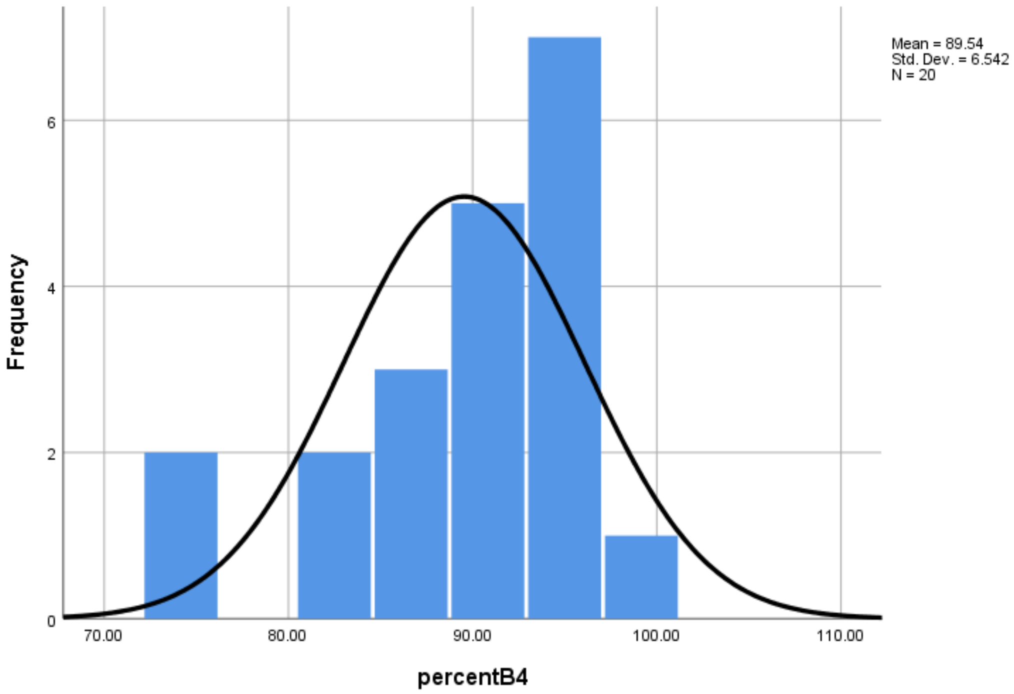


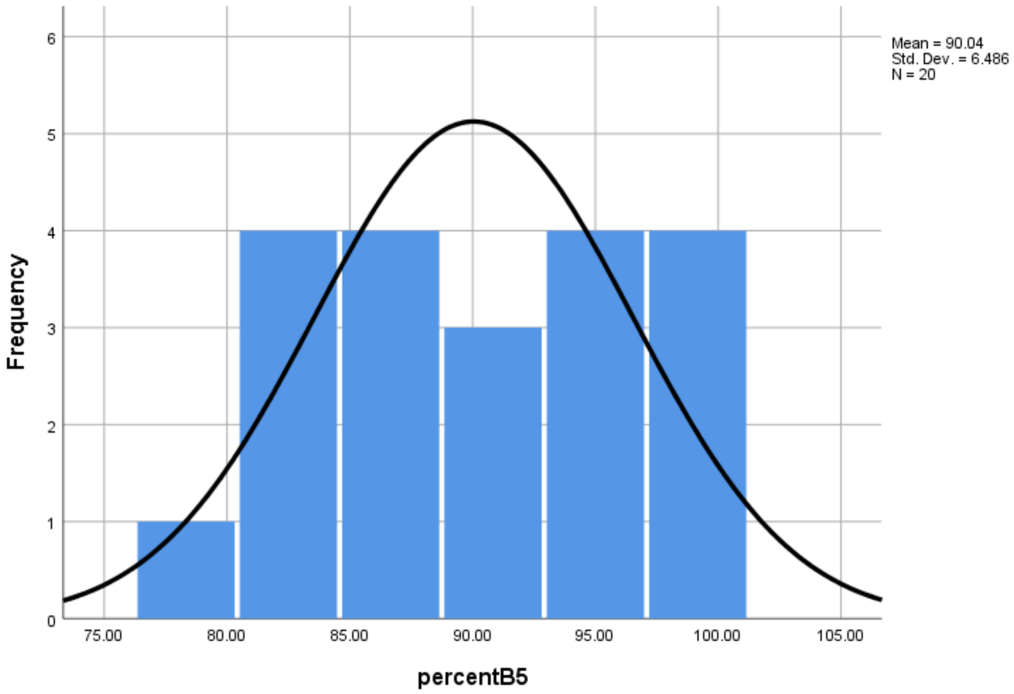
Histograms group three

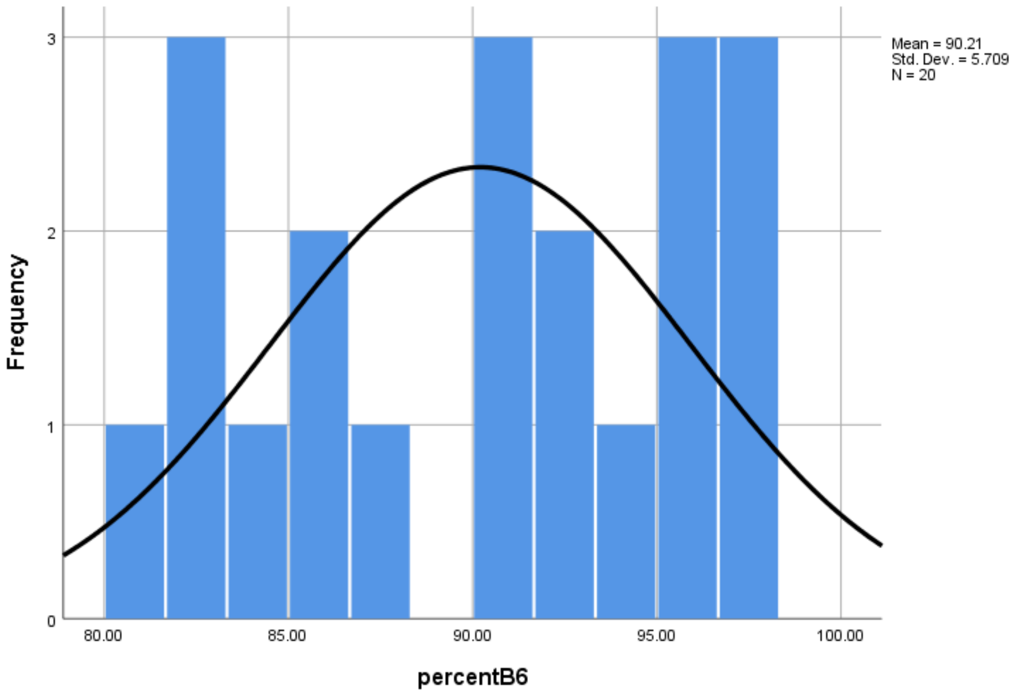



Mean = 91.63
Std. Dev. = 6.99
N = 20
Frequency
0
1
2
3
4
5
70.00
80.00
90.00
100.00
110.00
percentB2


Mean = 89.87
Std. Dev. = 7.581
N = 20
Frequency
0
2
4
6
70.00
75.00
80.00
85.00
90.00
95.00
100.00
percentB3


Mean = 89.54
Std. Dev. = 6.542
N = 20
Frequency
percentB4
0
2
4
6
70.00
80.00
90.00
100.00
110.00


Mean = 90.04
Std. Dev. = 6.486
N = 20
Frequency
percentB5
0
1
2
3
4
5
6
75.00
80.00
85.00
90.00
95.00
100.00
105.00


Mean = 90.21
Std. Dev. = 5.709
N = 20
Frequency
3
2
1
0
80.00
85.00
90.00
95.00
100.00
percentB6

Appendix H: Frequencies for Reaction To Task Setting.

NOTE: group numbers refer to:

