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The Green Office

Master Thesis

The influence of plants at the office, effectuating a more natural environment, on restoration from mental fatigue and stress as mediated by restorative characteristics among office employees

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MASTER THESIS
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Abstract

Objective. Our performance-based society causes an increasing number of people to face work-related mental health issues like stress and mental fatigue. Currently, 36.9% of absenteeism is caused by stress and pressure at work. This is especially the case for office workers who spend a lot of time indoors. Hence, people face a need for restoration which can be fulfilled by using nature in environmental design. This study aims to establish a more natural office environment, through adding plants, to see if this brings restoration from mental fatigue and stress as mediated by restorative characteristics among office employees of Dura Vermeer Hengelo, a construction firm in the Netherlands.

Method. Two separate studies, external and internal to the company, were conducted. Study 1 uses an online survey through photo assessment to test the presence of restorative characteristics in a photo of an office with plants versus a photo of an office without plants. Participants (N=182) reflect the general working population. Study 2 is a field experiment at the office in the form of a between-subjects design using a questionnaire in combination with a wearable device (Empatica E4 wristband) to measure psycho-physiological Restoration through the restorative effects of Pleasure, Environmental Preference, and Restoration. Two meeting rooms are compared where one is designed with plants (plant condition) and the other one is without plants (no-plant condition). Participants (N=108) are office workers of Dura Vermeer Hengelo. Additionally, sensor data is retrieved to reflect on the indoor office climate.

Results. Plants are considered a fascinating addition to the meeting room (*Fascination*). They provide a sense of physically being away (*Being Away – Novelty*) and cause the meeting room to better fulfil the needs of the individual (*Compatibility – Ability*). In turn, this resulted in a significant Environmental Preference for the meeting room with plants. Thus, plants increase the restorative potential of the meeting room through Environmental Preference. The meeting room with plants was considered more desirable and was graded higher. The restorative effects of Pleasure and psycho-physiological Restoration are not sufficiently proven in this study. The indoor office climate was in line with the benchmark. The plants only slightly influenced the indoor climate through humidity.

Conclusion. This research shows that plants at the office do positively affect employees. It strengthens the scarce yet promising evidence that nature benefits human beings. Whereas plants as the only element of nature may not be enough to achieve the effects of Pleasure and Restoration, the fact that solely adding plants to a built environment results in benefits shows the broader potential of nature. This study supports the idea that a nature element is indeed better than a non-nature element. Green is good for you. A more optimal working environment through nature may evoke a win-win situation for the employer and the employee resulting in improved well-being, higher satisfaction and productivity, or lower costs.

Keywords**:** stress and mental fatigue, psychophysiological restoration, nature – plants, Attention Restoration Theory (ART), Stress Reduction Theory (SRT), environmental office design

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Contents

Abbreviations

ACC	Acceleration. The change in movement of an individual over time. It concerns motion-based activity and is measured in G-forces (g).
ART	Attention Restoration Theory. An influential theory in the field of *restorative environments research* and *Environmental Psychology* developed by Kaplan and Kaplan (1989). It argues a restorative (natural) environment can bring restoration from stress and mental fatigue. The theory is based on restorative characteristics and restorative effects.
BAE	Being Away Escape. A sense of feeling psychological distance from the everyday environment, able to forget obligations. This is a restorative characteristic.
BAN	Being Away Novelty. A sense of feeling physical distance from the everyday environment, able to forget obligations. This is a restorative characteristic.
BPM	Beats Per Minute. This is a measurement unit to give the heart rate of an individual.
BVP	Blood Volume Pulse. This measures the heart rate variability of a person. It is about changes in the blood volume.
CO_2	Carbon Dioxide. A greenhouse gas mainly caused by humans through for example burning fossil fuels. It may negatively affect the Indoor Air Quality (IAQ) and can be harmful in large quantities affecting a person's concentration, productivity, and well-being.
COH	Coherence. The extent to which there is harmony in the environment. Whether everything fits together. This is a restorative characteristic.
COA	Compatibility Ability. The extent to which the environment is in line with the needs and abilities of a person. This is a restorative characteristic.
COE	Compatibility Expectation. The extent to which the environment is in line with the expectations of a person. This is a restorative characteristic.
dB	Decibel. This is the measurement unit to indicate sound and noise.
EDA	Electrodermal Activity. This is about the fluctuations and changes in certain electrical properties of the skin. It is measured in microSiemens (µS) and related to skin conductance.
FAS	Fascination. The idea that one does not need to deliberately pay attention to an object or phenomenon as you already do this because of simply being drawn or interested in it. This is a restorative characteristic.
G-force	Gravitational force equivalent. This is the measurement unit of acceleration. To calculate the activity and acceleration of an object in comparison to the earth's gravity.
HAVO	Hoger Algemeen Voortgezet Onderwijs. This is *higher general continued education* in English and is a level in the secondary educational system of the Netherlands.
HBO	Hoger Beroepsonderwijs. This is *higher professional education* in English. This means one studies at a university of applied sciences. It is more concrete and practical than WO.
HPGBs	High-Performance Green Buildings. This is a building that is designed to enhance human well-being and health through establishing a healthy indoor environment as well as has

	lower environmental impact and diminished energy use. Nature and green are often an important part of these buildings.
HR	Heart Rate. Heart rate is how often your heart beats, contractions of the heart, which is given in beats per minute (BPM).
IAQ	Indoor Air Quality. The quality of the air in and around a building. This affects a person's health and well-being. Poor air quality can lead to (health) problems and even the sick building syndrome (SBS).
IBI	Inter-Beat Interval. This is an indication of how fast the heart beats. It shows the seconds an interval lasts and the seconds up till the next beat. This is used to measure the heartbeat of a person. Inter-Beat Interval is given in seconds (sec).
IEQ	Indoor Environmental Quality. This includes IAQ as well as other factors (i.e. light and thermal comfort) that influence the indoor climate in and around a building. It is about the quality of a building when considering the health and well-being of its occupants.
IWBI	International WELL Building Institute. This is the organisation that came up with the WELL Building Standard. Their aim is to design buildings to positively affect humans. To create environments in which people thrive and will be successful.
LED	Light-Emitting Diode. A type of light source where electric current produces light.
MBO	Middelbaar Beroepsonderwijs. In English this is *middle-level applied education*. The focus is on practical, vocational education that can be followed after having completed secondary education VMBO.
NEA	Nationale Enquête Arbeidsomstandigheden. This is an annual Dutch survey on working conditions. It considers multiple industries and different types of jobs. It asks employees to rate certain aspects of their job and work situation like absenteeism, safety, well-being, and stress.
O_2	Oxygen. This enables us to breath.
OFAD	Office For A Day. This is the term Dura Vermeer Bouw Hengelo B.V. uses for the meeting rooms in which measurements were taken for this study.
PLE	Pleasure. A positive affective response i.e. in the form of joy. This is a restorative effect.
Ppm	Parts per million. A measurement unit to represent small concentrations of for example CO_2 or VOC.
PRE	Environmental Preference. A positive evaluation of the environment which causes one to evaluate one environment over another environment. This is a restorative effect.
PRCQ	Perceived Restorative Characteristics Questionnaire. This is a research instrument in the form of a questionnaire with items to use for research in the field of environmental psychology and restorativeness that is tested to be both valid and reliable. It is created by Pals (2012).
PRS	Perceived Restorativeness Scale. This is a measurement instrument that is often used in restoration research and was used to come up with the PRCQ. It focusses on perceived restoration in an environment. It was created by Korpela and Hartig (1996).

RCS	Restorative Components Scale. This is a measurement instrument that is often used in restoration research and was used to come up with the PRCQ. It focusses on perceived restoration of an environment. It was created by Laumann, Gärling and Stormark (2001).
RES	Restoration. A process of recovery to renew attentional capacity and lessen or even dissolve mental health issues like mental fatigue and stress. It is a measure of overall psychophysiological well-being. This is a restorative effect.
SBS	Sick Building Syndrome. When the occupants of a building encounter health problems or negative effects, but no illness or infection can be found. The problems seem to be caused by the amount of time spent in a building and related to the environment one is in which assumedly can make people ill.
SRT	Stress Reduction Theory. This is an influential theory in the field of *restorative environments research* and *Environmental Psychology* developed by Ulrich (1983). This theory argues nature has the ability to lessen states of arousal thereby reducing symptoms of stress. It claims nature brings restorativeness which makes people less physiologically and psychologically stressed.
TEMP	Temperature. In this study temperature is about peripheral skin temperature which is measured in degrees Celsius (ºC).
VMBO	Voorbereidend Middelbaar Beroepsonderwijs. This is *preparatory middle-level vocational education* in English and combines practical, vocational with more theoretical education. It is a level in the secondary educational system of the Netherlands.
VIF	Variance Inflation Factor. Its values show whether predictors in a model have an independent effect or not. It enables you to detect multicollinearity in your research.
VOC	Volatile Organic Compounds. These are a variety of chemicals, or emitted gasses, that can negatively impact one's health and well-being. There are many products that may release these organic compounds to the air like solvents, printers, paint, furnishing, and cigarettes.
VWO	Voorbereidend Wetenschappelijk Onderwijs. This is *preparatory scientific education* in English and is the highest level in the secondary educational system of the Netherlands.
WO	Wetenschappelijk Onderwijs. This is academic university education. This means one studies at a research university. It is more analytical and abstract than HBO.

Glossary

Affective response	A human reaction in or on a situation. It has to do with the psychological state of the person and is often about emotions and mood.
Amenities	Services and facilities. Here; of a building or environment.
Attentional restoration capacity	The extent to which an individual is able to restore and improve attention span, focus, and concentration ability. To achieve restoration.
Baseline	The starting point for measuring physiological restoration through physical features like heart beat or skin temperature. This differs per person and may be influenced by genes or use of medication. Person A may have a higher skin temperature than person B irrespective of external influences. There is no clear, equal point zero.
Between-subjects design	The same person is not exposed to both conditions in the experiment. An individual is only experiencing one of the experimental conditions, for example either the intervention or the control condition.
Biophilia	A genetically determined, deep connection between human (well-)beings and nature.
Biophilic design	Using elements of nature in the design, layout of an environment.
Built environment	The surrounding that is created by and for humans to live, work, and recreate. It is a non-nature environment in which human interference is clearly visible.
Burnout	A state of exhaustion resulting from long-term or severe stress and/or pressure. This can be emotional, physical, or mental exhaustion as well as a combination thereof. This often goes hand in hand with mental fatigue, a sense of emptiness, and a feeling of begin burnt out.
Cognitive endeavour	The amount of mental energy that is used to process everything around us. How motivated and able you are to deal with your surroundings. How much effort it costs you.
Control condition	In an experiment; the situation in which there is no manipulation or treatment.
Convenience sampling method	Data collection that is based on availability of participants which results in a research sample consisting of people who are easy to reach or contact.
Covariate	This is a characteristic of the population and the sample, i.e. age, which may affect the outcomes of your research. This covariate(s) needs to be controlled for to get reliable and valid results.
Cross-over design	A type of research design in which the control and intervention condition swap to ensure that there are no other factors of influence. Here; the focus is on ensuring that small differences between the meeting rooms will not affect the outcomes and that the effect is actually derived from the intervention; plants.
Data logger	A device that measures the Indoor Environmental Quality (IEQ) – temperature, humidity, and CO_2 – of the room or environment they are placed in.

Debriefing	A way of informing the research participants and/or respondents about the intervention and providing information that was initially held back to ensure this would not influence them. To try and prevent bias.
Empatica E4 wearable	This is a way of measuring physiological features of human beings. It is a device in the form of a bracelet that measures Acceleration, Blood Volume Pulse, Inter-Beat Interval, Electrodermal Activity, Heart Rate, and Temperature. It enables you to say something about arousal, stress and the physical state of the person.
Environmental psychology	An interdisciplinary field of research which focusses on the relationship(s) between the physical surrounding and the individual with an eye to the well-being and health of society at large.
Generalisability	The ability to say something about a larger population based on the research sample of your study.
Hydroculture growing system	A way of growing plants in water with added nutrients instead of in soil. Pots are filled with expanded clay pebbles which absorb the water and nutrients to give it back to the plant through its roots. A level indicator is added which shows if the plant is in need for more water.
Intervention	The experimental condition. It is an addition or change to a situation, product or environment in order to measure effects. Here the intervention was plants. It is the opposite of the control condition.
Lean office environment	An office environment in which everything is functional and useful. Where all unnecessary and 'waste' is eliminated to focus on what is really important.
Learning effect	The awareness of the aim of the research or the intervention among participants. This may affect the outcome of the research as this knowledge is likely to steer thoughts or even change behaviour.
Mediator (mediating effect)	A variable that explains the relationship between the dependent and independent variable. In case of complete mediation it is even so that without the mediator this cause – effect relationship between the dependent and independent variable would not exist.
Mental fatigue	A non-physical, worn-out state. It is a lessened ability to direct attention to something due to a longer period of cognitive activity. Mental fatigue is intertwined with stress.
Micro restorative experience	The possibility of experiencing restoration only seconds or minutes after having viewed nature. The mere view of nature brings positive effects already.
Multisensory research	Based on the idea that people make up their mind and process information using all of their senses. This type of research focusses on all the senses of a person for a more holistic view on the research topic.
Natural environment	An outdoor area lacking clear input of humans, i.e. a forest.
Physical comfort	The extent to which a person feels comfortable in the environment. It is about a physical sense of well-being. A state of physical ease, free from stress or pain.

Physical environment	A surrounding that involves solely physical factors that a person experiences with his or her senses, like indoor environmental factors (i.e. air) or design (i.e. furniture).
Psychophysiological arousal	A sense of excitement aligned with mood and emotions. A psychological or physical reaction to external influences which can be positive or negative.
Restoration	Recovery of attentional capacity in times of stress or mental fatigue which is affected by the environment. To re-energise mentally and physically.
Restorativeness	The extent to which a surrounding enables one to achieve restoration from mental fatigue and stress. Similar to restorative potential.
Restorative characteristics	The components an environment needs in order to have restorative potential and bring restoration. These components are Fascination, Being Away (Novelty and Escape), Compatibility, and Coherence.
Restorative effects	Environments in which restorative characteristics are present are likely to bring restorative effects in the form of Pleasure, Preference, and psychophysiological Restoration. The presence of these effects in an environment give an indication of the restorative potential of the environment.
Restorative environment	An environment that has restorative potential and brings restoration from mental fatigue and stress.
Restorative potential	The extent to which a surrounding enables one to achieve restoration from mental fatigue and stress. Similar to restorativeness.
Sample	A small part of the entire population that is the focus of a research in order to say something about a larger population. It is a small group of people that presumably reflects the population.
Sensor data	Devices/sensors used to gather data on the Indoor Environmental Quality (IEQ) by measuring the indoor climate through humidity, CO_2, temperature, sound, and VOC.
Skin conductance	This is in line with Electrodermal Activity (EDA). It concerns the fluctuations and changes in certain electrical properties of the skin.
Social desirability bias	It is the tendency of people to respond in a way that is considered favourable by others. A person may discard one's true opinion and align one's answers with expectations of others in order to be likeable.
Stress	A person's perception of one's individual resources to be insufficient of living up to situational demands. Stress only occurs in states of negative evaluation, anticipation, harm or threat. Stress is intertwined with mental fatigue.
Thermal comfort	The extent to which a person evaluates the temperature in a room or environment as comfortable and pleasant.
Twentse nuchterheid	The no-nonsense and down-to-earth mentality that characterises the people living in the Eastern part of the Netherlands, more specifically Twente.

Visual salience	The possibility to see or look at something. When something is placed in the visual angle of a person to make sure attention is paid to it.
Vitamin G	Nature is considered vitamin G, because of the many health benefits it brings.
Well-being	A state or condition in which a person is healthy, happy, and comfortable. It is a combination of physical and psychological aspects.
WELL Building Standard	This is a set of guidelines created by the IWBI which help you to design a building in a way that is supportive of human health and well-being. Following these guidelines can result in an optimal environment for people to be successful. The WELL Building Standard includes aspects on for instance air, water, light, and comfort.

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1 Introduction

Work-related mental health issues like stress and mental fatigue form a growing problem in our performance-based society. In the Netherlands, the number of people encountering stress at work is on the increase with burnout-related complaints having risen to 17% of the working population in 2019 (Hooftman et al., 2020). This comprises one out of seven employees equalling one million Dutch people. The problem is the largest among people in the age of 25-54 years (Hooftman et al., 2019) with even one out of every six employees being in the age of 25-35 (Scherder, 2018). According to the *Nationale Enquête Arbeidsomstandigheden (NEA*), an annual Dutch survey on working conditions, 36.9% (even 41.2% in business) of the people who noted absenteeism from work mention the reason for that being stress and pressure deriving from work-related tasks. Additionally, 38.8% wants their employer to take more measures to lower work-related stress (Hooftman et al., 2020). The severity of these mental health problems emphasises the need for a coping strategy (Custers & Van den Berg, 2007).

One of the main reasons for mental health issues including stress and mental fatigue is claimed to be the increasing amount of time spent indoors (Al Horr et al., 2016; Dreyer, Coulombe, Whitney, Riemer, & Labbé, 2018; Kaplan & Kaplan, 1989; Ulrich et al., 1991). People spend about 90% of the time indoors (European Commission, 2003; International WELL Building Institute, 2018; Pitarma, Marques, & Ferreira, 2017) which accordingly means one spends less time outdoors in natural environments. This percentage is expected to increase even further because of societal trends and lifestyle (Gillis & Gatersleben, 2015), continued urbanisation, the focus on technology in life (CIA, 2019) and the rise of the service industry resulting in more desk jobs (Al Horr et al., 2016). Work is one of the places where people spend a lot of time indoors, which is particularly the case for office workers at computer workstations. In the Netherlands, one out of every four people works at an office (Buitelaar, Van den Berge, Van Dongen, Weterings, & Maarseveen, 2017; Scherder, 2018). That is why this large, seemingly more vulnerable group is the focus of this study. More specifically, research is conducted in collaboration with Dura Vermeer (Hengelo office) a well-known construction firm in the Netherlands.

When feeling stressed or mentally fatigued, people face a need for restoration. This is a process of recovery to renew attentional capacity and lessen or even dissolve mental health issues (Kaplan &

Kaplan, 1989; Taylor & Kuo, 2011). People and their restoration capacity are influenced by the physical environment (Taylor & Kuo, 2011), with the workplace being an important determinant of well-being (Dreyer et al., 2018). This means that turning the office into a restorative environment may be beneficial. Previous research shows the beneficial effects of nature in environmental design as it brings restorative characteristics which may in turn result in restorative effects (Berto, 2014; Hartig & Evans, 1993; Kaplan & Kaplan, 1989; Neilson, Nguyen, Bukowski, & Klein, 2017; Pals, 2012; Ulrich et al., 1991). Bringing nature into the office environment may therefore result in such a desired and much needed restorative environment enabling restoration and lowering mental fatigue, stress among employees.

