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Impact of indoor plants on work engagement and well-being perceptions

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Declaration

I declare that this research project is my own, unaided work. It has not been submitted before for any other degree or examination at this or another university.

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Abstract

Much evidence exists with regard to indoor plants and their positive effect on psychological perceptions as well as environmental air quality. However, this type of research has only ever been conducted once in a South African setting, which can be argued, is different to international contexts, in terms of climate and financial status. Indoor plants and their positive effects may have monumental effects on employees. This research assessed the presence of plants, on a sample of 34 employees at Discovery VitalityLife, consisting of Human Resources workers and call centre agents, on psychological perceptions (work engagement; psychological well-being; physical well-being and aesthetics) and on environmental factors (Total Volatile Organic Compounds; Benzene; Xylene; Carbon Dioxide (CO_2); temperature and relative humidity). This research was conducted over a period of approximately three months whereby at Time 1 plants were absent and Time 2 plants were present. The same questionnaires were administered at both times. So too were Volatile Organic Compounds measured weekly and three measurement devices were installed in the workplace taking measurements of CO_2, humidity, and indoor temperature every hour. The results found were that there were no statistically significant differences for the psychological perceptions from Time 1 to Time 2. This was concluded to be a result of the context in which this research took place. Total Volatile Organic Compounds, Benzene and relative humidity levels statistically significantly decreased at Time 2. Xylene levels statistically significantly increased at Time 2. There was no evidence to suggest statistically significant differences for CO_2 and temperature from Time 1 to Time 2.

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CHAPTER 1: LITERATURE REVIEW

The purpose of this chapter was to discuss the theoretical foundations underlying the positive effects of plants on people. This chapter encompasses relevant literature and related studies to add to the evidence and to show the necessity for this study. The topics discussed and looked at in the literature review are the rationale and context of the study; the theoretical framework which is the Attention Restoration Theory; the psychological perceptions of indoor plants which include work engagement, psychological well-being, physical well-being and aesthetics; an introduction to the workspace used in the study and the companies involved (Discovery VitalityLife, Bidvest Execuflora and SE Controls); the types of plants utilised; indoor air quality which includes looking at Total Volatile Organic Compounds, Benzene, Xylene, Carbon Dioxide, temperature and relative humidly levels in the air. This chapter ends with the 10 research questions that are pertinent to the study and points to what the study intends to achieve.

1. Introduction

Much evidence exists for the use of indoor plants and plants for ornamental purposes, from thousands of years ago. There exists written evidence that in the 3rd century BC, Egyptians brought plants indoors. So too, does evidence in the ruins of Pompeii reveal the use of indoor plants, more than 2000 years ago (Manaker, 1996). It was discovered that between 13 700 and 11 700 years ago, the Nastufian people, in Israel, lined the graves of their loved ones with mud and flowering plants (Nadel et al., 2013).

In 2010, David Cameron, the Prime Minister of the United Kingdom, publicly criticised the spending of money on plants in government offices. Cameron believed that spending money on indoor plants was a complete waste of money (Nieuwenhuis, Knight, Postmes & Haslam, 2014). However contrary to this belief there are numerous studies that are indicating that indoor plants have numerous positive effects in offices (see for example Bringslimark, Hartig & Patil, 2009; Dijkstra, Pieterse & Pruyn, 2008; Dravigne, Waliczek, Lineberger & Zajicek, 2008; Evensen, Raanaas & Patil, 2013; Fjeld, 2000; Gou & Lau, 2012; Knight & Haslam, 2010; Nieuwenhuis et al., 2014; Raanaas, Evensen, Rich, Sjøstrøm & Patil, 2011; Ulrich, 1981). These positive effects are both psychological and physical and imply that indoor plants may in fact be an easy and relatively cheaper intervention to install in organisations than for example making an entire building ‘green’ or establishing a stress intervention for

employees (Claudio, 2011; Dela Cruz, Christensen, Thomsen & Muller, 2014; Tarran, Torpy & Burchett, 2007).

1.2 Rationale & Context

There are numerous reasons why this research is important. Stress and burnout cost organisations millions every year. South Africans experience unusually high levels of stress as compared to overseas countries (Van Zyl, 2002). A genuine fear of retrenchment has emerged from the poor economic climate in South Africa and even worldwide. According to Eriksson (2012) as much as R3 billion a year is being lost to workplace stress in South Africa. Indoor plants may be able to contribute towards addressing these problems and not cost companies a fortune such as with an expensive intervention. The Biophilia Hypothesis posits that humans have an inherent disposition to connect with nature and that being surrounded by natural elements has a calming effect upon people. It also suggests that an environment empty of natural elements leads to negative consequences (Grinde & Patil, 2009; Wilson, 1984) and thus, indoor plants may lead to a decrease in stress levels. Another important aspect to consider in the work environment is that of job satisfaction and its consequences.

Employees who have low job satisfaction have a myriad of negative consequences. Job dissatisfaction ultimately leads to higher levels of stress at work and will impact the quality of work that employees submit and ultimately may lead to high turnover. Turnover then costs companies to recruit and train new employees (Robbins, Judge, Odendaal & Roodt, 2009). This has been estimated to cost South African companies millions every year. In 2006 alone average staff turnover in South Africa was 12.3% and the numbers are only increasing per annum (Robbins et al., 2009). Not only are psychological perceptions an important aspect to consider but so too are physical factors important to look at, due to their potentially negative consequences on well-being and effectiveness.

Sick Building Syndrome (SBS) is a reality within organisations and can have dire consequences. SBS is a phenomenon that occurs in people working in buildings who experience symptoms that are linked to the building but have no other specific cause (USEPA, 2009). This is usually caused by factors such as poor ventilation, contaminants in the air and high temperatures (Miller & Pogue, 2009; USEPA, 2009). A study conducted by Chang, Yang, Wang and Li (2015) in Taiwan, found that about 84% of the participants

suffered from at least one SBS-related symptom. This has obvious implications for employee absenteeism. According to Occupational Care South Africa and Statistics South Africa (as cited in Skosana, 2014) the South African economy loses between R12 to R16 billion a year as a result of absenteeism. This, in turn, has implications for an organisation's productivity levels and may hinder a person's ability to perform optimally if they are feeling ill at work. As a result of plants being able to clean the air and remove toxic compounds from the air that cause adverse effects on peoples' health, indoor plants may lead to a decrease in SBS that may be caused by the poor air quality of the workspace.

Richard Andrews (2016) conducted a study involving 12 000 South African employees who were asked what was the most important aspect for them in the workplace. Interestingly, 71% of the respondents cited greenery and 87% cited a healthy environment as the most important factor, both of which are very pertinent to this study. This suggests that the research topic is important in a South African workplace setting.

Numerous studies have been conducted with regard to indoor plants internationally including Norway (Bringslimark, Hartig & Patil, 2007; Bringslimark et al., 2009; Evensen et al., 2013; Fjeld, 2000; Raanaas et al., 2011), the United Kingdom (Knight & Haslam, 2010), the United States (Dravigne et al., 2008; Largo-Wight, Chen, Dodd & Weiler, 2011; Lohr, Pearson-Mims & Goodwin, 1996; Ulrich, 1981; Ulrich, 1984), the Netherlands (Dijkstra et al., 2008; Nieuwenhuis et al., 2014), and China (Gou & Lau, 2012) but there has only ever been one other known piece of research in a South African context.

This research was conducted by a Masters student doing a Master's degree in Organisational Psychology at the University of the Witwatersrand (Kalantzis, 2016) and the results were not entirely in favour of indoor plants in the workplace. This research looked at the effects of indoor plants on physical well-being, psychological well-being, perceptions of the physical environment, and work engagement (Kalantzis, 2016). The only variable that showed a statistically significant difference after the introduction of indoor plants was the decrease in work engagement (Kalantzis, 2016). This is despite the results indicating that CO_2 levels decreased by 21%, humidity levels decreased by 8% to settle within the acceptable range of 30% to 60%, and ambient temperature decreased by 3%. It was posited that the results were a consequence of the specific work environment under study (Kalantzis, 2016) – a call centre. This study intends to build on previous research, in a slightly different organisational context in South Africa to assess whether indoor plants can make a difference to employees'

psychological perceptions. South Africa is unique to other countries. Two examples of how it differs are its climate and economic status. South Africa has been described as semi-arid with sunny days and cool nights as compared to Northern USA which has been described as mostly temperate with low winter temperatures and the United Kingdom which has been described as temperate, windy and mostly over-cast (PG Tops, 2016). When looking specifically at Johannesburg, it has been described as having a subtropical highland climate, with a fairly sunny climate, and moderate temperatures (South African Weather Service, 2016).

The Gini coefficient is a measure of inequality in terms of income. It ranges from 0 (perfectly equal society) to 1 (perfectly unequal society) (Bhorat, 2015). In 2015, South Africa's Gini coefficient was 0.77, which indicates a high level of inequality, as compared to the USA, with a Gini coefficient of 0.40 (Sherman, 2015; Vavi, 2016). South Africa has reached the highest level of unemployment since 2004, with 27.1% of the population unemployed in 2016 (Statistics South Africa) as compared to the USA's 5.3% unemployment rate (Statista, 2016). This suggests different levels of economic stressors that would affect employees in South Africa.

1.3 Theoretical Framework

1.3.1 Attention Restoration Theory

One way of explaining the positive effects of plants on cognitive functioning such as work engagement and psychological well-being is that of the Attention Restoration Theory (ART) which posits that the natural environment is able to restore a person's directed attention. This is based on the attention model by James (1892, as cited in Raanaas et al., 2011). This theory is based upon the fact that focusing for prolonged periods on a task will result in fatigue. The ART posits that natural elements do not require extensive prolonged periods of attention and thus, will have a relaxing effect on brain functions and allow the fatigue from prolonged attention to be reversed. Thus, it is posited that after one has interacted with nature, one is better able to perform on tasks requiring high levels of attention and are better able to engage with their work thus, increasing work engagement (Kaplan, 1993; Nieuwenhuis et al., 2014).

This is in direct opposition to the Taylorist approach to office space; whereby there is a removal of everything from the workplace that does not directly involve the job. This idea is that a minimalist office space is intended to focus employees' attention solely on the work at

hand (Knight & Haslam, 2010; Tapping & Dunn, 2006); which is in contrast to the idea of the attention restoration concept of nature by the ART.

A field-based study (not in an office setting) that shows support for the ART was conducted by Hartig, Mang and Evans (1991) who compared people who holidayed in the outdoors with people who visited an urban destination and a control group who did not go on any sort of holiday. Three weeks after the holiday, the outdoors group showed the highest levels of overall happiness as opposed to the other two groups and demonstrated a statistically significant improvement in their proofreading performance (an activity requiring high levels of attention). This indicates that contact with nature improved peoples' ability to hold their directed attention. It is however important to note that plants in an outdoor setting may strongly differ from plants in an indoor setting (Bringslimark et al., 2009). It has been argued that plants in an indoor setting are not in a natural environment but are simply part of the built environment, which affects the experience of the environment. Thus, plants indoors are more ambiguous than an outdoor experience. This research focused on recreational activities whereby indoor plants usually involve people involved with their work, who may not even notice the plants (Bringslimark et al., 2009).

Another study providing empirical support for the ART was by Tennessen and Cimprich (1995) who found that plants were able to reduce mental fatigue and increase concentration levels. Their study included observing students performing different tasks in their dormitory rooms and recording the view from their windows. Students whose view was one of nature (grass, trees) were less mentally fatigued and more productive than those who had views of non-nature aspects (buildings, roads). This too was not conducted within a workplace setting and the sample was one of students, which can be quite homogenous and therefore, the results were not entirely generalisable to other samples (Bringslimark et al., 2009).

Ulrich (1984) conducted a study to illustrate the psychological restoration benefits of plants. This was conducted in a hospital setting; however the results support the ART. The research looked at recovery of patients after cholecystectomies (surgical removal of the gall bladder), in a hospital, in the USA, between 1972 and 1981. There were two rooms of almost identical dimensions and physical characteristics, both with the same nurses. The only difference was that one room had a view of a tree and the other of a brick wall. Patients were assigned rooms when they were vacant. The researcher then matched patients (both had different window views) based on specific criteria such as gender, age, past hospitalisation stays, surgical

complications and weight. The sample consisted of 23 pairs of patients. Seven pairs were able to be matched to specific doctors. The patients who had a view of the trees had shorter postoperative hospital stays; received less negative comments in the nurses' notes, and took fewer analgesics than their matched counterparts. This demonstrates that patients were more stimulated by the natural view and this was more therapeutic than the brick wall. These results were also found in a very similar study conducted in 2009 by Park and Mattson. It is important to note that the settings in which plants are used can be significant. Hospitals are places intended for restoration and healing whereas a workspace is not. Thus, plants in different settings may have different effects (Bringslimark et al., 2009).

Another lab-based study supporting ART was whereby 187 people were asked to choose the best setting in which to achieve specific goals (Herzog, Black, Fountaine & Knotts, 1997). The goals were broadly recovering attention from a dull attentionally-demanding task and secondly reflecting on personal problems. They were then presented with slides of settings divided into three themes: natural settings (e.g. field; forest), sports/entertainment settings (e.g. golf course; movie theatre), and urban settings (e.g. streets; petrol station). Natural settings were uniformly found as having the highest restorative potential as opposed to urban settings which had the least. The reason for this is that urban settings demand directed attention; whereas natural settings require more passive attention that allows one to restore and reflect (Herzog et al., 1997). Once again this does not directly pertain to a workplace situation, whereby recreational or outdoor activities are irrelevant.

Nieuwenhuis et al. (2014) found that enriched offices were superior to lean offices in terms improved concentration of the participants. In this study enriched refers to conditions including plants and lean conditions were void of plants. This is a real-life work setting that supports the ART. Although there was a statistically significant result, no effect sizes were reported so it is difficult to tell how meaningful the differences were.

Shibata and Suzuki (2002) did take into account how much effect there was depending on how much of the plants participants could see. This study involved participants performing an association task and an attentionally-demanding task, with or without the presence of plants. The participants performed better on an association task compared to the more attentionally-demanding task when they had a plant placed in front of them, compared to a no-plant condition. This could be due to the fact that a task requiring high attentional resources does not allow a person to attend to their environment. Therefore, plants may have little effect in

highly stressful work environments where employees are expected to be working intensely to reach deadlines. However these results were only relevant for the male participants. This points to the fact that perhaps gender needs to be explored more as that may be a moderating variable affecting results.

The results of these studies suggest there is a link between nature and an increase in engagement and attention and a decrease in stress. Thus, following from the hypothesis of the ART the following factors will be focused on with regard to indoor plants: work engagement and psychological well-being. An issue however is that of the studies either being experimental or based in a non-work setting. There is a need for evidence in an actual real-life work setting. Physical well-being is included, firstly due to the cleaning power of plants as well as empirical research supporting this concept.

1.4 Psychological Perceptions & Indoor Plants

1.4.1 Work Engagement & Indoor Plants

Robinson, Perryman and Hayday (2004) define work engagement as "a positive attitude held by the employee towards the organisation and its values. An engaged employee is aware of the business context and works with colleagues to improve performance within the job for the benefit of the organisation." (p. 6). Maslach, Schaufeli and Leiter (2010) argued that a lack of work engagement is likely to lead to employees wasting time on tasks that are unimportant, not putting in the maximum effort into tasks and leaving their jobs often. Much evidence exists that points to the importance of employers making work engagement an important focus within companies.

Work engagement is difficult to measure directly and thus, proxies are used in order to assess engagement. Studies looking specifically at work engagement and plants are unknown, except for two. According to Schaufeli and Bakker (2006) work engagement is "a positive work-related state of fulfilment that is characterised by vigour, dedication, and absorption" (p. 701) and has been described as the opposite of burnout. One can assess useful proxy measures when unpacking the concepts of 'vigour', 'dedication' and absorption'.

Vigour is explained as high levels of energy and mental resilience while working even during difficult times (Schaufeli & Bakker, 2006). A proxy of vigour could be productivity, in that an employee continues to meet deadlines, even if they are experiencing a setback. They are

still productive, unlike people with burnout who are likely to be less productive. People displaying high levels of vigour are likely to have high productivity levels. Dedication refers to being strongly involved in one's work and experiencing a sense of significance, enthusiasm, pride and challenge (Schaufeli & Bakker, 2006). Proxies of dedication could be absenteeism/retention; job satisfaction and productivity, in that the employees are strongly involved in their work as well as organisational citizenship behaviour (OCB). OCB refers to an employee's voluntary commitment to an organisation, without the explicit promise of a reward (Organ, 1988). People who are dedicated are likely to display high levels of OCB. Absorption can be described as being engrossed and fully concentrated in one's work (Schaufeli & Bakker, 2006). It is very likely that attention and concentration are closely linked to absorption in that those people who concentrate a lot and have higher attention capacities are likely to be more engrossed in their work. These were the proxies looked at below.

Studies have demonstrated that work engagement is positively related to performance outcomes such as retention and productivity. Work engagement has been found to positively correlate with productivity for example in a study of professional service firms, the Hay Group found that offices with engaged employees were 43% more productive than companies without engaged employees (Watson Wyatt Worldwide, 2002). According to Nieuwenhuis et al.'s (2014) study, work engagement should result in enhanced concentration levels and a greater sense of job satisfaction.

Public Display Technologies' (2015) State of Employee Engagement in South Africa survey suggested a bleak engagement problem in South Africa. The results indicated a general decline since the 2014 survey. Results suggested that at least 42 out of every 100 employees are not motivated to positively change their organisations.

Knight and Haslam (2010) conducted an experiment on 47 office workers. There were four different room conditions: a room without plants, a room with plants, a room decorated by the participant and a room that was decorated by the participant and then redecorated by the experimenter. Amongst other measures, the participants were assessed on a measure of OCB. Participants were asked to conceptualise that they were responsible for 10 extra tasks above their normal workload. Five of the extra tasks were undesirable and five were desirable. Participants were informed that any of the 10 extra tasks could be delegated to a co-worker and that this would have no negative consequences for them as the company's management

would ensure that the co-workers would never find out about the source of their increased workload. Results indicated that the environments with plants or were self-decorated led to increased OCB as opposed to the lean and disempowered environments. However, since the presence of plants only formed one part of their study it is difficult to identify the independent influence of plants alone.

Nieuwenhuis et al.'s (2014) three-part field study compared enriched offices (plants) to lean offices (no plants). When the participants were all in the same office but the two conditions were divided by cabinets, results showed an increase in perceived productivity for the enriched condition. When the participants were separated physically into the two different conditions, results showed an increase in work engagement for the enriched condition. The study suggested that work engagement mediates the relationship between condition (plant/no plant) and workplace satisfaction. The implications are that working in an office with indoor plants tends to increase employees' levels of engagement which would have implications such as increasing productivity levels. When the participants were placed in experimentally controlled environments, results indicated an increased level of objective work performance for the enriched condition. This study utilised an experimental design. There is a distinction between passive and guided interactions with indoor plants. Studies that are experimental are more guided and not indicative of a natural work-setting, whereby workers would generally passively interact with the plants (Bringslimark et al., 2009).

Lohr et al. (1996) measured productivity on a computer task in a lab-based experiment. This was assessed by looking at the reaction time taken on a specific task. This computer task involved high levels of concentration, mental processing and dexterity. The sample consisted of 81 students and 15 non-students in a large, windowless university computer lab. Those in the plant condition were exposed to 17 plants for about 15 minutes. For people in the presence of plants, their reaction time was 12% faster than those in the absence of plants, indicating that plants contributed to increased productivity and engagement. Although the results are favourable, the environment was experimental. Participants in the room with plants reported feeling more attentive (an increase of .5 on a self-reported scale from one to five) than people in the room with no plants, which supports the ART. Once again the issue of who formed the sample is salient as well as the length of exposure time to the plants (which was very short) and the guided interaction. The plants were placed around the periphery of the computer lab. As a result of the plants not being able to be directly seen by the participants, it raises questions as to what really caused an increased reaction time.

Another problem is that this study either found significant differences only on an item-level, and not holistically on the construct.

Raanaas et al. (2011) measured attention capacity as the number of correctly memorised sentences as presented. Thirty-four students were randomly assigned into one of two conditions: an office setting with four indoor plants or an office setting without plants. Improved performance was found in the plant condition versus those in the no plant condition. This is once again experimental. Nieuwenhuis et al. (2014) found similar results in terms of attention. These studies support the ART. No effect sizes were reported for the significant results.

Although the above results are favourable, the environments were all controlled and experimental and did not represent a real-life work setting. Other issues have been raised such as the sample used, no reporting of effect sizes, length of exposure time to the plants, ability to see the plants and guided interactions with plants. Below are two studies that looked at real-life work settings.

Bringslimark et al. (2007) conducted a study on 385 Norwegian office workers, whom worked in offices with plants, but this study controlled for all other differing variables such as gender, age, temperature, window view, noise, job control and work demands. The independent variables were personal characteristics, physical workplace factors, psychosocial workplace factors and how close the indoor plants were to the participants. The dependent variables were perceived stress, perceived absenteeism and perceived productivity. Even after controlling for differing variables, the results still found that the number of plants in the workplace were related to decreased perceived absenteeism and increased perceived productivity. This study controlled for all other variables that may have affected the outcome. However this research was not experimental and thus, the ability to make causal claims are limited.

A study in the South African context directly assessed the effect of the presence of indoor plants on work engagement (Kalantzis, 2016). Participants were exposed to plants for a period of six weeks. The results suggested that the presence of indoor plants within the work environment led to a decrease in work engagement. This study was conducted in a real-life work setting. Reasons cited were problems within the organisation as well as the length of time of the research.