1) control=1
2) Guided relaxation= 2
3) In-door plants= 3

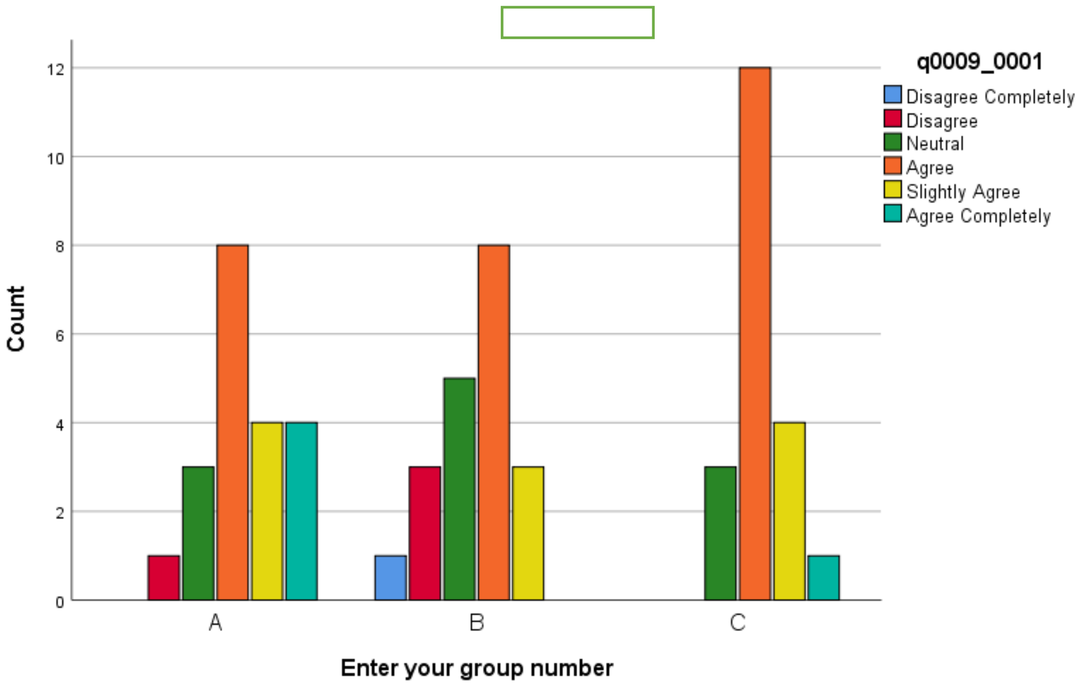


Figure 8 This is a pleasant room in which to work