This study investigates the potential to improve employee well-being at the office, specifically reducing mental fatigue and stress, through the addition of elements of nature to the built environment to see whether a more natural environment causes people to experience restoration. To realise this, one can focus on making environmental adjustments including a physical change of the office environment (Largo-Wight, Chen, Dodd, & Weiler, 2011). Research is conducted into the restorative potential of nature by establishing a naturalised office environment through the addition of plants. This is done to see if a more natural environment brings restorative effects as mediated by restorative characteristics that are expected to arise from plants. This study is based on Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) and Stress Reduction Theory (SRT; Ulrich, 1983; Ulrich et al., 1991). A combination of methods in the form of a wearable device and a self-reported survey instrument is used to conduct research. Furthermore, sensor data is obtained to provide a detailed description of the Indoor Environmental Quality (IEQ). The aim is to answer the following research question:

To what extent do plants at the office, effectuating a more natural environment, bring restoration from mental fatigue and stress as mediated by restorative characteristics among office employees?

Although the effect of nature has been researched before, nature's effect on restorativeness through the effects of Pleasure, Environmental Preference, and Restoration in an office environment is not yet fully understood. Only a few studies combine ART with SRT and many focus on the effect of outdoor nature. Established results on the benefits of plants are scarce, yet promising (Dreyer et al., 2018). Contrasting results and methodological limitations support the need for further research (Han & Ruan, 2019).

2 Theoretical framework

With the severe and growing problem of mental fatigue and stress, it is of the essence to conduct research on how this development can be reversed or at least improved. The increasing amount of time spent indoors, about 90%, is one of the main reasons for mental health issues like stress and mental fatigue to occur (Deng & Deng, 2018; Dreyer et al., 2018; Pitarma, Marques, & Ferreira, 2017). A trend that is expected to continue (CIA, 2019; Gillis & Gatersleben, 2015).

2.1 Mental fatigue and stress

Mental fatigue is a lessened ability to direct attention to something due to a longer period of cognitive activity. Kaplan & Kaplan (1989) define mental fatigue as a non-physical worn-out state. This can lead to both short-term effects of exhaustion, distraction or decreased motivation, as well as long-term health issues including stress, burnout or depression (Kaplan & Kaplan, 1989; Pals, Steg, Siero, & Van der Zee, 2009). In turn, this may result in lower performance as well as declined general functioning. It could even negatively affect one's relationships with others. Mental fatigue is visible in a negative mood, irritation and insensitiveness. (Berto, 2014; Hartig, Mang, & Evans, 1991; Kaplan, 1993).

Kaplan & Kaplan (1989, p. 178) state mental fatigue is not the same as stress, because stress "involves the preparation for an anticipated event that has been evaluated as being threatening or harmful". Whereas mental fatigue can also occur from joyful activities and hard work, stress only occurs in these states of negative evaluation, anticipation, harm or threat (Kaplan & Kaplan, 1989) such as work overload or interpersonal conflict. Stress is a person's perception of one's individual resources to be insufficient of living up to situational demands (Steg, Van den Berg, & De Groot, 2013; Stokols & Altman, 1987). Stress is often caused by work-related tasks (Dreyer et al., 2018) and can have both physical and mental impact. Mental fatigue is claimed to be less severe than stress and not related to anticipated threat (as it may originate from being perfectionistic or a lack of sleep), but getting and overcoming it is more difficult (Hartig & Evans, 1993; Kaplan & Kaplan, 1989). Nevertheless, Ulrich et al. (1991) argue mental fatigue and stress are intertwined and can therefore be used interchangeably which is done in other research too (e.g. Pals, 2012).

2.2 The physical environment

The physical environment influences a person's well-being (Berto, 2014; Taylor & Kuo, 2011) and consequently impacts mental fatigue and stress levels. Therefore, this study is conducted in the interdisciplinary field of environmental psychology which considers the relationship(s) between the physical surrounding and the individual focussing on the well-being and health of society at large (Gifford, 2007). Environmental psychology includes the social environment, the natural environment, and the built environment. The social environment is about individual-individual or individual-environment interactions (Steg, Van den Berg, & De Groot, 2013) as well as about family ties and culture (Hartig et al., 2011). The natural environment is comprised of an outdoor area lacking clear input of humans (Hartig et al., 2011; Pitt & Zube, 1987), like a forest. This study, however, focusses on the built environment which can be specified as the surrounding that is created by and for humans to live, work and recreate (Gifford, 2007; Mehrabian & Russell, 1974). The built environment is a non-nature environment (Steg, Van den Berg, & De Groot, 2013) where human interference is inevitably visible through, for example, houses and streets (Hartig et al., 2011). Research has been conducted on multiple built environments including schools, hospitals, residences, and stores (Han & Ruan, 2019). This paper specifically explores the office environment.

2.2.1 The office environment

The focus of this research is on the office environment because the workplace is an important determinant of health (Burton, 2010; Dreyer et al., 2018; Largo-Wight, Chen, Dodd, & Weiler, 2011). Furthermore, office workers spend a lot of time indoors at computer workstations making them particularly vulnerable to be affected by mental fatigue and stress (Al Horr et al., 2016; Hartig et al., 2011). In the Netherlands, one out of every four working people is an office worker (Buitelaar et al., 2017; Scherder, 2018) and more desk jobs will be created because of the growth of the service industry (Al Horr et al., 2016). Currently, one out of seven employees (one million Dutch people) faces burnout-related complaints with numbers expected to rise in the near future (CBS, 2018; Hooftman et al., 2019). Annually, another 160 million people get a work-associated illness globally (Burton, 2010). Thus, there is a need for change.

Based on Indoor Environmental Quality (IEQ) factors, the WELL Building Standard and scientific papers of, amongst others, Al Horr, et al. (2016), Kim and De Dear (2013), Wong, Mui, and Hui (2008), the indoor office environment can be argued to consist of the following dimensions:

- Biophilia and Views;
- Indoor Air Quality (IAQ) and Ventilation;
- Lighting and Daylighting;
- Location and Amenities;
- Look and Feel;
- Noise and Acoustics;
- Office Layout;
- Thermal Comfort.

All these physiological environment dimensions interrelate and affect employees. Hence, all dimensions contribute to improving the IEQ. A low IEQ may negatively affect employee productivity, mood, and concentration ability (Al Horr et al., 2016; Deng & Deng, 2018). A potential health problem in the form of a building-related illness called Sick Building Syndrome (SBS) could even arise (Al Horr et al., 2016; Allen et al., 2016; Pommer et al., 2004; Redlich, Sparer, & Cullen, 1997). This shows that the effect of the physical surrounding on people is serious. On the contrary, it seems that the environment can be designed in a way for it to positively affect people and their health too, for instance through nature.

2.2.2 Biophilia and views

This paper investigates the dimension *biophilia and views* as there appears to be a link between nature and human well-being as well as happiness, therewith lowering mental fatigue and stress levels (Al Horr et al., 2016; Grahn & Stigsdotter, 2010; Newsham et al., 2013). Biophilia can be defined as a genetically determined, deep connection with nature (Ulrich, 1993; Wilson, 1984). The use of biophilic design in built environments, through elements of nature, is suggested by environmental psychology studies (Gillis & Gatersleben, 2015). This research considers both the physiological and psychological effects of nature as understanding the combination of mental and physical effects works best to examine the influence of nature on employee health and well-being (Steg, Van den Berg, & De Groot, 2013).

Workplace health is on the agenda of an increasing number of companies nowadays (Mills, Fleck, & Kozikowski, 2013). By not only acknowledging the societal problem of mental fatigue and stress, but taking action to do something about it, therewith supporting employees, a company can benefit (Bjørnstad, Patil, & Raanaas, 2016). The perception of the employer caring about employee well-being shows their engagement with staff which, in turn, is likely to result in similar engagement of staff with the company. This results in dropping absenteeism rates as well as higher employee satisfaction (Bjørnstad, Patil, & Raanaas, 2016; Eisenberger, Armeli, Rexwinkel, Lynch, & Rhoades, 2001; Mills, Fleck, & Kozikowski, 2013). Positive effects are twofold, both for the organisation as well as for staff in terms of well-being, health, productivity, and retention (Newsham et al., 2013). In order to take action, the employer can focus on environmental adjustments in the form of physical change (Bjørnstad, Patil, & Raanaas, 2016; Largo-Wight, Chen, Dodd, & Weiler, 2011) for instance through the usage of natural elements establishing a biophilic office design (Gillis & Gatersleben, 2015; Kellert, Heerwagen, & Mador, 2008). When creating high-performance green buildings (HPGBs) several additional benefits can be achieved; lower environmental impact, a healthy indoor environment, providing an indoor nature experience, and diminished energy use (Dreyer et al., 2018).

2.3 The influence of nature

Nature is deeply rooted in humans (Deng & Deng, 2018; Steg, Van den Berg, & De Groot, 2013; Ulrich et al., 1991). Human evolution took place in nature enabling survival as water and food are to be found there. Human beings seem physiologically and psychologically adjusted to nature (Kaplan & Kaplan, 1989; Ulrich et al., 1991) as well as are drawn to natural elements and surroundings (Deng & Deng, 2018). It is in our biology to evaluate natural environments over built environments (Mehrabian & Russell, 1974; Van den Berg, Koole, & Van der Wulp, 2003; Wilson, 1984). This genetically determined, deep connection with nature, biophilia (Ulrich, 1993; Wilson, 1984), enables numerous beneficial effects to arise when exposed to nature as explored by previous research;

- Better attention and performance (Raanaas, Evensen, Rich, Sjøstrøm, & Patil, 2011; Shibata & Suzuki, 2002, 2004)
- Enhanced creativity (Plambech & Konijnendijk van den Bosch, 2015; Tooley et al., 2006)

- Higher productivity (Berto, 2014; Bringslimark, Hartig, & Patil, 2007)
- Improved health (Bjørnstad, Patil, & Raanaas, 2016; Deng & Deng, 2018; Kaplan, 1993)
- Physical comfort (Berto, 2014; Han & Ruan, 2019)
- Pleasure from the environment (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Pals, 2012; Pals, Steg, Siero, & Van der Zee, 2009; Staats, Gatersleben, & Hartig, 1997)
- Positive mood and emotions (Berto 2014; Brengman, Willems, & Joye, 2012; Han & Ruan, 2019; Newsham et al., 2013; Purani & Kumar, 2018)
- Preference for the environment (Laumann, Gärling, & Stormark, 2001; Pals, 2012; Purcell, Peron, & Berto, 2001; Staats, Kievit, & Hartig, 2003)
- Restoration from mental fatigue and stress (Berto, 2014; Bringslimark, Hartig, & Patil, 2007; Evensen, Raanaas, Hägerhäll, Johansson, & Patil, 2015; Largo-Wight, Chen, Dodd, & Weiler, 2011; Shibata & Suzuki, 2001; Van den Berg, 2005)

Some researchers even talk about nature as vitamin G (green) because of its great health benefits (Groenewegen, Van den Berg, Maas, Verheij, & De Vries, 2012). Nature's ability to relieve or even dissolve stress and mental fatigue through restoration (Berto, 2014; Berto, Baroni, Zainaghi, & Bettella, 2010; Steg, Van den Berg, & De Groot, 2013) as claimed in the field of restorative environment research, is the focus of this research. Steg, Van den Berg, and De Groot (2013) provide a model (Figure 1) showing the relationships among nature and health. As the solid arrows show, the relationships between nature and health as well as among nature, stress reduction and health are sufficiently established. Additionally, their work supports the claim that looking at natural environments instead of non-natural or built environments results in restoration therewith lessening mental fatigue and stress (Steg, Van den Berg, & De Groot, 2013). Nature works as a buffer for work-related stress in particular (Berto, 2014; Hartig, 2007) which will be tested in this study by turning the built environment (office) into a more natural environment.

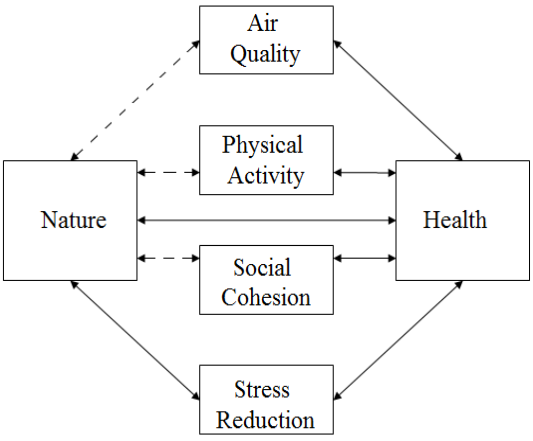

Figure 1. Relationships nature, health, and underlying mechanisms (Steg, Van den Berg, & De Groot, 2013)

2.3.1 Restoration from mental fatigue and stress

This study can be placed in *restorative environments research* which evolved in the 1980s and is about the restorative effects of environments. The increasing number of mental health issues and the negative effects thereof make it crucial to gain an understanding of how to retain balance and recover (Ulrich, 1983). Hence, people face a need for restoration which can be defined as recovery of attentional capacity in times of stress or mental fatigue (Kaplan & Kaplan, 1989; Taylor & Kuo, 2011) or as cited by Steg, Van den Berg, and De Groot: "a psychological and/or physiological recovery process that is triggered by particular environments and environmental configurations" (2013, p. 58). Any physical environment, whether natural or not, influences people and their restoration capacity (Berto, 2014; Taylor & Kuo, 2011). Turning the office into a restorative environment may benefit employee state of mind (Taylor & Kuo, 2011) as supported by prior research in the office environment (e.g. Hermans et al., 2019; Largo-wight, Chen, Dodd, & Weiler, 2011). Additionally, Neilson, Nguyen, Bukowski, and Klein (2017) state work environments with restorative characteristics may reduce stress and the number of burnouts.

A specific direction in restorative environments research is the influence of nature (Custers & Van den Berg, 2007). Previous studies have shown that using nature in environmental design can bring restorative characteristics resulting in Restoration (Berto, 2014; Hartig & Evans, 1993; Kaplan & Kaplan, 1989; Neilson, Nguyen, Bukowski, & Klein, 2017; Pals, 2012; Ulrich et al., 1991; Van den Berg, Koole, & Van der Wulp, 2003). A psychologically supportive environment can then be established (Kellert, Heerwagen, & Mador, 2008), therewith creating a healthy workplace and office (Largo-Wight, Chen, Dodd, & Weiler, 2011). A natural environment results in lower levels of psychophysiological arousal, meaning that this type of environment is more likely to bring Restoration (Berto, 2014; Bringslimark, Hartig, & Patil, 2009; Mehrabian & Russell, 1974). Natural surroundings enable human beings to achieve, retain and strengthen psycho-physiological Restoration better (Berto, 2014). Merely looking at natural elements equals a micro restorative experience already, thus enabling Restoration from stress and mental fatigue (Kaplan, 1993; Steg, Van den Berg, & De Groot, 2013). The work of Berto (2005) and that of Hartig et al. (2003) show that exposure to nature through real-life nature as well as in pictures works.

The opposite seems to be true as well. The negative or non-existent restorative effects of urban environments, like an office, are widely supported (Berto, 2005, 2014; Hartig et al., 2003; Kaplan & Kaplan, 1989; Neilson, Nguyen, Bukowski, & Klein, 2017; Ulrich, 1983). This is due to the fact that it is more exhaustive and effortful to deal with all environmental elements (Kaplan, Bardwell, & Slakter, 1993; Ouellette, Kaplan, & Kaplan, 2005). Negative effects, a result of not viewing or experiencing any element of nature at all, include a bad mood (possibly aggressiveness) and lessened concentration (De Kort, Meijnders, Sponselee, & IJsselsteijn, 2006; Hartig, Mang, & Evans, 1991; Van den Berg, 2005). Both blood pressure as well as self-reported emotions of people with stress were more positively rated after having looked at nature environments instead of built environments (Ulrich et al., 1991). This leads us to believe that a nature element is always better than a non-nature element.

2.3.2 Attention Restoration Theory (ART)

Research in the field of restoration has developed into the influential *Attention Restoration Theory* (ART; Kaplan & Kaplan, 1989). ART argues that the need for restoration can be fulfilled by being in a restorative (natural) environment (Kaplan & Kaplan, 1989; Pals, 2012). Attentional restoration capacity is dependent on, and improves with, the presence of restorative characteristics in the environment (which nature can bring) (Pals, 2012). Pals (2012) describes four characteristics as supported by Kaplan and Kaplan (1989). Firstly, *Being Away* which can be a physical (Novelty) or psychological (Escape) distance from the everyday environment. Secondly, *Coherence* is a harmonious environment that lessens the need for cognitive endeavour (Kaplan, 2001). Thirdly, *Compatibility* is when the environment is in line with the expectations and desires of the person. Finally, *Fascination* which is the idea that one does not need to deliberately pay attention to an object or phenomenon as you already do this because of simply being drawn to or interested in it. The higher an environment scores on these characteristics, the more likely for restorative effects to occur (Kaplan & Kaplan, 1989; Pals, 2012). Pals (2012) mentions three restorative effects: overall well-being lowering mental fatigue and stress (Perceived Restoration), experience of positive affective responses (Pleasure) and positive evaluations of the environment (Environmental Preference). Previous work shows that these three effects are closely related (Pals, 2012; Pals, Steg, Dontje, Siero, & Van der Zee, 2014; Staats, Kievit, & Hartig, 2003; Ulrich, 1993; Van den

Berg, Koole, & Van der Wulp, 2003). Preference for an environment forms the base for Restoration and vice versa (Kaplan & Kaplan, 1989; Pals, 2012; Purcell, Peron, & Berto, 2001). In turn, a positive affective response, Pleasure, to a natural environment is linked to Environmental Preference and Restoration (Custers & Van den Berg, 2007; Ulrich, 1993). In this study, the aim is to measure all three effects to provide a holistic view of environmental restorativeness. ART has been successfully applied to investigate an office setting before, for example in the studies of Adamson and Thatcher (2018), Evensen, Raanaas, Hägerhäll, Johansson, and Patil (2017), and Raanaas et al. (2011). These studies add natural (plants) and/or non-living elements to the environment to measure restorative effects through completion of a work-related task or by means of photo assessments. Nieuwenhuis, Knight, Postmes, and Haslam (2014) tested lean versus green office environments by comparing existing offices to test productivity backed-up by ART where the green office (plant condition) brought most beneficial effects.

2.3.3 Stress Reduction Theory (SRT)

Another prominent theory is *Stress Reduction Theory* (SRT; Ulrich, 1983; Ulrich et al., 1991). SRT adds to this knowledge that nature serves as a moderator of thoughts, diminishing negativity. Furthermore, it lessens states of arousal, thereby reducing stress symptoms. Nature may reduce blood pressure as well as stress hormone levels to make people feel less physiologically and psychologically stressed. SRT has been used to look at single elements of nature as well as landscapes. SRT has been successfully applied to simulated office workplaces as well as to actual offices (e.g. Bjørnstad, Patil, & Raanaas, 2016; Nieuwenhuis, Knight, Postmes, & Haslam, 2014), sometimes in combination with ART (e.g. Evensen et al., 2017). This theory also argues urban environments have the opposite effect therewith negatively affecting restorativeness (Ulrich, 1983; Ulrich et al., 1991). SRT and ART are complementary theories in the field of restoration. SRT can be connected with ART (Hartig & Evans, 1993) in that one may view the lacking ability to focus and concentrate resulting in lessened attention (Kaplan, 1995) as a source for stress and mental fatigue (Ulrich et al., 1991). Both theories emphasize the beneficial effects of using nature in environmental design as restorative qualities are deep-rooted therein. The difference is that ART (psycho-functionalist theory) focusses on mental fatigue, whereas SRT (psycho-evolutionary theory) focusses on stress (Berto, 2014).