1.4.1 Psychological Well-Being & Indoor Plants

Psychological benefits are defined broadly by Bringslimark et al. (2009) as "changes in cognition, emotion, and physiology that are positively valued and/or enhance effectiveness and adaptive capacity" (p. 423). Numerous studies have investigated the positive effects of indoor plants on various psychological well-being indicators such as stress (Dijkstra et al., 2008; Largo-Wight et al., 2011; Lohr et al., 1996; Ulrich, 1979; Ulrich, 1981), job satisfaction (Dravigne et al., 2008; Knight & Haslam, 2010); psychological comfort (Knight & Haslam, 2010) and anxiety (Chang & Chen, 2005; Park & Mattson, 2009).

Two studies showed that, after viewing a stressful event, people recovered faster when viewing images of nature as opposed to non-nature objects (Ulrich, 1979; Ulrich, 1981). This indicated that nature has a calming effect on people and can impact mental well-being. This was conducted in a laboratory setting. So too, in a real-life work setting often people do not have time to focus on the plants around them as they are extremely busy. A later study showed that being in a room with plants reduced stress but one does not even need to be actively focusing on the plants (Lohr et al., 1996). Participants were asked to perform a simple timed computer task either in the presence of plants or not. Those in the plant condition showed systolic blood pressure readings lowered by one to four units, as compared to the no plant condition. This study however, did not report any effect sizes.

Research has shown that psychological well-being is linked to job satisfaction. Rothner (2005) intended to determine the relationship between psychological well-being (self-efficacy, positive and negative affect, and sense of coherence) and job satisfaction of employees. The results showed significant positive correlations between high levels of psychological well-being and significantly negative correlations between decreased psychological well-being and job satisfaction. This was a South African study. Faragher, Cass and Cooper (2005) found similar results, with job satisfaction being most strongly associated with psychological problems. Thus, job satisfaction can be assumed to be a good proxy of psychological well-being as they have found to be highly correlated.

Dravigne et al. (2008) conducted a study in the USA. A survey was posted on the internet and administered to office workers. The survey included questions regarding job satisfaction, physical work environments, the presence or absence of indoor plants and windows, environmental preferences of the office workers, and demographic information. The final sample consisted of 450 participants. The participants' answers were assigned into one of

four conditions namely: 1) no plants and no windows with views of nature; 2) plants and no windows with views of nature; 3) no plants and windows with views of nature and 4) plants and windows with views of nature. The results indicated that respondents in offices with both plants and windows as well as those with plants but no windows rated their overall job satisfaction as high. These results were not found for participants who were in offices with windows but no plants or offices without both windows and plants. The issue with this study however is that the researchers had no knowledge of the workplaces, except for what the participants told them. It was totally dependent on the subjective opinion of the participants. There is no information regarding issues such as how big the plants were or if they were they visible. These factors can play a large role in the effect of plants on people. No effect sizes were reported either.

Kaplan, Talbot and Kaplan (1988, as cited in Kaplan, 1993) compared two groups of people in an organisation, those with a view of nature from their desks and those who did not have a view of nature. Based on a single item related to overall job satisfaction, a statistically significant difference was found. Those with a view of nature showed a higher level of job satisfaction. This study was conducted in a real-life work setting. The results however do not explore the issue that perhaps there were existing differences between the groups prior to the experiment (Bringslimark et al., 2009; Shadish, Cook & Campbell, 2002).

Shoemaker, Randall and Geller (1992) conducted a quasi-experiment with participants consisting of workers in an office. Only 14 people answered all three questionnaires with regard to job satisfaction and assessment of the workplace, thus, the sample was very small. The experiment involved removing all the plants in the office, then after three months installing plants and artwork. The results however, were non-significant. The researcher cited numerous reasons as to why this might have been including habituation, small sample size and a lack of control of extraneous variables.

Knight and Haslam (2010) hypothesised that working in an office space with plants is likely to increase productivity, job satisfaction and comfort. There were 112 employees who were exposed to one of four conditions. The two conditions relevant here are the lean condition, which had no additions and the enriched condition, which had six pot plants and six pictures of plants hung on the walls. Psychological comfort, physical comfort and job satisfaction were higher in the enriched condition as opposed to the lean condition. The variables of

interest here are psychological comfort and job satisfaction. However, this was much like a laboratory type study and not the same as a real-life work setting.

Largo-Wight et al. (2011) conducted a study in a real-life work context. The sample consisted of 503 office staff at a university in the USA. The aim of the study was first to establish nature contact at work and then assessed general perceived stress, stress-related health behaviours, and stress-related health outcomes as the dependent variables. The results showed that those participants in the high nature-contact group were one standard deviation above the mean and the low-nature-contact group was one standard deviation below the mean on the Nature Contact Questionnaire. Thus, as nature contact increased, the dependent variables decreased. These results suggest that plants in the workplace could be incorporated as part of a stress intervention. This was a cross-sectional design experiment and thus, causal claims could not be made confidently.

Kalantzis (2016) did not find any significant results with regard to participants, plants and an increase in psychological well-being. The reasons cited were intrinsic issues within the organisation.

When looking at many different studies all employing different proxy measures of psychological well-being in an organisational context (stress reduction; job satisfaction; psychological comfort), one can see the potentially positive consequences of having indoor plants inside a work environment. However, much of the research is experimentally controlled and there is a lack of evidence in real-life work settings.

1.4.3 Physical Well-being & Indoor Plants

Physical well-being in this context can be defined in terms of Sick Building Syndrome (SBS) symptoms. As previously defined, SBS is a phenomenon that occurs in people working in buildings who experience symptoms that are linked to the buildings that have no other specific cause (USEPA, 2009). Common SBS symptoms as described by Joshi (2008, p. 61) are "headaches, dizziness, nausea, eye, nose or throat irritations, dry cough, dry or itching skin, difficulty in concentration, fatigue, sensitivity to odours, hoarseness of voice, allergies, colds, flu-like symptoms, increased incidence of asthma attacks and personality changes".

Many studies have documented the positive effects of plants on physical symptoms (Evenson et al., 2013; Fjeld, 2000; Fjeld, Levy, Bonnevie, Sandvik, Veiersted & Riise, 1999; Fjeld, Veiersted, Sandvik, Riise, & Levy, 1998).

Kaplan et al., (1988, as cited in Kaplan, 1993) conducted a study with 115 employees in a desk job, with 55 having no view to the outside or no views of natural elements and 60 who could see natural elements from their desks. When comparing these two groups of employees, those with a view of nature reported fewer ailments than those with no view of nature and this difference was found to be statistically significant. From a list of 11 ailments, those with a view of nature checked on average 2.45 ailments whereas those with no view of nature checked 3.02 ailments, in the last six months. Although these results were significant, it is important to consider that if the participants had a choice of where to sit; those who enjoyed nature more would choose desks nearer the plants. This raises the issue of whether there were differences between the two groups prior to the study.

Evenson et al. (2013), in a work setting, found that after plants were introduced into a workspace there was a significant reduction in both reported health complaints and environmental complaints. The experimental condition consisted of 15 participants and the control group had seven participants. The health complaints consisted of neuropsychological symptoms such as fatigue, headaches and concentration levels; mucous membrane symptoms such as itching or irritation of the eyes and a dry or hoarse throat and skin irritation problems such as dry or flushed facial skin. The environmental complaints were weak lighting, glare, "stuffy"/"bad" air, dry air, dusty, too low temperature, too high temperature, temperature variances, draught, unpleasant smell, static electricity, and noise. Unfortunately these results, after some time, were not statistically significant from the control group. This may be due to the small sample size.

Fjeld (2000) conducted a study whereby the intention was to assess whether indoor plants affected self-reported health and discomfort symptoms. This study is quite similar to the current study in that 51 participants experienced a time with plants in the office (three months) and a time without plants in the office (three months). The plant intervention consisted of 13 different plants. The participants completed a questionnaire every second week during the two periods. It was found that the mean score sum, as a mean of 12 symptoms, was 23% lower during the period when the participants were exposed to plants in their offices compared to the period without plants. The participants reported fewer physical symptoms, including coughing, hoarse throat, and fatigue, than when no plants were present. This study was able to control for seasonal differences by ensuring both three month periods were conducted in spring (the study was conducted over a period of a year). Fjeld et al. (1998) conducted a field-based study using 51 participants who all had the same private type

of office, with a large window. The participants were then separated into a plant condition and a no plant condition. The plant condition consisted of 18 plants in total, and the participants were exposed during workdays over a period of three months. Results showed that those in the plant condition indicated experiencing less fatigue. It has however been suggested that long exposure to plants may create a habituation to the effects, meaning that initially the effects are strong but over time they diminish (Bringslimark et al., 2009). Shoemaker et al. (1992) cited habituation as one of the reasons their research may have yielded non-significant results.

Kalantzis (2016) who conducted a very similar research project in a South African organisational context found that there was insufficient evidence to suggest that the presence of the plants impacted the employees' physical well-being, which may be due to the season in which the research took place. There are numerous ways in which seasonal change could affect people's health. It can have an effect on psychological well-being with conditions such as Seasonal Affective Disorder (SAD). SAD is associated with winter and may lead to an increased feeling of depression, anxiety, tiredness, weight gain and demotivation (Partonen & Lönnqvist, 1998). Even though SAD is usually more associated with countries that have decreased daylight during winter, such as Sweden or Finland, South Africans are also likely to be affected. SAD is most common in people who live at least 30 degrees latitude north or south from the equator (Robinson & Segal, 2016). Johannesburg is approximately 26 degrees latitude south of the equator and South Africa in general is 30 degrees south of the equator (South African Weather Service, 2016). People who are at an increased risk of developing SAD are females, people already suffering from a mood disorder and people who have family members who suffer from SAD (Targum & Rosenthal, 2008).

For many people, spring brings an increase in pollen, which may result in allergies and a feeling of general sickness including symptoms such as sneezing, difficulty breathing, itchy eyes and a runny nose (Cohen, 2013) which may mimic SBS symptoms. So too are people more likely to be infected with a cold virus in winter due to people closing windows, to prevent cold air coming in, and are thus, more vulnerable to getting sick from sick employees nearby (Mozes, 2015).

All the above studies which employed looking at the perceptions of physical symptoms are problematic in that they depended on the subjective experiences of people and may be

inaccurate or biased. It is important to assess the above studies as the current study also employed a subjective measure of physical well-being.

A study that looked at the actual biological responses to nature was conducted by Chang and Chen (2005). They looked at the effects of window views of nature versus views of non-nature scenes and the presence of indoor plants on peoples' physiological and state-anxiety well-being. There were 38 participants and using technology, six different office environments were simulated: 1) office without a window view and no indoor plants; 2) office without a window view but with indoor plants; 3) office with a window view of buildings and no indoor plants; 4) office with a window view of buildings and indoor plants; 5) office with a window view of nature and no indoor plants and 6) office with a window view of nature and indoor plants. The interaction between the parasympathetic and sympathetic nervous system was assessed using a biofeedback device. The physiological aspects assessed were Electroencephalography (EEG), with higher readings indicating the participants were in a relaxed state; Electromyography (EMG), with increased readings indicating an increase in muscle tension and Blood volume pulse (BVP), with a higher pulse indicating increased tension. While they were being continuously assessed physiologically, participants were asked to complete the State-Anxiety Inventory. In the condition with the view of nature as well as indoor plants, the EEG readings were the highest and BVP were the lowest and the group had the lowest state-anxiety level. Although this does not directly link to SBS, it does show a link between the positive effects of plants on physical factors, which may indicate that the perceptions of physical symptoms hold merit. This research is very interesting; however, the majority of the literature has to depend on the subjective opinions of the participants.

1.4.4 Aesthetics & Indoor Plants

Aesthetics refer to an appreciation of aspects concerned with beauty and nature (Sykes, 1982). Grinde (1996) defines aesthetics as "features that make something more visually attractive" (p. 31). Grinde (1996) posits a theoretical understanding of aesthetics. He uses the example of just as when one burns their finger, they avoid fires and one pursues what is good for one. People presumably influence behaviour by offering rewards and punishments. The brain has various mechanisms (emotions) used for persuasion. Any emotion that rouses a positive feeling is considered rewarding. Thus, those who view plants as aesthetically pleasing will be "rewarded" with a positive emotion leading to other positive consequences

such as improved well-being whereas those who do not will be "punished" and not receive any positive consequences.

Another physical outcome of plants is that they are potentially more aesthetic (Doyle, 2013). This can create a less sterile and more pleasing workspace for occupants. Most research looking at the relationship between plants and people, focus on the "people" aspect rather than taking into account both the people and the nature aspects. Most of the past research focused on humans' affinity to plants based on their utilitarian value (such as a potential source of medicine, food and protection) and the aesthetic value has largely been ignored. A mutualism framework has been proposed to assist in taking into account both people and plants (Wilson, Kendal & Moore, 2016). Mutualism can be described as a "biological relationship between different species, where both parties benefit from the relationship" (Wilson et al., 2016, p. 257). Wilson et al. (2016) posits that a mutualism exists between plants because of their pleasing aesthetics; they are rewarding and induce positive emotions in people. In turn people become fond of plants and are thus, more inclined to help cultivate them, keep them alive and healthy and disperse them. Thus, this aids in plants' two biggest enemies, reproduction and safety (Thatcher, 2012; Wilson et al., 2016).

Lohr and Pearson-Mims (2000) conducted a study with 176 students and 22 university employees, and found that occupants in a room with plants (five plants with an exposure time of about 20 minutes) generally reported higher levels of positive emotions, such as feeling relaxed and open, than those in the control (colourful items) or non-plant objects rooms. The room with plants was assessed as more pleasant than the other two conditions. In terms of aesthetics, a study found the underlying mechanism for the stress-reducing effects of indoor plants was due to perceived attractiveness of the room (Dijkstra et al., 2008).

According to Kweon, Ulrich, Walker and Tassinary (2008) aesthetically pleasing art, particularly images of nature, is believed to reduce stress and anger in the working environment. Much evidence by Ulrich suggests that when exposed to a natural environment as opposed to a non-natural environment people react positively in terms of: 1) aesthetic and affective responses (for example Ulrich, 1983); 2) psychological well-being (for example Ulrich, 1979); 3) physiological effects (for example Ulrich, 1981) and 4) stress recovery (Ulrich & Simons, 1986).

There has been much research to find the reason why people may have positive attitudes towards nature. Two reasons have been posited. Firstly it has been posited that human vision

is particularly attuned to fractal patterns and aesthetically pleasing forms in nature (Cheung & Wells, 2004) and thus, is associated with more mathematical explanations than cultural. Fractals, which are forms with patterns that repeat themselves, are often found in nature (Lohr, 2010). Secondly it has been posited, from an evolutionary perspective, plants allowed for survival and thus, that is why people are attuned to nature (Bringslimark et al., 2009; Gullone, 2000).

There is much evidence to support the idea that aesthetically pleasing environments have a myriad of positive consequences such as stress reduction, as seen above. What is largely not researched is the effect of an environment on people's perceptions, if they do not find the environment to be aesthetically pleasing. It is assumed that people automatically prefer and find natural settings aesthetically pleasing which is not necessarily true. Kellert (2005) put forward nine perspectives that describe humans' relationship with the natural world namely: Utilitarian; Naturalistic; Ecologistic-Scientific; Aesthetics; Symbolic; Humanistic; Moralistic; Dominionistic and lastly Negativistic valuations of nature (Kellert, 2005). Of interest here is that of a negativistic relationship which refers to negative affect associated with nature experiences including fear, aversion and disgust (Kellert, 2005). According to Kellert (2005) people may not find plants to be aesthetically pleasing due to learning or experiences within cultural or community contexts as well as due to how people attach meaning to plants. This is largely ignored in previous studies and may in fact have important implications in this field of study.

According to Grinde (1996) above, if one finds something aesthetically pleasing they will have positive consequences whereas if someone does not find something aesthetically pleasing, they will not derive any positive consequences. Thus, it can be suggested that people who find plants aesthetically pleasing are more likely to have positive perceptions in the presence of plants than those who are neutral or who do not like the look of plants. It still needs to be explored as to whether people who do not find their environment and indoor plants aesthetically pleasing are less likely to hold positive perceptions.

Bringslimark et al. (2009) raise two issues. Firstly, when results are significant they tend to be exaggerated by the researcher, and then effect sizes are not reported (blurring what may be a realistically meaningless result). Secondly, it is questionable as to how many studies that show non-significant results are actually published.

Most of the studies above show the positive effects that plants have on people. There are however many factors that must be taken into account when interpreting the results, such as, very experimentally controlled environments are not representative of a natural workplace setting; the sample and its generalisability; the sample size; an indoor setting is different to an outdoor setting; most research does not give the effect sizes for significant results; most of the research does not take into account extraneous variables; experimental designs guide a participant's attention to plants whereas at work the attention is passive; at work people may not have the time to look at the plants around them; the length of time of exposure to the plants; the type of research design and the ability to make causal claims; and the fact that there may be differences in groups prior to the research. So too is there a lack of South African studies pertaining to indoor plants. Thus, there is a need for research in this area in a real-life workplace setting that accounts for all the factors above and is set in a South African context.

1.5 The Work Space: Discovery VitalityLife

Adrian Gore is the founder and Chief Executive Officer of the Discovery Group. He launched Discovery in 1992 with a simple, core purpose of making people healthier and enhancing and protecting their lives (Discovery Limited, 2016). Discovery has since evolved into a diversified and multinational financial services group. Discovery is widely acknowledged as a global thought leader in wellness behavioural change and its integration with health, life and short-term insurance (Discovery Limited, 2016).

Discovery is VitalityLife's parent company and is a global insurance leader. Discovery is a global financial services business. Its focus is on life insurance, private medical insurance and general insurance, as well as in investments and credit (VitalityLife, 2016). Discovery listed on the JSE in 1997. In 1997, Discovery introduced Vitality, the world's first incentive-based wellness programme linked to insurance. Discovery generates total income flows in excess of R50 billion and has over 8000 employees globally serving six million customers world-wide (VitalityLife, 2016). Their mission statement states "We're continually innovating to make people healthier, and to protect and improve the quality of their lives" (VitalityLife, 2016). The office space was open plan and was 357m^2. The floor that was accessed was divided into two areas. One area was the Human Resources department and the other functioned as a call centre, whereby agents spoke to brokers regarding issues such as their commission generated on policies. The majority of employees were part of the call centre.

Due to the fact that VitalityLife are so invested in the health of their clients, they were very willing to assist in investigating both the psychological and physical well-being of their employees.

1.6 Indoor Plants

Plants are able to clean the air. As a simple explanation, plants have pores on the underside of their leaves. They are able to absorb gases, such as CO_2 and Volatile Organic Compounds (VOCs), and along with sunlight, turn this into energy for growth. This is part of the photosynthesis process. Plants are able to convert CO_2 into oxygen which they release into the air (Morison, 1993). Thus, plants have begun to be known as the world's natural air cleaners. The reasons why this is important will be discussed below.

1.6.1 Bidvest ExecuFlora

ExecuFlora was established in 1979, when the concept of interior planstscaping was still new. ExecuFlora was bought by Bidvest in 2003 (ExecuFlora, 2015). Bidvest ExecuFlora is a South African 'interior plantscaping' company with their motto of "bringing the outdoors indoors" (ExecuFlora, 2015). Primarily, they offer installations of a wide range of packages to medium and small businesses; malls and shopping centres; corporate offices; hotels and restaurants, including indoor plants; pots (that are biodegradable and recyclable); flower arrangements; canvas picture rentals; and 'green' walls (ExecuFlora, 2015).

To support the idea that indoor plants offer benefits beyond a merely decorative role, ExecuFlora claims a range of research stressing health, industrial and corporate advantages of plants. These include improvement of air quality, increases in productivity, reduction of absenteeism and health complaints, reduction of noise levels, lowering of stress levels and increases in a sense of well-being (ExecuFlora, 2015).

Bidvest Execuflora is a member of The Green Building Council South Africa. The Green Building Council South Africa (GBCSA) is an independent, non-profit company that was formed in 2007 to lead the greening of South Africa's built environment. They promote raising awareness of the benefits of green buildings; supporting government to lead by example, to legislate and facilitate the adoption of green building practices and recognising and rewarding industry leaders who achieve green building excellence (GBCSA, 2016).

1.6.2 Indoor Plants

Some plants have been graded and tested according to their efficiency on removing VOCs from the air. These are rated from one to ten with one being poor and ten being excellent. The plants used in this study were (ExecuFlora, 2015; Kobayashi, Kaufman, Griffis & McConnell, 2007):

a. *Sanserveria trifasciata* also known as Mother in Law Tongue or Viper's bowstring hemp has stiff and sharply tipped tongue-shaped leaves with sturdy flowering stalks. It is indigenous to South Africa. It has a VOC rating of three (ExecuFlora, 2015). Sriprapat, Suksabye, Areephak, Klantup, Waraha, Sawattan and Thiravetyan (2014) were interested in the VOC removal potential of twelve species of plants. Of the 12 plant species examined, the highest Toluene removal was found by *Sansevieria trifasciata*. Treesubsuntorn and Thiravetyan (2012) found *Sanserveria trifasciata* to have a high removal efficiency of Benzene from indoor air.
b. *Chamaedorea Seifritzii* also known as Reed Palm is an upright structured palm with multiple stems and dark green fronds and comes from Mexico. It resembles bamboo. It has a VOC rating of 10, which is excellent (ExecuFlora, 2015). Wolverton (1996) tested 50 different plants and listed the top 20, which are those that are most effective for removing VOCs from the air, with *Chamaedorea Seifritzii* on the list. Saxena and Ghosh (2015) found *Chamaedorea Seifritzii* to effectively remove Benzene from the air.
c. *Ficus Alii* is a hardy growing tree with long narrow glossy leaves and comes from Malaysia. It has a high VOC rating of seven (ExecuFlora, 2015). Wolverton (1996) tested 50 different plants and listed the top 20, which are those that are most effective for removing VOCs from the air, with *Ficus Alii* on the list. Claudio (2011) named *Ficus Alii* as one of the top 10 houseplant air cleaners.
d. *Ficus Lyrata* also known as Fiddle Leaf Fig is a hardy evergreen tree producing broad leaves and resembles a fiddle. They originate from West Africa. They also have a high VOC rating of eight (ExecuFlora, 2015).
e. *Aglaonema* also known as Silver Queen is a low growing foliage plant with elongated silvery green leaves. It originates from the Phillipines and Malaysia.