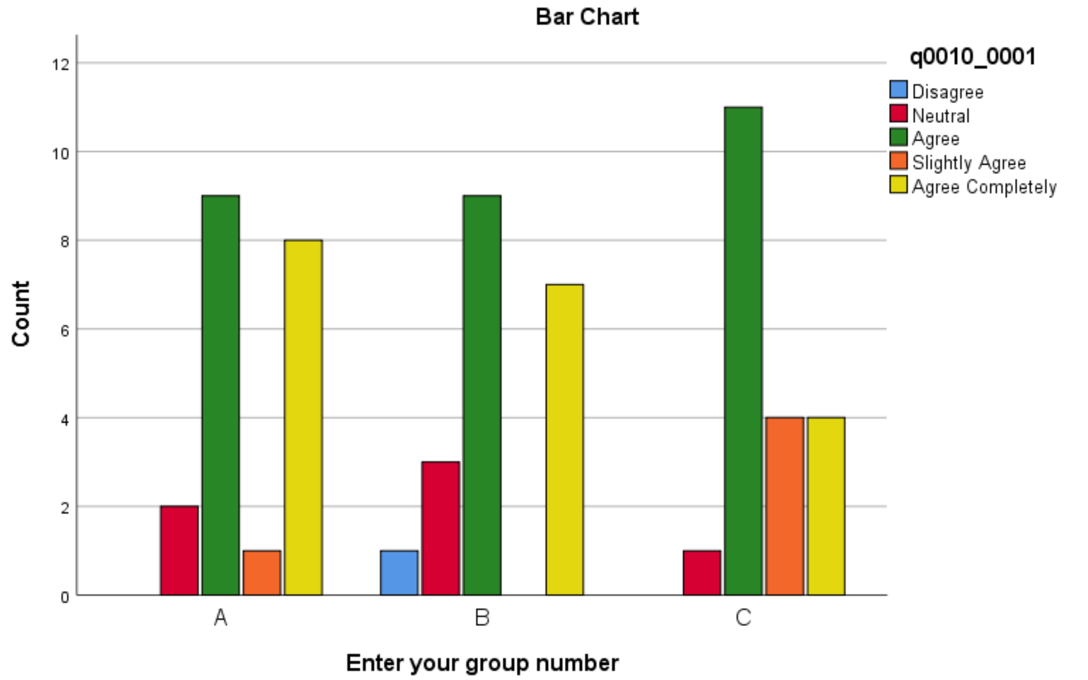


Figure 9 I feel comfortable in the room

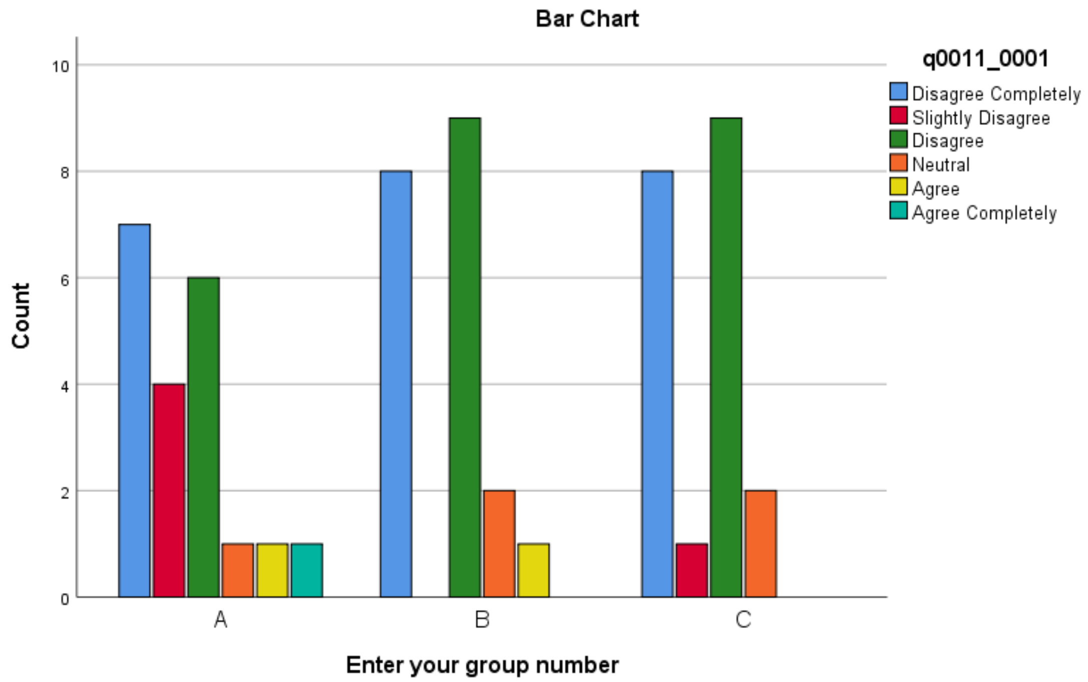


Figure 10 I feel uncomfortable in the room