2.4 The power of plants

Even though many studies focus on outdoor nature (Dreyer et al., 2018; Joye, Pals, Steg, & Evans, 2013; Ulrich et al., 1991), this study focusses on the indoor office environment. Certain practical decisions were made in close consultation with Dura Vermeer Hengelo (the researched company). This resulted in a focus on elements of nature instead of landscapes. Both may bring desired results (Ulrich, 1983), but the company recently renovated the building and preferred not to make too many changes to the physical office environment. Prior research is conducted on different elements of nature including a window view (Evensen et al., 2015; Van den Berg, 2005), light (Knez, 1995; Veitch, 1997), water and sound (Ulrich et al., 1991; White et al., 2010), or the colour green (Al Horr et al., 2016; Mahnke, 1996). In this study, nature is represented through plants. The choice for real-life plants over artificial (e.g. Radikovic, Leggett, Keyser, & Ulrich, 2005) or virtual (e.g. Pals et al., 2014) methods is made based on the desire to look at the combination of physiological and psychological effects plants may have.

2.4.1 Physiological and psychological effects of plants

Plants may bring positive physiological as well as psychological effects. Physiological effects have to do with the indoor climate. The higher the Indoor Air Quality (IAQ), the better a person's health. Many studies claim that plants improve the IAQ by reducing volatile organic compounds (VOC) and by fixing CO_2 levels turning it into O_2 benefiting human health (Deng & Deng, 2018; Torpy, Irga, & Burchett, 2014). However, these effects were often measured in a closed lab environment and new research shows contrary results of the effect of plants on VOC in a real-time office (Cummings & Waring, 2019). This recent study on VOC claims you need between 10 and 1,000 plants per square meter to bring the desired effects, which is unrealistic. Nevertheless, other studies argue plants positively affect humidity by increasing it (Deng & Deng, 2018; Kichah, Bournet, Migeon, & Boulard, 2012), temperature by providing a cooling effect (Hermans et al., 2019; Jim, 2014), sound by muffling it, and energy consumption in a building by reducing it resulting in cost savings (Deng & Deng, 2018; Hermans et al., 2019). Light is influenced by greenery too as plants absorb, transmit and reflect it (Hermans et al., 2019).

Additionally, multiple studies show the beneficial psychological effects of plants (Bjørnstad, Patil, & Raanaas, 2016; Deng & Deng, 2018; Hartig, Mang, & Evans, 1991; Ulrich et al., 1991). Exposure to

plants may result in similar benefits as nature in general, for example increased productivity (Berto, 2014; Bringslimark, Hartig, & Patil, 2007), better attention and performance (Raanaas et al., 2011; Shibata & Suzuki, 2002), and restoration from mental fatigue and stress (Bringslimark, Hartig, & Patil, 2007; Evensen et al., 2015; Largo-Wight, Chen, Dodd, & Weiler, 2011; Van den Berg, 2005). The latter is the focus of this paper. In order for plants to enable these positive effects it is crucial that plants are taken good care of, through appropriate lighting, watering, and temperature, as poorly tended greenery does not bring the desired results (Deng & Deng, 2018; Thomsen, Sønderstrup-Andersen, & Müller, 2011). Positive psycho-physiological effects of plants have been discovered in the office environment before (e.g. Gray & Birrell, 2014; Hermans et al., 2019; Mangone, Kurvers, & Luscuere, 2014; Nieuwenhuis, Knight, Postmes, & Haslam, 2014; Smith, Tucker, & Pitt, 2011). Symptoms of psycho-physiological stress can be countered or avoided through exposure to plants (Berto, 2014).

2.4.2 Conditions for success

Visual salience of plants is important. The plants need to be placed in the visual angle of the person to make sure attention is paid to the greenery (Bringslimark, Hartig, & Patil, 2009; Hermans et al., 2019). The mere view of plants provides benefits already, even when these are outdoors and only visible through a window (Al Horr et al., 2016; Chang & Chen, 2005; Gray & Birrell, 2014). The study of Park, Mattson and Kim (2002) shows that for most success, plants need to be within three meters from the person. Furthermore, the environment is perceived as more attractive when plants are in close proximity of people (Han & Ruan, 2019). Exposure to the plant(s) does not necessarily need to be long. Previous research shows that positive effects are present in less than 20 minutes (Evensen et al., 2017; Qin, Sun, Zhou, Leng, & Lian, 2014). Custers and Van den Berg (2007) even argue restoration is possible within seconds after having viewed nature. Nonetheless, repetitive visual access to nature, like plants, will lead to accumulation of the positive effects and bring long-term health benefits (Hartig et al., 2011).

Some studies argue that the presence of one single plant is enough to achieve significant benefits (i.e. Burchett, Torpy, Brennan, & Craig, 2010), others suggest the more plants the better (Ulrich, 1983). The literature review of Bringslimark, Hartig, and Patil (2009) shows that studies use between one and 22 plants. This is supported by the more recent review of Han and Ruan (2019) which argues that both

the usage of one single plant as well as multiple ones brings favourable effects. With regards to the type of plant, prior work shows that flowering plants bring even more positive results than green plants (Bringslimark, Hartig, & Patil, 2009; Park, Mattson, & Kim, 2002). A careful first conclusion was drawn saying that pink-purple and green plants work best (Li et al., 2012) with calmness and comfort being most positively affected by yellow-green- and fresh-green-coloured plants (Elsadek, Sun, & Fujii, 2016). In the research of Hermans et al. (2019) the participants themselves asked for colour variation in plants indicating potential Environmental Preference and enhanced effect. Most studies use potted plants in their research (Han & Ruan, 2019). Information gathered through visiting the company *Planting Power (*Almelo, the Netherlands), expert in the field, supports the importance of visual salience. Additional advice was to focus on green plants instead of flowers, to use a considerable amount of plants, and not to take too small plants. Pots ought to be functional as these are only there to tend plants. Pots should be low and blend in with environmental design, in line with the function of the room.

2.4.3 Research gap

Whereas in certain environments the influence of nature is very much established already, the restorative potential of plants in an office environment could be investigated further as prior work shows many inconsistencies (Bjørnstad, Patil, & Raanaas, 2016; Van den Berg & Van den Berg, 2015). Despite the positive outcomes of multiple studies as mentioned earlier, other work argues the beneficial effects of plants do not exist (i.e. Bringslimark, Hartig, & Patil, 2009; Rich, 2007; Shibata & Suzuki, 2002). Positive effects of plants on stress level, concentration ability, and productivity at the office were lacking in the work of Jumeno and Matsumoto (2013). No difference in effect of the addition of plants versus non-live objects in a workplace setting on concentration is found (Evensen et al., 2015), positive effects do not last in repeated measure design (Raanaas et al., 2011), and, Hermans et al. (2019) found that plants actually increased the need for restoration. The literature review of Deng and Deng (2018) is in line with these varied outcomes. Han and Ruan (2019) claim there is a need for more objective research methods to see whether objective data is in line with subjective data. However, Dreyer et al. (2018) claim a need for more subjective data. Largo-Wight, Chen, Dodd, and Weiler (2011) argue that benefits only occur through contact with outdoor nature which is then again refuted by Gray and Birrell (2014).

Moreover, methodological limitations are claimed by multiple studies (Dreyer et al., 2018; Gray & Birrell, 2014). Certain studies re-create office settings (Evensen et al., 2015, 2017) whereas there is a need for conducting research at existing companies with employees, a more real-life situation instead of a lab (Hermans et al., 2019; Mangone, Kurvers, & Luscuere, 2014). This need is further supported by the recent findings of Cummings and Waring (2019) who showed that the results of numerous lab studies on VOC and IAQ are rejected in the actual office environment. This would solve the limitation that many studies use students as participants making generalisation more difficult as well (Deng & Deng, 2018; Han & Ruan, 2019). Others only investigated one (or several) aspect(s), characteristic(s) of restoration which may lead to a limited account of restoration underestimating its full effects (i.e. Evensen et al., 2015). Hermans et al. (2019) claim it is important, when using a questionnaire, to keep it short and simple to positively enhance participation in the experiment. Additionally, research could present more details like length of exposure, room climate etcetera as this may influence results (Bringslimark, Hartig, & Patil, 2009; Han & Ruan, 2019). The lack of these details and the diversity in research approaches results in the inability to come up with a general conclusion on the effects of plants (Hermans et al., 2019). In sum, Han and Ruan (2019) state that more studies are needed to contribute to the creation of a standardised protocol, a set of guidelines and measurement units for indoor plants.

The current study aims to add to the knowledge in the field of environmental psychology focussing on the ability of nature to benefit health and well-being in built environments. More specifically, the ability of indoor plants to bring restoration, therewith reducing mental fatigue and stress among office employees. It does not simulate a work environment or use a supposedly fatiguing task, but gathers data during the actual meetings and work that is done at the company with participants being office employees, not students. Furthermore, this study considers all restorative characteristics and multiple restorative effects to form a full account of restoration. Whereas a lot of studies focus on either subjective, psychological effects of restoration (e.g. Pals, Steg, Siero, & Van der Zee, 2009; Purcell, Peron, & Berto, 2001) or objective, physiological restoration (Hartig et al., 2003; Ulrich et al., 1991), this study aims to look at both by using a combination of methods; a self-report survey and a wearable device. This is the best way to examine the influence of nature on employee health and well-being (Steg,

Van den Berg, & De Groot, 2013). Additionally, an overview of details, including sensor data, to describe the physical environment as well as the experiment will be provided to set guidelines and enable replication. No repeated measure design is used, but data is measured at a single point in time. Research is done through two separate studies. This is done to form a solid foundation for the results as well as to enable a shorter survey and less time needed to enhance participation of employees in the main experiment.

2.5 Conceptual research model

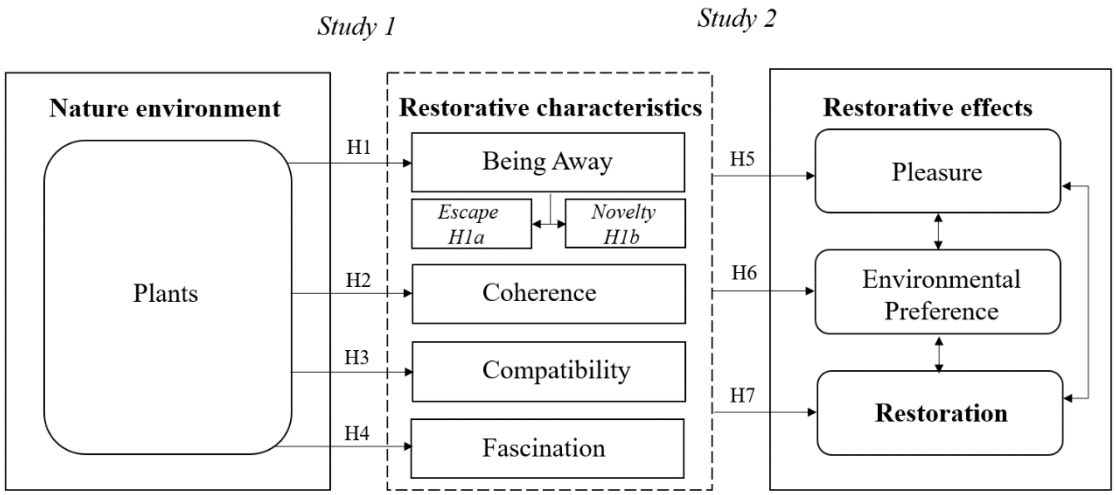

Figure 2. Visual representation of the proposed research model

The research in this paper proposes plants as an intervention creating a more nature-oriented built environment (here; office) to achieve benefits. Prior research indicates the importance of understanding which physical elements evoke restoration in order for practitioners to be able to adjust the physical design of the environment to enhance these restorative effects (Pals et al., 2014). In this study the physical element introduced is plants. Thus, this study focusses on the multifaceted aspects of the office naturalising it to see whether plants can bring restoration therewith lessening or preventing mental fatigue and stress. Physical elements, like plants, in the environment affect human-environment relations via restorative characteristics. Meaning that restorative characteristics mediate the relationship between the physical element of nature and the restoration capacity (Pals et al., 2014). Restoration can already exist when just one restorative characteristic is present, however ART argues restorativeness of an environment is higher the more characteristics are present (Bagot, 2004; Rennit & Maikov, 2015). Study 1 uses a self-report survey instrument to measure the presence of restorative characteristics in the created

environment. Only then, restorative effects can be measured in Study 2 which is done through a field experiment among office employees at Dura Vermeer. All restorative effects influence one another, but the focus is on the effect of Restoration as emphasized (bold) in the research model. Figure 2 presents the conceptual model. It investigates if a natural environment, created by adding plants, brings restorative effects as mediated by the presence of restorative characteristics. This paper aims to answer the following research question:

To what extent do plants at the office, effectuating a more natural environment, bring restoration from mental fatigue and stress as mediated by restorative characteristics among office employees?

Emerging from this are the following hypotheses:

H1: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Being Away* which, in turn, positively influences the restorative potential of the environment.

> **H1a**: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Escape* which, in turn, positively influences the restorative potential of the environment.
>
> **H1b**: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Novelty* which, in turn, positively influences the restorative potential of the environment.

H2: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Coherence* which, in turn, positively influences the restorative potential of the environment.

H3: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Compatibility* which, in turn, positively influences the restorative potential of the environment.

H4: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Fascination* which, in turn, positively influences the restorative potential of the environment.

H5: The presence of restorative characteristics in a nature environment (presence of plants) in comparison to the lack thereof in a non-nature environment (absence of plants) brings the restorative effect of *Pleasure*.

H6: The presence of restorative characteristics in a nature environment (presence of plants) in comparison to the lack thereof in a non-nature environment (absence of plants) brings the restorative effect of *Environmental Preference*.

H7: The presence of restorative characteristics in a nature environment (presence of plants) in comparison to the lack thereof in a non-nature environment (absence of plants) brings the restorative effect of *Restoration*.

There may be covariates of influence in this study. These are not the main focus of this research, but may have to be accounted for as the sample will be limited to a specific organisation; Dura Vermeer Hengelo. For instance, demographics like age. Research shows that people in the age of 25-35, Millennials, encounter most stress (Scherder, 2018). More possible predictors are gender or familiarity. However, the work of Berto (2007) and Purcell, Peron, and Berto (2001) as supported by Pals (2012) argues that gender as well as familiarity do not strongly affect restoration. Other covariates can be room position, break activities, personality, time spent at the office, season, or time of day.

3 Study 1 Restorative characteristics – a survey

This first study aims to research whether the intervention, the plants, results in the presence of restorative characteristics in the meeting rooms of Dura Vermeer Hengelo. Additionally, this study serves as input for the second study by validating the questionnaire and selecting the items to use in Study 2. This first study is conducted through photo assessment in an online survey to test the first part (left side) of the research model (Figure 3).

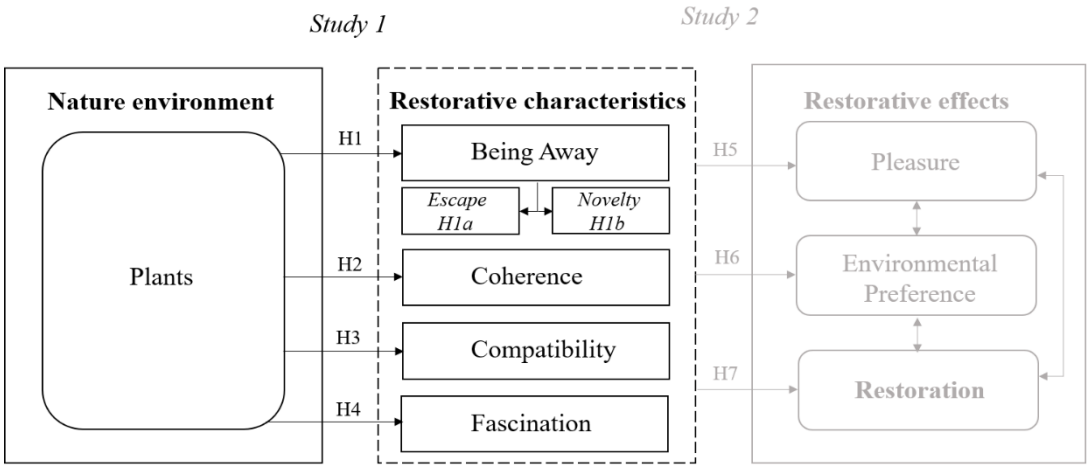

Figure 3. Research model focus – Study 1

3.1 Research design and methods

3.1.1 Design and procedure

Online experimental research in the form of a survey is conducted. Data is collected from the respondent at one moment in time to form a general idea of a larger population. The focus is not on long-term development or change as is often the case with more longitudinal designs. This design enables preliminary data collection for further research as well as the possibility to make inferences about the relationship between nature and restoration. An online survey instrument, created in Qualtrics (Appendix A), was used to test the presence of restorative characteristics in the meeting rooms of Dura Vermeer Hengelo through photo assessment. A self-report survey instrument is chosen as this is a good way to measure perception and feelings (Pals, 2012) which, in turn, can very well predict environmental restorativeness (Staats, Kievit, & Hartig, 2003). The independent variable is the physical element brought into the office to create a more natural environment; either the presence or absence of plants. The dependent variables are the restorative characteristics; *Fascination*, *Coherence*, *Compatibility*, and Being Away which is divided into *Novelty* and *Escape.*

The main reason to choose for two separate studies, internal and external to the company, is to prevent learning effects among Dura Vermeer employees as much as possible. Having participated in Study 1 employees may become aware of the intervention and aim of the research which may steer thoughts or even change behaviour in Study 2. When only participating in Study 2 (the experiment) in which the participant is exposed to either the intervention or the control condition at one point in time (between-subjects design) lowers the chance of such learning effects. Additionally, the questionnaire as part of Study 2 can now be shortened which motivates participation in the experiment (in line with Hermans et al., 2019). Furthermore, having a general population fill-out a survey on restorative characteristics in Study 1 enables the researcher to obtain a larger, more demographically-diverse sample of respondents to draw well-founded conclusions (Tipton, Hallberg, Hedges, & Chan, 2017).

The procedure of this first study was as follows: the online survey instrument was tested to check its comprehensiveness as well as to get rid of possible errors or unclarity in items. As the questionnaire was made in Qualtrics, an anonymous link was created which could be shared online. A convenience sampling method was used to distribute the questionnaire link by posting it on the social media accounts of the researcher and through the messaging platform WhatsApp. One could simply click on the link and fill-out the survey anonymously in case of voluntary participation, but only after indicating agreement to the informed consent statement in the introduction. Respondents were randomly exposed to one out of the two photos; either the presence (intervention) or the absence of plants (control). In other words, the respondent was shown a photo of the actual meeting room of Dura Vermeer Hengelo with or without plants for at least 30 seconds only once. This is done through randomisation, evenly presenting items, which causes respondents to be unaware of the fact that two different environments are tested. Items in the form of statements were provided and respondents were asked to what extent they agreed with the statements on a 7-point Likert scale with regards to the photo. The questionnaire included items on demographics as well as on restorative characteristics. The room on the photo (Figure 4) is exactly how it will be designed during the experiment (Study 2) to ensure resemblance, therewith enabling a comparison of results. Photos were taken when most people were not present. The setting and choices made on room composition are explained in paragraph 4.1.3.