It has a VOC rating of four (ExecuFlora, 2015). *Aglaonema* has been found to effectively reduce Xylene concentrations in the air (Song, Kim & Sohn, 2007).

1.6.3 Position of Plants

It is understood that there should be a minimum number of plants per square metre to help improve air filtration in the office and thus, plants should be placed as close to each other as possible. The Green Building Council Interiors tool technical manual stipulates that one plant unit needs to be provided for every $50m^2$ of regularly occupied space (GBCSA, 2016).

1.7 Indoor Air Quality

A few factors of the indoor and work environment have been found to be associated with occupant health, such as concentrations in the air of VOCs, carbon dioxide, temperature and relative humidity (Allen, MacNaughton, Satish, Santanam, Vallarino, & Spengler, 2015). This is important to consider since office workers spend about 90% of their time indoors (Dela Cruz et al., 2014; Tarran et al., 2007; Wood, Burchett, Alquezar, Orwell, Tarran & Torpy, 2006).

Indoor environmental quality (IEQ) usually focuses on indoor air constituents (VOCs, CO_2) and comfort factors (temperature, relative humidity) (Mitchell, Zhang, Sigsgaard, Jantunen, Lioy, Samson & Karol, 2007). Indoor air quality is so important that the World Health Organisation has stipulated that clean air is a basic human right (WHO, 2000).

Gou and Lau (2012) found that introducing indoor plants in a workspace improved the occupants' perceptions of the indoor environmental quality (IEQ). Nieuwenhuis et al. (2014) found, in two separate studies, that participants in an office with plants reported improved perceived air quality than those in the no plant condition.

Khan, Younis, Riaz and Abbas (2005) conducted a study looking at air quality. The sample consisted of 222 masters and graduate students and 28 teachers at a college. Plants were introduced into the setting and the participants were exposed to the plants for approximately 30 days. They found that the participants who were exposed to plants reported that the air quality had improved, the environment was more pleasant and their performance improved. These studies suggested that by introducing plants into a setting should have a positive effect of the perceived air quality.

Indoor air quality is very important to assess in light of this research because air quality has a direct impact on peoples' physical and psychological well-being and this could lead to an increased understanding of employees' perceptions, and why they might be what they are.

Indoor air quality has obvious implications for physical health. Indoor air may contain many different harmful substances that have negative health consequences ranging from symptoms such as dry eyes, dizziness and allergies to more chronic illnesses such as asthma or cancer (Greenberg, 1986; Mitchell et al., 2007). If people are experiencing these symptoms, it will have obvious implications for their perceived physical well-being.

Along with physical well-being, IEQ has been shown to affect psychological well-being too (Ekpanyaskul & Jiamjarasrangsi, 2004; Klitzman & Stellman, 1989). It has been shown that poor indoor air quality in buildings can decrease productivity in addition to causing dissatisfaction (Ghodrati, Samari & Shafiei, 2012; Hedge, 2001). The size of the effect on most aspects of office work performance appears to be as high as six to nine percent (Wyon, 2004). Singh, Syal, Grady and Korkmaz (2010) suggested that air quality in particular is an essential factor affecting well-being.

Allen et al. (2015) conducted a study in the USA whereby two IEQ conditions were simulated. The 24 participants were unaware of the differing conditions. On differing days participants were exposed to a "conventional" (high levels of VOCs and elevated CO_2 levels) and a "green" environment (low levels of VOCs). The researchers then administered a cognitive assessment every day, which assessed higher-order decision-making. The results indicated that cognitive functioning was 61% higher on the "green" environment days than the "conventional" days.

The results of three independent studies show that the performance of simulated office work improves when air quality increases (Lagercrantz, Wistrand & Willen, 2000; Wargocki, Wyon & Baik, 1999; Wargocki, Wyon & Fanger, 2000). To simulate office work, typical office tasks were used (typing, adding, and editing). Air quality was altered either by decreasing the pollution load or by increasing the outdoor air supply rate while the pollution load was constant. In all three studies similar procedures were used: the subjects performed simulated office work during four and a half hours of exposure to different air quality levels and assessed the perceived air quality. A positive correlation was found between the acceptability of air quality and performance. Thus, this shows how IEQ has implications for psychological well-being as well as physical well-being.

1.8 Volatile Organic Compounds

In addition to CO_2, plants are able to absorb VOCs, which are types of compounds containing carbon (Dela Cruz et al., 2014; Orwell, Wood, Tarran, Torpy & Burchett, 2004; Wood et al., 2006; Yang, Pennisi, Son & Kays, 2009). VOCs have been linked to many serious conditions, ranging from asthma to more chronic diseases such as cancer, neurological conditions, kidney and liver disease and hormone disruptions (Claudio, 2011; Dela Cruz et al., 2014; Schiavon et al., 2015; Wolkoff, Wilkins, Clausen & Nielsen, 2005; Wu et al., 2012; Yang et al., 2009). Within an office environment there are numerous potential sources of VOCs such as paints, upholstery, cleaning agents, air-fresheners, adhesives, fabrics, solvents, carpeting, building materials and photocopying machines (Brits, 2011; Denisa et al., 2012; Sriprapat et al., 2014; Wolverton, 1996).

Although South Africa has laws such as the Air Quality Act 2004 (Act No. 39 of 2004), offices at risk are those built previously to the stipulated guidelines or companies that do not adhere to the regulations. The most at risk office spaces are those that have been newly outfitted, such as had new carpets put in or the walls painted with high VOC volume materials (Dela Cruz et al., 2014). Two common VOCs found indoors are Benzene and Xylene.

1.8.1 Total VOCs

In order to assess the effects of VOCs, it has been suggested that the concentration of VOCs are added up to produce a Total Volatile Organic Compounds (TVOC) value (Abraham, Gola & Cometto-Muñiz, 2016). Wood et al. (2006) suggested that potted plants are able to reduce TVOCs by 50-75%. Levels of .1-.5 ppm (parts per million) of TVOCs are causes of sick building syndrome (Brown, Sim, Abramson & Gray, 1994).

Orwell, Wood, Burchett, Tarran, and Torpy (2006) conducted a study in different offices. TVOC levels in the offices ranged from .06–.35 ppm. Offices were either decorated with plants or were exposed to no plants. Offices with no plants had TVOC concentrations rise above about .1 ppm whereas offices with plants were reduced by 75% to below .1 ppm.

1.8.2 Benzene

Benzene is known to cause many diseases, especially cancers (Saxena & Ghosh, 2015; Schnatter, Rosamili & Wojcik, 2005; Wolverton, 1996; Yang et al., 2009). The Association Advancing Occupational and Environmental Health (ACGIH), US Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC) have deemed Benzene a cancer-causing carcinogen (IARC, 2000; Treesubsuntorn & Thiravetyan, 2012; WHO, 2000). WHO (1993) has suggested that about 50% of inhaled Benzene in air is absorbed. Benzene is found in paints, plastic, rubber, inks, adhesives, photocopiers, chipboard, varnishes and wall covering lacquers (Denisa et al., 2012; Sriprapat et al., 2014; Wolverton, 1996). The maximum acceptable level of Benzene is one ppm (NIOSH, 2014; OSHA, 2005).

1.8.3 Xylene

Xylene is a colourless and sweet-smelling liquid or gas (Kandyala, Raghavendra & Rajasekharan, 2010). Xylene has been associated with negative neurological effects, such as nausea, vomiting, dizziness and headaches (Kandyala et al., 2010; Wu et al., 2012). One is able to smell Xylene in the air at .08-3.7 ppm (Kandyala et al., 2010). The current USA's Occupational Safety and Health Administration permissible exposure limit for Xylene is 100 ppm as an eight hour time-weighted average concentration (OSHA, 2005). Xylene is found in adhesives, paints, chipboard, varnishes and is a by-product of human respiration (Wolverton, 1996).

1.9 SE Controls Data

SE Controls has more than 30 years of experience in delivering specialist smoke and natural ventilation control systems to buildings of all sizes and types (SE Controls, 2016a). SE Controls has the ability to design a fully integrated ventilation system providing tailored solutions to all types of buildings including apartments, offices, schools, colleges, hospitals and shopping centres (SE Controls, 2016a). This study involved an office space, which was an appropriate space for SE Controls. SE Controls offers the complete solution from design and manufacture through to installation commissioning and on-going servicing of the building. According to SE Controls, commercial buildings are one of the greatest sources of CO_2 emissions as well as being associated with high internal heat gains due to high occupant density and a large amount of technology equipment (SE Controls, 2016b). So too, according

to SE Controls, do buildings currently consume almost half of all commercial energy usage, producing 50% of global carbon emissions (SE Controls, 2016b). SE Controls are currently working in many buildings in South Africa such as Capital Hill in Sandton; the FADA building at Wits University and the University of Johannesburg's Kingsway Campus; thus they are aware of the South African context.

1.9.1 Carbon Dioxide

Carbon Dioxide (CO_2) is a naturally occurring gas in the air and is both odourless and colourless. It is present in the Earth's atmosphere at about .04 percent (400 ppm) by volume (National Oceanic & Atmospheric Administration, 2016). Although it is vital to life on Earth, in high quantities it is harmful to people. Through a complex process plants absorb light from the sun and carbon dioxide (CO_2) from the air and uses the carbon and releases oxygen (O_2). Thus, plants reduce CO_2 levels in the air (Claudio, 2011; Tarran et al., 2007). This is advantageous because exposure to even low levels of CO_2 have been known to cause "headaches, dizziness, restlessness, breathlessness, increased heart rate and higher blood pressure" (Bureau Of Land Management, 2006, p. 4-7).

The effects can be so adverse that South Africa has included CO_2 regulations into the South African legislation. Section 35 of The Machinery and Occupational Safety Act, 1983 (Act 6 of 1983), as part of the Environmental Regulations for Workplaces (1987) has explicitly stipulated with regard to ventilation that "the time-weighted average concentration of carbon dioxide therein, taken over an eight-hour period, does not exceed one half per cent by volume of air" and "the carbon dioxide content thereof does not at any time exceed three per cent by volume of air". The South African exposure limit of CO_2 is 5000 ppm over 8 hours (ACGIH, 1997). It has been suggested that increased dissatisfaction can arise with CO_2 levels greater than 500-650 ppm (Newsham, Veitch & Charles, 2008; Zhang, Wargocki, Lian & Thyregod, 2016).

1.9.2 Temperature

Temperature within an office is often a very subjective concept. It is usually controlled by an air-conditioning system but may not always suit employees' personal preferences. This can be affected by factors such as where in the office an employee

sits relative to the air-conditioning vent, type of clothing worn, level of physical activity and gender (women report feeling colder than men in the same environment) (Brits, 2011; South African Labour Guide, 2016).

Plants are able to decrease temperatures indoors in three different ways. Firstly through respiration, plants give of water vapour which has a cooling effect. Secondly, plants use sunlight for photosynthesis. Lastly plants absorb CO_2 molecules, which usually trap heat (Kurniawan, 2004).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE, 1992) have recommended that indoor temperatures must be a maximum of 23 ± 1.5°C during summer and 21 ± 1.5°C during winter, and that optimal performance usually occurs when temperatures are between 21-23ºC.

According to the South African Labour Guide (2016), temperatures inside offices should range between 21°C and 26°C. The summer temperature range is 21-24 °C and the winter temperature range is 24-26 °C. When temperatures are below these ranges people may start to experience adverse symptoms, such as cold and stiff fingers as well as a pins and needles feeling in their extremities, headaches, a loss of concentration and shivering. The same is true for temperatures above the suggested range. People may experience dizziness, a loss of concentration, thermal discomfort and heat stress and may begin to sweat which may lead to headaches and dehydration,

1.9.3 Relative Humidity

Relative humidity has been defined as a "measure of the amount of water (moisture) in air as compared to the maximum amount of water the air can absorb, expressed as a percentage. When air cannot absorb any more moisture (is fully saturated), its relative humidity is 100%" (Relative Humidity, The Business Dictionary, 2017).

Through transpiration, a plant releases vapour into the air, thus, increasing the humidity levels (Dela Cruz et al., 2014; Kobayashi et al., 2007; Schiavon, Scapinello, Tosi, Ragazzi, Torretta & Rada, 2015; Wood et al., 2006; Wolverton & Wolverton, 1996). Plants are able to increase relative humidity by five to ten percent (Denisa, Maria, Erzsebet & Ioana, 2012).

The optimal relative humidity levels in an office are between 30-60% (ASHRAE, 1992; Fang, Clausen & Fanger, 1998). Low humidity levels can increase the chances for dry nasal passages and skin, eczema and asthma. High humidity levels can contribute to growth of fungi and bacteria in air-conditioning vents, which can cause illness (Brits, 2011). The average relative humidity level in Johannesburg is 59.2%, which is considered to be a bit dry (World Weather and Climate Information, 2016). Thus, it is hoped that the introduction of plants allow the relative humidity levels indoors to fall within the acceptable range.

In an experiment by Smith and Pitt (2011) in London, an area in an office was exposed to plants and the effects before and after were observed. Prior the introduction of plants the relative humidity levels were very low and recorded below 30%, which is below the recommended range of relative humidity (40-70%). After exposure to the plants, relative humidity fell between the ranges of 40-60%.

After looking at all the numerous research studies above, which all yielded mixed results and were conducted in differing contexts and under different conditions, it would be interesting to conduct research in a different context. Thus, work engagement; psychological well-being; physical well-being; perceived aesthetics; volatile organic compounds and air quality will be assessed in a uniquely South African context, such as taking into account its different climate and economic status.

1.10 Research Questions

1.10.1 Psychological Perceptions

1. Does engagement with work of the occupants increase after the introduction of indoor plants in a workspace?
2. Does psychological well-being of the occupants increase after the introduction of indoor plants in a workspace?
3. Does physical well-being of the occupants increase after the introduction of indoor plants in a workspace?
4. Do perceived aesthetics and perceived attractiveness of the plants moderate the above relationships?

1.10.2 Environmental Factors

5. Do TVOC levels decrease in the air after the introduction of indoor plants in a workspace?
6. Do Benzene levels decrease in the air after the introduction of indoor plants in a workspace?
7. Do Xylene levels decrease in the air after the introduction of indoor plants in a workspace?
8. Do CO_2 levels decrease in the air after the introduction of indoor plants in a workspace?
9. Do temperature levels decrease in the air after the introduction of indoor plants in a workspace?
10. Do relative humidity levels fall within the acceptable range in the air after the introduction of indoor plants in a workspace?

CHAPTER 2: METHODS

The purpose of this chapter was to look at how the study was conducted, namely the methods. The following topics are covered in order to understand this study in depth: the research design, details about the sample and sampling method utilised; the instruments used (both psychological and environmental); the procedure followed; the ethical considerations as well as a summary of how the data were analysed.

2.1 Research Design

This research was a longitudinal, quantitative pre-test/post-test, pre-experimental study (Payne & Payne, 2004; Salkind, 2006; Walliman, 2001). The study was longitudinal as it took place over a period of approximately three months and was observed as a change over time. The post-test, which was a once-off, took place approximately three months after the pre-test was administered. The independent variable (indoor plants) was manipulated to a degree in that at Time 1 there were no plants and at Time 2 plants were present. There were no control groups or random assignment because all the occupants received the same conditions. As it was pre-experimental it does not allow one to draw causal inferences confidently (Davis & Brenner, 2006). However, it may suggest a relationship between plants and psychological perceptions.

2.2 Sample & Sampling

The work space consisted of about 60 employees from floor four of Discovery VitalityLife in Sandton. However, not all employees were at work and some were either in training or on leave at the time of data collection. The type of sampling strategy that was used was non-probability, convenience sampling because it depended on the willingness of the employees to complete the research (Terre Blanche & Durrheim, 2002; Walliman, 2001). The research was voluntary and the researcher could not control how many questionnaires were returned.

At Time 1, 47 questionnaires were distributed; however only 43 were returned. Thus, the response rate at Time 1 was 91.5%. Not all questionnaires were completed in full. At Time 2, 37 questionnaires were distributed and 34 were returned. Thus, the response rate at Time 2 was 91.9%. Not all questionnaires were completed in full. No questionnaires were excluded due to the fact that no large amounts of data were missing. Missing data were handled by pairwise deletion. This means that the analyses were still conducted on cases that contained

some missing data (Peugh & Enders, 2004). The reason for this was that the sample was already quite small and the researcher did not want analysis only run on cases that had a complete set of data as this would decrease the sample size and limit the results. After assessing all the questionnaires the researcher had a sample of 34 of questionnaires that could be matched from Time 1 to Time 2.

Ultimately, the sample was made up of 34 participants between the ages of 22 and 46 years of age, of differing genders, tenure of between less than one month and 10 years and differing organisational positions.

Table 1: Descriptive Statistics for Age and Tenure for the matched sample

Age & Tenure				
	Mean	**Standard Deviation**	**Minimum**	**Maximum**
Age	28.85	4.73	22.00	46.00
Tenure	3.44	2.27	.00	10.00

It must be noted that one employee did not provide their age. Tenure was calculated in years. This means that those employed in 2016 received tenure of .00 (or less than six months). Tenure was slightly skewed to the left which means that the majority of the sample did not hold a long tenure. Age was slightly skewed to the left which means most of the sample were younger.

Table 2: Descriptive Statistics for Gender for the matched sample

Gender		
	Frequency	**Percent (%)**
Female	19	55.9
Male	15	44.1
Total	34	100.0

As depicted in Table 2 above, although there were slightly more females in the sample, it is basically equally distributed.

Table 3: Descriptive Statistics for Organisational Level for the matched sample

Organisational Level		
	Frequency	**Percent (%)**
Staff	32	94.1
Manager	1	2.9
Team Leader	1	2.9
Total	34	100.0

As depicted in Table 3 above, general staff make up the majority of the sample.

Table 4: Descriptive Statistics for Chronic Underlying Illnesses for the matched sample

Chronic Underlying Illnesses		
	Frequency	**Percent (%)**
None	27	79.4
Asthma	2	5.9
Hay fever/Pollen Allergies	2	5.9
Sinus problems only	2	5.9
Sinus & High blood pressure	1	2.9
Total	34	100.0

As depicted in Table 4 above, the majority of the sample reported that they had no chronic underlying illnesses.

2.3 Measures / Instruments

2.3.1 Psychological Perceptions

a. Demographic questionnaire: This self-developed questionnaire included questions regarding gender, tenure, organisational level, how many hours per day were spent in the workspace, how many days per week were spent in the workspace and any underlying chronic illnesses (Appendix B).
b. Kessler Psychological Distress Scale (KPDS): This scale contains six items assessing non-specific psychological distress. Responses for each item were attained by means of a likert-type scale ranging from one to five (i.e. none of the time, a little of the time, some of the time, most of the time, all of the time) (Kessler et al., 2002). Total scores range from six (indicating no distress) to 30 (indicating severe distress) (Kessler et al., 2003). The original 10 item scale was reduced based on Item Response

Theory models (Kessler, et al., 2002). Kessler et al. (2002) found a Cronbach's alpha of .89 for their USA pilot study (N=1000). Convergent construct validity is evidenced by accuracy with DSM-IV diagnoses of depression and/or anxiety (Kessler et al., 2002). This scale has also been shown to have little bias with regards to education and gender (Kessler et al., 2002). (Appendix C).

c. Sick Building Syndrome (SBS) questions: This scale measures physical well-being by means of 15 questions which contain responses on a four-point scale (i.e. never, one to three times per month, one to three times per week, every day). Hedge, Erickson and Rubin (1996) did not make mention of the validity or reliability of these scales. However, a study conducted in South Africa assessing the physical work environment's impact on well-being revealed a Cronbach's alpha of .93, which is good (Musa, 2013). Thatcher and Milner (2014) reported internal consistencies ranging from .90 to .93 in their South African Study (Appendix D).

d. Utrecht Work Engagement Scale: Work engagement was measured through nine self-report questions (UWES-9) (Schaufeli, Bakker & Salanova, 2006). Participants were asked to what extent they experienced particular conditions in the office during the previous month and were asked to provide responses on a seven-point scale (i.e. never, almost never, rarely, sometimes, often, very often, always). Originally the scale consisted of 17 items (UWES) consisting of three subscales (Vigour, Dedication and Absorption), however, it was psychometrically shortened to the UWES-9 (Schaufeli et al., 2006). Internal consistencies were tested in several countries, including South Africa and these results reflected that Cronbach's alpha values ranged between .70 and .80 in the majority of cases (Schaufeli et al., 2006). Kalantzis (2016) reported a Cronbach's alpha of .88, which is good (Appendix E).

e. Aesthetics Questionnaire: This scale consisted of 17 items from Lohr and Pearson-Mims (2000). The respondents were expected to rate their current office environment on a continuum comparing two opposing adjectives and rate it on a five-point scale (1 = unfavourable; 5 = favourable). This was developed by Lohr and Pearson-Mims (2000) after assessing similar assessments used by other researchers. The order of the pairs was randomised. No psychometric properties were reported, which posed a risk, however, it was chosen as it was used in a similar context (Lohr & Pearson-Mims, 2000). An extra question (to what extent do you think that the plants in your office are attractive?) was added for the participants at Time 2. Participants were asked to provide responses on a five-point scale (i.e. not at all attractive, somewhat attractive,

neutral, attractive, extremely attractive) (Appendix F). Although this scale does not directly measure aesthetics in terms of plants, it speaks to the overall aesthetic perception of the workplace, which may change with the presence of plants (for example, adjectives that are likely to be weighted more heavily after the introduction of plants into the workspace are Fresh Air, Ornate, Cheerful, Colourful, Attractive, Inviting, Pleasant and Calming)

f. Number of Plants: This scale consisted of four items namely: a) how many live plants can you see inside the office from your desk/workstation?; b) how many windows can you see out of from your desk/workstation?; c) how many of those windows have a view of nature (i.e. trees, shrubs, flowers, etc.)?; and d) how many pictures of plants or of a natural setting can you see from your desk/workstation? Participants were asked to indicate any number between zero and five or more. This was to determine if there is a difference in plant contact between Time 1 and Time 2 (Appendix G). The four answers to the questions were averaged in order to get a composite measure of number of plants.