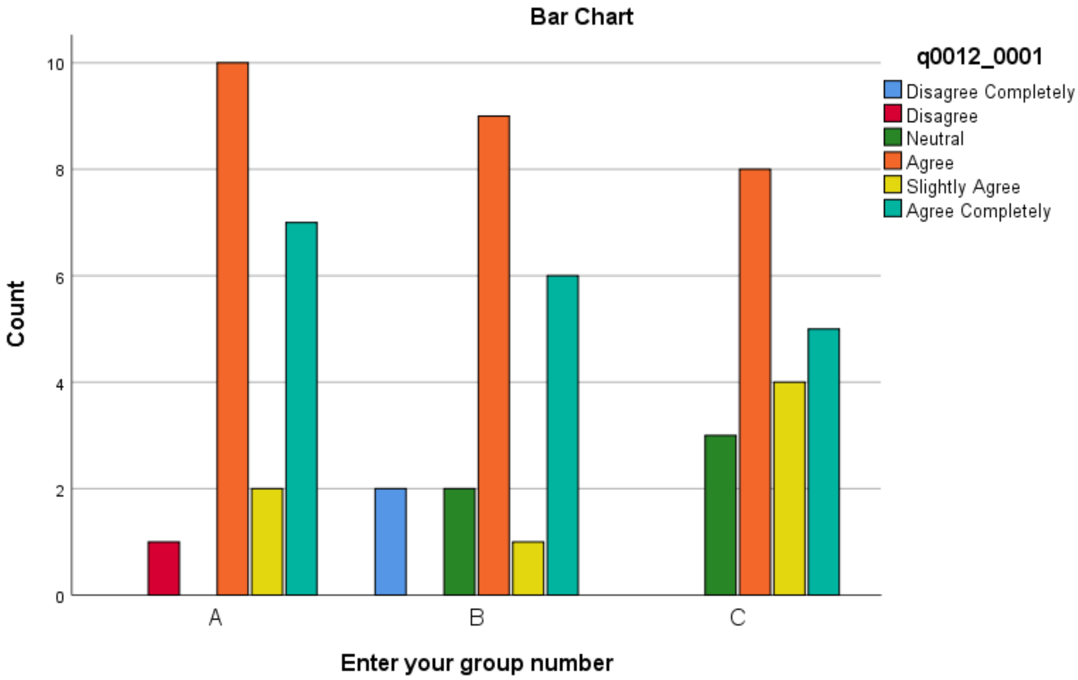


Figure 11 I am able to concentrate in the room

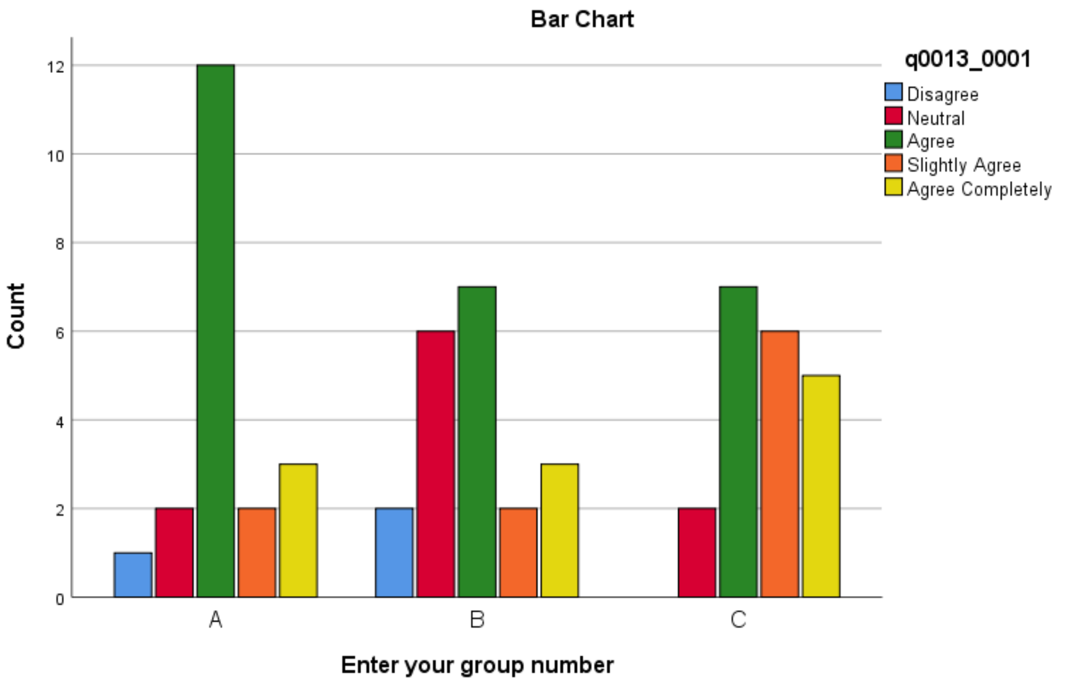