Figure 4. Photos in online survey Study 1 – plant environment (left), no-plant environment (right)

The data for Study 1 were gathered in one phase and within a time span of seven days starting December 9 not too close to Christmas as this may influence a person's mood and emotional state. The decision for an online survey was prompted by its suitability to measure perception and feelings as well as the ability to reach out to a large, diverse sample. The questionnaire could be filled-out relatively quickly enhancing motivation to participate with an average completion time of 7.36 minutes (SD=2.97 minutes), with a minimum of 1.72 minutes and a maximum of 16.02 minutes.

3.1.2 Respondents

The aim was to find at least 100 respondents to research the presence of restorative characteristics and to establish a qualitative factor analysis enabling the re-use of items with high factor loading values in Study 2. In total, 210 respondents started the survey of which 28 respondents (13.3%) were discarded and the data of 182 respondents (86.7 %) was used for statistical analysis. Responses were deleted if these were pre-tests (5), incomplete answers (21), or non-Dutch respondents (2). It was decided to maintain 5 incomplete responses as they reached 79% or more completion therewith filling out (almost) all statements on restorative characteristics within a reasonable duration time.

Table 1 presents an overview of the demographics of the respondents. It shows a majority of female respondents. The mean age is 36.13 years (SD=15.07) with a minimum of 19 and a maximum of 97 years. The age category of 36-45 as well as the category over 65 years is underrepresented in the sample. Most respondents live in the province Overijssel, whereas Limburg is not represented. The low number of respondents for several provinces combined with the low numbers for certain age categories may

harm the generalisability of this study. In terms of education, 'low' stands for primary education, VMBO. 'Middle' is Havo, Vwo and MBO. 'High' consists of HBO or WO. The average number of working hours was 30.38 (SD=12.93) with a minimum of 0 and a maximum of 75 of which an average of 19.88 hours was spent at an office (SD=15.55) with a minimum of 0 and a maximum of 50. Respondents seem comfortable with the questions as '*prefer not to answer'* is not often used.

Table 1. Demographic information of survey respondents – Study 1

Demographic category	No-plant photo (frequency)	Plant photo (frequency)	Total (frequency)	Percentage (%)	
Gender					
Male	26	38	64	35.2	(X^2=2.71, df=1, p=.099)
Female	62	54	116	63.7	
Prefer no answer	1	1	2	1.1	
Age					(t-test, independent samples,
Mean age	37.20	35.12	36.13		equal variance=-.92, df=177,
Standard deviation	15.71	14.44	15.07		p=.358)
Province/domicile					
Drenthe	1	1	2	1.1	(X^2=9.22, df=10, p=.512)
Flevoland	-	1	1	.5	
Friesland	-	1	1	.5	
Gelderland	6	6	12	6.6	
Groningen	-	2	2	1.1	
Noord-Brabant	-	2	2	1.1	
Noord-Holland	3	5	8	4.4	
Overijssel	71	68	139	76.4	
Utrecht	6	4	10	5.6	
Zeeland	-	2	2	1.1	
Zuid-Holland	2	1	3	1.6	
Environment					
Rural	49	54	103	56.6	(X^2=1.11, df=2, p=.575)
Urban	28	31	59	32.4	
Neutral	12	8	20	11.0	
Marital status					
Single, never married	22	20	42	23.1	(X^2=7.58, df=6, p=.271)
In a relationship	25	37	62	34.1	
Married, partner	38	30	68	37.3	
Widow	-	2	2	1.1	
Divorced	3	3	6	3.3	
Prefer no answer	1	1	2	1.1	
Level of education					
Low	6	2	8	4.4	(t-test, independent samples,
Middle	28	21	49	26.9	equal variance= .90, df = 180,
High	55	70	125	68.7	p = .368)
Total	89	93	182	100.0	

To check the equality of the sample for each photo situation, a Chi-square test was performed for the demographic variables gender, province, living environment, marital status. All demographic variables were found not to be significantly different between the plant and no-plant group. The significance threshold was set at .05. Independent sample t-tests were conducted which showed no significant difference in sample population between the plant and no-plant group when considering age

and level of education. The outcomes showed that the sample was equally distributed between the plant and no-plant photo situation enabling further analysis ($p > .05$).

3.1.3 The survey instrument

The survey instrument (Appendix A) started with an introduction to inform the respondents about the research topic, respondent's rights, and the procedure. The topic was introduced as employee well-being in an office environment. The influence of nature, specifically plants, was not mentioned at first as this may influence respondents. Additionally, the contact details of the researcher were given in case of questions or hesitations. The introduction ends with an informed consent statement. The first part of the questionnaire consisted of general, easier questions on demographics to get an idea of the researched sample. Furthermore, items were used to find out in which type of environment people live, how many hours they work, and how many of these working hours are spent in an office environment. This first section comprised 9 items apart from the first question on consent.

In the second part, a photo of either the plant or the no-plant environment was shown asking the respondent to take a good look as all questions in the survey are about the photo shown. Beneath the photo was one question asking respondents to give three words to describe the photo to ensure that people take the time to look at it. Therefore, a 30-second timer was added too. Then, respondents were asked for their opinion on the meeting room presented in the photo through 25 statements on the five constructs – restorative characteristics (see Table 2 for examples of items). Items to measure restorative characteristics were based on the Perceived Restorative Characteristics Questionnaire (PRCQ; Pals, 2012) which is in turn based on the Perceived Restorativeness Scale (PRS; Korpela & Hartig, 1996), which incorporates ART, and the Restorative Components Scale (RCS; Laumann, Gärling, & Stormark, 2001). All items were measured on a 7-point Likert scale ranging from '*totally disagree*' (1 = '*helemaal niet mee eens*') to '*totally agree*' (7 = '*helemaal mee eens'*). A 7-point Likert scale was opted over a 5-point Likert scale as it provides more nuance in answers and may therewith prevent neutral answering. There is an official translation of the PRCQ to Dutch available which was used in this research as it is tested to be both valid and reliable (Pals, 2012). All items used are worded in a positive way as previous work has shown that the use of both positive and negative wording in items could result in differential

responses (Benson & Hocevar, 1985; Eys, Carron, Bray, & Brawley, 2007; Pals, 2012). The restorative characteristics of Being Away, Coherence, Compatibility and Fascination were all based on the study of Pals, Steg, Siero, and Van der Zee (2009). Being Away was measured as a two-dimensional construct consisting of Novelty and Escape. Novelty, physical Being Away, was measured through 4 items. Another 4 items were used to investigate Escape, psychological Being Away. Coherence was measured through 3 items. There were 6 items to measure Compatibility. Fascination was measured through 5 items. After factor analysis (Table 2) only 22 items showed to be adequate.

The final part of the questionnaire comprised 4 questions. These items intended to measure the general judgement of the meeting room, for instance through an item asking to give the room a grade from 1 to 10 (Grade). Furthermore, 2 items to see whether respondents would opt for this meeting room when in need for one (Choice) or if they would desire to work in this meeting room (Desire) were tested on a 7-point Likert scale. The last question was an open-ended question asking whether people would like to add something to the room for improvement. This provides respondents with a space to voice their opinion. In the concluding statement respondents are thanked for their participation. This statement debriefs respondents by explaining that the influence of nature, and plants, was tested. Meaning that the person has only seen one of the two photos – either the presence or the absence of plants. Respondents are presented with the contact details of the researcher again in case of hesitations on their participation deriving from this new information. The coding scheme is to be found in Appendix B.

3.1.4 Data analysis

IBM SPSS Statistics version 25 was used to conduct analysis on the data. With a value of .79 the Kaiser-Meyer Olkin Measure of Sampling Adequacy is higher than the recommended value of .60, meaning that factor analysis is appropriate to be conducted and its results are useful (Kaiser, 1974). The correlations among the items as visible in Bartlett's Test of Sphericity [X^2 (300) = 2,234.69, p <0.01] indicate the suitability of performing a principal component analysis (Snedecor & Cochran, 1989).

Validity

A principal component analysis was conducted on the initial 25 items used to measure the validity of the constructs on restorative characteristics. For an item to be considered significant, the factor loading

value needs to be equal to or exceeding .50 (Field, 2018; Hair, Black, Babin, & Anderson, 2014). Thus, to increase construct validity, certain items were discarded. However, caution was taken here as the questionnaire is based on an instrument that has already been tested as both reliable and valid before.

Table 2. Results of factor analysis survey instrument – Study 1

Construct	Item	Factor					
		1	2	3	4	5	6
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations		.79				
	BAE.2 In the meeting room I feel that I am away from everything		.80				
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations		.74				
	BAE.4 When I am in the meeting room I feel free from my daily routine		.83				
Being Away – Novelty (BAN)	BAN.1 There are many things to see in the meeting room that are new to me			.61			
	BAN.2 The meeting room is unique			.82			
	BAN.3 The meeting room is novel			.77			
	BAN.4 The meeting room is original			.73			
Coherence (COH)	COH.1 The meeting room is well organised				.76		
	COH.2 Everything I see in the meeting room goes well together				.82		
	COH.3 Everything I see in the meeting room belongs there				.73		
Compatibility – Ability (COA)	COA.1 The meeting room matches with what I want to do at this moment					.80	
	COA.2 In the meeting room I can find the information I need					.63	
	COA.3 In the meeting room I can do things I like					.80	
Compatibility – Expectation (COE)	COE.1 I know what I can and cannot do in the meeting room						.88
	COE.2 I know how to behave in the meeting room						.88
	COE.3 What I can do in the meeting room fits with my expectations						.58
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.82					
	FAS.2 There are many interesting things to see in the meeting room	.86					
	FAS.3 Being in the meeting room makes me wonder about many things	.67					
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.77					
	FAS.5 There is much to discover in the meeting room	.78					

Therefore, before discarding items an exploratory factor analysis was conducted for all constructs at once and for all separate constructs as well to come up with a sensible factor model. Repeatedly, in all three analyses, the first two items of Being Away – Novelty as well as the first three items of Compatibility loaded in a different factor from the other items in its construct leading up to seven factors instead of the expected five. The questionnaire and scales are taken from a valid and reliable research on restorative characteristics in a zoo which is argued to be useful in any type of environment. However, the difference between an office environment and a zoo may explain the rise of these new dimensions. The two items of Being Away – Novelty do not seem so different from the other items measuring this construct. Additionally, the Cronbach's alpha score of reliability is rather low with .36. Therefore, it was decided to discard these two items. The opposite seems true for the first three items of Compatibility (now Compatibility – Ability) as the Cronbach's alpha is .77 and the score for the last three items (now Compatibility – Expectation) would rise to .76. Hence, two factors emerged and Compatibility is divided into the two dimensions *Ability* and *Expectation* as factor loadings are high and items seem to match. It would be unfortunate to throw items out that are valid providing relevant results. Solely the sixth item of Compatibility is discarded due to wrongful loading with a low value. The results of this final analysis with all items righteously loaded within its suitable construct are visible in Table 2. An outlay of the four rounds of factor analysis resulting in a sensible factor model can be found in Appendix C.

Reliability

Table 3. Cronbach's alpha, mean score, standard deviation (SD) – Study 1

Constructs	Items	Cronbach's α	*M*	*SD*
Being Away – Escape (BAE)	4	.83	2.54	1.15
Being Away – Novelty (BAN)	4	.84	2.34	1.13
Coherence (COH)	3	.74	4.71	1.23
Compatibility – Ability (COA)	3	.77	3.33	1.30
Compatibility – Expectation (COE)	3	.76	4.65	1.25
Fascination (FAS)	5	.87	2.42	1.10

To check for reliability, and the internal consistency of each construct, Cronbach's alpha scores were calculated. Table 3 shows the reliability scores (α) as well as the mean scores and standard deviations of the constructs. Scores that exceed .70 are considered significant (Field, 2018; Hinton, 2004), meaning all constructs are contemplated to be reliable. The reliability score for Coherence is .74 which is the lowest alpha score detected. With an alpha of .87 the construct Fascination reached the highest score.

3.2 Results

Grades given were not high with a 5.81 for the plant photo and a 4.78 for the no-plant photo on a scale from 1 to 10. Nevertheless, the difference is significant meaning that the plant photo is graded significantly better than the no-plant photo. Additionally, respondents would opt for the meeting room with plants when in need for one and have a desire to work in the room with plants. One out of every three respondents who viewed the no-plant photo mentioned plants as addition for improvement. In general people indicated a desire for more colour (or specifically green), decoration, and cosiness. Practical improvements include a round table, one large screen or whiteboard instead of a computer, and coverage of the glass wall. Respondents who viewed the plant photo focussed on practical improvements instead of atmosphere which could be a positive result from the addition of plants. Plants have improved the room as quite a few individuals stated the plants to be a positive element. Nevertheless, some respondents indicated to dislike the (amount of) plants or how full the meeting room seemed.

Table 4. Mean score, standard deviation (SD), t-test plant photo versus no-plant photo – Study 1

Construct	Plant photo		No-plant photo		T-test, independent samples, equal variance		
	M	*SD*	*M*	*SD*	*t*	df	*p*
Being Away – Escape (BAE)	2.62	1.14	2.46	1.16	.93	179	.355
Being Away – Novelty (BAN)	2.63	1.28	2.05	.87	3.56	179	.000
Coherence (COH)	4.72	1.31	4.70	1.15	.11	179	.916
Compatibility – Ability (COA)	3.56	1.33	3.08	1.23	2.52	176	.013
Compatibility – Expectation (COE)	4.75	1.16	4.54	1.34	1.11	176	.268
Fascination (FAS)	3.01	1.11	1.80	.64	8.93	179	.000
Grade	5.81	1.76	4.78	1.82	3.80	172	.000
Choice	4.08	1.62	2.99	1.43	4.72	174	.000
Desire	4.04	1.61	2.95	1.32	4.94	171, 221	.000

The mean score for each construct is higher in the plant condition than in the no-plant condition. Independent sample t-tests are conducted to see whether the difference in mean scores for restorative characteristics between conditions are significant. Based on the results (Table 4) it can be stated that respondents find the plant environment more fascinating than the no-plant environment ($p < .05$). The same goes for the construct Being Away – Novelty (BAN), meaning that respondents indicated a stronger sense of physically Being Away in the plant environment. The new construct Compatibility – Ability (COA) shows a significant difference as well causing respondents to indicate a fit between the environment and the person. The room is more compatible with the needs and abilities of the person when plants are present. The presence of these restorative characteristics means that restorative effects

can now be measured (Bagot, 2004; Rennit & Maikov, 2015). Covariates like age, gender, and living environment do not show to have a significant influence.

Several respondents (N=15) did not complete the survey and stopped at the question with the photo. This may be because of the 30-second timer that is effective, meaning that you have to wait to continue. This was not explained in text as such, so may have caused some confusion as to why one was unable to continue. Furthermore, some people commented on the items saying certain items were odd for an office environment; the fifth item of Fascination, the second item of Being Away – Novelty and all items of Being Away – Escape. For instance, to be able to forget obligations or get away from daily routine seem irrelevant here as your work is mainly about fulfilling tasks and expectations. These comments are used as input for Study 2.

3.2.1 Correlation and regression analysis

Correlation analysis

Table 5. Results of correlation analysis – Study 1

	FAS	BAN	BAE	COH	COA	COE	Grade	Choice	Desire
FAS									
BAN	.56**								
BAE	.24**	.43**							
COH	.02	.21**	.20**						
COA	.27**	.32**	.32**	.48**					
COE	.07	.05	.17*	.35**	.35**				
Grade	.49**	.44**	.31**	.46**	.55**	.45**			
Choice	.54**	.46**	.32**	.37**	.60**	.37**	.74**		
Desire	.52**	.47**	.32**	.35**	.61**	.35**	.69**	.83**	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 5 presents the Pearson correlation coefficients of all constructs in the research model as well as the three variables *Grade, Desire* and *Choice*. Correlation analysis shows whether two variables are related and the extent to which the one influences the other. The correlation values range from .02 to .83. Values over .90 show high correlation and therewith a strong relationship (Burns & Burns, 2008). Moderate inter-correlations are between Choice and Compatibility – Ability (COA), Desire and Combability – Ability (COA), Grade and Choice, Grade and Desire, and finally Choice and Desire as values exceed .60. The highest correlation coefficient and therewith the strongest relationship is between Choice and Desire with .83. All values are positive representing a positive relationship between variables. With correlation values lower than .90 it can be stated that the variables do not measure the

same variance (De Veaux et al., 2005). Moreover, the VIF (variance inflation factor) values are between 1.22 and 1.75 which shows all predictors to have an independent effect, therefore there is no need to worry about multicollinearity (Burns & Burns, 2008).

Regression analysis

Multiple linear regression analysis (Table 6) was conducted to further investigate the relationships between variables. This type of analysis measures the amount of variance that is explained by the research model in this study and the model's strength. Additionally, regression analysis enables one to find out which constructs – here: restorative characteristics – are significant predictors of the variables Grade, Choice or Desire. *Grade* is how respondents rated the meeting room on a scale from 1 to 10. *Choice* is about the extent to which a respondent would opt for the specific meeting room when in need for one. *Desire* comprises the extent to which one would like to work in the specific meeting room.

Table 6. Results of multiple linear regression analysis – Study 1

Model		*B*	Std. Error	*β*	*t* Value	*Sig.*
Grade	Constant	-.99	.49		-2.01	.046
	FAS	.56	.11	.33	5.23	.000
	BAN	.20	.11	.12	1.75	.082
	BAE	.04	.09	.03	.43	.672
	COA	.29	.09	.21	3.17	.002
	COE	.40	.08	.27	4.77	.000
	COH	.33	.09	.22	3.57	.000
	R^2	.557				
	df	6, 167				
	P	.00				
Choice	Constant	-1.36	.43		-3.19	.002
	FAS	.54	.09	.36	5.77	.000
	BAN	.15	.10	.11	1.57	.118
	BAE	.05	.08	.03	.59	.556
	COA	.42	.08	.34	5.28	.000
	COE	.23	.07	.18	3.13	.002
	COH	.14	.08	.12	1.77	.078
	R^2	.561				
	df	6, 169				
	P	.00				
Desire	Constant	-.99	.42		-2.36	.020
	FAS	.46	.09	.32	5.04	.000
	BAN	.19	.09	.14	2.05	.042
	BAE	.03	.08	.02	.42	.679
	COA	.46	.08	.38	5.87	.000
	COE	.21	.07	.17	2.91	.004
	COH	.08	.08	.06	.99	.325
	R^2	.550				
	df	6, 169				
	P	.00				

The R^2 value shows that 55.7% ($F=38.16$, with $p<.001$) of variance in grade can be explained by the constructs in the model. Slightly lower is the result for desire with 55.0% of the variance to be

accounted for by the current model (F=35.56, with p<.001). For choice the R^2 of .56 equals 56.1% of variance (F=37.41, with p<.001). Fascination, Compatibility – Ability, Compatibility – Expectation, and Coherence show to be predictors of grade (p<.01) with Fascination to be the strongest predictor with β=.33. For choice the actual predictors are Fascination, Compatibility – Ability, and Compatibility – Expectation (p<.01) with Fascination as the strongest predictor (β=.36) too. For desire predictors are Fascination, Compatibility – Ability, and Compatibility – Expectation (p<.01) with Compatibility – Ability as the strongest predictor with β=.38.