2.3.2 Indoor Plants

The following plants were placed in the workspace. They were all specifically chosen for their aesthetically pleasing qualities, their low chance for any allergic reactions from the occupants, as well as their positive air quality characteristics.

1. *Sanserveria trifasciata* also known as Mother in Law Tongue or Viper's bowstring hemp (nine x 40cm tubus square pots) (Figure 1).
2. *Chamaedorea Seifritzii* also known as Reed Palm (eight x 40cm tubus square pots) (Figure 2).
3. *Ficus Alii* (three x 40cm tubus square pots) (Figure 3).
4. *Ficus Lyrata* also known as Fiddle Leaf Fig (one x 40cm tubus square pot) (Figure 4).
5. *Aglaonema* also known as Silver Queen (three x rectangular desk bowls) (Figure 5).

Figure 1: *Sanserveria trifasciata* "Mother in Law Tongue"

Figure 2: *Chamaedorea Seifritzii* "Reed Palm"

Figure 3: *Ficus Alii*

Figure 4: *Ficus Lyrata* "Fiddle-Leaf Fig"

Figure 5: *Aglaonema* "Silver Queen"

The work space was 357m^2 with a total of 24 plants. This amounted to about one plant unit for about every 14m^2 which was well within the guidelines (as previously mentioned, one plant unit needs to be provided for every 50m^2 of regularly occupied space (GBCSA, 2016)). This can be equated to .5 plant units per employee or occupant (GBCSA, 2016). There were about a total of 60 employees in the work space so that equated to .4 plant units per employee, which was slightly below the guidelines but not significantly, although not everyone was in the office all the time.

2.3.3 Carbon Dioxide, Temperature & Humidity Levels

The device used to assess carbon dioxide, temperature and relative humidity levels was the NVLogIQ Room Controller. The device has been designed to offer an effective, efficient and user-friendly solution for adaptive natural ventilation applications that is easily integrated

into a new or refurbished building (SE Controls, 2016c). The device can easily be mounted on a wall. Room conditions and status were constantly displayed on the integral LCD screen which is further enhanced with a traffic light indication according to predefined criteria (SE Controls, 2016c). The device can ensure that optimal indoor air quality is being provided by providing information regarding CO_2, indoor air temperature and relative humidity levels, which can be downloaded at any time. No reliability or validity information regarding the device was found, however, it is compliant with applicable regulations (SE Controls, 2016c).

Figure 6: NVLogIQ Room Controller

2.3.4 Volatile Organic Compounds

The Tiger^{LT} is a handheld VOC detector which provides accurate and reliable results (Ion Science, 2015). The Tiger^{LT} accurately detects various gases from .1 to 5 000 ppm and has a response rate of two seconds (Ion Science, 2015). It utilises a push-to-log data logging system of up to 80 000 data points in up to 128 user selectable zones and claims to provide fast, accurate and reliable results (Ion Science, 2015). No reliability or validity information regarding the device was found, however, the following features could be considered as advantageous. It is intrinsically safe (it meets the safety requirements of the following institutes: Atmosphères Explosibles, the International Electrotechnical Commission System for certification to standards relating to equipment for use in explosive atmospheres, UL and the Canadian Standards Association), it is resistant to relative humidity levels of up to 99% and has an anti-contamination design.

Figure 7: Tiger^{LT} handheld VOC monitor

2.4 Procedure

The University of the Witwatersrand Ethics Committee ((HREC Non-Medical) was a given a proposal and completed ethics forms regarding the research. An internal committee assessed it, and gave the research ethical clearance (Ethics Protocol Number: MORG/16/011 IH) (Appendix H).

Once ethical clearance was given, the manager of VitalityLife was approached and given a brief proposal about the research project as well as an organisational access request letter (Appendix I). Once permission was granted formal non-disclosure documents were presented, approved and signed by the organisation as well as the researcher and research supervisor.

Firstly, ExecuFlora came during Week 1 (20 June 2016) to remove all the plants currently in the workspace. These consisted of 9 x 40cm diameter stainless steel pots consisting of two *Dracaena Americana*, two *Ficus Alii*, three *Natal Mahogany*, one *Bamboo Palm* and one *Dracaena Warneckii*. There were also six rectangular desk bowls filled with *Aglaonema* that were removed.

SE Controls also came during Week 1 (21 June 2016) and installed three NVLogIQ Room Controllers in different areas of the work space. The three areas can be found on the floor plan (Appendix A). These devices took measurements of CO_2 levels, temperature and relative humidity approximately every 30 minutes. They were specifically placed in order to get full coverage of the area.

VOCs were measured on a weekly basis beginning 23 June 2016 using the Tiger^{LT} device. All measurements were conducted on a Thursday morning at about 10:00, until 21 July 2016. From 22 July 2016 until 5 September 2016 the Tiger^{LT} had to be sent to the UK for its yearly calibration. VOC measurements continued as soon as it returned to South Africa on 8 September 2016. To assess whether VOC levels returned to pre-intervention levels, VOC readings were taken on 6 October 2016, for the final time.

Before Week 1 the researcher was trained on how to use the Tiger^{LT} and was able to pre-programme data points into the device based on where the researcher wanted the data points in VitalityLife to be. The data points can be found on the floor plan (Appendix A). Nine data points were chosen. These were chosen specifically because they were not near air-conditioning vents and were equally distributed amongst the work space. The researcher had to measure the data points three times each. Firstly measuring TVOCs, then Benzene and lastly Xylene levels in the air. After every session the results were transferred onto the researcher's computer using a special Ion Science PC package and the results were tabulated into an Excel document.

During Week 3 (7 August 2016), while there were still no plants present, the researcher organised a convenient time to go to VitalityLife to approach the employees in order to get baseline psychological perception measures. The researcher and research supervisor were present and approached each employee separately. Each employee was given the questionnaires by hand and briefed that the project was assessing employee well-being. They were shown the information sheet (Appendix J) and it was emphasised that the research was voluntary. Employees were also told that the researcher was there if they wanted to ask any questions pertaining to the questionnaires.

The information sheet included the fact that there was to be another assessment with the same questionnaires after approximately three months. They were provided with a prompt to create a special code that would only have meaning to the individual. This enabled the matching of responses from Time 1 to Time 2. The prompt was as follows: please put the first letter of the month you were born; the last letter of your surname; the second letter of your first name] for example Lara Bloch's (Born in April) special number would be AHA.

The researcher remained in the office for four hours afterwards and either walked up and down the work space asking if the employees had completed their questionnaires or remained in the pause area while waiting. Some employees were too busy to complete the

questionnaire that day so the researcher returned briefly two days afterwards to collect any outstanding questionnaires.

All the information from the questionnaires were captured and inputted into a Microsoft Excel document.

At the beginning of Week 4 (11 July 2016), ExecuFlora returned and installed plants around the work space. At the beginning of Week 5 (19 July 2016) ExecuFlora returned and installed more plants, bringing the total number to 24. These plants consisted of nine *Sanserveria trifasciata* plants in tubus square pots; eight *Chamaedorea Seifritzii* plants in tubus square pots; three *Ficus Alii* plants in tubus square pots; one *Ficus Lyrata* plant in a tubus square pot and three *Aglaonema* plants in rectangular desk bowls. They were specifically placed in order to get full coverage of the area.

During Week 13 (15 September 2016) the same procedure occurred as during Week 3. The same employees were approached and asked to complete a revised version of the same questionnaires. They were provided with the same information. Only one question was added to the Aesthetics Questionnaire at Time 2. The same procedure from Week 3 was followed.

During Week 14 (27 September 2016), ExecuFlora removed all their plants from the workplace. ExecuFlora replaced the plants that were previously in the work space back in their respective places on 17 October 2016 (Week 17).

SE Controls removed the three NVLogIQ Room Controllers during Week 18 (24 October 2016).

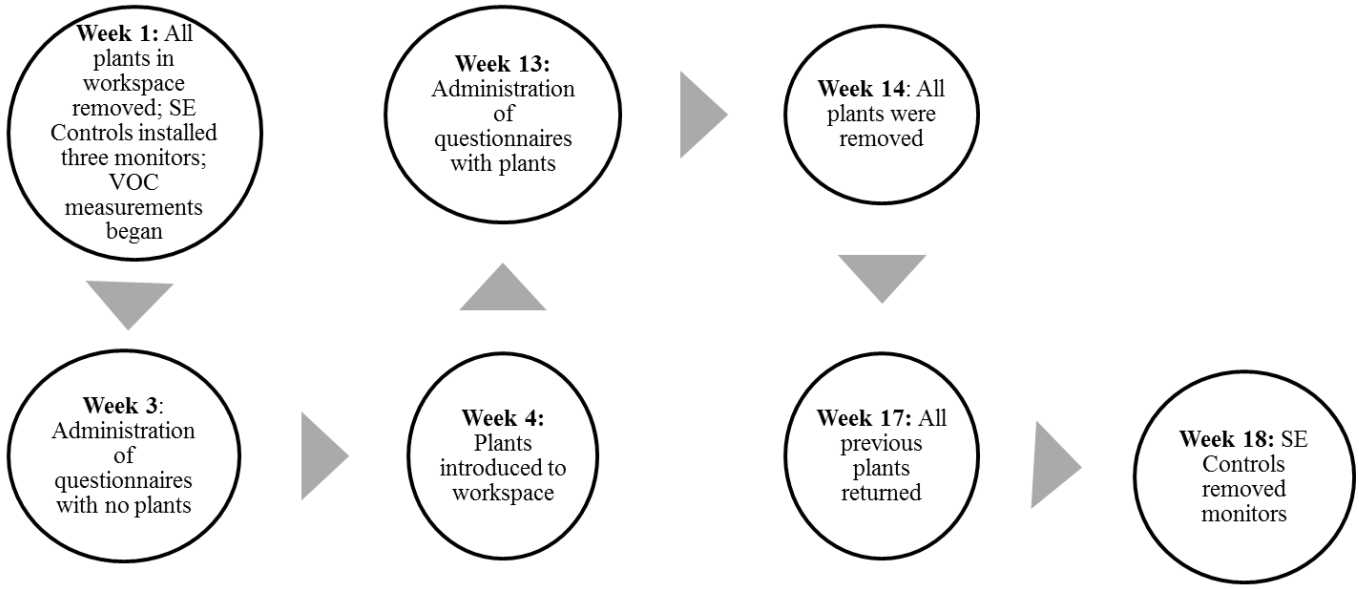

Figure 8: Timeline of the Research Process

It is important to note that there may have been a threat to internal validity with that of experimenter effects as a result of the researcher being on site during the research; however it may serve in a positive light in that participants were less likely to not partake in the research when the researcher is on site (Salkind, 2006). This was accounted for by the researcher not making any hints and simply handing out the questionnaires and then removing themselves from the process by standing back and away from the participants while they completed the questionnaires.

2.5 Ethical Considerations

Before any data were collected, the research was presented to the Human Research Ethics Committee of the School of Human and Community Development of the University of the Witwatersrand for ethical clearance. Data collection only began once ethical clearance was granted.

Informed consent is very important in research as it speaks to taking part in research once you are knowledgeable about what the research entails and what is expected of you and that you are not being coerced into participating. This was ensured through the participant information sheet that outlined what the study is about and that it was voluntary. The submission of the questionnaire was considered as consent.

Anonymity refers to concealing the identities of participants resulting from the research (Walford, 2005; Wiles, Crow, Heath & Charles, 2008). Anonymity was ensured because the employees were presented with a prompt to create their own special code which only had meaning to the individual. There was no way for the researcher to identify who the participant was by looking at their special code. The researcher was not provided with a list of the names of the participants. This was merely a way of coding the questionnaires and matching them from Time 1 to Time 2. Only the researcher and supervisor had access to the raw data, and the organisation did not.

Confidentiality is also important in research as it is concerned with who has the right of access to the data provided by the participants (Walford, 2005; Wiles et al., 2008). Confidentiality was ensured by all raw data being kept in a locked cupboard and electronic data being kept on a password protected computer as well as only reporting on grouped data and general trends.

The participants also had the right to withdraw from the study at any point by providing the researcher with their special code, in order to identify the questionnaires to be removed from the study (Barrett, 2006; Salkind, 2006). However, no participants withdrew during the study. Individuals were not disadvantaged if they chose not to participate or advantaged if they chose to participate.

2.6 Data Analysis

All the data were put into Microsoft Excel and cleaned and checked for any errors. Then the questionnaires were matched according to the code the participants had to generate. Once this was completed the data were analysed using SPSS23. Descriptive statistics for the sample were generated and recorded, including means, standard deviation and frequencies.

The Internal Consistency Reliabilities for the measures were assessed using Cronbach's Alpha and reported on.

Before choosing what statistical tests to use, tests of normality were conducted for the psychological perceptions data, the VOC data and the SE Controls data. The skewness and kurtosis was analysed as well as the Shapiro-Wilk statistic. Due to all the data not being completely normally distributed, it underwent a Log Transformation, to try and make the data more normal; however the transformations on all the data either made little difference or

made the data even more non-normal. Thus, the original data were used. Based on the normality results and the fulfilment of the required assumptions, psychological perceptions research questions one to three were assessed using the parametric Matched-Pairs t-test and the non-parametric Wilcoxon Matched-Pairs Signed-Ranks Test. Research question four was divided into two different sections. The reason for this was that perceived attractiveness was only assessed at one time and thus, a moderation analysis could not be conducted. One section was assessed using a moderation analysis using Andrew Hayes' PROCESS add-on, which is a versatile computational tool that was optionally added to SPSS. Amongst many other abilities it is able to compute moderations and this tool was used (Hayes, 2012). The other section used a partial correlation. A variable was added called "Number of Plants" which was a manipulation check in order to assess whether the participants noticed a difference between Time 1 and Time 2. A Matched-Pairs t-test was used to assess any statistically significant differences. With regard to the VOC and SE Controls data, based on the normality results and the fulfilment of the required assumptions, these variables were assessed using the non-parametric Wilcoxon Matched-Pairs Signed-Ranks Test.

All data were presented in tables and included the test statistic, p-value and if the statistic was significant or not. Those results that were significant had effect sizes reported for them.

CHAPTER 3: RESULTS

The purpose of this chapter was to document the results obtained from the collected data. This chapter is roughly divided into two sections. Section one looks at the workplace exposure descriptive statistics and the results of the psychological perceptions. The reliabilities of the scales are included and then the tests of normality (Kurtosis, Skewness and Shapiro-Wilk) are conducted in order to determine which statistical tests were most appropriate. The Matched-Pairs t-test was used in order to analyse the results for research questions one to three. Research question four was divided into two parts. Part one was analysed by using a moderation analysis and part two used a partial correlation. Section two focuses on the results pertaining to the physical environment (research questions 5-10). Both VOC and SE Controls data were assessed for normality (Kurtosis, Skewness and Shapiro-Wilk) in order to determine which tests were appropriate. The test used in order to analyse this section's results was the Wilcoxon Matched-Pairs Signed-Ranks test. All means and standard deviations were reported and effect sizes were reported for any significant result. This chapter utilises tables, graphs and figures in order to illustrate the results in a comprehensive manner. The researcher used SPSS23 in order to generate the statistics for the current study. The results are presented below.

3.1 Workplace Exposure Descriptive Statistics

Table 5: Descriptive Statistics for Hours per Day at the Workspace for the matched sample

Hours per Day at Workspace			
Mean	**Standard Deviation**	**Minimum**	**Maximum**
8.53	1.08	7.00	11.00

Table 6: Descriptive Statistics for Days per Week at the Workspace for the matched sample

Days per Week at Workspace			
Mean	**Standard Deviation**	**Minimum**	**Maximum**
4.71	1.19	5.00	6.00

3.2 Psychological Perceptions Results

3.2.1 Reliability Tests

This section shows the reliability coefficients for the perception scales used in this study during Time 1 and Time 2, as well as what the values indicated. Internal consistency reliability is defined as consistency across the questions of a measuring instrument (Cortina, 1993; Huck, 2012). The statistic of Cronbach's Alpha was chosen in order to assess the internal consistency reliability because it can be used with instruments made up of items that can be scored with three or more possible values, as in this study (Huck, 2012). Although Schmitt (1996) suggested that there is no acceptable or unacceptable level of alpha, Pallant (2013) suggested that it is preferred to have an alpha level of above .80 to be considered as acceptable.

Table 7: Reliability tests for the scales used in the study

Cronbach's Alpha (Time 1 and Time 2)			
	N	**Cronbach's Alpha (α) (Time 1)**	**Cronbach's Alpha (α) (Time 2)**
KPDS	6	.87	.91
SBS Questions	15	.89	.87
UWES-9	9	.95	.97
Aesthetics Questionnaire	17	.92	.94

As indicated in Table 7 all four scales were well within the acceptable levels and in fact showed extremely high levels of internal consistency reliability at both Time 1 and Time 2. The lowest alpha level was .87 (KPDS at Time 1 and the SBS Questions at Time 2) which was well above .80. This shows that the KPDS; the SBS Questions; the UWES-9 and the Aesthetics Questionnaire all showed extremely good levels of internal reliability.

3.2.2 Tests of Normality for Psychological Perceptions

In order to assess which test to use in order to answer the research questions, namely a parametric or a non-parametric test, one needs to look at the assumptions of normality for the data. Numerous tests of normality were reported in the tables below and the results were discussed in order to reach a conclusion.

Missing data were handled by pairwise deletion. This means that the analyses were still conducted on cases that contained some missing data (Peugh & Enders, 2004). The reason for this was that the sample was already quite small and the researcher did not want analysis only run on cases that had a complete set of data as this would have decreased the sample size and limited the results.

Table 8: Kurtosis and Skewness for the scales used in the study

Kurtosis and Skewness (Time 1 and Time 2)				
	Time 1		**Time 2**	
	Kurtosis	**Skewness**	**Kurtosis**	**Skewness**
KPDS	2.45	1.38	1.85	1.32
SBS Questions	-1.18	.38*****	-1.04	.36*****
UWES-9	.93*****	-.79*****	-.87*****	-.35*****
Aesthetics Questionnaire	.25*****	.08*****	1.10	-.96*****

****** falls within the -1; 1 range*

Kurtosis and skewness are indicators of normality. If the values fall within the -1; 1 range, it can be considered as normally distributed (Field, 2009; Huck, 2012; Joanes & Gill, 1998). As indicated in Table 8 above, the UWES-9 and the Aesthetics Questionnaire at Time 1 were normally distributed as all the values fell within the -1; 1 range. The rest of the scales did not fall within the -1; 1 range, with the highest value being 2.45.

Table 9: Shapiro-Wilk Tests of Normality for the scales used in the study

Shapiro-Wilk (Time 1 and Time 2)						
	Time 1			**Time 2**		
	Stat	***p-value***	***Sig.***	***Stat***	***p-value***	***Sig.***
KPDS	.17	.02*	**Sig**	.16	.03*	**Sig**
SBS Questions	.15	.06	**N/S**	.15	.07	**N/S**
UWES-9	.17	.02*	**Sig**	.12	.20	**N/S**
Aesthetics Questionnaire	.69	.20	**N/S**	.14	.12	**N/S**

The Shapiro-Wilk is a test of normality. The null hypothesis of this test is that the variables are normally distributed. Thus, if the significance value is less than .05, then the null hypothesis is rejected and there is evidence that the data tested are not normally distributed

(Field, 2009; Huck, 2012). Thus, looking at Table 9 above, one can see that only the KPDS at Time 1 ($W_{(33)} = .87$, $p < 0.05$) and Time 2 ($W_{(33)} = .86$, $p < 0.05$) showed insufficient evidence to suggest it is normally distributed, as well as the UWES-9 at Time 1. The other scales however ($p > .05$) showed evidence of them being normally distributed.

Thus, by looking at the results of the normality tests above, it can be seen that although not all the skewness and kurtosis values fell within the -1; 1 range, they were not far out of the range. The Shapiro-Wilk indicated that all the tests were normally distributed except for the KPDS.