Figure 12 the room has a good atmosphere in which to work

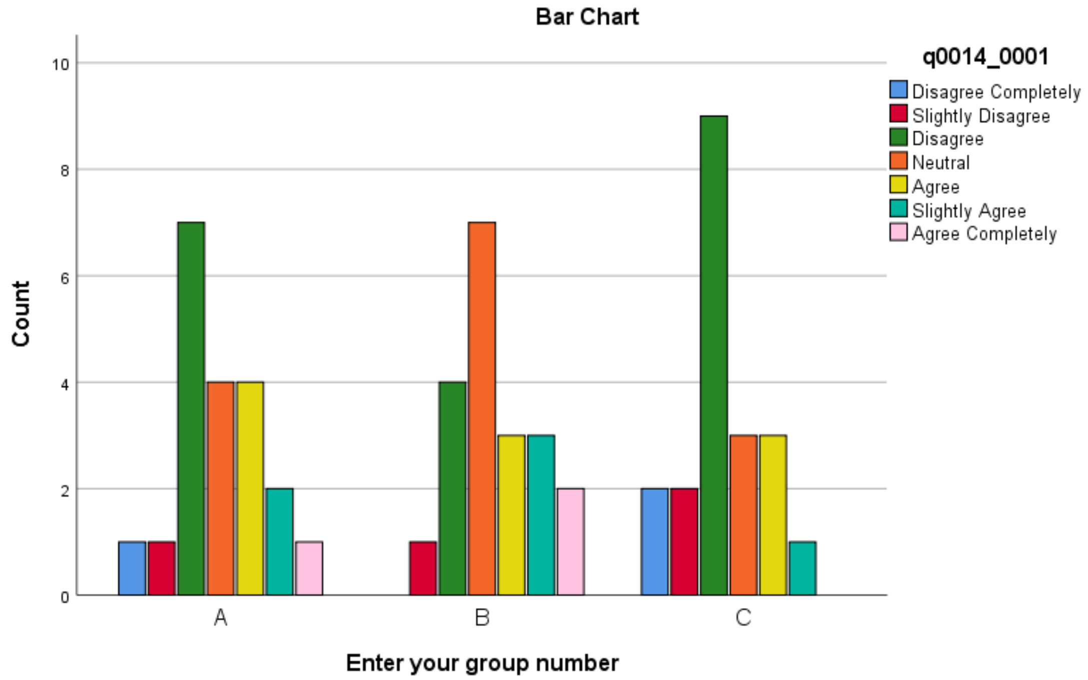


Figure 13 The air in the room is stuffy

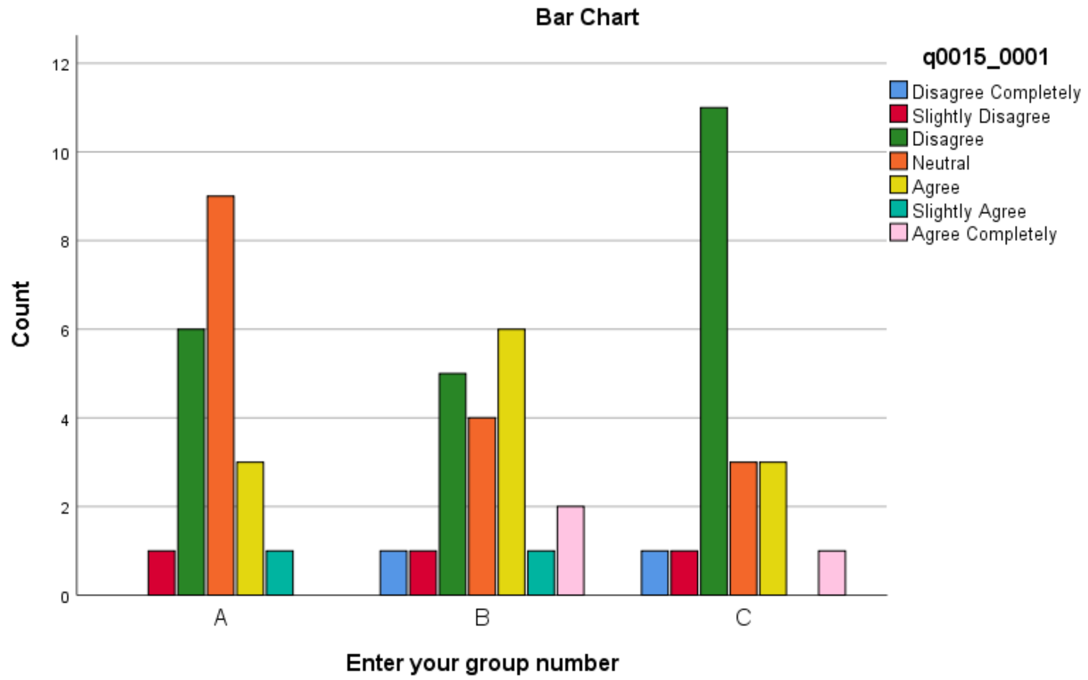