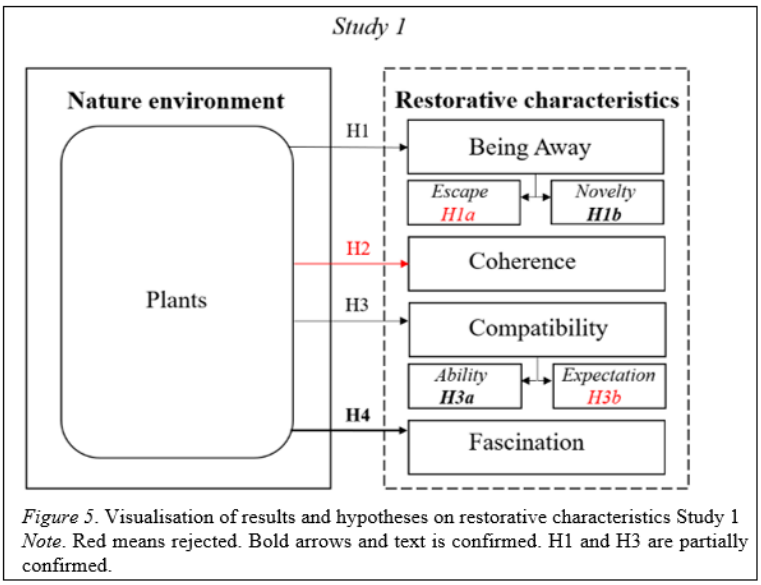

Figure 5. Visualisation of results and hypotheses on restorative characteristics Study 1
Note. Red means rejected. Bold arrows and text is confirmed. H1 and H3 are partially confirmed.

To conclude, this study showed significant differences in the presence of restorative characteristics in either a plant or a no-plant environment visible in a photo. The validity and reliability of the questionnaire is established and the highest-scoring items will be used in Study 2 to research whether similar characteristics as well as resulting effects are present in a real-time office environment. Figure 5 presents a visualization of the results of the hypotheses on restorative characteristics resulting from Study 1. The results show the construct Compatibility to consist of two dimensions; Compatibility – Ability and Compatibility – Expectation which will from now on be used as such therewith making a slight change to the research model for Study 2 as visible in Figure 6. This adds two more hypothesis to the research:

> **H3a**: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Compatibility – Ability* which, in turn, positively influences the restorative potential of the environment.
>
> **H3b**: A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Compatibility – Expectation* which, in turn, positively influences the restorative potential of the environment.

4 Study 2 Restorative effects – a field experiment

Having established support for the presence of restorative characteristics, it is now possible to measure the presence of the restorative effects of Restoration, Pleasure, and Environmental Preference among employees of Dura Vermeer Hengelo (the right part of the model, Figure 6). This is done by conducting a field experiment using a self-report instrument (questionnaire) in combination with a wearable device to measure both psychological and physiological effects during a meeting.

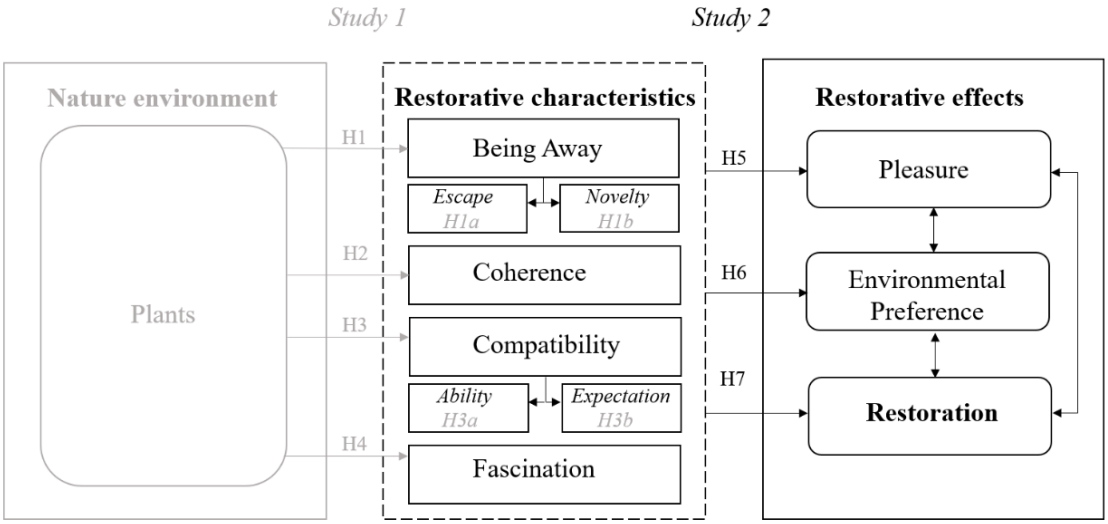

Figure 6. Research model focus – Study 2

4.1 Research design and methods

4.1.1 Design and procedure

To measure restorative effects, a field experiment using a between-subjects design was conducted as the same person is not exposed to both conditions to reduce learning effects and enable easier randomisation. The environmental treatment condition is the presence or the absence of plants. Hence, the independent variable in this study is plants. The dependent variable is restoration – through the restorative effects of Pleasure, Environmental Preference, and Restoration. Two meeting rooms were used per floor (designed as in the photos used in Study 1, Figure 4) where one was manipulated by adding plants and the other one served to be the control room. Participants were exposed to one of the conditions randomly, without the researcher's interference, as they made the decision for a room by booking it. Multiple research methods were used to combine qualitative and quantitative data. A self-report instrument in the form of a questionnaire was used to obtain data on psychological Restoration, Environmental Preference, and Pleasure (subjective). Additionally, a wearable device was used to measure physiological Restoration

(objective), therewith enabling comparison. Data is collected on an individual level from the employees who are present in the meeting room when discussing or working with co-workers, on a group level. Notably, the presence of other people during the meeting is likely to affect individual data. Humans are social creatures and very much influenced by others. The discussion section will elaborate on this effect. Moreover, sensors and data loggers were used to obtain data on the indoor office climate.

The office building has four floors with similar lay-out enabling measurements on all floors to get a representative group of participants and a large amount of data. This leads to a proper distribution therewith avoiding a large influence of certain people at a specific floor. Furthermore, a cross-over design is applied meaning that the control condition and intervention (plants) switch per meeting room per floor. This is done to ensure the effect is derived from plants and no other environmental stimuli as well as to account for small differences between the rooms. To examine causal relationships, room similarity and keeping environmental factors constant is important. Conditions are swapped between floors in the evening, but not more often than necessary as employees may notice change resulting in learning effects. Measurements were taken over full weeks for a good average considering differences that may occur between days, accounting for what Allen et al. (2016) refer to as Monday or Friday effects, or even part of day. These precautions aim to ensure plants cause the effect and nothing else.

Initially, Dura Vermeer employees were informed about the research on employee well-being at the office starting February 3 to enhance motivation to participate by email with an attached information sheet (Appendix D). The plants were (re-)placed on the specific floor and the questionnaire, data loggers, and wearable devices were tested. The data for this study were gathered in one phase and within a time span of four weeks starting February 3. The experimental procedure was as follows: at the start, when entering a meeting room, participants were asked to sign the informed consent form (Appendix E) indicating willingness to participate in this experiment according to what was stated in the information sheet received before. Participants were informed about the process, measurement instruments, and the general reason of the research being employee well-being. The environmental factor, nature in the form of plants, was not mentioned at first. Besides, they were asked to wear a device; the Empatica E4 Wristband, which measures Acceleration, Blood Volume Pulse, Inter-Beat Interval, Electrodermal

Activity, Heart Rate, and Temperature. Participants were told to behave as usual and simply proceed with their meeting or work. There was no specific task or guideline to follow as it was intended to measure real-time work sessions. At the end of the work session, participants were asked to fill-out a self-report questionnaire which is anonymous therewith diminishing social desirability bias. Anonymity was made possible as Dura Vermeer stated no need to access the datasets. The experimenter was not present in the room, but was seated in close proximity of both rooms to ensure a right process. When participants left the room they were asked to hand-in the wearable device combined with the paper questionnaire. After the four weeks of data collection participants were debriefed via email (Appendix F) and could contact the researcher with questions or uncertainties.

The average time spent in the room, exposure time, was 87.08 minutes (SD=67.40) with a minimum of 21 and a maximum of 515 minutes. For the plant condition the mean exposure time was 81.24 minutes (SD=51.05) with a minimum of 21 and a maximum of 216. The exposure time in the no-plant condition was higher; 91.93 minutes (SD=78.55) with a minimum of 40 and a maximum of 515. It took participants about 5 minutes to fill-out the questionnaire. Measurements were taken during (wearable device) and straight after (questionnaire) the meeting as prior research shows restoration can occur after a short exposure time, namely within minutes (Evensen et al., 2017; Qin et al., 2014) or even seconds (Custers & Van den Berg, 2007) after having seen plants bringing a so-called micro restorative experience (Kaplan, 1993). Sensor data was continuously available for consideration. Additionally, to live up to the need for more details on the experiment, an overview of additional information was filled-out by the researcher per meeting (Appendix G). The experiment was conducted during winter season in the month February with the full study lasting 35 weeks starting September 16 ending May 27.

4.1.2 Participants

Participants were office workers of Dura Vermeer in Hengelo, the Netherlands. Participants were not deliberately recruited, but were asked to participate when entering one of both meeting rooms. In consultation with the organisation, no reward was provided. On average, 90-120 employees work in Hengelo on a daily basis with each floor providing space for about 30-40 employees. In total, 108 employees participated. No participants were discarded. Five external people were included as they

work in an office environment and visited the office before. One Dutch person working at Dura Vermeer was included while living in Germany as this person suits the target group. Furthermore, two incomplete answers were considered as full blocks of questions were filled-out and a considerate amount of time was spent on participation. Whereas the focus is on the data of the individual, measurements were taken during meetings on a group-level. In total, there were 52 meetings; 23 in the plant condition and 29 in the no-plant condition. An average meeting was attended by 2.08 people. Table 7 shows the number of participants per floor, per condition. Table 8 presents the demographic information on the sample.

Table 7. The number of participants per floor, per condition - Study 2

Participants	Floor 1	Floor 2	Floor 3	Floor 4	Total
Plant-condition	15	15	9	10	49
No-plant condition	23	13	10	13	59
Total	38	28	19	23	108

Table 8. Demographic information of experiment participants – Study 2

Demographic Category	Plant condition (frequency)	No-plant condition (frequency)	Total (frequency)	Percentage (%)	
Gender					
Male	34	52	86	79.6	(X^2=5.80, df=1, p=.016)
Female	15	7	22	20.4	
Age					
Mean	35.24	40.17	37.92		(t-test, independent samples, equal
Standard deviation	9.26	10.04	9.96		variance=-2.62, df=105, p=.010)
Province/domicile					
Drenthe	1	-	1	.9	(X^2=3.76, df=5, p=.584)
Gelderland	6	5	11	10.2	
Niedersachsen	-	1	1	.9	
Noord-Holland	1	1	2	1.9	
Overijssel	40	52	92	85.2	
Utrecht	1	-	1	.9	
Environment					
Rural	28	25	53	49.1	(X^2=2.36, df=2, p=.308)
Urban	14	22	36	33.3	
Neutral	7	12	19	17.6	
Working hours					
Mean	39.96	43.51	41.90		(t-test, independent samples, equal
Standard deviation	9.14	7.30	8.34		variance=-2.24, df =106 , p=.027)
Office hours					
Mean	32.40	34.19	33.38		(t-test, independent samples, equal
Standard deviation	7.67	7.8	7.76		variance=-1.19, df =105, p=.237)
Lunchtime outside					
Mean	2	2	2		(t-test, independent samples, equal
Standard deviation	1.77	1.66	1.71		variance =.64, df=106, p=.526)
Window view					
Yes	40	54	94	87.0	(X^2=2.32, df=1, p=.128)
No	9	5	14	13.0	
Total	49	59	108	100.0	

Female participants are underrepresented and comprise only 20.4% (N=22) of the sample. The mean age is 37.92 (SD=9.96) with a minimum of 19 and a maximum of 61 years. A quarter of

participants is aged 30 or younger and 85% is under the age of 50. The majority of participants lives in Overijssel (85.2%), probably because Dura Vermeer has locations all over the country making it possible to work close to home. There are no participants from Flevoland, Friesland, Groningen, Limburg, Noord-Brabant, Zeeland, and Zuid-Holland which may affect the generalisability of this study. In terms of living environment, about half of the participants lives in a rural, nature-oriented area. Participants who work more than 40 hours a week, with a maximum of 70 hours, comprise 36.1% (N=39) of the sample. Another 22 people (20.4%) work part-time and therefore less than 40 hours with a minimum of 8 hours. The other 47 people (43.5%) work exactly 40 hours per week. Participants who spend all their working hours at the office account for 38.0% of the sample. During lunch breaks, 28.7% (N=31) never goes outside while 11.1% (N=12) spends the break outside every working day. A limitation in prior research on the office environment was that effects are mainly tested among students in a lab. This is addressed in this study by conducting research at a company, in an actual office with employees which is a more real-life situation (Hermans et al., 2019; Mangone, Kurvers, & Luscuere, 2014).

4.1.3 Setting and experimental stimuli

Similarly designed meeting rooms, or as Dura Vermeer calls them; office for a day (OFAD) spaces, were used for this experiment. Two such rooms, named Hamer and Steiger, are located on each floor of the office building in Hengelo. This building has been completely renovated with its re-opening in January 2019. Most of the floor is open-office area, with some meeting rooms, quiet rooms, a pantry, bathrooms and a utility room. A floor plan is to be found in Appendix H. All floors are designed in the exact same way therewith enabling comparison. It is worthwhile mentioning that the open office area is designed with green and blue colours, some plants and many windows providing an outside view, whereas the meeting rooms are not as green or nature-oriented with a complete lack of plants.

The meeting rooms have a white-painted wall, a light-greyish painted wall, and a glass wall looking into the open-office area. The fourth wall in Room 1 '*De Steiger'* is light-greyish, whereas Room 2 '*De Hamer'* has a wood-covered wall instead. The rooms have a dark-grey, blackish carpeted floor and a suspended ceiling. Room 1 is rectangular 531.5 cm (L) x 352.5 cm (W) x 270 cm (H) resulting in about 19 m^2. Room 2 has five angles and measures 616.2 cm (L) x 352.5 cm (W) x 270 cm (H) resulting in

about 18 m^2. A floorplan of both OFADs with measurements is to be found in Appendix I. Standard office lighting is present. Both rooms have the same hanging lamp. Room 1 has six 60x60 LED lighting panels, whereas Room 2 has five. However, Room 1 has two windows whereas Room 2 has three. The window view encompasses some elements of nature including grass and trees without leaves, but some elements of the built environment including buildings, a road and a cycle path. Both rooms are equipped with a large white table and five chairs. There is a desktop computer with dual monitors available. Decorations are minimal with three wooden circles on one of the walls and an umbrella rack. Appendix J presents an impression of the rooms and window views through photographs.

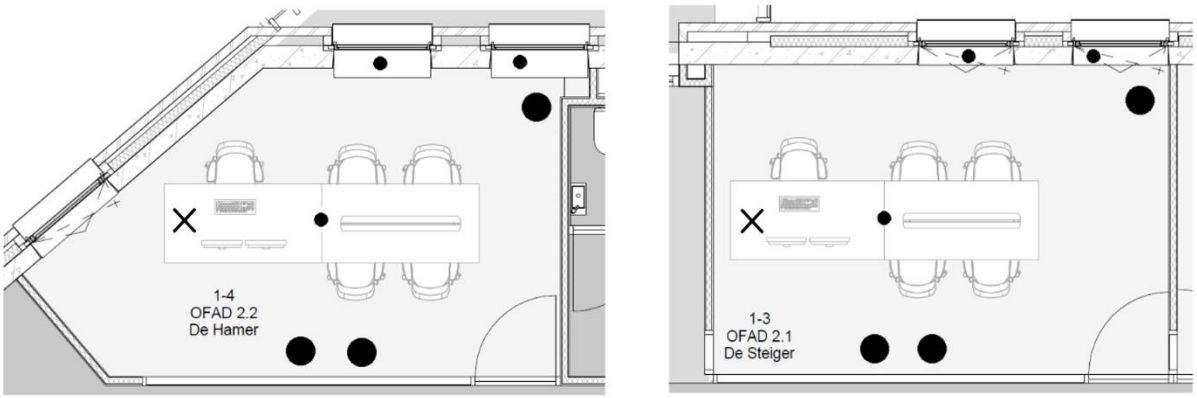

Figure 7. Room arrangement for plant and no-plant condition – Study 2

Six plants were placed in the intervention room to design the experimental condition; a nature-oriented office environment ensuring visual salience of plants. Specifically, plants that do not need much water and little natural daylight, so tending does not take too much effort. Two smaller green plants *Sansevieria Kirkii 'Friends'* (approximately 30 cm) in white pots were placed on the windowsills of the room. One pink-, purple-coloured flowering plant *Anthurium Sweet Dream* (approximately 40 cm) in a white pot was placed on the table. Two large green plants *Kentia Howea Forsteriana* (approximately 140 cm) in black pots were placed on the floor along the glass wall therewith diminishing disturbance from people walking by. Another *Kentia Howea Forsteriana* (black pot) was placed in one of the corners of the room. The positioning of all plants for both types of rooms is represented by the black dots in Figure 7. All plants are placed in the visual angle of the people in the room within three metres proximity. It is attempted to put equal amounts of greenery on both sides of the room to ensure equality for people sitting on either side of the table. The colour and size of the pots was attempted to blend in with office design as well as be solely functional not taking away attention from the plants. Round, more natural,

shapes of pots were used instead of squares and angles. These decisions are made based on the initial conclusions drawn in literature as well as considering the advice of experts in the field; *Planting Power* (personal communication, November 14, 2019) and *Van Ginkel Interieurbeplanting* (personal communication, November 13, 2019). Van Ginkel is contracted by Dura Vermeer to arrange all greenery in their offices country wide. They delivered all of the plants for this study in the desired pots with a hydroculture growing system and a water meter.

4.1.4 Sensor data

Sensors were placed by an external organisation on the second floor of the office building of Dura Vermeer in Hengelo the 3rd of September 2019 to measure the indoor climate by looking at temperature, humidity, CO_2, VOC, and sound. The data map objective measures of the environment according to benchmarks derived from literature (e.g. International WELL Building Institute, 2018) as stated by the sensor organisation. This fulfils the need for a more detailed description of the environment in research (Bringslimark, Hartig, & Patil, 2009; Han & Ruan, 2019). Appendix K shows what the data look like. The benchmarks and averages per condition, considering occupancy as well, are described in Table 9. Table 10 shows the averages per floor. Both tables only include measurements on weekdays during working hours (07:00a.m.–19:00p.m.). Two data loggers which measure temperature, humidity and CO_2 were used in the meeting rooms at the floors without sensors. The data loggers were placed on the table, central in the room (not too close to a window or computer system) as indicated by the x in Figure 7.