Thus, the parametric Matched-Pairs t-test was used, in order to answer research questions regarding the SBS and UWES-9, under the psychological perceptions and the KPDS was assessed using the non-parametric Wilcoxon Matched-Pairs Signed-Ranks Test. A Matched-Pairs t-test was conducted on the Aesthetics Questionnaire. In order to answer question four under psychological perceptions, a moderation analysis and a partial correlation were conducted. As a result of the data not being completely normally distributed, a Log Transformation was conducted. The log transformation can be used to make highly skewed distributions less skewed (Feng et al., 2014). However, the transformation either made little difference or made the data even more non-normal, so the original data were used.

3.3 Research Questions 1-3 for Psychological Perceptions

This section answers the following questions:

1. Does engagement with work of the occupants increase after the introduction of indoor plants in a workspace?

2. Does psychological well-being of the occupants increase after the introduction of indoor plants in a workspace?

3. Does physical well-being of the occupants increase after the introduction of indoor plants in a workspace?

Before beginning the analyses, the following assumptions of the Matched-Pairs t-test were considered:

a. Data are paired or matched and have been drawn from the same population. This was true for this sample;
b. Each pair is chosen randomly and independently in that every person in the sample has an equal chance of being chosen. This was also true for this sample;
c. The data are continuous in nature, which was true for this sample; and
d. The data should be approximately normally distributed, which it was (Field, 2009). According to Santiago (2015), the Matched-Pairs t-test is quite "robust" to violations of normality, meaning even if the data are not completely normally distributed, the results remain valid. The KPDS however, was not normally distributed for all the tests of normality (kurtosis, skewness and the Shapiro-Wilk).

So too were the assumptions of the Wilcoxon Matched-Pairs Signed-Ranks Test met namely:

a. Data are paired or matched and have been drawn from the same population. This was true for this sample;
b. Each pair is chosen randomly and independently in that every person in the sample has an equal chance of being chosen. This was true for this sample; and
c. The data are at least ordinal in nature, which this study's data were (Kerby, 2014).

The means and standard deviations of the scales at Time 1 and Time 2 are reported below.

Table 10: Means and Standard Deviations between Psychological Perceptions at Time 1 and Time 2

Means & Standard Deviations (Time 1 and Time 2)

	Time 1		**Time 2**	
	Means	**SD**	**Means**	**SD**
KDPS	1.71	.69	1.79	.79
SBS Questions	1.78	.48	1.76	.53
UWES-9	4.00	1.26	3.78	1.39
Aesthetics Questionnaire	3.05	.89	3.13	.75

For all the Matched-pairs t-tests, missing data were handled by excluding cases analysis by analysis which means that each t-test used all cases that had valid data for the variable tested (Kirkpatrick & Feeney, 2012).

Table 11: Matched-Pairs t-test for Number of Plants variable

	Number of plants	
t-statistic	-7.56	
p-value	.00	
Sig.	**Significant**	
ES	1.42 (large)	
	Mean (*SD*) (Time 1)	**Mean (*SD*) (Time 2)**
	1.90 (*.82)*	3.25 (*1.06*)

A question was added in the questionnaire with regard to how many plants, windows with a view of nature and how many artworks of nature each employee was able to see from their desk. This was a manipulation check to ensure that there was a difference between Time 1 and Time 2 in terms of being in contact with plants. The results as depicted above indicated that there was significant evidence to suggest that there was a difference, which was the desired effect. A Wilcoxon Matched-Pairs Signed-Ranks Test was also run and yielded the same results ($Z_{(34)} = -4.716$, $p < 0.05$).

An effect size does not refer to statistical significance but rather how meaningful the difference of the effect was (Howell, 2008). Although an effect may be statistically significant, an effect size assesses the practical significance (Huck, 2012). Cohen's d was selected as it is an appropriate effect size statistic for the comparison between two means and was used to indicate the standardised difference between two means (Howell, 2008). Cohen (1988) suggested the following criteria of .2 being a small effect size; .5 being a moderate effect size; and .8 being a large effect size. The formula used, for a Matched-Pairs t-test, was Cohen's $d = (M_2 - M_1) / SD_{pooled}$, where $SD_{pooled} = \sqrt{((SD_1^2 + SD_2^2) / 2)}$ (Howell, 2008). The calculated effect size above was 1.42 which is extremely large. This indicates a very meaningful difference between Time 1 and Time 2.

Table 12: Matched-Pairs t-test for SBS, UWES-9 and Aesthetics Questionnaire at Time 1 and Time 2

	SBS Questions	**UWES-9**	**Aesthetics**
t-statistic	.24	1.37	-.42
p-value	.81	.18	.68
Sig.	**N/S**	**N/S**	**N/S**

As shown in Table 12 above, there is no statistically significant relationship between Aesthetics at Time 1 and Time 2.

Table 13: Wilcoxon Matched-Pairs Signed-Ranks Table for the KPDS

Ranks for KPDS				
		N	**Mean Rank**	**Sum of Ranks**
TVOC Time 2 – TVOC Time 1	**Negative Ranks**	11[a]	14.59	160.50
	Positive Ranks	17[b]	14.44	245.50
	Ties	6[c]		
	Total	34		

a. KPDS Time 2 < KPDS Time 1

b. KPDS Time 2 > KPDS Time 1

c. KPDS Time 2 = KPDS Time 1

As depicted above in Table 13, one can see that the majority of responses at Time 2 were higher than the levels at Time 1.

Table 14: Summary of Wilcoxon Matched-Pairs Signed-Ranks Test for the KPDS

KPDS	
Z-statistic	-.97[a]
p-value	.33
Sig.	**N/S**

a. Based on negative ranks

As depicted in Tables 12 and 14 above, the results for questions one to three under psychological perceptions showed that psychological well-being; physical well-being and

work engagement were non-significant. A Wilcoxon Matched-Pairs Signed-Ranks Test was also run and yielded the same non-significant results, for the SBS and UWES-9. This means that there is insufficient evidence to suggest that there is a relationship between the presence of plants and differences in these psychological perceptions at Time 1 and Time 2. As these relationships were non-significant, no effect sizes were calculated. This ultimately means that in terms of the research questions one to three, there were no statistically significant differences or increases found.

In order to see if there were any other differences, the researcher decided to look at each item on the scales in order to see if there were specific individual differences by doing separate tests for each item. They are presented and discussed in the tables below.

Table 15: Wilcoxon Matched-Pairs Signed-Ranks Test for variables at Time 1 and Time 2 on the Kessler Psychological Distress Scale Items

KPDS Items					
	Mean (*SD*) (Time 1)	**Mean (*SD*) (Time 2)**	***Z-statistic***	***p-value***	***Sig.***
Feel so depressed that nothing could cheer you up	1.79 (*.96)*	1.88 (*1.04*)	-.70[a]	.48	**N/S**
Feel nervous	1.70 (*.88*)	2.03 (*.94*)	-1.86[a]	.06	**N/S**
Feel restless or fidgety	1.97 (*.98*)	2.06 (.93)	-.45[a]	.65	**N/S**
Feel worthless	1.39 (*.75*)	1.35 (*.82*)	-.11[b]	.91	**N/S**
Feel hopeless	1.36 (*.60*)	1.44 (*.83*)	-.81[a]	.42	**N/S**
Feel that everything was an effort	2 (*1.07*)	2 (*1.13*)	-.17[b]	.87	**N/S**

a. Based on negative ranks
b. Based on positive ranks

As depicted in Table 15, the Wilcoxon Matched-Pairs Signed-Ranks Test showed that all the items on the scale showed that there is insufficient evidence to suggest that there is a difference between Time 1 and Time 2 for the KPDS items. As these relationships were non-significant, no effect sizes were calculated.

Table 16: Matched-Pairs t-test for variables at Time 1 and Time 2 on the Sick Building Syndrome Questions Items

SBS Questions					
	Mean (*SD*) (Time 1)	**Mean (*SD*) (Time 2)**	***t-statistic***	***p-value***	***Sig.***
Excessive mental fatigue	1.91 (*.91*)	2.94 (*1.79*)	-1.19	.24	**N/S**
Headache in your forehead	1.94 (*.78*)	2.03 (*.94*)	-.57	.57	**N/S**
Dry eyes	1.85 (*.96*)	1.68 (*.74*)	1.44	.16	**N/S**
Irritated or sore eyes	2.03 (*.90*)	1.79 (*.77*)	1.44	.16	**N/S**
Tiredness / Strained eyes	2.29 (*.85*)	2.12 (*.89*)	1.00	.33	**N/S**
Nervousness or irritability	1.82 (*.76*)	1.82 (*.72*)	.00	1.99	**N/S**
Tiredness or lethargy	2.09 (*.91*)	2.18 (*.86*)	-.21	.84	**N/S**
Stuffy or congested nose	1.88 (*.78*)	2.03 (*1.00*)	-1.07	.29	**N/S**
Sore or irritated throat	1.71 (*.68*)	1.61 (*.89*)	.68	.50	**N/S**
Runny nose	1.85 (*.89*)	1.79 (*1.04*)	.37	.71	**N/S**
Hoarseness	1.29 (*.58*)	1.41 (*.70*)	-.94	.35	**N/S**
Dry skin	1.65 (*.88*)	1.62 (*.92*)	.17	.87	**N/S**
Dizziness	1.61 (*.79*)	1.47 (*.71*)	1.00	.33	**N/S**
Wheezing or chest tightness	1.39 (*.61*)	1.38 (*.60*)	.33	.74	**N/S**
Nausea	1.35 (*.60*)	1.29 (*.52*)	.53	.60	**N/S**

As depicted in Table 16, with regard to the Matched-pairs t-test all the items on the scale suggested that there was insufficient evidence to suggest that there was a difference between Time 1 and Time 2 for the SBS Questions items. As these relationships were non-significant, no effect sizes were calculated.

Table 17: Matched-Pairs t-test for variables at Time 1 and Time 2 on the Utrecht Work Engagement Scale Items

UWES-9					
	Mean (*SD*) (Time 1)	**Mean (*SD*) (Time 2)**	***t-statistic***	***p-value***	***Sig. (ES)***
At my work, I feel like I am bursting with energy	3.50 (*1.29*)	3.62 (*1.33*)	-.57	.57	**N/S**
At my job I feel strong and vigorous	3.74 (*1.36*)	3.79 (*1.47*)	-.31	.76	**N/S**
I am enthusiastic about my job	4.06 (*1.39*)	3.85 (*1.44*)	.88	.39	**N/S**
My job inspires me	3.79 (*1.50*)	3.42 (*1.46*)	1.88	.07	**N/S**
When I get up in the morning, I feel like going to work	3.94 (*1.63*)	3.62 (*1.49*)	1.99	.04	**Sig (*.20*)**
I feel happy when I am working intensely	4.12 (*1.50*)	3.94 (*1.67*)	.73	.47	**N/S**
I am proud of the work that I do	4.56 (*1.67*)	4.00 (*1.74*)	2.01	.04	**Sig (*.34*)**
I am immersed in my work	4.24 (*1.50*)	3.85 (*1.56*)	2.08	.04	**Sig *(.25)***
I get carried away when I am working	4.06 (*1.59*)	3.85 (*1.62*)	.88	.39	**N/S**

As depicted in Table 17, when looking at the Matched-pairs t-test the items that indicated sufficient evidence for a statistically significant difference between Time 1 and Time 2 were "When I get up in the morning, I feel like going to work"; "I am proud of the work that I do" and "I am immersed in my work". All three items' means decreased, indicating a significant decrease in work engagement.

The effect sizes were calculated for the three significant results using Cohen's d as explained above. The effect sizes for the three significant results were all small. This means that the differences were not very large or meaningful.

3.4 Research Question 4 for Psychological Perceptions

This section addresses the following question:

4) Do perceived aesthetics and perceived attractiveness of the plants moderate the above relationships (psychological well-being; physical well-being and work engagement)?

3.4.1 Moderation of Perceived Aesthetics on Psychological Perceptions

A "new" variable was created which was called a change in aesthetics. The way in which this was calculated was Aesthetics at Time 1 was subtracted from Aesthetics at Time 2 for each item. Change in Aesthetics became the moderating variable.

Table 18: Mean and Standard Deviation for Change in Aesthetics Variable

Change In Aesthetics	
Mean	**SD**
.79	1.90

All variables were mean centred in order to make the interpretation of the parameter estimates easier. So too was the chance of the lack of heteroscedasticity controlled for and taken into account (Field, 2013).

For each psychological measure three moderations were conducted. The Hayes tool was used to conduct the moderations below.

Table 19: Moderation of Change in Aesthetics on psychological perceptions

Moderation of Perceived Aesthetics			
	p-value	***R^2 increase due to the interaction***	***Sig.***
Psychological Well-Being	.22	.09 (N/S)	**N/S**
Physical Well-Being	.91	.00 (N/S)	**N/S**
Work Engagement	.35	.73 (N/S)	**N/S**

Psychological Well-Being

The overall model was significant F (3,29) = 4.61, $p < .05$ which means that psychological well-being at Time 1, perceived aesthetics and their interaction predicted psychological well-being at Time 2 better than chance. The $R^2 = .57$, which means that 57% of the variance was due to psychological well-being at Time 1, perceived aesthetics and their interaction.

There was however, a non-significant interaction between perceived aesthetics and the relationship between psychological well-being (b = -.47, t (29) = -1.24, $p > .05$).

Physical Well-Being

The overall model was significant F (3,29) = 4.22, $p < .05$ which means that physical well-being at Time 1, perceived aesthetics and their interaction predicted physical well-being at Time 2 better than chance. The $R^2 = .46$, which means that 46% of the variance was due to physical well-being at Time 1, perceived aesthetics and their interaction.

There was however, a non-significant interaction between perceived aesthetics and the relationship between physical well-being (b = -.04, t (29) = .12, $p > .05$).

Work Engagement

The overall model was significant F (3,29) = 14.46, $p < .05$ which means that work engagement at Time 1, perceived aesthetics and their interaction predicted work engagement at Time 2 better than chance. The $R^2 = .65$, which means that 65% of the variance was due to work engagement at Time 1, perceived aesthetics and their interaction.

There was however, a non-significant interaction between perceived aesthetics and the relationship between work engagement (b = -.08, t (29) = .35, $p > .05$).

3.4.2 Partial Correlation of Perceived Attractiveness of plants on Psychological Perceptions

A question was added at Time 2 "to what extent do you think that the plants in your office are attractive?" The potential answers were (1) not at all attractive; (2) somewhat attractive; (3) neutral; (4) attractive and (5) extremely attractive. Thus, a higher score indicated an increase in perceived attractiveness of the plants.

Table 20: Mean and Standard Deviation for perceived attractiveness Variable

Perceived Attractiveness	
Mean	**SD**
3.25	1.21

Table 21: Frequency Table for perceived attractiveness variable

Item Response	Frequency	Percent (%)
Not at all Attractive	4	11.8
Somewhat Attractive	3	8.8
Neutral	13	38.2
Attractive	8	23.5
Extremely Attractive	6	17.6

As depicted in Table 21, the 'neutral' response was reported by 38.2% of the participants, with 20.6% falling toward the unattractive side and 41.1% falling toward the attractive side.

Table 22: Normality Tests for Perceived Attractiveness

Normality of Perceived Attractiveness				
Kurtosis	**Skewness**	**Shapiro-Wilk**		
-.45*	-.33*	***Stat***	***p-value***	***Sig***
		.90	.004	Sig

**falls within the -1; 1 range*

As shown above in Table 22, according to skewness and kurtosis, perceived attractiveness is normally distributed; however, the Shapiro-Wilk suggests it is not. A Log Transformation was run and made the data even more non-normally distributed, thus, the original data were used.

Table 23: Correlations between the IVS, DVs and Perceived Attractiveness

Correlations	
KPDS Time 1 - Perceived Attractiveness	.11
KPDS Time 2 - Perceived Attractiveness	-.15
KPDS Time 1 – Time 2	.54
SBS Time 1 - Perceived Attractiveness	-.25
SBS Time 2 - Perceived Attractiveness	-.31
SBS Time 1 – Time 2	.66
UWES-9 Time 1 - Perceived Attractiveness	.17
UWES-9 Time 2 - Perceived Attractiveness	.16
UWES-9 Time 1 – Time 2	.76

As shown in Table 23, the above correlations are extremely small and do not indicate linear relationships.

The partial correlation assesses whether the relationships between Time 1 and Time 2 persist after partialling out the variance explained by perceived attractiveness. The reason a normal moderation was not used was because perceived attractiveness was only assessed at Time 2.

The assumptions of a partial correlation were considered below:

a. There is one dependent variable and one independent variable and both are at least interval, which they are;
b. There are one or more control variables that are at least interval, which perceived attractiveness is;
c. There needs to be a linear relationship between all three variables. This is violated as shown in Table 22;
d. There should be no significant outliers. There are some outliers but due to the small sample size it is less statistically defensible to simply remove them;
e. The variables are approximately normally distributed, which they are (Linn & Werts, 1969; Osborne & Waters, 2002).

Table 24: Partial Correlation on psychological perceptions while controlling for perceived attractiveness

	Partial Correlation	
	Zero-Order Correlation	***Partial Correlation****
Psychological Well-Being	.54	.57
Physical Well-Being	.66	.64
Work Engagement	.76	.75

**when controlling for Perceived Attractiveness*

Psychological Well-Being

The zero-order correlation showed that there was a statistically significant large, positive correlation between psychological well-being at Time 1 and Time 2 ($r_{(32)} = .54$, $p < .05$) and the partial correlation showed that there was a statistically significant large, positive correlation between psychological well-being at Time 1 and Time 2, whilst controlling for perceived attractiveness($r_{(31)} = .57$, $p < .05$). The fact that the change was so small suggests that perceived attractiveness had virtually no influence in controlling for the relationship between psychological well-being at Time 1 and Time 2.

Physical Well-Being

The zero-order correlation showed that there was a statistically significant large, positive correlation between physical well-being at Time 1 and Time 2 ($r_{(32)} = .66$, $p < .05$) and the partial correlation showed that there was a statistically significant large, positive correlation between physical well-being at Time 1 and Time 2, whilst controlling for perceived attractiveness($r_{(31)} = .64$, $p < .05$). The fact that the change was so small suggests that perceived attractiveness had virtually no influence in controlling for the relationship between physical well-being at Time 1 and Time 2.

Work Engagement

The zero-order correlation showed that there was a statistically significant large, positive correlation between work engagement at Time 1 and Time 2 ($r_{(32)} = .76$, $p < .05$) and the partial correlation showed that there was a statistically significant large, positive correlation

between work engagement at Time 1 and Time 2, whilst controlling for perceived attractiveness($r_{(31)}$ = .75, p < .05). The fact that the change was so small suggests that perceived attractiveness had virtually no influence in controlling for the relationship between work engagement at Time 1 and Time 2.

The small correlations found in Table 23 also explain why there were no moderations. It suggested that the perceived attractiveness of the plants does not impact on well-being or performance outcomes.

In terms of question four there are no statistically significant results indicating any moderations.

3.4 Environmental Factors Results

3.4.1 Volatile Organic Compounds

3.4.1.1 Tests of Normality for Volatile Organic Compound Data

Although there were three different types of measurements taken: namely Time 1 (no plants); Time 2 (plants) and Time 3 (no plants), Time 3 consisted of only one reading. Thus, Time 1 and Time 3 readings were combined and averaged, in order to have the same weighting as the no plant condition. Thus, there were two groups: Time 1 (no plants) and Time 2 (plants). It is important to note that there were no missing data for the VOC measurements. This same method was used for the SE Controls data.

In order to assess which test to use in order to answer the research questions, namely a parametric or a non-parametric test, one needs to look at the assumption of normality for the data. Numerous tests of normality were reported in the tables below and the results were discussed in order to reach a conclusion.

Table 25: Kurtosis and Skewness for the VOC measurements

Kurtosis and Skewness (Time 1 and Time 2)				
	Time 1		**Time 2**	
	Kurtosis	**Skewness**	**Kurtosis**	**Skewness**
TVOC	-.83*	.92*	0.19*	1.01
Benzene	-2.56	-.27*	-1.71	.86*
Xylene	9.00	3.00	-1.71	.86*

**falls within the -1; 1 range*

If the values fall within the -1; 1 range, it can be considered as normally distributed (Field, 2009; Huck, 2012; Joanes & Gill, 1998). As indicated in Table 24 above, not all values fell within the -1; 1 range (TVOC Time 2; Benzene Time 1 and Time 2 and Xylene Time 1 and Time 2). Although some of the values did not fall within the -1; 1 range, they were not far out. There were only two very large values not within the -1; 1 range which were 9.00 and 3.00.

Table 26: Shapiro-Wilk Tests of Normality for the VOC measurements

Shapiro-Wilk (Time 1 and Time 2)						
	Time 1			**Time 2**		
	Stat	***p-value***	***Sig.***	***Stat***	***p-value***	***Sig.***
TVOC	.89	.22	**N/S**	.76	.008	**Sig**
Benzene	.66	.00	**Sig**	.62	.00	**Sig**
Xylene	.39	.00	**Sig**	.62	.00	**Sig**

The Shapiro-Wilk is a test of normality. The null hypothesis of this test is that the variables are normally distributed. Thus, if the significance value is less than .05, then the null hypothesis is rejected and there is evidence that the data tested are not normally distributed (Field, 2009; Huck, 2012). Thus, looking at Table 26 above, one can see that all the data were not normally distributed except for TVOCs at Time 1.

Thus, by looking at the results of the normality tests above, it can be seen although not all the skewness and kurtosis values fell within the -1; 1 range, they were not far out of the range.