Figure 14 The air in the room is stale

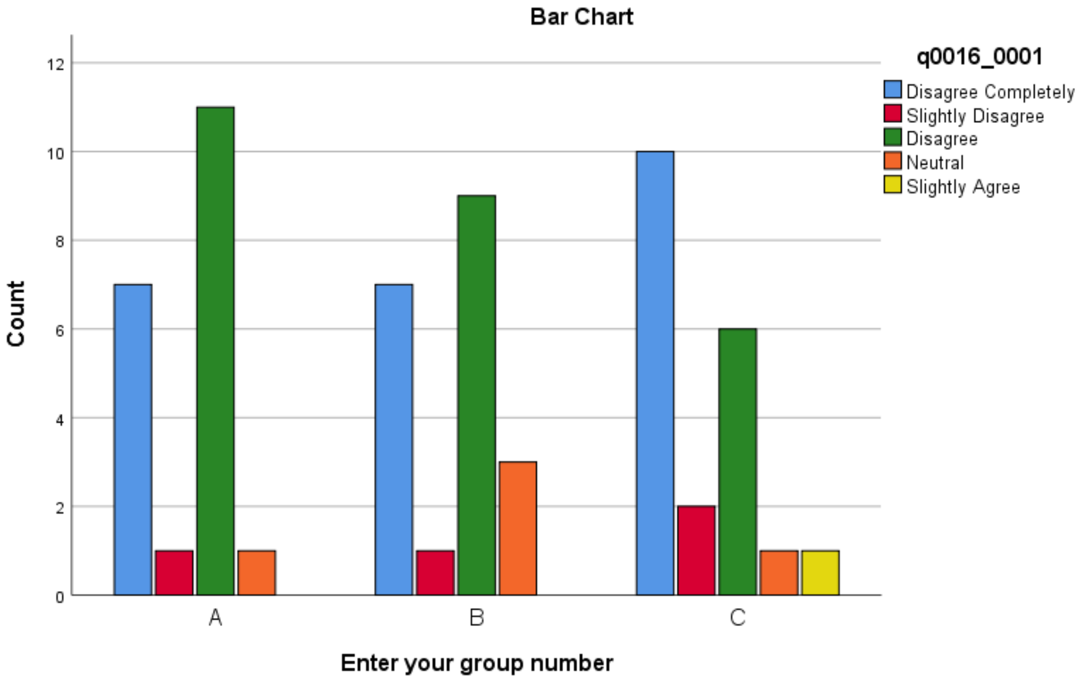


Figure 15 The room is too cold The

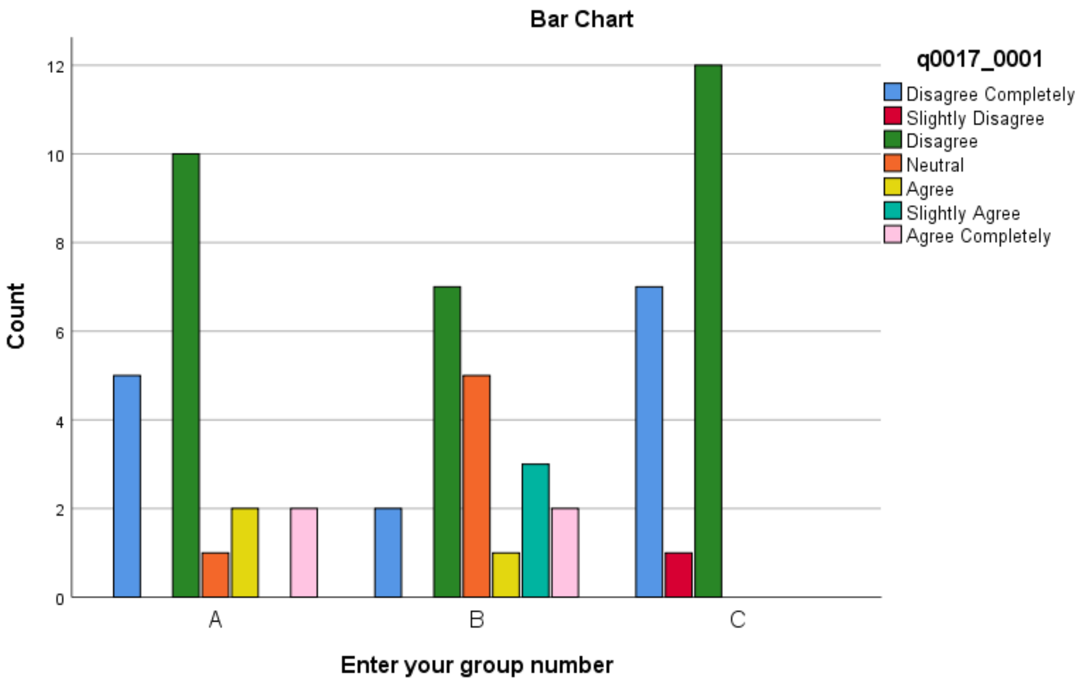