Table 9 shows that all averages are in line with the benchmarks for a good indoor office climate. However, Table 10 shows the CO_2 level to be too high in case of occupancy on the second floor. The tables show that occupancy, and therewith people, strongly influences the indoor climate with lower numbers for all sensor units, especially for CO_2 and VOC, when the room is vacant. In general, the CO_2 and VOC levels are higher in the no-plant condition, whereas the temperature and humidity levels are higher in the plant condition. However, while the difference in sound can be attributed to people and occupancy, it is difficult to state if the underlying reason for the differences in the other climate features is plants, occupancy or something different. Additionally, caution needs to be taken when looking at the

VOC level between the plant and the no-plant condition as this is only measurable on one floor. Unfortunately, it was practically impossible to run more tests after the experiment.

Table 9. Benchmarks and averages of indoor climate features working week – Study 2

Sensor unit	Benchmark	Average plant condition			Average no-plant condition		
		Average	Occupied	Vacant	Average	Occupied	Vacant
CO_2	< 1,000 ppm	668.98	723.92	586.58	694.52	755.95	525.58
Temperature	21 – 25 °C	21.59	21.79	21.28	21.53	21.67	21.15
Humidity	30 – 70%	33.84	34.09	33.47	32.98	33.19	32.42
VOC	< 1,000 ppm	341.02	364.39	331.00	685.48	916.67	496.33
Sound	< 80 dB	39.97	41.61	39.26	42.4	46.33	39.18

Note. Caution as VOC and Sound values are based on single measurements over 1 week instead of averages over four weeks.

Table 10. Averages of indoor climate features per condition per week – Study 2

Week	Sensor unit	Plant condition			No-plant condition		
		Average	Occupied	Vacant	Average	Occupied	Vacant
1	CO_2 (ppm)	619.24	721.15	575.56	600.53	705.72	520.09
	Temperature (°C)	21.73	22.35	21.46	21.87	22.36	21.50
	Humidity (%)	32.12	32.21	32.07	31.37	33.00	30.12
2	CO_2 (ppm)	619.03	761.00	558.19	779.83	1,030.78	574.52
	Temperature (°C)	21.42	21.82	21.24	21.90	22.32	21.55
	Humidity (%)	35.45	35.81	35.29	35.53	36.31	34.88
	VOC (ppm)	341.02	364.39	331.00	685.48	916.67	496.33
	Sound (dB)	39.97	41.61	39.26	42.40	46.33	39.18
3	CO_2 (ppm)	745.02	826.97	707.77	715.28	921.87	640.16
	Temperature (°C)	21.47	21.59	21.42	20.86	21.27	20.71
	Humidity (%)	36.54	36.48	36.56	33.62	34.59	33.27
4	CO_2 (ppm)	707.08	821.96	661.66	682.42	775.56	611.19
	Temperature (°C)	21.56	22.04	21.37	21.48	21.69	21.33
	Humidity (%)	32.23	32.53	32.11	31.41	32.15	30.85

Table 11 presents the development of all sensor units during a working week (shown per day) leading up to the averages as given in Table 9. Figure 8 visualises the data of the plant condition and Figure 9 shows the no-plant condition. It is visible that CO_2 level and temperature rise whereas humidity and VOC decrease towards the end of the day irrespective of the condition. There is no big difference between days. At 17:00p.m. all numbers are declining, possibly because employees start their working day early to leave early as well, again emphasising the influence of occupancy. In the graphs you see that the CO_2 level rises and falls along with occupancy showing a lower average level in the plant condition than in the no-plant condition. Temperature remains stable during the day in both conditions with slightly higher numbers for the no-plant condition which is in line with the cooling effect of plants (Hermans et al., 2019). In general, humidity is higher in the plant condition which could be a beneficial effect of plants. Sound is in line with occupancy which is visible in the graph through the peaks when the room is occupied. The VOC level is lower and more stable in the plant condition, whereas in the no-

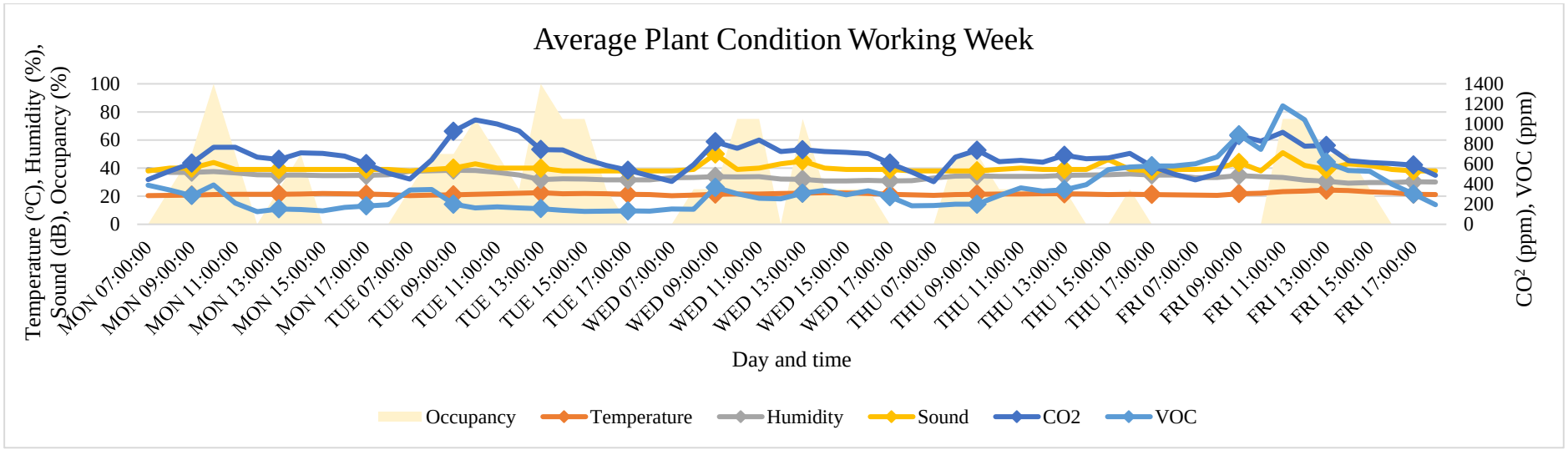

Figure 8. Average sensor and logger data plant condition working week – Study 2

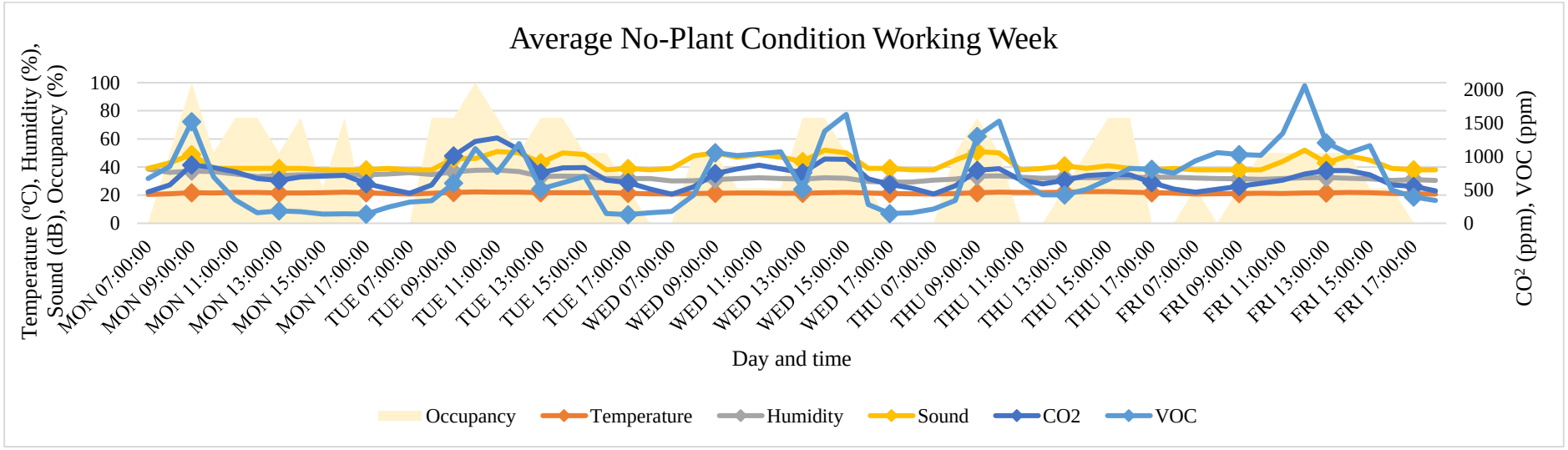

Figure 9. Average sensor and logger data no-plant condition working week – Study 2

Table 11. Average sensor and logger data both conditions working week – Study 2

	CO_2 (ppm)		Temperature (°C)		Humidity (%)		Sound (dB)		VOC (ppm)		Occupancy (%)	
	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
MON 07:00	446.88	467.38	20.41	20.47	39.01	38.55	38	39	389	668	0	0
MON 09:00 ♦	608.74	872.46	20.77	21.73	37.04	37.06	40	49	287	1,520	50	100
MON 11:00	766.59	767.00	21.30	21.90	36.62	35.01	39	39	210	349	50	75
MON 13:00 ♦	646.66	638.88	21.40	21.50	34.97	33.89	39	39	153	183	25	50
MON 15:00	706.09	702.29	21.94	21.82	34.66	34.56	39	38	134	136	0	25
MON 17:00 ♦	602.84	593.63	21.48	21.70	34.86	34.45	39	38	183	135	0	0
TUE 07:00	451.21	446.38	20.47	20.86	37.78	35.92	38	38	343	317	25	0
TUE 09:00 ♦	926.38	1,007.92	20.90	21.96	38.53	36.57	40	46	200	602	50	75
TUE 11:00	1,000.17	1,274.54	21.76	22.18	37.04	37.90	40	51	173	761	50	75
TUE 13:00 ♦	744.71	757.04	22.50	21.64	31.84	33.32	40	43	156	512	100	75
TUE 15:00	651.13	832.09	21.84	21.78	32.15	33.37	38	49	129	701	75	50
TUE 17:00 ♦	538.75	609.67	21.43	21.36	31.62	31.84	38	39	133	130	0	25
WED 07:00	425.75	433.59	20.35	20.79	33.12	30.18	38	39	152	177	0	0
WED 09:00 ♦	821.46	744.59	21.41	21.42	34.00	31.08	50	50	367	1,054	25	50
WED 11:00	838.46	868.46	21.61	21.46	33.88	32.46	40	49	260	1,039	75	25
WED 13:00 ♦	743.84	754.54	22.13	21.44	31.97	31.41	45	44	309	508	75	75
WED 15:00	716.33	956.64	22.33	21.98	30.82	31.92	39	50	295	1,626	25	50
WED 17:00 ♦	608.79	579.04	21.32	21.16	30.93	29.20	39	39	275	143	0	0
THU 07:00	424.54	437.79	20.63	20.84	32.92	30.63	38	38	188	214	0	0
THU 09:00 ♦	737.59	790.83	21.44	21.73	34.50	33.46	38	51	200	1,299	50	75
THU 11:00	637.25	643.50	21.60	21.85	34.15	32.67	40	38	364	633	25	0
THU 13:00 ♦	687.21	640.33	21.72	22.16	34.95	32.30	39	41	345	425	25	25
THU 15:00	660.92	731.54	21.26	22.54	35.34	32.58	46	41	543	652	0	75
THU 17:00 ♦	579.54	607.13	21.22	21.74	35.08	32.69	38	38	582	806	0	0
FRI 07:00	442.44	465.42	20.72	20.85	33.23	32.23	39	38	603	932	0	25
FRI 09:00 ♦	882.50	550.88	21.81	21.13	34.68	31.52	44	38	893	1,028	0	25
FRI 11:00	916.50	644.21	23.17	21.18	33.31	31.87	51	44	1,181	1,344	75	50
FRI 13:00 ♦	785.28	785.71	24.39	21.62	30.62	32.55	39	43	619	1,202	50	50
FRI 15:00	615.44	725.54	22.98	21.66	29.67	31.65	42	45	528	1,160	25	25
FRI 17:00 ♦	590.17	552.25	21.37	20.97	30.24	31.11	38	38	301	392	0	0

Note. Caution as VOC and Sound values are based on single measurements over 1 week instead of averages over four weeks. Appendix L5 shows the corresponding data specifically per hour.

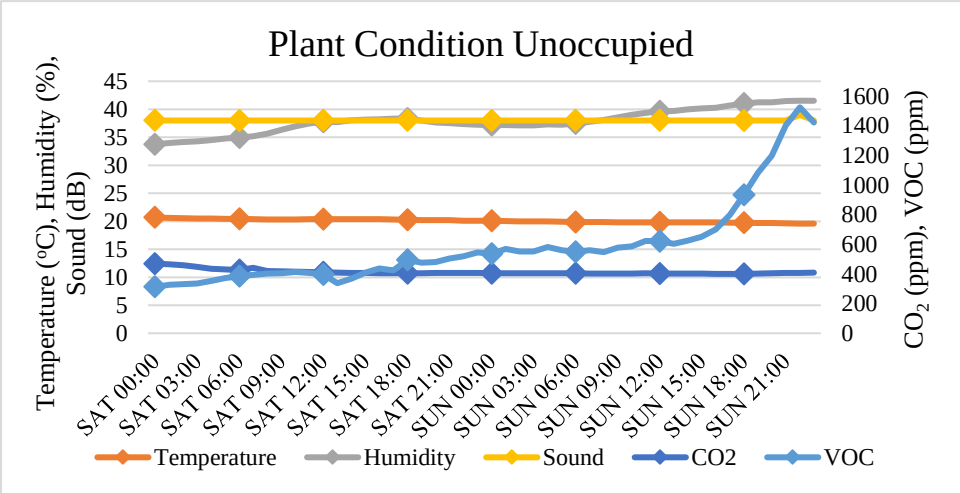

Figure 10. Plant condition unoccupied effect – Study 2

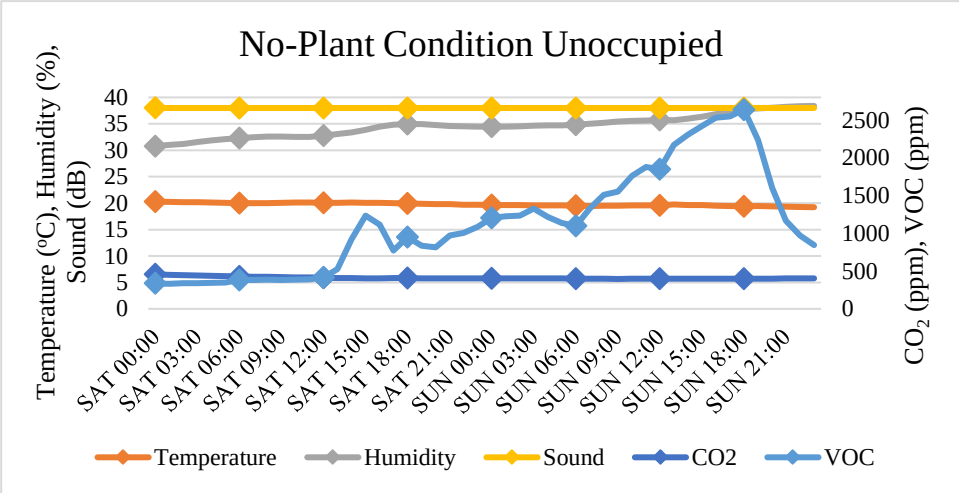

Figure 11. No-plant condition unoccupied effect – Study 2

Table 12. Both conditions unoccupied effect – Study 2

Day	Time	CO_2 (ppm)		Temperature (ºC)		Humidity (%)		Sound (dB)		VOC (ppm)	
		Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
Saturday	00:00 ♦	469.61	457.17	20.68	20.27	33.74	30.77	38	38	313	338
	03:00	447.39	441.50	20.51	20.16	34.26	31.54	38	38	335	341
	06:00 ♦	426.72	429.28	20.43	20.01	34.95	32.32	38	38	386	381
	09:00	418.50	421.45	20.33	20.06	36.35	32.62	38	38	404	384
	12:00 ♦	410.50	411.61	20.40	20.05	37.76	32.78	38	38	396	418
	15:00	406.00	404.83	20.40	20.07	38.17	33.84	38	38	409	1,236
	18:00 ♦	405.39	406.84	20.29	19.92	38.33	34.98	38	38	496	950
	21:00	407.83	403.67	20.18	19.79	37.51	34.58	38	38	504	970
Sunday	00:00 ♦	405.89	402.94	20.10	19.66	37.16	34.46	38	38	537	1,207
	03:00	405.89	403.94	20.00	19.58	37.15	34.65	38	38	552	1,329
	06:00 ♦	403.89	400.55	19.89	19.52	37.49	34.81	38	38	550	1,100
	09:00	402.94	395.78	19.83	19.52	38.56	35.43	38	38	577	1,554
	12:00 ♦	403.61	401.05	19.83	19.57	39.62	35.77	38	38	620	1,849
	15:00	401.78	399.72	19.80	19.61	40.18	36.35	38	38	652	2,423
	18:00 ♦	400.44	398.83	19.76	19.42	41.03	37.72	38	38	934	2,639
	21:00	407.44	401.78	19.64	19.32	41.46	38.23	38	38	1,402	1,167
Average		413.07	410.10	20.10	19.77	37.88	34.58	38.02	38	587.31	1,141.44

Note. Caution as VOC and Sound values are based on single measurements over 1 week instead of averages over four weeks

plant condition it seems to fluctuate along with occupancy. There is a huge difference in VOC level between conditions with one peak in the plant condition on Fridays. The room is in use then, but this does not seem to be the explanation as during other periods of occupancy this is not the case. In sum, even though plants can positively influence the indoor climate, occupancy is likely to have an effect here which can explain the inconsistencies. The average occupancy for the plant condition is 28.3% and for the no-plant condition it is 39.6% of the average working day.