The Shapiro-Wilk indicated that only TVOCs at Time 1 were normally distributed. Thus, by looking at the results of the normality tests above, it could be seen that most evidence points to the fact that the data were not normally distributed. Thus, the non-parametric version of the Matched-Pairs t-test was used, namely the Wilcoxon Matched-Pairs Signed-Ranks Test in order to answer research questions five to seven under the environmental factors. All the assumptions were met for the Wilcoxon Matched-Pairs Signed-Ranks Test (refer above).

As a result of the data not being completely normally distributed, a Log Transformation was conducted. However, the transformation either made little difference to the data or made it even more non-normal, thus, the original data were used.

This section answers the following questions with regard to Volatile Organic Compounds in the air:

5. Do TVOC levels decrease in the air after the introduction of indoor plants in a workspace?

6. Do Benzene levels decrease in the air after the introduction of indoor plants in a workspace?

7. Do Xylene levels decrease in the air after the introduction of indoor plants in a workspace?

Table 27: Means and Standard Deviations of the VOC Levels

Volatile Organic Compounds (ppm)				
	Time 1 (No Plants)		**Time 2 (Plants)**	
	Means	**SD**	**Means**	**SD**
TVOC	.69	.06	.55	.02
Benzene	.21	.01	.18	.02
Xylene	.13	.01	.14	.02

As can be seen in Table 27, simply by looking at the means TVOC levels and Benzene decreased at Time 2. Xylene, however, had a small increase at Time 2.

Table 28: Wilcoxon Matched-Pairs Signed-Ranks Table for TVOCs

Ranks for TVOCs				
		N	**Mean Rank**	**Sum of Ranks**
TVOC Time 2 – TVOC Time 1	**Negative Ranks**	9[a]	5.00	45.00
	Positive Ranks	0[b]	.00	.00
	Ties	0[c]		
	Total	9		

a. TVOC Time 2 < TVOC Time 1

b. TVOC Time 2 > TVOC Time 2

c. TVOC Time 2 = TVOC Time 1

As depicted above in Table 28, one can see that all observations of TVOCs at Time 2 were less than the levels at Time 1.

Table 29: Wilcoxon Matched-Pairs Signed-Ranks Table for Benzene

Ranks for Benzene				
		N	**Mean Rank**	**Sum of Ranks**
Benzene Time 2 – Benzene Time 1	**Negative Ranks**	9[a]	5.00	45.00
	Positive Ranks	0[b]	.00	.00
	Ties	0[c]		
	Total	9		

a. Benzene Time 2 < Benzene Time 1

b. Benzene Time 2 > Benzene Time 2

c. Benzene Time 2 = Benzene Time 1

As depicted above in Table 29, one can see that all observations of Benzene at Time 2 were less than the levels at Time 1.

Table 30: Wilcoxon Matched-Pairs Signed-Ranks Table for Xylene

Ranks for Xylene				
		N	**Mean Rank**	**Sum of Ranks**
Xylene Time 2 – Xylene Time 1	**Negative Ranks**	0[a]	.00	.00
	Positive Ranks	9[b]	5.00	45.00
	Ties	0[c]		
	Total	9		

a. Xylene Time 2 < Xylene Time 1
b. Xylene Time 2 > Xylene Time 2
c. Xylene Time 2 = Xylene Time 1

As depicted above in Table 30, one can see that all observations of Xylene at Time 2 were higher than the levels at Time 1.

It should be noted that there were no missing data for the VOCs.

Table 31: Summary of Wilcoxon Matched-Pairs Signed-Ranks Test for the VOCs

	TVOC	**Benzene**	**Xylene**
Z-statistic	-2.67[a]	-2.07[a]	-2.75[b]
p-value	.008	.007	.006
Sig.	**Significant**	**Significant**	**Significant**
Effect Size (r)	-.63 (moderate)	-.49 (moderate)	-.65 (moderate)

a. Based on positive ranks
b. Based on negative ranks

As depicted in Table 31 above, all VOCs were found to be significant, meaning there was statistically significant evidence to suggest a difference between the levels at Time 1 and Time 2. Thus, in terms of questions five to seven, by looking at the means, TVOCs and Benzene statistically significantly decreased in the air at Time 2, whereas Xylene levels appeared to have increased in the air after the introduction of plants.

There appear to be many ways of calculating the effect size for the Wilcoxon Matched-Pairs Signed-Ranks Test, however Pallant (2013) suggested dividing the Z-Statistic by the square root of N, where N is the number of observations of the two periods thus, (N*2). Then it was

interpreted with the same cut-offs as Cohen's d above. The Cohen's statistics reported above in Table 28 indicate that the effects were moderate and thus, quite meaningful.

3.4.2 SE Controls Data

Data were retrieved from the NVLogIQ Room Controllers, which had been installed in the workplace in three separate areas. Although there were devices placed in three separate areas, all areas were averaged to make one area. The reason for this was that there was nothing specifically special or outstanding about each area and they were all very similar and thus, they should all have yielded similar results. The reason for placing three devices in the workspace was to get an overall average of the readings for that workspace, not for each separate area. The hourly readings were taken and averaged for Time 1 (no plants) and Time 2 (plants). There were no missing data for the SE Controls data.

3.4.2.1 Tests of Normality for SE Controls Data

In order to assess which test to use in order to answer the research questions, namely a parametric or a non-parametric test, one needs to look at the assumption of normality for the data. Numerous tests of normality were reported in the tables below and the results were discussed in order to reach a conclusion.

Table 32: Kurtosis and Skewness for the SE Controls measurements

Kurtosis & Skewness (Time 1 & Time 2)				
	Time 1		**Time 2**	
	Kurtosis	**Skewness**	**Kurtosis**	**Skewness**
CO_2 (ppm)	.81*	1.30	.70*	1.29
Temperature (^{O}C)	-1.12	-.25*	.23*	-.54*
Humidity (%)	-.24*	-.03*	1.41	-.72*

**falls within the -1; 1 range*

If the values fall within the -1; 1 range, it can be considered as normally distributed (Field, 2009; Huck, 2012; Joanes & Gill, 1998). As indicated in Table 32 above, not all the values fell within the -1; 1 range (CO_2 levels at Time 1 and Time 2; temperature at Time 1 and humidity at Time 2). Although some of the values did not fall within the -1; 1 range, the largest number was 1.30.

Table 33: Shapiro-Wilk Tests of Normality for the SE Controls measurements

Shapiro-Wilk (Time 1 & Time 2)						
	Time 1			Time 2		
	Stat	***p-value***	***Sig.***	***Stat***	***p-value***	***Sig.***
CO_2 (ppm)	.82	.00*	**Sig**	.82	.00*	**Sig**
Temperature (ºC)	.95	.00*	**Sig**	.98	.00*	**Sig**
Humidity (%)	.99	.00*	**Sig**	.95	.00*	**Sig**

The Shapiro-Wilk is a test of normality. The null hypothesis of this test is that the variables are normally distributed. Thus, if the significance value is less than 0.05, then the null hypothesis is rejected and there is evidence that the data tested are not normally distributed (Field, 2009; Huck, 2012). Thus, looking at Table 33 above, one can see that all the data were not normally distributed. Thus, by looking at the results of the normality tests above, it can be concluded that the data were not normally distributed. Thus, the non-parametric version of the Matched-Pairs t-test was used, namely the Wilcoxon Matched-Pairs Signed-Ranks Test in order to answer research questions eight to ten under the environmental factors. All the assumptions were met for the Wilcoxon Matched-Pairs Signed-Ranks Test (refer above).

As a result of the data not being completely normally distributed, a Log Transformation was conducted. The transformation either made little difference to the original data or made the data even more non-normal, thus, the original data were used.

This section answers the following questions with regard to SE Controls:

8. Do CO_2 levels decrease in the air after the introduction of indoor plants in a workspace?

9. Do temperature levels decrease in the air after the introduction of indoor plants in a workspace?

10. Do relative humidity levels fall within the acceptable range in the air after the introduction of indoor plants in a workspace?

Table 34: Means and Standard Deviations of the SE Controls Data

SE Controls				
	Time 1 (No Plants)		Time 2 (Plants)	
	Means	**SD**	**Means**	**SD**
CO_2 (ppm)	661.17	273.19	643.53	242.22
Temperature (ºC)	22.78	1.56	22.73	1.57
Humidity (%)	30.87	10.13	25.74	8.76

By simply looking at the Table above one can see that CO_2, temperature and relative humidity levels decreased at Time 2. However, in order to assess whether the changes were statistically significant, Wilcoxon Matched-Pairs Signed-Ranks Tests were conducted below.

Table 35: Wilcoxon Matched-Pairs Signed-Ranks Table for CO_2 levels

Ranks for CO_2 levels				
		N	**Mean Rank**	**Sum of Ranks**
CO_2 Time 2 – CO_2 Time 1	**Negative Ranks**	582[a]	654.63	380995.00
	Positive Ranks	657[b]	589.32	387185.00
	Ties	78[c]		
	Total	1317		

a. CO_2 Time 2 < CO_2 Time 1

b. CO_2 Time 2 > CO_2 Time 2

c. CO_2 Time 2 = CO_2 Time 1

As depicted in Table 35 above, the majority of the results indicate that CO_2 levels at Time 2 were greater than at Time 1.

Table 36: Wilcoxon Matched-Pairs Signed-Ranks Table for Temperature

Ranks for Temperature				
		N	**Mean Rank**	**Sum of Ranks**
Temperature Time 2 – Temperature Time 1	**Negative Ranks**	635[a]	649.50	412433.00
	Positive Ranks	657[b]	643.60	422845.00
	Ties	25[c]		
	Total	1317		

a. Temperature Time 2 < Temperature Time 1

b. Temperature Time 2 > Temperature Time 2

c. Temperature Time 2 = Temperature Time 1

As depicted above in Table 36, the majority of the results indicate that Temperature levels at Time 2 were greater than at Time 1.

Table 37: Wilcoxon Matched-Pairs Signed-Ranks Table for Humidity

Ranks for Humidity				
		N	**Mean Rank**	**Sum of Ranks**
Humidity Time 2 – Humidity Time 1	**Negative Ranks**	882[a]	676.06	596285
	Positive Ranks	420[b]	599.92	251968.00
	Ties	15[c]		
	Total	1317		

a. Humidity Time 2 < Humidity Time 1

b. Humidity Time 2 > Humidity Time 2

c. Humidity Time 2 = Humidity Time 1

As depicted above in Table 37, the majority of the results indicate that humidity levels at Time 2 were less than at Time 1.

Table 38: Summary of Wilcoxon Matched-Pairs Signed-Ranks Test for the SE Controls data

	CO_2	Temperature	Humidity
Z-statistic	-.25[a]	-.39[b]	-12.69[a]
p-value	.81	.70	.00
Sig.	**N/S**	**N/S**	**Significant**
Effect Size (r)			-.23 (small)

a. Based on negative ranks

b. Based on positive ranks

Thus, in terms of questions eight and nine, there was no statistically significant evidence to suggest that there was a change in the levels of CO_2 and temperature at Time 1 and Time 2. In terms of question 10, there was statistically significant evidence to suggest that relative humidity levels decreased at Time 2. The effect size was only calculated for humidity as it was the only significant finding. The small effect size suggested that the difference was not large.

In summary the results showed that there were no statistically significant changes for work engagement, psychological well-being and physical well-being from Time 1 to Time 2. There were no moderations for perceived aesthetics from Time 1 to Time 2. In terms of environmental factors, TVOCs, Benzene and relative humidity statistically significantly decreased from Time 1 to Time 2. Xylene statistically significantly increased from Time 1 to Time 2. There was no statistically significant evidence to suggest a change in CO_2 and temperature levels from Time 1 to Time 2.

CHAPTER 4: DISCUSSION

The purpose of this chapter was to expand on and explain the results found, by considering the results within the context and within the theoretical framework of the study. The chapter is divided into two separate sections, namely the psychological perception results and the environmental factors results. The psychological perception results first consider three issues that pertain generally to the research questions and then the four research questions will be discussed separately. The environmental factors results section is divided into six sub-sections, namely the six research questions pertaining to the environmental factors. Finally, this chapter looks at the limitations of this study and provides recommendations for future research as well as the theoretical and practical implications of this study. The chapter ends off with a conclusion of this study.

4.1 Psychological Perceptions

With regard to the first three research questions (does engagement with work of the occupants increase after the introduction of indoor plants in a workspace?; does psychological well-being of the occupants increase after the introduction of indoor plants in a workspace?; does physical well-being of the occupants increase after the introduction of indoor plants in a workspace?), all results indicated that there were no statistically significant differences after the introduction of the plants. Three general issues that applied to all three questions are discussed below and then the three questions are considered separately.

a. Length of time of exposure to the plants: According to Bringslimark et al. (2009) habituation can play a very important role in studies involving plants. Habituation can be defined as "the diminishing of an innate response to a frequently repeated stimulus" (Colman, 2009, p. 330). Shoemaker et al. (1992) cited habituation as one of the reasons their research may have yielded non-significant results. Their research took place over three months. The plants in this study were introduced into the workspace on 11 July and the questionnaires were administered on 15 September. That is approximately 10 weeks. Thus, the plants may have had an effect in the first week but by the time the questionnaires were administered 10 weeks later, the effect had diminished. Even though for the number of plants questionnaire, the number of plants surrounding the participants increased statistically significantly at Time 2, the researcher was asking the participants to actively look around them at the plants. This is different to being passively surrounded by

plants and not being actively directed toward them at the time of answering the questionnaire. So too is it important to note that even prior to this research the workspace contained 15 plants, so the employees were potentially already used to seeing plants where they worked.

Compared to other studies which found significant results, their exposure times were extremely short such as 10-15 minutes (Lohr et al., 1996); 20 minutes (Larsen, Adams, Deal, Kweon & Tyler, 1998; Lohr & Pearson-Mims, 2000); 15 minutes (Kim & Mattson, 2002) and 10 minutes (Park, Mattson & Kim, 2004). Thus, if the participants had rather had shorter periods of exposure to the plants it may have yielded significant results due to the concentrated time periods.

On the other hand, the exposure time may have in fact been too short. For example, Fjeld (2000) conducted their study over a period of one year. They found significant results. Thus, if this research had been conducted over a longer period of time, it may have been able to take into account long-term extraneous variables such as the season changes, changes within the company and anything else that takes longer than three months to make a difference.

b. The Setting: This research was conducted in a real-life work setting. Most other research was conducted in different settings, whereby their significant results may have been due to the research context. There are a few distinctions to be made between some studies and their significant results as compared to the current study.

Some empirical research was conducted in an outdoor setting (Hartig et al., 1991) or in a setting with reference to recreational activities (Herzog et al., 1997). It is however, important to note that plants in an outdoor setting may strongly differ from plants in an indoor setting (Bringslimark et al., 2009). It has been argued that plants in an indoor setting are not in a natural environment but are simply part of the built environment, which affects the experience of the environment. Thus, plants indoors are more ambiguous than an outdoor experience. So too do recreational activities have no relevance to a work setting.

Most research with regard to plants is either lab-based or experimental (example Chang & Chen, 2005; Dravigne et al., 2008; Fjeld, 2000; Knight & Haslam, 2010; Lohr et al.,

1996; Raanaas et al., 2011; Ulrich 1979; Ulrich, 1981). This research however, was pre-experimental. Experimental research has many advantages that pre-experimental research does not. Firstly, experimental research is able to control for a number of extraneous variables that cannot be accounted for in pre-experimental research. Secondly, studies that are experimental are more guided and not indicative of a natural work-setting, whereby workers would generally passively interact with the plants (Bringslimark et al., 2009). In a highly stressful work environment it is unclear as to whether employees have time to focus on the plants around them. Lab-based studies, although they may yield significant results, do not represent a real-life work setting, such as the context where this research was conducted.

The setting in which the research takes place is extremely important as the effects of plants in different contexts may differ. Tennessen and Cimprich's (1995) setting was a university dormitory and Largo-Wight et al. (2011) used a university. These can easily be argued as very different to a work setting. Two studies discussed previously were conducted in a hospital setting (Park & Mattson, 2009; Ulrich, 1984). The main intention was to assess the length of recovery, after surgery, in two different conditions. Hospitals are places intended for restoration and healing whereas a workspace is not. Thus, plants in different settings may have different effects (Bringslimark et al., 2009).

Lastly something very important to focus on when assessing research is to look at the sample used. An example is Tennessen and Cimprich (1995) who found significant results but used a sample of students. Students are usually very homogenous and the results are not easily generalisable. Students are not the same as employees in a highly stressful work environment.

c. It is important to note that the majority of employees worked in the call centre and that a call centre is a very specific type of work environment. The concept of call centres being called "toxic" arose in the 1990s (Campbell, 2006). Bagnara and Marti (2001) have described call centres as "modern factories" (p. 223). Campbell (2006) argued that call centres have a sweatshop mentality whereby employees simply work to make money and where high turnover levels exist, which appears to be true in this study. So too does Campbell (2006) argue that call centres usually have a lack of regard for their employees and have poor management practices, which is another issue that arose during this research. Lombard (2008) suggests that as a result of call centre employees being exposed

to such sensory offensives (such as telephones ringing; continually speaking to people; and computer screens), employees are more likely to be stressed than people who do not work in a call centre.

4.1.1 Work Engagement

- *Does engagement with work of the occupants increase after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of work engagement had decreased (from 4.00 to 3.78) (a higher number indicates increased work engagement) however, this was shown to be statistically non-significant, by the Matched-Pairs t-test.

Robinson, Perryman and Hayday (2004) define work engagement as "a positive attitude held by the employee towards the organisation and its values. An engaged employee is aware of the business context and works with colleagues to improve performance within the job for the benefit of the organisation." (p. 6). The researcher had many informal conversations with the employees and issues that came up were a general unhappiness in their jobs, a lack of motivation from management, low remuneration, a feeling of being underappreciated and a feeling that their needs were not being taken into consideration. Thus, there appeared to be a problem within the organisation and with employee satisfaction towards the organisation.

These aspects could very possibly have negatively affected work engagement. The UWES-9 scale used to assess work engagement contained three aspects namely vigour, dedication, and absorption (Schaufeli & Bakker, 2006). The above factors would negatively affect mental resilience, a sense of enthusiasm and pride as well as being engrossed in one's work.

These results are in direct opposition to many studies discussed above (Knight & Haslam, 2010; Nieuwenhuis et al., 2014; Raanaas et al., 2011) as well as the ART. A likely explanation is that discussed above, the toxic call centre context.

Three items on the UWES-9 were found to be statistically significant. These items were "when I get up in the morning, I feel like going to work", where the means dropped from 3.94 to 3.62; "I am proud of the work that I do" where the means dropped from 4.56 to 4.00 and "I am immersed in my work" where the means dropped from 4.24 to 3.85. The reduction in means suggest a decrease in work engagement and supports what is suggested above. Nieuwenhuis et al.'s (2014) research suggested that engagement should result in enhanced

concentration levels and a greater sense of job satisfaction, which supports the above items and their decreased means.

Kalantzis (2016) found very similar results, in a very similar context. The researcher also used the UWES-9 scale and found that work engagement statistically significantly reduced from Time 1 to Time 2. The researcher also found statistically significant decreases in the means for the following items "I am enthusiastic about my job"; "I feel happy when I am working intensely" and lastly the item "I am proud of the work that I do" which was also found in this study. The main reason cited for this decrease was the problems within the organisation.

Employees who have low job satisfaction, such as those in this study, may have a myriad of negative consequences. Job dissatisfaction ultimately leads to higher levels of stress at work and will impact the quality of work that employees submit and ultimately lead to high turnover (Robbins, Judge, Odendaal & Roodt, 2009). In this study there was a difficulty in getting a large matched sample and it appeared to be due to high levels of turnover within the workspace from Time 1 and Time 2. This also indicates a potential problem within the organisation.

A possibility may have been that due to the problems within the organisation, the employees perceived the introduction of plants as a sort of bribery rather than a desire to improve the environment. This may have hindered their potentially positive response to the plants due to their scepticism.

According to the ART theory, focusing for prolonged periods on a task will result in fatigue. The ART posits that natural elements do not require extensive prolonged periods of attention and thus, will have a relaxing effect on brain functions and allow the fatigue from prolonged attention to be reversed (James, 1892, as cited in Raanaas et al., 2011). However, the ART requires people to actually focus on plants. Shibata and Suzuki's (2002) study involved participants performing an association task and an attentionally-demanding task, with or without the presence of plants. The participants performed better on an association task compared to the more attentionally-demanding task when they had a plant placed in front of them, compared to a no-plant condition. This could be due to the fact that a task requiring high attentional resources does not allow a person to attend to their environment. Therefore, plants may have little effect in highly stressful work environments. Thus, in an environment whereby there are tight deadlines and over-watching managers, it is doubtful that employees

have much time to focus on the plants around them. This may link to the habituation effect, whereby the employees almost forget to notice the plants as they become part of the workspace.

It is extremely important to take into account that physical work conditions, such as introducing plants into a workspace may not in fact be effective without investing in changing the psychosocial aspects of the workspace, such as managerial motivation, recognition, uncertainty or a lack of teamwork (Kraatz, Lang, Kraus, Munster & Ochsmannet, 2013; Widanarko, Legg, Devereux & Stevenson, 2014).

One also needs to take into account potential extraneous variables. These could include issues at home and financial stress that could affect the productivity of employees. According to Coka (2016), an average of 20 hours per month is spent by a financially stressed employee dealing with their financial issues at work. This obviously has an effect on the productivity of employees.