Figure 16 room is too hot

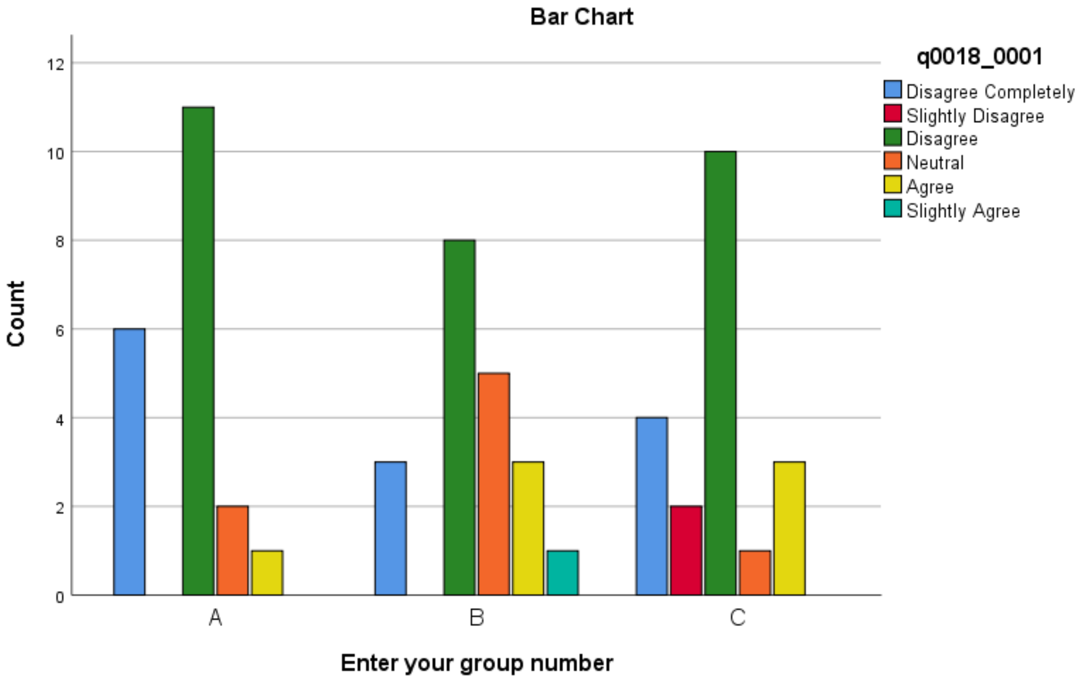


Figure 17

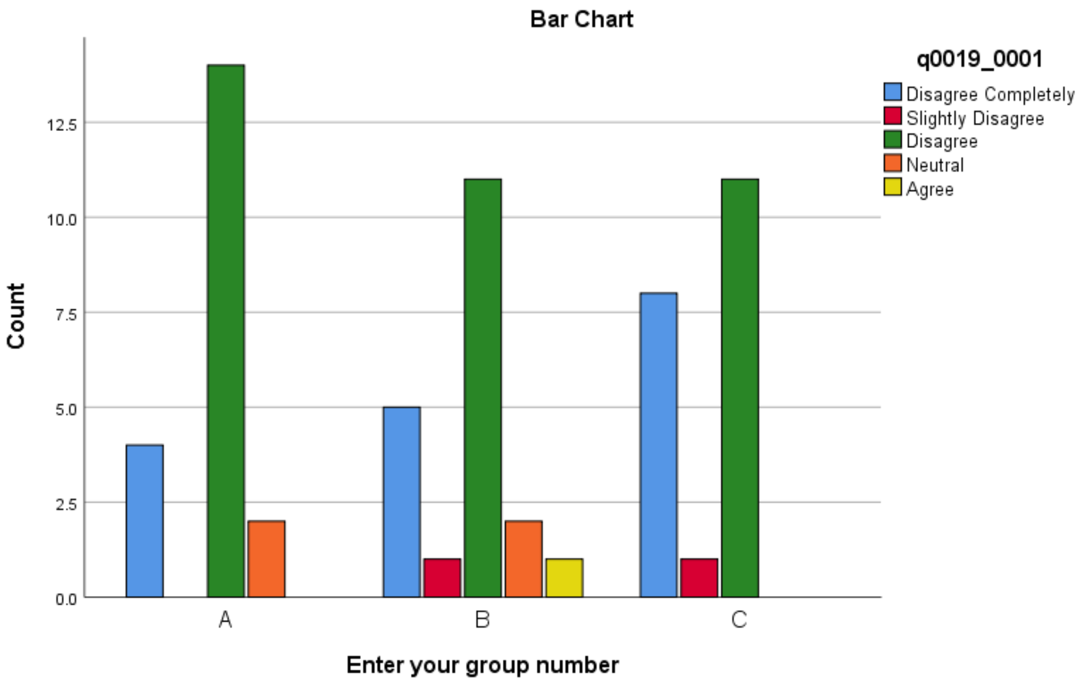


Figure 18 The lights are too dim