Having looked at the indoor climate during office hours to get an idea of the environmental factors during the experiment, it is now time to look at the effect of plants without human interference. Therefore, Figure 10 shows the effect of plants during the weekend, unoccupied. Figure 11 presents the no-plant condition. Table 12 outlays the accompanying numbers. There are no extreme differences visible in any of the measurements except for VOC. The VOC level is almost twice as high in the no-plant condition in comparison to the plant condition. Even though literature states that plants diminish the VOC level (Deng & Deng, 2018; Torpy, Irga, & Burchett, 2014) this does not seem to explain these numbers, especially since there is counter-evidence (Cummings & Waring, 2019) as well saying you would need way more plants to achieve a difference, let alone such a difference. The average VOC level in the meeting room during January is 594.50 on Saturdays and 389.67 on Sundays. Therefore, with a weekend average of 492.09, instead of the 1,141.44 as in the experiment, there needs to be a different explanation. There could have been a technical error in the sensor equipment, or it has something to do with the mechanical systems of the building, especially the ventilation system possibly causing low rates of air exchange. The humidity is higher in the plant condition which is supported by literature (Deng & Deng, 2018; Kichah, Bournet, Migeon, & Boulard, 2012) and especially useful in winter season when there is shortage of humidity in the air. However, the relative rise of humidity during the weekend seems equal for both conditions. CO_2 levels do not differ a lot between conditions. The same goes for temperature. There is no cooling down mechanism visible in this study. In sum, the cooling potential, sound muffling ability, and CO_2 reducing effect of plants are not sustained. Maybe because of winter season, lights and ventilation systems turned off during the weekend, plants are less active and do not bring the expected benefits. Another reason could be that there are not enough plants to achieve the

desired results. The possibility of error in the VOC measurements make it difficult to draw conclusions thereon. However, plants do seem to positively affect humidity. The two meeting rooms are comparable with measurements not showing strong differences between the rooms. By taking an average of the two rooms over different floors, crossover design, the researcher controlled for differences in the rooms. Detailed graphs per separate climate feature comparing the two conditions as well as graphs per week to see the development of all measurement units during a working week per floor, per condition are provided in Appendix L.

4.1.5 Apparatus and instruments

The questionnaire

As perception is a good predictor of the restorativeness of an environment (Pals, 2012; Staat, Kievit, & Hartig, 2003) with a person's own evaluation being key in predicting well-being (Moser, 2009; Weden, Carpiano, & Robert, 2008) a self-reported instrument is used (Dreyer et al., 2018) to measure psychological restorative effects. Affective measures focussing on how happy or sad or stressed someone is at a specific moment in time form a good way to measure environmental restorativeness (Steg, Van den Berg, & De Groot, 2013). All items on the effect of self-report Restoration are measured on a 7-point Likert scale ranging from '*totally agree*' (1) to '*totally disagree*' (7). The restorative effects of Pleasure and Environmental Preference are measured based on semantical differential items on a scale from 1 to 7. The items were translated into Dutch by the researcher in cooperation with a small group of people to enhance validity and reliability.

The questionnaire started with an introduction. Participants could opt-out at any time and the questionnaire provided answering options in which they could refuse to answer. The first section comprised 4 demographic items and 5 items on working life, for example the number of working hours and why the person opted for this specific meeting room at that time. The next section consisted of 9 items to confirm the presence of restorative characteristics. These items were taken from Study 1 based on the highest factor loading values. Afterwards, there were 17 items to investigate whether participants experienced restorative effects. All the constructs and items are inspired by or slightly modified based on previous studies. The restorative effect of Pleasure is measured based on six semantic differential

items based on the prior work of Mehrabian and Russell (1974): How (happy, pleased, satisfied, content, relaxed, hopeful) do you feel in this meeting room? Environmental Preference was measured through five items based on the work of Mehrabian and Russell (1974), Pals et al. (2014), and Russell (2003): How (pleasant, positive, attractive, enjoyable, stimulating) do you evaluate this meeting room? Staats, Kieviet, and Hartig (2003) supported by the more recent work of Pals et al. (2014) form the base for the six items measuring perceived Restoration. There were two items on focus and concentration, two on letting go of tension, and two on energy levels of which one item was created by the researcher. The final section comprised 3 items of which one was an open question asking respondents what they would like to add to the meeting room to change or improve it. This provided room to voice an opinion. The other two items focussed on desire and grade similar to Study 1. After factor analysis only 25 items (see Table 13 for examples of items) showed to be adequate. The coding scheme, Appendix M, shows each construct and its corresponding items. The complete questionnaire including the explanation paper of how to fill it out is to be found in Appendix N.

The wearable device

Restoration can be measured through recording data of physical features too (Custers & Van den Berg, 2007; Park, 2006; Steg, Van den Berg, & De Groot, 2013; Ulrich et al., 1991), which is in line with Ulrich's SRT that claims lowered arousal, reduced blood pressure as well as lowered stress hormone levels indicate Restoration (Ulrich et al., 1991). Skin properties, blood pressure and heart rate have shown higher restorativeness in natural settings than in built environments (De Kort, Meijnders, Sponselee, & IJsselsteijn, 2006; Hartig et al., 2003; Laumann, Gärling, & Stormark, 2003). Physical features can be measured by a wearable device. Using wearable device data provides another, more objective, dimension to this study. In case of recovery from stress and mental fatigue, Restoration, the measured wearable data is supposed to be lower than when feeling stressed. Stress is visible in higher BVP, being very active and tensioned, higher skin conductance, and higher temperatures (℃) (Ulrich et al., 1991). Therefore, it is expected that measurements are lower in the plant condition than in the no-plant condition. Measurements are taken during the meeting or work that is done in the meeting room through the wearable's internal real-time clock with 5ppm high accuracy time reference. It enables in-

depth analysis of the physiological data acquired with the data being displayed on a secure cloud platform. It is an unobtrusive way of monitoring which can be done in multiple environments besides a lab (Empatica Inc., 2019). The Empatica E4 Wristband was used which measures Acceleration, Blood Volume Pulse, Inter-Beat Interval, Electrodermal Activity, Heart Rate, and Temperature. Appendix O gives an example of the output. Using a wearable device (physiological data) combined with a self-report instrument (psychological data) enables one to see whether what people describe in the questionnaire is visible in the data from the device. To enable comparison, the data from the wearable device and the questionnaire responses is anonymised and kept together providing a full account of psycho-physiological Restoration.

4.1.6 Data analysis

IBM SPSS Statistics version 25 was used for data analysis. The Kaiser-Meyer Olkin Measure of Sampling Adequacy was .858. Therefore, factor analysis brings useful results and can be used to look at the validity of the constructs and its 25 items (Kaiser, 1974). The correlations among the items as visible in Bartlett's Test of Sphericity [X^2 (325)=1,720.52, p<.001] indicate the suitability of performing a principal component analysis (Snedecor & Cochran, 1989).

Validity

Table 13. Results of factor analysis restorative effects questionnaire – Study 2

Construct	Item	Factor		
		1	2	3
Pleasure (PLE)	PLE.1 Sad/happy	.84		
	PLE.2 Annoyed/pleased	.74		
	PLE.3 Dissatisfied/satisfied	.74		
	PLE.4 Gloomy/cheerful	.79		
	PLE.5 Bored/content	.58		
	PLE.6 Desperate/hopeful	.71		
Environmental Preference (PRE)	PRE.1 Unpleasant/pleasant		.77	
	PRE.2 Negative/positive		.82	
	PRE.3 Unattractive/attractive		.68	
	PRE.4 Unenjoyable/enjoyable		.77	
	PRE.5 Not stimulating/ stimulating		.75	
Restoration (RES)	RES.1 In the meeting room I was able to concentrate well			.51
	RES.2 In the meeting room I was able to focus on myself			.62
	RES.3 In the meeting room I was able to release all tension			.77
	RES.4 In the meeting room I was able to relax			.85
	RES.5 In the meeting room my energy level got renewed			.66
	RES.6 In the meeting room I felt energetic			.63

As the constructs and belonging items on restorative characteristics were tested to be both reliable and valid in Study 1 already, this is not the focus here. An outlay of factor analysis of restorative characteristics in this study which lead to discard the first item of Compatibility – Ability is in Appendix P. Principal component analysis shows that all factor loading values for restorative effects exceed .50 which is needed for an item to be considered significant (Field, 2018; Hair, Black, Babin, & Anderson, 2014). All items immediately loaded in its suitable construct in the first round of analysis, so no items were discarded. The scores are contemplated to be valid and are shown in Table 13.

Reliability

The internal consistency of the constructs, the reliability, was tested by means of correlation scores (*r*) for the two-item constructs and Cronbach's alpha scores (α) for the constructs with more than two items. The reliability scores, means, and standard deviations of all constructs in this study are visible in Table 14. With Cronbach's alpha scores (α) well over .70 (Field, 2018; Hinton, 2004) and correlation scores (*r*) exceeding .60 (Burns & Burns, 2008; De Veaux et al., 2005) all constructs are considered reliable.

Table 14. Cronbach's alpha, mean score, standard deviation (SD) – Study 2

Constructs	Items	Cronbach's *α* / Correlation (*r*)	*M*	*SD*
Being Away – Escape (BAE)	1		3.78	1.48
Being Away – Novelty (BAN)	2	*r*=.67	3.44	1.36
Coherence (COH)	1		5.08	1.13
Compatibility – Ability (COA)	1		4.30	1.26
Compatibility – Expectation (COE)	1		5.98	1.00
Fascination (FAS)	2	*r*=.79	3.11	1.24
Pleasure (PLE)	6	*α* =.90	5.29	.75
Environmental Preference (PRE)	5	*α* =.88	5.02	.92
Restoration (RES)	6	*α* =.86	4.95	.80

4.2 Results

4.2.1 Self-reported restorativeness

The mean score for each construct, except for Compatibility – Expectation and Pleasure, is higher in the plant condition than in the no-plant condition. Independent sample t-tests (Table 15) show a significant difference ($p < .05$) between conditions for Being Away – Novelty, Fascination, Environmental Preference, and grade. Similar to Study 1 participants perceive the plant condition to be more fascinating as well as providing a sense of physical being away. The results show that there is a higher Environmental Preference for the room with plants meaning that participants experience the plant

condition as more positive, appealing and stimulating. The meeting room with plants is evaluated better than the meeting room without plants. The participants in the room with plants gave the room a higher grade than the participants in the room without plants. Desire showed a marginally significant difference with a p-value of .05 indicating a desire to work in the plant condition instead of the no-plant condition.

Table 15. Mean score, standard deviation (SD), t-test plant versus no-plant condition – Study 2

Construct	Plant condition		No-plant condition		T-test, independent samples, equal variance		
	M	*SD*	*M*	*SD*	*t*	Df	*p*
Being Away – Escape (BAE)	4.02	1.45	3.57	1.48	1.59	105	.115
Being Away – Novelty (BAN)	3.99	1.17	2.98	1.35	4.08	105	.000
Coherence (COH)	5.20	1.06	4.98	1.18	1.01	105	.313
Compatibility – Ability (COA)	4.31	1.31	4.29	1.23	.05	105	.958
Compatibility – Expectation (COE)	5.90	.98	6.05	1.02	-.79	105	.431
Fascination (FAS)	3.68	1.05	2.62	1.19	4.86	105	.000
Pleasure	5.26	.68	5.31	.81	-.34	105	.732
Environmental Preference	5.31	.70	4.78	1.02	3.14	100,803	.002
Restoration	5.07	.68	4.85	.88	1.46	106	.148
Grade	7.45	.82	6.88	1.53	2.46	91,606	.016
Desire	5.39	.91	4.97	1.26	1.96	106	.053

Note. A multivariate analysis of variance (MANOVA), including age as a covariate as well, showed that there is no significant difference in conditions based on gender, $F(11.000, 90.000) = .605$, $p > .05$; Wilk's $\lambda = .931$

The meeting rooms were created for two to four people, but in 26.9% of cases the OFAD was used in a way that its capacity was not estimated to be suitable for. Some meetings included five to six people (N=4) while others involved only one person (N=10). The type of meeting was often described as information exchange in the form of updates and project meetings. Most meeting were held on a Wednesday (N=14) with the lowest number for the Friday (N=8). There is no significant difference in grade, desire or restorative effects between days. Additionally, there is no clear Environmental Preference for either the Hamer (N=53) or the Steiger (N=55). The most frequent reasons to choose for a meeting room include availability and having a meeting. Other reasons comprise the need for a quiet working space, it being someone else's decision, and the room being closest to one's desk. Notably, two participants said to deliberately opt for the plant condition.

Comments of participants

Considering room improvements in the no-plant condition, participants mainly commented on unused potential of design, colour and decoration in the meeting room. Additionally, there were complaints about the indoor office climate as well as the lack of privacy. People stated a need for more nature, plants and the colour green. In the plant condition participants emphasized the presence of a positive atmosphere and for the plants to be a desirable aspect of the room. Only some complaints about the

indoor environmental quality were made. Increased coverage and privacy seem an incidental gain of plants in this study. During the experiment the pink-, purple-coloured flowering plant *Anthurium Sweet Dream* on the table was removed or replaced multiple times. Some participants commented on the questionnaire as they did not expect items based on feelings and mood which were considered to be rather profound in the context of employee well-being and office design.

Correlation analysis

Table 16. Results of correlation analysis – Study 2

	FAS	BAN	BAE	COH	COA	COE	PLE	PRE	RES	Grade	Desire
FAS											
BAN	.39**										
BAE	.36**	.41**									
COH	.27**	.15	.02								
COA	.21*	.24*	.20*	.20*							
COE	-.06	-.11	-.07	.29**	.18						
PLE	.18	.12	.16	.31**	.16	.35**					
PRE	.54**	.39**	.31**	.46**	.29**	.21**	.60**				
RES	.37**	.20*	.37**	.32**	.29**	.31**	.64**	.64**			
Grade	.48**	.37**	.28**	.42**	.22*	.21*	.49**	.74**	.63**		
Desire	.30**	.13	.20*	.40**	.20*	.14	.40**	.56**	.48**	.69**	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Correlation analysis was conducted to check and establish further foundation for the idea that the restorative effects – Pleasure, Environmental Preference, Restoration – are related. Additionally, this analysis gives a first idea of the relationships between the restorative characteristics and the restorative effects. Table 16 shows the Pearson correlation coefficients of all constructs in the research model. With inter-correlations higher than .60 it can be stated that there are significant moderate positive relationships (Burns & Burns, 2008; De Veaux et al., 2005) between Pleasure and Environmental Preference, Pleasure and Restoration, Environmental Preference and Restoration. This analysis supports that the restorative effects are interrelated and do not stand alone. Considering restorative characteristics, Fascination and Being Away – Escape have the strongest correlation values with Restoration (both .37). Secondly, Fascination correlates most with Environmental Preference (.54). Then Compatibility – Expectation shows the highest correlation values with Pleasure (.35). The variables do not measure the same variance with values under .90. Furthermore, all predictors have an independent effect and there is no reason to worry about multicollinearity as VIF values are between 1.09 and 3.70 not exceeding 10 (Burns & Burns, 2008). Correlation analysis is conducted for both conditions independently too (Appendix Q).

Regression analysis

For further analysis on the relationships between the restorative characteristics and the restorative effects hierarchical regression analysis is conducted. As psychological restoration showed not to be significantly present in the plant condition, this analysis shows which percentage of Restoration is explained by the research model. Model 1 solely incorporates the restorative characteristics and explains 31.5% ($F=9.05$, $p<.001$) of variance in Restoration. Model 2 adds Environmental Preference and Pleasure which shows that 54.7% ($F=16.82$, $p<.001$) of variance in Restoration is explained by the model. Predictors of Restoration in Model 1 are Being Away – Escape, Compatibility – Expectation, and Fascination with Being Away – Escape as the strongest predictor ($\beta=.30$). In Model 2 predictors are Being Away – Escape, Pleasure, and Environmental Preference with Pleasure as the strongest predictor ($\beta=.39$). Environmental Preference and Pleasure being predictors of Restoration further supports that all restorative effects in this research are interdependent influencing each other. Multiple linear regression analysis is done for all separate restorative effects as well as Grade and Desire of which an outlay is to be found in Appendix R Here you will find analyses for the separate conditions too. The analysis shows that adding the plant versus no-plant condition causes a minimal rise in variance for all restorative effects, but it is not a significant predictor of the respective effects. Compatibility – Expectation is the only significant predictor ($p<.01$) of Pleasure with $\beta=.31$. Significant predictors of Environmental Preference are Compatibility – Expectation ($\beta=.16$), Coherence ($\beta=.27$), and Fascination ($\beta=.34$).

Table 17. Results of hierarchical regression analysis – Study 2

Restoration		*B*	Std. Error	*β*	*t* value	Sig.	*Adj.* R^2 *(ΔR^2)*
Model 1	Constant	1.75	.50		3.52	.001	*Adj.* R^2 =
	BAE	.16	.05	.30	3.23	.002	.315 (.666)
	BAN	-.02	.06	-.03	-.28	.782	R^2 = .354
	COA	.07	.06	.10	1.20	.235	Df = 6, 99
	COE	.22	.07	.27	3.13	.002	$p < .001$
	COH	.11	.06	.16	1.78	.079	
	FAS	.14	.06	.22	2.37	.020	
Model 2	Constant	.35	.46		.76	.451	*Adj.* R^2 =
	BAE	.12	.04	.23	2.97	.004	.547 (.542)
	BAN	-.05	.05	-.08	-1.03	.308	R^2 =.581
	COA	.05	.05	.07	1.02	.310	Df = 8, 97
	COE	.09	.06	.11	1.42	.160	$p < .001$
	COH	.01	.06	.01	.15	.885	
	FAS	.06	.05	.10	1.14	.258	
	PLE	.41	.09	.39	4.43	.000	
	PRE	.24	.09	.27	2.52	.013	

Mediation analysis

It is clear that the restorative characteristics and restorative effects are related and influence each other. Mediation analysis is conducted using SPSS PROCESS (Preacher & Hayes, 2004) to check if the restorative characteristics Fascination, Being Away – Novelty, and Compatibility – Ability actually mediate the effect of the intervention on Restoration, especially since the plant versus no-plant condition do not appear to significantly predict Restoration (b=-.22) directly. A bootstrap estimation approach of 5000 samples is used to research the indirect effects. Fascination mediates the direct effect of the intervention condition (plants or no-plants) on Restoration (b=-.26, SE=.097, CI=-.4777, -.0949) with a confidence interval of 95%, excluding 0 (Figure 12). This results in the intervention condition no longer being a significant predictor of Restoration which is in line with the regression analyses performed. Both Being Away – Novelty and Compatibility – Ability showed not to be mediators of Restoration because the indirect effect is statistically insignificant with the confidence interval including zero.

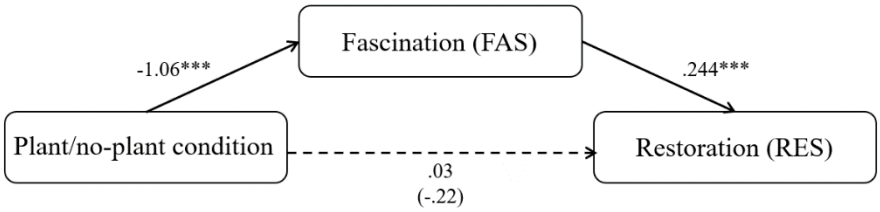

Figure 12. Mediation analysis Restoration with Fascination as mediator – Study 2
Note. Unstandardized coefficients are given and significant values (*p<.05, ** p<.01, ***P<.001) with the effect neglecting the mediator are presented in brackets.

Furthermore, mediation analysis (Figure 13) is done to see whether the restorative effects Pleasure and Environmental Preference mediate the effect of the intervention on Restoration. A bootstrap estimation approach of 5000 samples is used to research indirect effects. Environmental Preference mediates the direct effect of the intervention on Restoration (b=-.30, SE=.095, CI=-.4835, -.1123) with a confidence interval of 95%, excluding 0. This means the plant or no-plant condition is no longer a significant predictor of Restoration. On the contrary, Pleasure is not a mediator of Restoration.