A study conducted by UNISA and Momentum in 2015, categorise people into four categories: financially distressed (4.3%) (constantly borrowing money just to be able to afford food, a place to live and transport); financially unstable (29.4%) (households that regularly miss payments and borrow more money every year just to get by every month); financially exposed (38.4%) (financial situation will be compromised by unexpected events and would require delving into long-term savings) and financially stable (27.9%) (households that plan finances over a long-term period and have savings put aside) (de Clerq et al., 2015).

4.1.2 Psychological Well-Being

- *Does psychological well-being of the occupants increase after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of psychological well-being had increased (from 1.71 to 1.79) (a higher number indicates increased psychological distress) however, this was shown to be statistically non-significant, by the Wilcoxon Matched-Pairs Signed-Ranks test. So too were none of the items on the KPDS found to be statistically significant. These findings were also found in a similar research context (Kalantzis, 2016).

There are numerous reasons for why this may have occurred. The studies cited above with regards to psychological well-being employed different proxy measures of psychological

well-being in an organisational context such as stress reduction (Largo-Wight, 2011; Ulrich, 1979; Ulrich 1984); job satisfaction (Dravigne et al., 2008; Knight & Haslam, 2010) and psychological comfort (Dravigne et al., 2008; Knight & Haslam, 2010). The scale used to assess psychological well-being can be argued to assess none of those proxies. When looking at the KPDS (Appendix C) one can see that it in fact assessed psychological well-being in terms of depression and anxiety. This is supported by the fact that there exists convergent construct validity with the DSM-IV diagnoses of depression and/or anxiety with the KPDS (Kessler et al., 2002). Thus, significant results may not have been found due to the measurement tool used. If a person was diagnosed with anxiety or depression, it is unlikely that the presence of plants would eradicate that. It is a clinical disorder that usually requires medication or intensive psychotherapy to attenuate the effects.

Along with depression and anxiety there are numerous other extraneous variables that could have accounted for no statistical differences. Two examples are worries over retrenchment and financial stresses. In the first three months of 2016, 15 000 South African employees lost their jobs (Peyper, 2016), thus, the fear of retrenchment is real. A study conducted in 2015 by the World Bank ranked South Africa as the world's top borrower (Coka, 2016). Seventy percent of unscheduled absenteeism is related to stress-related illnesses of which one of the causes is financial distress (Coka, 2016). Once again the presence of plants is unlikely to reduce these real stressors.

The same issues that pertain to work engagement above can be applied to psychological well-being namely the employees being unable to focus on the plants due to a stressful work schedule and the fact that if one does not address the psychosocial factors in the organisation, the physical changes may not be effective (Kraatz et al., 2013; Widanarko et al., 2014).

Unlike most of the experimental and international studies, Kalantzis (2016) conducted a study in South Africa, in a real-life work setting. The researcher also did not find any significant results with regard to participants, plants and an increase in psychological well-being. The reasons cited were intrinsic issues within the organisation. The researcher believes the same can be said about this study, as discussed above, such as high levels of turnover as well as the scepticism aspect as described above may also explain the non-significant results for psychological well-being.

This research was conducted mostly in winter and, as described above, SAD, is likely to have an effect on people's psychological well-being. Partonen and Lönnqvist (1998) describe SAD as "a form of recurrent depressive or bipolar disorder, with episodes that vary in severity" (p. 1369) and that "atypical depressive symptoms commonly precede impaired functioning, and somatic symptoms are frequently the presenting complaint at visits to family physicians" (p. 1369) which is a likely explanation for the non-significant differences found.

4.1.3 Physical Well-Being

- *Does physical well-being of the occupants increase after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of physical well-being had decreased (from 1.78 to 1.76) (a higher number indicates decreased physical well-being) however, this was shown to be statistically non-significant, by the Matched-Pairs t-test. So too were none of the items on the SBS questions found to be statistically significant. Kalantzis (2016) also found insufficient evidence to suggest that the presence of plants impacted the employees' physical well-being.

It is important to note that seven employees said they had a chronic underlying illness (Asthma; hay fever/pollen allergies; sinus problems only; sinus & high blood pressure). Although it is important to note that no flowering plants were chosen due to a chance of allergic reactions, if one has a chronic illness, it is unlikely plants would improve that monumentally.

A factor that may have contributed to the non-significant results is the weather or seasonal changes. Time 1 spanned from 21 June to 11 July (winter) (no plants), and Time 2 spanned from 12 July to 28 September (winter / spring) (plants). The changes in seasons may have affected the employees differently. The research was conducted mostly in winter. There was an increased chance of employees being sick throughout the entire period due to colds or flu as the employees sit very close together and no windows were open for fresh air (Mozes, 2015). Thus, the inclusion of plants would not have been able to make a profound difference to ill health.

Fjeld (2000) conducted a study whereby the intention was to assess whether indoor plants affected self-reported health and discomfort symptoms. It was found that the mean score sum, as a mean of 12 symptoms, was 23% lower during the period when the participants were

exposed to plants in their offices compared to the period without plants. However, the difference is that the study was able to control for seasonal differences by ensuring both three month periods were conducted in spring (the study was conducted over a period of a year).

Evenson et al. (2013), in a work setting, found that after plants were introduced into a workspace there was a significant reduction in both reported health complaints and environmental complaints. These results, after some time, were not statistically significant from the control group, which may have been due to habituation or the small sample size. The issues of habituation and a small sample size are equally pertinent to this study.

Another factor is the indoor air quality. SBS is usually caused by factors such as poor ventilation, contaminants in the air and high temperatures (Miller & Pogue, 2009; USEPA, 2009). As discussed below, the air quality was actually relatively good at Time 1, and contaminants were very low. Thus, as a result of the good air quality at Time 1 and Time 2, it is unlikely that there would be a significant difference between SBS as the air was never of a bad quality.

Lastly as mentioned above, it is important to note that introducing plants into an environment may not in fact be effective if the psychosocial issues in the environment are not attended to as well (Kraatz et al., 2013; Widanarko et al., 2014).

4.1.4 Aesthetics

- *Do perceived aesthetics and perceived attractiveness of the plants moderate the above relationships?*

Aesthetics refer to an appreciation of aspects concerned with beauty and nature (Sykes, 1982). Grinde (1996) posits a theoretical understanding of aesthetics. Those who view plants as aesthetically pleasing will be "rewarded" with a positive emotion leading to other positive consequences such as improved well-being whereas those who do not will be "punished" and not receive any positive consequences.

a. Change in Aesthetics: As shown in Chapter 3, no significant moderations were found for change in aesthetics on work engagement, psychological well-being or physical well-being. As shown in Chapter 3, there were no statistically significant differences found between a Change in Aesthetics between Time 1 and Time 2. As a result of there being no

relationship between the two variables, it was not possible for a moderation to have existed.

One of the biggest reasons the researcher believes this happened was a result of the measure used (Appendix F). The researcher wanted to find out whether the way in which the participants perceived the aesthetics of the plants would moderate psychological perceptions, not the aesthetics of the workplace. When looking at the Aesthetics Questionnaire, one can see it is very general to the workspace and not specific to plants. Aspects assessed such as whether the workspace is uncomfortable/comfortable; messy/neat; frightening/safe; crowded/uncrowded; noisy/quiet; drafty/still and confined/spacious are not at all related to the plants nor did they change during the research period. Thus, it was not assessing what the researcher intended it to assess and thus, no significant findings were found.

b. Perceived Attractiveness: As shown in Chapter 3, the partial correlations indicated that perceived attractiveness had no influence in controlling for the relationships between work engagement, psychological well-being and physical well-being.

It is important to take note of the frequencies of responses to the question: "To what extent do you think that the plants in your office are attractive?". The 'neutral' response was reported by 38.2% of the participants, with 20.6% falling toward the unattractive side and 41.1% falling toward the attractive side. Thus, one can see that most people either found the plants to be attractive or were neutral towards them. This is contradictory to some of the informal comments that the researcher received such as "it looks like a jungle in here" and "all these plants are bringing in bugs".

In terms of finding that perceived attractiveness is independent of the relationships between the psychological perceptions, there could be many reasons. It is assumed that people automatically prefer and find natural settings aesthetically pleasing which is not necessarily true. As previously mentioned people may not find plants to be aesthetically pleasing due to learning or experiences within cultural or community contexts as well as due to how people attach meaning to plants (Kellert, 2005).

This aspect was not explored within this study and may have had an impact as to why no relationships or moderations were found for perceived attractiveness. South Africa is

made up of numerous cultures and perhaps more research needs to explore how different South African cultures perceive plants.

As shown above, no significant relationships existed for the psychological perceptions to begin with. Thus, it would have been unlikely for a moderation to occur. Factors discussed above may be relevant to these non-significant results. No matter how attractive one finds plants, other factors may have overridden the effects such as psychosocial problems within the organisation, scepticism surrounding the introduction of the plants, not having time to attend to the plants, and habituation. No literature was found that specifically assessed the moderating effect of aesthetics on the relationships between work engagement and well-being, which would have been advantageous to compare and contrast to this research.

As previously mentioned, psychological well-being appeared to be assessing participants in a more clinical sense (depression and anxiety) rather than general stress. Thus, even if a depressed participant found plants to be attractive, it is unlikely to have had a major effect. So too if the participants were sick and cold throughout the research period, due to the season, the attractiveness of the plants, may not have had a large effect.

Wilson et al. (2016) posited a mutualism framework between plants and people. It was posited that a mutualism exists between plants because of their pleasing aesthetics; they are rewarding and induce positive emotions in people. In turn, people become fond of plants and are thus, more inclined to help cultivate them, keep them alive and healthy and disperse them. Thus, this aids in plants' two biggest enemies, reproduction and safety (Wilson et al., 2016). However, Wilson et al. (2016) was referring more towards flowering plants. Flowering plants could not have been used in this study due to the potential of any allergic reactions from the participants. Thus, perhaps if the plants had flowers, they would have been more likely to moderate the relationships.

4.2 Environmental Factors

It is important to take note that prior to this research, the workplace was not completely bereft of plants. There were already 15 plants in the workspace and although it may not have been sufficient, it is likely to have affected the air quality before the study began.

4.2.1 Total VOCs

- *Do TVOC levels decrease in the air after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of TVOCs had decreased (from .69 to .55 ppm) and this was shown to be statistically significant, with a moderate to large effect size, by the Wilcoxon Matched-Pairs Signed-Ranks test. The effect size suggests that the difference is quite meaningful. TVOC levels decreased in the air by 20% after the introduction of indoor plants into the workspace.

The fact that VOC levels significantly decreased supports the notion that plants are able to absorb and decrease VOC levels in the air. Wood et al. (2006) suggested that plants are able to reduce TVOCs by 50-75%. This study found a 20% decrease from Time 1, which is relatively large considering the TVOC levels were below 1 ppm at both Time 1 and Time 2. This result is supported by the study by Orwell et al. (2006) whereby plants reduced the TVOC levels in an office by 75%.

4.2.2 Benzene

- *Do Benzene levels decrease in the air after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of Benzene had decreased (from .21 to .18 ppm) and this was shown to be statistically significant, with a moderate effect size, by the Wilcoxon Matched-Pairs Signed-Ranks test. The effect size suggests that the difference is quite meaningful.

The acceptable level of Benzene is 1 ppm (NIOSH, 2014; OSHA, 2005). The workspace in the study had levels well below that, which was a positive start. Benzene levels in the air decreased by 14.29% at Time 2. These results are supported by the literature that different VOCs can be absorbed from the air by plants. The results are most likely due to the specific plants used. As previously mentioned, Treesubsuntorn and Thiravetyan (2012) found *Sanserveria trifasciata* to have a high removal efficiency of Benzene from indoor air and Saxena and Ghosh (2015) found *Chamaedorea Seifritzii* to effectively remove Benzene from the air. The workplace had nine *Sanservia trifasciata* and eight *Chamaedorea Seifritzii*

installed, which were obviously enough in order to decrease Benzene levels in the air. So too does *Chamaedora Seifritzii* have a VOC removal rating of 10, which is extremely high.

4.2.3 Xylene

- *Do Xylene levels decrease in the air after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of Xylene had slightly increased (from .13 to .14 ppm) however; this was shown to be statistically significant, with a moderate effect size, by the Wilcoxon Matched-Pairs Signed-Ranks test.

The current US Occupational Safety and Health Administration permissible exposure limit for Xylene is 100 ppm as an eight hour time-weighted average concentration (OSHA, 2005). In the workplace the Xylene levels were extremely low. Thus, it was never at a threatening level to begin with. Xylene did however, increase in the air by 7.69% at Time 2.

Amongst other things, Xylene is a by-product of human respiration (Wolverton, 1996). Although *Aglaonema* has been found to effectively reduce Xylene concentrations in the air (Song, Kim & Sohn, 2007), there were only three desk bowls installed and *Aglaonema* has a relatively low VOC removal rating of four. It is unclear as to whether the bowls were perhaps not placed in areas where there was a higher concentration of people and if not, the *Algaonema* may not have been able to remove enough Xylene from the air for a significant decrease. The workplace was quite tightly packed with people sitting in open plan offices very close together. So too may the levels already have been too low for any significant decreases. It is also possible that the plants needed to be installed for longer to see a decrease.

4.2.4 Carbon Dioxide

- *Do CO_2 levels decrease in the air after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of CO_2 had decreased (from 661.17 to 643.53 ppm) however; this was shown to not be statistically significant, by the Wilcoxon Matched-Pairs Signed-Ranks test.

The South African exposure limit of CO_2 is 5000 ppm (ACGIH, 1997). Thus, it can be clearly seen that the workplace levels are well below the limit. CO_2 levels in the air decreased

by 2.67% at Time 2, which is supported by the literature that plants are able to decrease CO_2 levels in the air. Although it was not statistically significant there was in fact a decrease. According to Kane International Limited (2016), CO_2 concentrations typical of occupied indoor spaces are usually between 350-1000 ppm, which is where the workplace levels were.

The reason the result may have been non-significant though could be due to the ventilation system installed in the workplace. The ventilation system is usually responsible for removing much of the CO_2 levels from the air and if it is a poor system, the plants are able to reduce only as much as they could alone. This would need to be explored.

4.2.5 Temperature

- *Do temperature levels decrease in the air after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of temperature had minimally decreased (from 22.78 to 22.73 ^{o}C) and this was shown to not be statistically significant by the Wilcoxon Matched-Pairs Signed-Ranks test. Temperature levels decreased by .22% at Time 2.

The slight decrease is supported in the literature as plants are able to decrease temperatures indoors in three different ways. Firstly through respiration, plants give of water vapour which has a cooling effect. Secondly, plants use sunlight for photosynthesis. Lastly, plants absorb carbon dioxide molecules, which usually trap heat (Kurniawan, 2004).

According to the South African Labour Guide (2016), temperatures inside offices should range between 21°C and 26°C. The summer temperature range is 21-24 °C and the winter temperature range is 24-26 °C.

As previously described in Chapter 3, Time 1 and Time 3 were combined. Thus, Time 1 spanned from 21 June to 11 July (winter) and "Time 3" spanned from 27 September to 24 October (spring / summer) (no plants), and Time 2 spanned from 12 July to 28 September (winter / spring) (plants). Although the temperatures were within the 21–26 °C range, Time 1 and Time 2, occurred in winter, and should have been between 24-26 °C, which it was not. This is consistent with the informal conversations had with many employees who continually complained of it being too cold. This is likely to have impacted work engagement, physical well-being and psychological well-being negatively.

Discovery VitalityLife uses a chiller plant using fan coil units for their indoor air-conditioning system. Discovery's standard building temperature is 21-24^{0}C. The air-conditioning system may not have allowed the plants to significantly decrease the temperature because it was too strong. Perhaps the temperature system should be allowed to be adjusted to suit the employees' comfort levels in order to potentially increase their work engagement, physical well-being and psychological well-being.

4.2.6 Relative Humidity

- *Do relative humidity levels fall within the acceptable range in the air after the introduction of indoor plants in a workspace?*

As shown in Chapter 3, at Time 2, the means of relative humidity had decreased (from 30.87 to 25.74%) and this was shown to be statistically significant, with a small effect size, by the Wilcoxon Matched-Pairs Signed-Ranks test. The effect size suggests that the change was not very meaningful. Relative humidity reduced by 16.62% at Time 2.

The optimal relative humidity levels in an office are between 30-60% (ASHRAE, 1992; Fang et al., 1998). Thus, at Time 1 the humidity levels were within the acceptable range, however by Time 2 it was below the acceptable level. Low humidity levels can increase the chances for dry nasal passages and skin, eczema and asthma (Brits, 2011).

As previously described in Chapter 3, Time 1 and Time 3 were combined. Thus, Time 1 spanned from 21 June to 11 July (winter) and "Time 3" spanned from 27 September to 24 October (spring / summer) (no plants), and Time 2 spanned from 12 July to 28 September (winter / spring) (plants).

According to ASHRAE (1992), if the relative humidity is 30%, the recommended temperature in winter should be between 21-24^{0}C, which it is, but on the low side.

In Johannesburg, the average humidity during the months of Time 1 is 51.75%. The average humidity during the months at Time 2 is 48.67% (World Weather and Climate Information, 2016). August is considered as the least humid month (which is the month included in Time 2). The relative humidity is Johannesburg is only considered comfortable when it reaches about 60%, thus, Johannesburg already has dry air, especially in winter.

In Johannesburg, the humidity at Time 1 is higher than the humidity at Time 2. This is in line with the results above. Time 2 mostly occurred in winter. The colder the temperature is the lower the humidity levels are (World Weather and Climate Information, 2016).

Thus, the researcher believes that the combination of the colder outside air, and the very low temperatures in the workplace, contributed to a decrease in relative humidity at Time 2.

There are numerous reasons why the plants may have been unable to increase the relative humidity in the air. It has been suggested that one needs to group plants closely together in a cluster in order for them to increase relative humidly effectively (Kostelnick, 2014). When the relative humidity is very low, the rate of transpiration increases. This can result in dehydration for the plant as well as potential tissue damage (Brown, 2015). Thus, the low humidity may have compromised the effective functioning of the plant. Some plants thrive in high humidity environments, such as *Ficus* trees (Kostelnick, 2014). This study had seven *Ficus Alii* and eight *Ficus Lyrata* plants. The ideal humidity range for healthy plant growth is 40-60% (Mortensen, 1986; Mortensen, 2000). Thus the low humidity may have been too low for effective plant functioning. Thus, it is suggested that the workplace increases the temperature levels and perhaps use humidifiers in winter to increase humidity to fall within the recommended range. It is also possible that the air-conditioning system removed humidity from the air.

4.3 Limitations of the Study

It is important to take note of some limitations of this study that may have affected the results.

This research was pre-experimental and thus, it was difficult to control for extraneous variables. The study focused on work engagement, psychological well-being and physical well-being. There are numerous factors that may affect these outcomes (personality-type; personal problems; attitudes), however only plants were looked at and assumed to be the only cause.

There are always limitations when using a pre-experimental research design. This design does not allow for causal inferences, thus, it leaves the actual reasons for the associations found quite unclear. That is, while the fact that two variables are related does not allow one to directly infer causation.

Convenience sampling is a sampling technique when asking for volunteers, or the consequence of not all those selected finally participating, or a set of subjects who just happen to be available. There are many limitations to this kind of sampling (Payne & Payne, 2004; Salkind, 2006; Stangor, 2011). The most obvious criticism about convenience sampling is sampling bias and that the sample is not representative of the entire population. This refers to a constant difference between the results from the sample and the theoretical results from the entire population. It is often common that due to using a convenience sample, the results of a study sample differs from that of an entire population (Black, 1999; Salkind, 2006; Stangor, 2011). This makes the generalisability of results to other groups of people very difficult.

This research was conducted in one organisational setting in one large organisation. The culture and 'politics' of the context of this study's organisation may not be the same as all other organisational settings or even to other departments in the same organisation. Thus, the generalisability of the results must be questioned.

All the measures used to assess psychological perceptions were self-report measures. It depended purely on the subjective opinion of the participants. People, depending on their moods or personality, are likely to over or under exaggerate factors representing themselves. The results can be considered to be biased such as wanting to appear socially-desirable. It would have been more ideal, for example, instead of work engagement, to use an objective productivity measure. However, this was not possible for this study. So too were some of the measures not measuring exactly what needed to be assessed or what was reflected in the literature, such as the KPDS and change in aesthetics.

Although this study was a longitudinal repeated-measures design, the sample of 34 matched pairs was small. This has implications for the power of the study and the ability to find significant results. Shoemaker et al. (1992) had a small sample size of 14 participants and cited this as one of the reasons for their non-significant results. Statistical tests normally require a larger sample size to ensure a representative distribution of the population and to be considered representative of groups of people to whom results will be generalised. So too could normality have been an issue with data not being as optimally "normal" as it could be because of a small sample size (Howell, 2008). The small sample size also has implications when generalising results to larger populations.

Unfortunately a lot of the data were not normally distributed and thus, non-parametric tests had to be used. It has been argued that non-parametric tests are less sensitive to finding differences that exist between groups than parametric tests (Pallant, 2013).

The participants completed the same questionnaire on two separate occasions. Carry-over effects may have occurred and influenced the way in which the questionnaires were answered. So too, as a result of the plants being present at Time 2, the participants may have been aware of the purpose of the study and changed their answers accordingly.

The length of time of exposure to the plants may have had an effect on the results. Most laboratory setting experiments were conducted over very short periods of time and yielded significant effects. This research took place over approximately three months. It was argued earlier that habituation may have been a reality that negatively affected the results. It is also important to note that the workspace chosen already had plants installed prior to the research, albeit fewer. Thus, plants were not a completely new aspect to the employees.

It could also be argued that this research took place over too short a period of time and it takes longer than three months for an effect to occur. The fact that this research did not take place over a very long time period meant that seasonal changes could not be taken into account and the weather is likely to have played a part in the results. Finally different times of the year may be more or less stressful for the employees.

4.4 Recommendations for Future Research

After considering all the limitations of this research, it is advantageous to look at how research could be improved and conducted in the future. It is recommended that in future that a larger sample be recruited. Perhaps finding an organisation with a larger number of employees would enable the sample to increase. Hopefully a larger sample would yield more normally distributed data and thus, more robust parametric tests can be used that are more sensitive to identifying differences between groups.

It would be interesting to perhaps use more than one organisation and choose similar organisational contexts to compare results and make them more generalisable. It may be very interesting to look at organisations whereby employees have control over certain environmental factors, such as temperature. This may yield different psychological perception results, if employees are more comfortable in their environment. It is

recommended that a different context is chosen – not a call centre. Before conducting the research the researcher must first identify any negative psychosocial factors within the organisation and try and reduce them or take them into account. Conducting research in an organisation with limited psychosocial problems would be ideal. Also identifying an organisation that has never had any plants in it before would be advantageous.

In order to attempt to make causal claims, it is suggested that there be a control group who are never exposed to plants, in the office over the same duration. This will strengthen any findings found. It is recommended that a qualitative aspect be included in future. It would be interesting to interview some employees with regard to aspects such as extraneous variables; their feelings about the workplace and their feelings toward plants. Quantitative methods have yielded differing results and perhaps, based on anecdotal comments, a more systematic collection of qualitative information may help to explain why this is the case.

In terms of the measures used, it would be advantageous to use objective measures whereby biases can be reduced. This is obviously dependent on the availability of reliable and valid objective measures or if objective measures are practical. So too, it may be useful to include other measures such as job satisfaction and absenteeism. Also more relevant measures that are reflected in the literature would make explaining and concluding the results easier.

Another area to look into is the length of time the research takes place. It may be advantageous to manipulate the times, by using two very similar organisational contexts and exposing the employees in one organisation to plants for a few minutes and then the other organisation over a long period of time, such as a year. Thus, would also be able to control for seasonal changes.

This type of research is relatively new in a South African context, with this being the second known study to assess the effect of plants on psychological perceptions. It is important to fully understand the South African organisational context before conducting research. It would also be important to examine the differing South African cultures' attitudes towards plants. This will aid in optimising research and results in this new field of study, in the future.

4.5 Theoretical and Practical Implications of the Study

The results achieved in this study have both theoretical and practical implications.

Theoretically this research has three major implications. Firstly there was no relationship found for what plants are claimed to be able to do and the effect on people's experiences. Secondly, plants are able to improve the air quality. Lastly, although the ART has been proven, it has not yet been proven in a real-life work setting and thus, it needs to be explored as to whether it applies in all contexts or only those in which restoration is supposed to occur. In this study, plants had no restorative effect on the participants.

In terms of the ART, it is important to explore whether people notice the plants in their surroundings, because if they do not, the ART's effect cannot take place.

The practical implications are that one needs to assess carefully whether the introduction of plants into the workspace is advantageous. Practically it appears that it will make no difference to people's perceptions but could aid in improving air quality. This study can aid future research in the field by way of laying the groundwork for the optimisation of research methods and results, by assessing its limitations and recommendations for future research.

4.6 Conclusion

This study investigated the relationship between the introduction of plants and its effect on psychological perceptions (work engagement; psychological well-being; physical well-being and aesthetics) and environmental factors (TVOCs; Benzene; Xylene; CO_2; temperature and relative humidity). This study intended to build on the work of Kalantzis (2016) who also conducted research in a South African context, very similar to the one in this research.

The results showed that there were no significant differences for the psychological perceptions from Time 1 to Time 2. However, the plants did affect the environmental quality to an extent.

As an outcome of the results not being entirely favourable many different reasons were explored in terms of the context and with relation to other studies who found different results. Some of the issues identified where those within the organisation at the time, habituation effects, the toxic call centre, the length of time of exposure to the plants and the season in which the research took place.

After considering these factors, it is clear that research in this field in South Africa is very limited and needs to be explored more in-depth by considering any extraneous variables. It is however, clear from the research that plants do have a positive effect on the environmental air quality.

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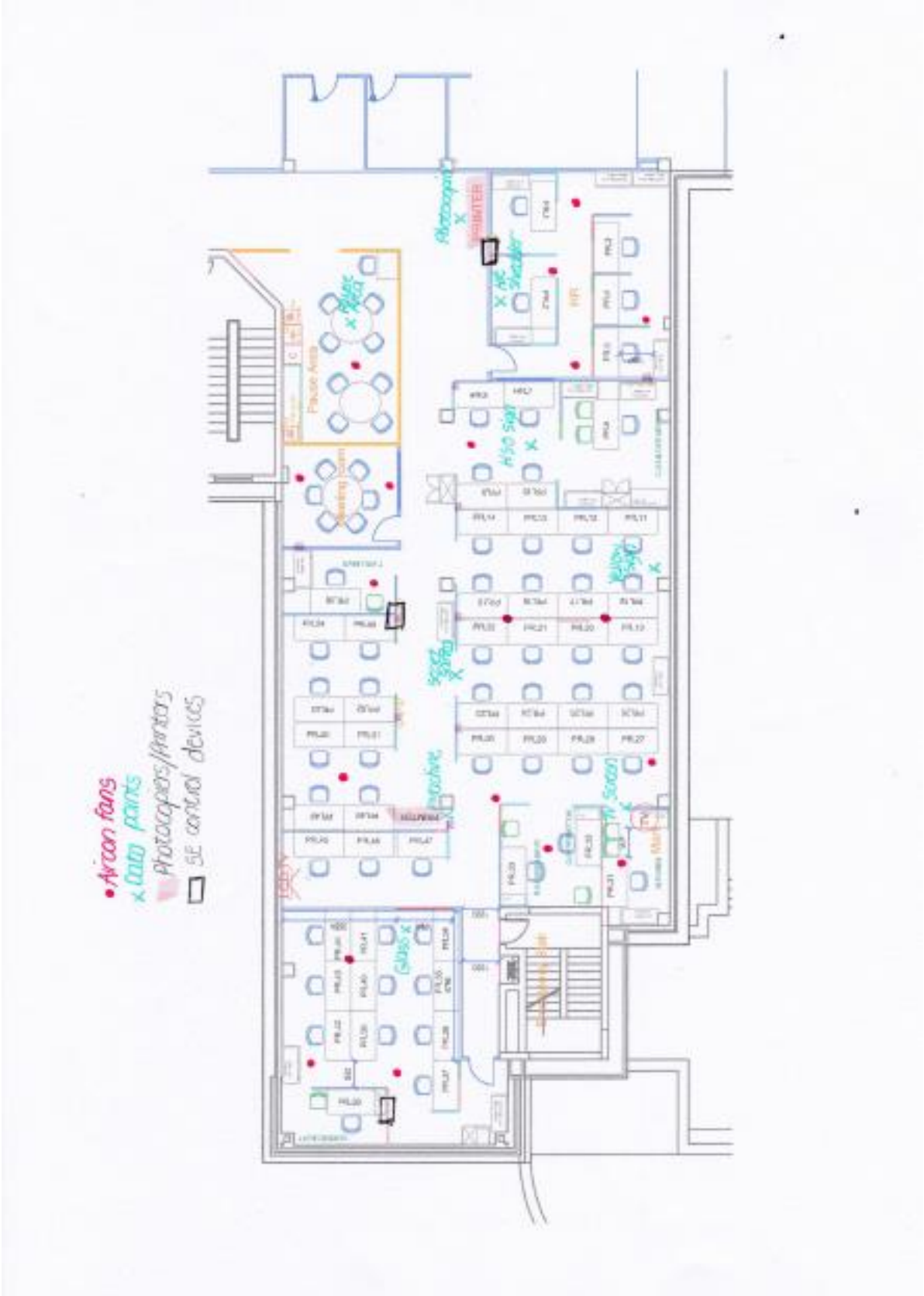
APPENDICES

Appendix A – Discovery VitalityLife Floor Plan



Appendix B – Demographic Questionnaire

Number to match Time 1 to Time 2 (please generate your own special number for matching purposes only; it will only have meaning to you) [Please put the first letter of the month you were born; the last letter of your surname; the second letter of your first name] for example Lara Bloch's (Born in April) special number would be AHA:

_____ [only used to match baseline to final]

Gender:

Male		Female	

Date of Birth: _____

When did you start working at Vitality Life? _____

Organisation Level:

Manager		Team Leader		Staff	

How many hours per day on average do you spend working in your workspace?

_____

How many days per week on average do you come in to work in this office?

_____

Do you have any of the following chronic underlying illnesses: (tick all that apply)

Asthma	
Pollen or fungal spore allergies	
Other (please specify)	

Appendix C – Kessler Psychological Distress Scale

During the **past month**, how often did you:

	None of the time	A little of the time	Some of the time	Most of the time	All of the time
Feel so depressed that nothing could cheer you up					
Feel nervous					
Feel restless or fidgety					
Feel worthless					
Feel hopeless					
Feel that everything was an effort					

Appendix D – Sick Building Syndrome Questions

In the **last month** how often have you experienced the following symptoms while **at work**?

	Never	1-3 times a **month**	1-3 times a **week**	Everyday
Excessive mental fatigue				
Headache in your forehead				
Dry eyes				
Irritated or sore eyes				
Tiredness / Strained eyes				
Nervousness or irritability				
Tiredness or lethargy				
Stuffy or congested nose				
Sore or irritated throat				
Runny nose				
Hoarseness				
Dry skin				

Dizziness				
Wheezing or chest tightness				
Nausea				

Appendix E – Utrecht Work Engagement Scale

While **at work**, to what extent have you experience the following conditions during the **last month**:

	Never	Almost Never	Rarely	Sometimes	Often	Very Often	Always
At my work, I feel like I am bursting with energy							
At my job I feel strong and vigorous							
I am enthusiastic about my job							
My job inspires me							
When I get up in the morning, I feel like going to work							
I feel happy when I am working intensely							
I am proud of the work							

that I do							
I am immersed in my work							
I get carried away when I am working							

Appendix F – Aesthetics Questionnaire

Please rate your perception of your **current office environment** depending on whether you perceive the environment to be unfavourable (1) or favourable (5).

	1	2	3	4	5	
Boring						Interesting
Gloomy						Cheerful
Drab or dull						Colourful
Hectic						Calming
Unpleasant						Pleasant
Ugly						Attractive
Uncomfortable						Comfortable
Messy						Neat
Uninviting						Inviting
Plain						Ornate
Tacky						Tasteful
Frightening						Safe
Crowded						Uncrowded
Stale air						Fresh air
Noisy						Quiet
Drafty						Still
Confined						Spacious

To what extent do you think that the plants in your office are attractive?

Not at all attractive	Somewhat attractive	Neutral	Attractive	Extremely attractive

Appendix G – Number of Plants

	0	**1**	**2**	**3**	**4**	**5 or more**
How many live plants can you see inside the office from your desk/workstation?						
How many windows can you see out of from your desk/workstation?						
How many of those windows have a view of nature (i.e. trees, shrubs, flowers, etc.)?						
How many pictures of plants or of a natural setting can you see from your desk/workstation?						

Appendix H – Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (SCHOOL OF HUMAN & COMMUNITY DEVELOPMENT

CLEARANCE CERTIFICATE	PROTOCOL NUMBER: MORG/16/011 HI
PROJECT TITLE:	Impact of indoor plants on work engagement and wellbeing perceptions.
INVESTIGATORS	Bloch Gabriella
DEPARTMENT	Psychology
DATE CONSIDERED	29/06/16
DECISION OF COMMITTEE*	Approved

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

DATE: 29 June 2016

CHAIRPERSON
(Professor B. Bozalek)

cc Supervisor:

Prof. Andrew Thatcher
Psychology

DECLARATION OF INVESTIGATOR (S)

To be completed in duplicate and one copy returned to the Secretary, Room 10001S, 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 those 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 2018

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix I - Organisational Access Request Letter

15 June 2016

THE SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT
(SHCD)

Private Bag 3, Wits, 2050 • Tel: 011 717 4524 • Fax: 011 717 4556 • E-mail: umthombo.SHCD@wits.ac.za

Dear Mmabatho,

My name is Lara Bloch and I am a student at the University of the Witwatersrand, and conducting research as part of the Masters in Organisational Psychology course. I am very interested in researching the well-being of employees as you are the driving force behind organisations and play a vital role. I would like to invite your organisation, Discovery VitalityLife, to take part in my research, as it would be most appreciated.

Participation will involve completing questionnaires that should take participants a maximum of 15-20 minutes and then the same questionnaires at a later time approximately three months later. Participation is voluntary and participants are able to refuse to take part in this study without negative consequences. There will be no direct advantages or disadvantages for participants partaking in this research or choosing not to partake in the research. There will be no identifying information required. Participants will be provided with instructions to create their own special code, which will only have meaning to them. These will only be used to match their Time 1 responses to their Time 2 responses. At no point will the organisation be given any raw data and I will not need a list of employee names from the organisation. Nobody will know which questionnaire is theirs as each questionnaire will be placed into a sealed box. Thus, their identity will remain anonymous. Their views will be kept confidential and no data will be reported in terms of individual responses, but rather only as general trends. They will have the right to withdraw from the study at any stage of the research, by providing me with their special code, simply so your questionnaire can be identified and removed.

I understand that time is valuable to employees at VitalityLife; however, your participation in this study will provide me with vital information and a better understanding of employee well-being in organisations in South Africa.

There are no foreseeable risks to completing the questionnaire. An executive summary of the results will be provided once the research is completed and you are more than welcome to email me if you would like a copy.

Thank you for considering participating in my study,

Kind Regards,

Lara Bloch	Professor Andrew Thatcher
082 532 3840	(011) 717 4533
Lara.Bloch@wits.ac.za	Andrew.Thatcher@wits.ac.za
Researcher Details	**Supervisor Details**

Appendix J - Information sheet

THE SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT
(SHCD)

Private Bag 3, Wits, 2050 • Tel: 011 717 4524 • Fax: 011 717 4556 • E-mail: umthombo.SHCD@wits.ac.za

Dear Madam/Sir,

My name is Lara Bloch and I am a student at the University of the Witwatersrand, and conducting research as part of the Masters in Organisational Psychology course. I am very interested in researching the well-being of employees as you are the driving force behind organisations and play a vital role.

I invite you to take part in my research, as it would be most appreciated.

Participation involves completing questionnaires that should take a maximum of 15-20 minutes and then the same questionnaires at a later time.

Participation is voluntary and you are able to refuse to take part in this study without negative consequences. There will be no advantages or disadvantages for partaking in this research.

There will be no identifying information required. You will be provided with instructions to create your own special code, which will only have meaning to you. These will only be used to match your Time 1 responses to your Time 2 responses. At no point will the organisation be given any raw data and I will not be given a list of employee names by the organisation. Nobody will know which questionnaire is yours as each questionnaire will be placed into a sealed box. Thus, your identity will remain anonymous. Your views will be kept confidential and no data will be reported in terms of individual responses, but rather only as general trends. You have the right to withdraw at any stage of the research, by providing me with your special code, simply so your questionnaire can be identified and removed.

I understand that as employees at Vitality Life, your time is valuable; however, your participation in this study will provide me with vital information and a better understanding of employee well-being in organisations in South Africa. The information may benefit other employees, working in similar environments, in the future.

There are no foreseeable risks to completing the questionnaires, however if anything in the questionnaires upset you or causes you any distress please let me or my supervisor know.

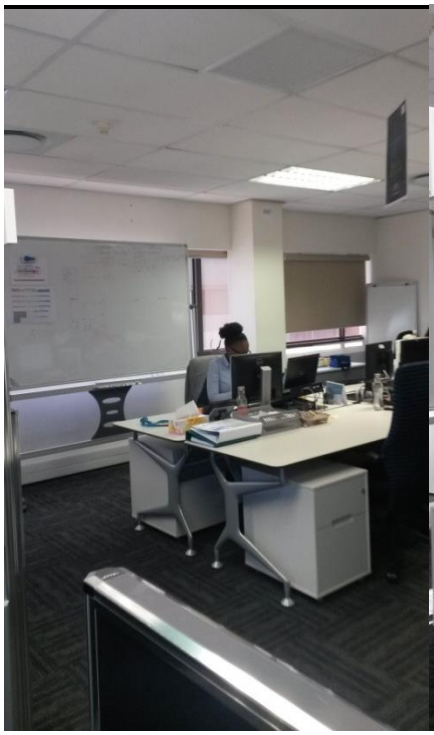
An executive summary of the results will be provided once the research is completed and you are more than welcome to email me if you would like a copy.

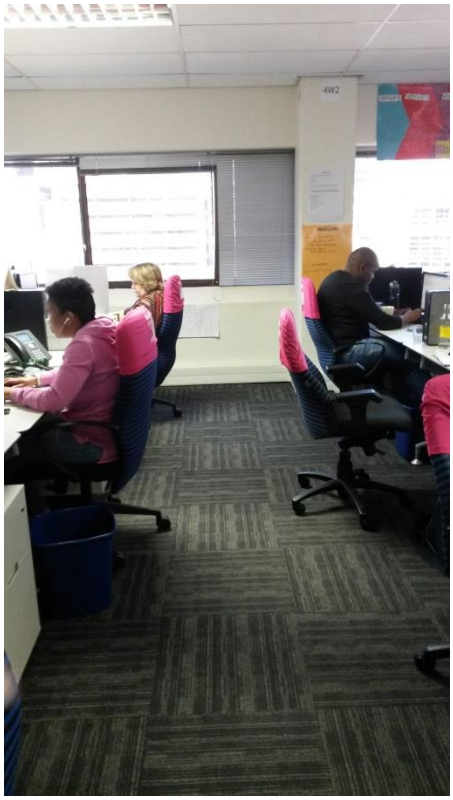
Thank you for considering participating in my study,

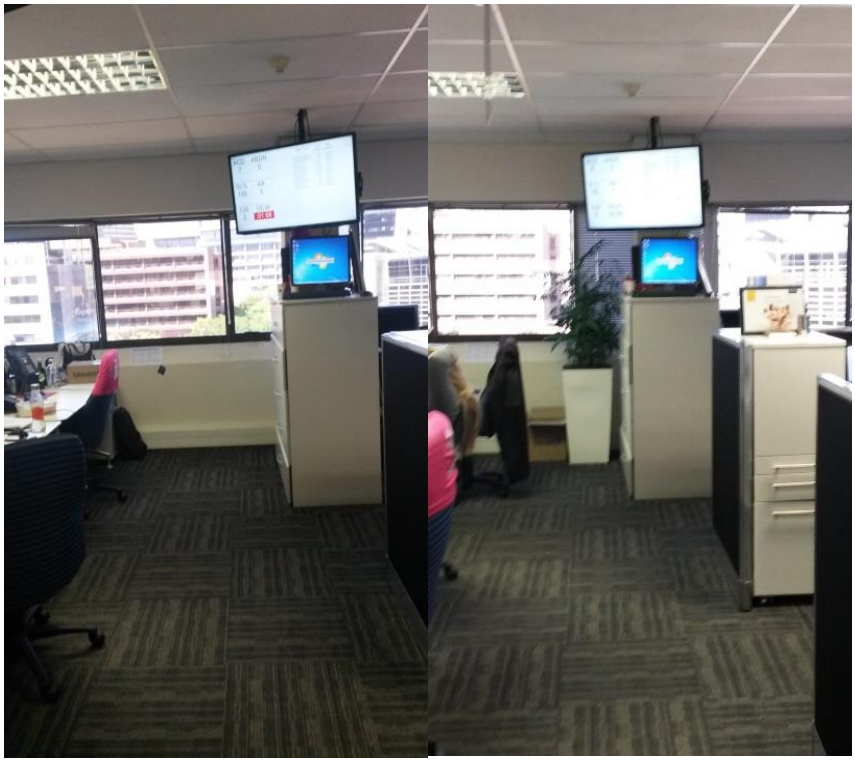
Kind Regards,

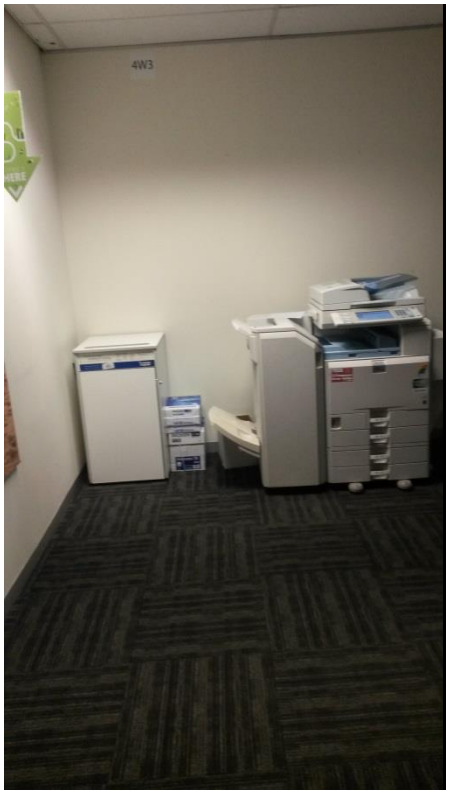
Researcher Details	**Supervisor Details**
Lara.Bloch@wits.ac.za	Andrew.Thatcher@wits.ac.za
082 532 3840	(011) 717 4533
Lara Bloch	Professor Andrew Thatcher

Appendix K – Comparison of Workspace at Time 1 (no plants) and Time 2 (plants) in photos








4W3


4W3