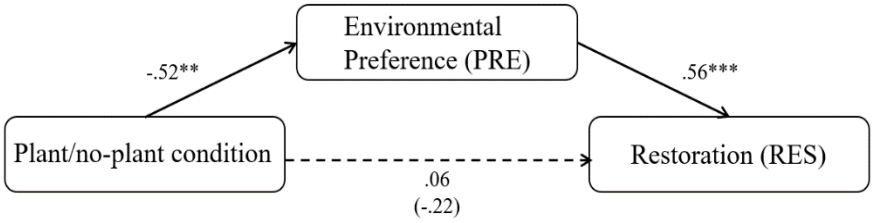

Figure 13. Mediation analysis Restoration with Environmental Preference as mediator – Study 2
Note. Unstandardized coefficients are given and significant values (*p<.05, ** p<.01, ***P<.001) with the effect neglecting the mediator are presented in brackets.

4.2.2 Wearable device

The Empatica E4 wearable data of 96 participants, 44 in the plant condition and 52 in the no-plant condition, could be used for analysis. For 12 participants the wearable did not register any data, or it was impossible to retrieve the data from the device. Heart Rate is given in beats per minute (BPM), Inter-Beat Interval is given in seconds (sec), Acceleration is presented in G-forces (g), Electrodermal Activity is measured in microSiemens (µS), and Temperature is given in degrees Celsius (ºC). Skin temperature is measured which is not as high as body temperature. The Empatica E4 support group claims Blood Volume Pulse (BVP) have no set measurement unit as it is a combination of measures.

Table 18. Empatica E4 wearable data per condition averages – Study 2

		ACC (g)	BVP	IBI (sec)	EDA (µS)	HR (BPM)	TEMP (ºC)
Plant condition	*M*	.997	-.003	.883	.470	78.04	30.91
	SD	.013	.036	.117	.669	5.18	2.56
	MIN	.970	-.156	.694	.021	69.07	24.43
	MAX	1.020	.152	1.252	2.823	88.57	37.24
No-plant condition	*M*	.997	-.001	.875	.759	79.43	31.41
	SD	.011	.006	.112	1.897	7.22	2.02
	MIN	.972	-.023	.642	.020	67.22	25.62
	MAX	1.016	.017	1.154	10.621	108.28	34.84
Total	*M*	.997	-.002	.879	.628	78.79	31.18
	SD	.012	.024	.113	1.474	6.37	2.28
	MIN	.970	-.156	.642	.020	67.22	24.43
	MAX	1.020	.152	1.252	10.621	108.28	37.24

The mean physical features of participants in the plant condition, as shown in Table 18, are slightly lower in case of acceleration (ACC), Electrodermal Activity (EDA), Heart Rate (HR), and Temperature (TEMP) in comparison to the no-plant condition. This could indicate increased recovery from stress and mental fatigue, Restoration, in the plant condition. Blood Volume Pulse (BVP) and Inter-Beat Interval (IBI) are comparable in conditions. However, independent sample t-tests (Table 19) show the differences to be insignificant. In the plant condition the range between the minimum and maximum value is lower for Electrodermal Activity and Heart Rate, but higher for all other physical features. It seems there is more fluctuation in physical feature data of participants in the plant condition.

Table 19. Mean score, standard deviation (SD), t-test Empatica E4 data both conditions – Study 2

Feature	Plant condition		No-plant condition		T-test, independent samples, equal variance		
	M	*SD*	*M*	*SD*	*t*	Df	*p*
ACC (g)	.997	.013	.997	.011	-.16	94	.877
BVP	-.003	.036	-.001	.006	-.37	45, 282	.711
IBI (sec)	.883	.117	.875	.112	.34	86	.737
EDA (µS)	.470	.669	.759	1.897	-.95	93	.345
HR (BPM)	78.04	5.18	79.43	7.22	-1.07	94	.289
TEMP (ºC)	30.91	2.56	31.41	2.02	-1.02	87	.312

To take a closer look at the differences in physical features, graphs (Figure 14 to 19) were created in which both conditions are shown over the first hour of a meeting. An hour shows a good average with a representative number of participants (most meetings did not last longer than 60 minutes), especially since Restoration can be visible within seconds or minutes after being exposed to nature. Table 20 shows the values accompanying the graphs and the number of participants that represent these numbers. Graphs and tables of the full duration can be found in Appendix S where you will see the difference in duration between the two conditions (210 versus 490 minutes) as the plant condition stops early. In the plant condition ACC shows a more stable development whereas participants in the no-plant condition seem more restless with peaks in the data. The plant condition shows a lower mean Acceleration in total, but in the first hour these participants are actually more active. Considering BVP both conditions show a similar development with the participants in the plant condition showing slightly lower values until the last interval from 50-60 minutes. From then on, over the full duration, there are more extremes and higher peaks for the plant condition. For IBI the curve seems to flatten for the plant condition whereas it keeps rising for the no-plant condition. Whereas IBI was higher for the plant condition in the total average, in the first hour it is actually lower. EDA is the only physical feature that is constantly lower in the plant condition and where lines do not cross. Over the first 30 minutes HR shows an equal development in both conditions until Heart Rate in the no-plant condition rises compared to the plant condition. TEMP shows quite a difference in favour of the plant condition with lower numbers for those participants. Nevertheless, after 40 minutes participants seem to have a more or less equal temperature.

Based on EDA and TEMP it seems plants have the most effect on physical features in the first 40 minutes. In general, HR, EDA and TEMP seem stable as these indicate to be lower in the plant condition in the first hour as well as over the full duration time. The mean values of ACC, EDA, HR, and TEMP are in line with literature (Ulrich et al., 1991) saying that nature and plants result in lower values of physical features as opposed to the no-plant condition. BVP and IBI do not support these claims with higher values in the plant condition. Yet, these two physical features are used to measure HR which is slightly lower in the plant condition. Although these seemingly positive effects, physiological Restoration is not present as the differences are small and not significant for any of the physical features.

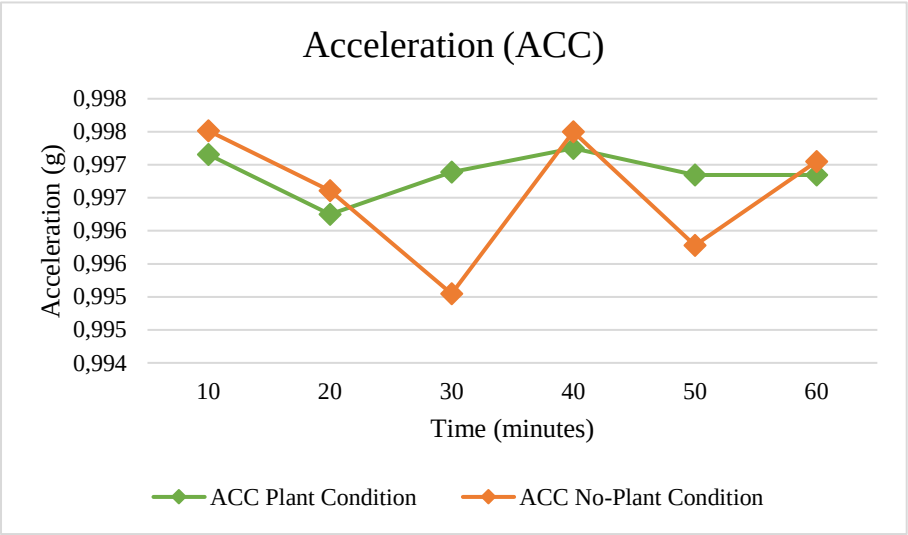

Figure 14. Empatica E4 data Acceleration (ACC) – Study 2

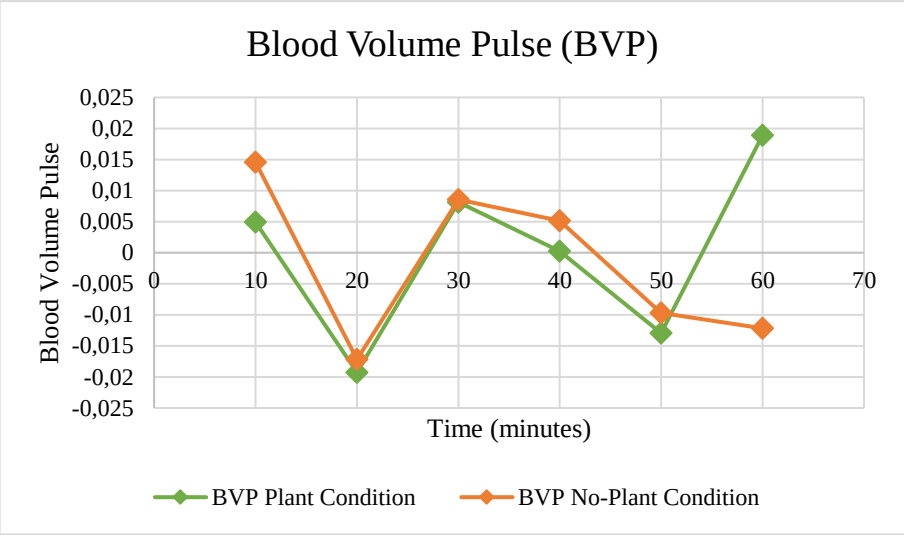

Figure 15. Empatica E4 data Blood Volume Pulse (BVP) – Study 2

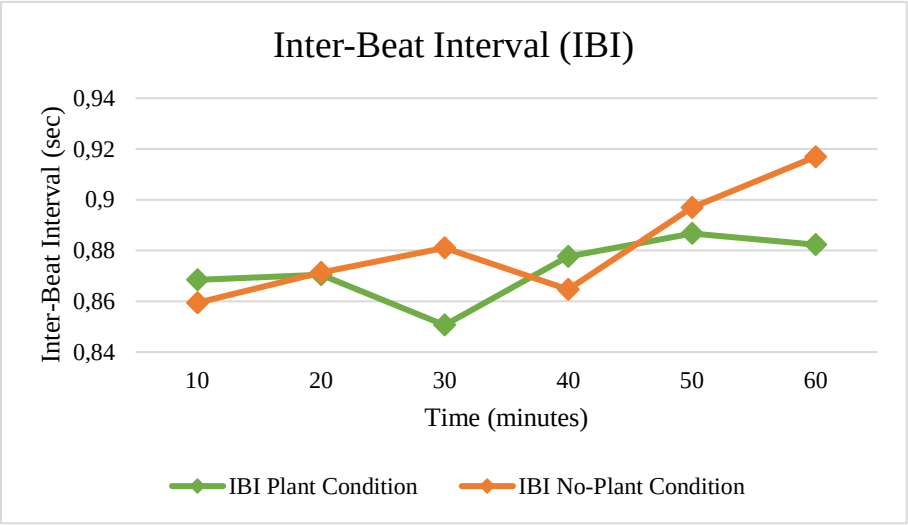

Figure 16. Empatica E4 data Inter-Beat Interval (IBI) – Study 2

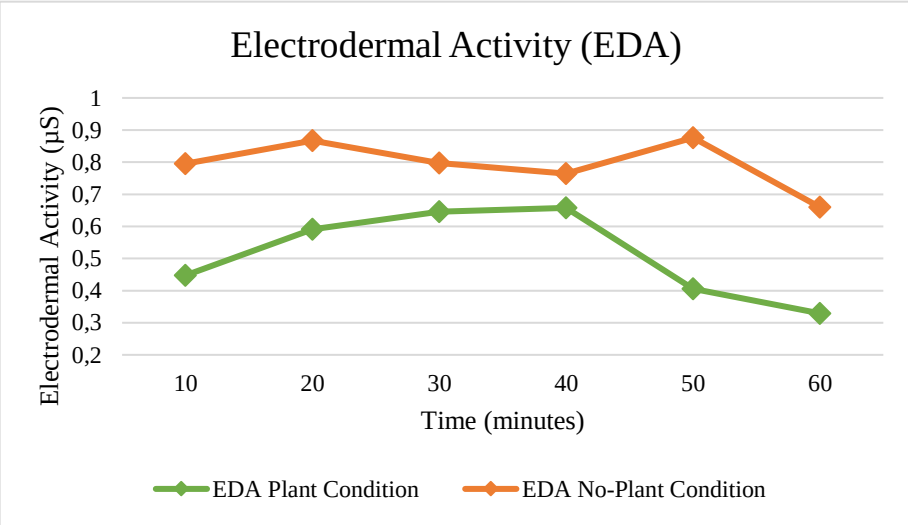

Figure 17. Empatica E4 data Electrodermal Activity (EDA) – Study 2

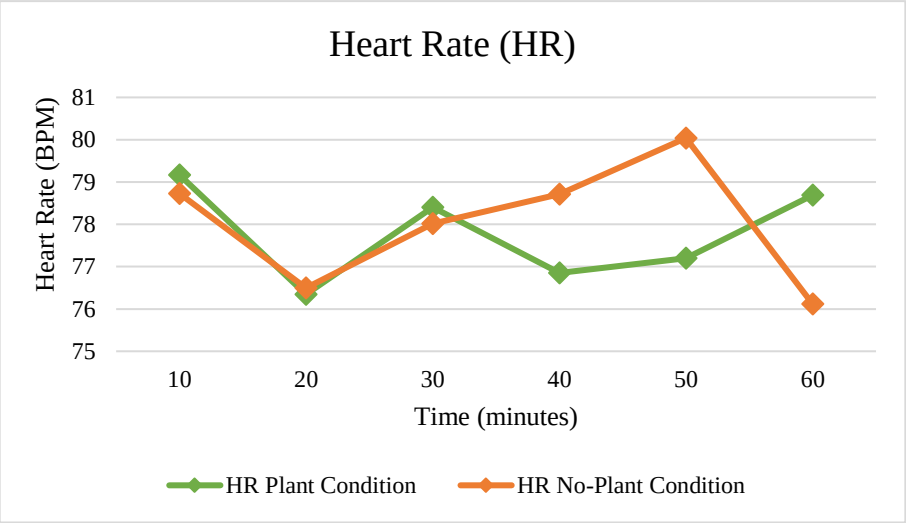

Figure 18. Empatica E4 data Heart Rate (HR) – Study 2

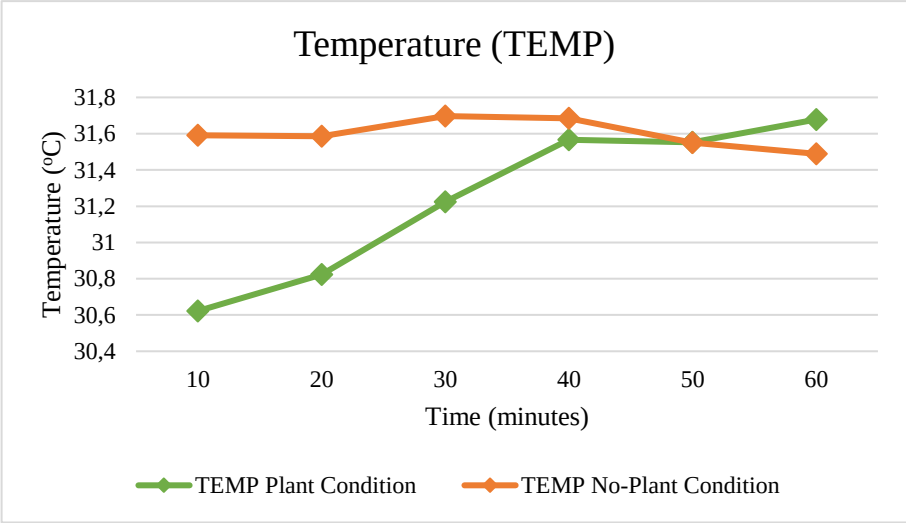

Figure 19. Empatica E4 data Temperature (TEMP) – Study 2

Table 20. Empatica E4 wearable data per condition over time – Study 2

	Time (minutes)	10	*N*	20	*N*	30	*N*	40	*N*	50	*N*	60	*N*	Total average
ACC	Plant condition	.997	44	.996	44	.997	39	.997	32	.997	30	.997	26	.997
(g)	No-plant condition	.998	49	.997	50	.995	50	.998	51	.996	44	.997	38	.997
BVP	Plant condition	0.005	44	-0.019	44	0.008	39	0.000	32	-0.013	30	0.019	26	0.00
	No-plant condition	0.015	49	-0.017	50	0.009	50	0.005	51	-0.010	44	-0.012	38	-0.002
IBI	Plant condition	0.868	39	0.871	39	0.851	37	0.878	30	0.887	29	0.882	25	0.873
(sec)	No-plant condition	0.859	43	0.871	45	0.881	44	0.865	44	0.897	41	0.917	35	0.882
EDA	Plant condition	0.448	43	0.591	43	0.646	38	0.658	32	0.406	30	0.329	26	0.513
(µS)	No-plant condition	0.796	49	0.867	50	0.797	50	0.764	50	0.876	44	0.660	37	0.793
HR	Plant condition	79.17	44	76.35	44	78.40	39	76.85	32	77.20	30	78.69	26	77.78
(BPM)	No-plant condition	78.73	49	76.50	50	78.02	50	78.72	51	80.04	44	76.12	38	78.02
TEMP	Plant condition	30.62	40	30.82	40	31.22	35	31.57	29	31.55	28	31.68	24	31.25
(°C)	No-plant condition	31.59	46	31.59	47	31.70	47	31.69	48	31.55	41	31.49	35	31.60

4.2.3 The hypotheses

Having looked at the results of Study 1 and Study 2, the hypotheses can be answered as shown in Table 21 and Figure 20. The plant situation gave rise to the significant presence of the restorative characteristics Fascination, Being Away – Novelty, and Compatibility – Ability which in turn resulted in the restorative effect of Environmental Preference. Even though all restorative effects have shown to be interrelated, both psychophysiological Restoration and Pleasure were not sustained in this research.

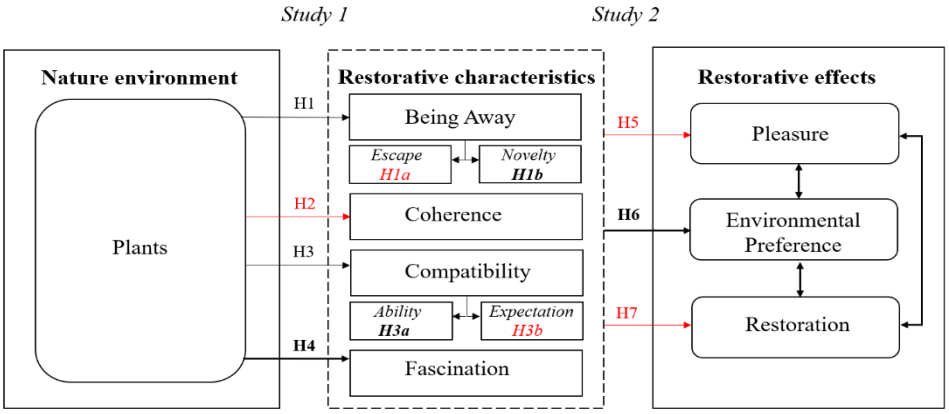

Figure 20. Visualisation of results and hypotheses
Note. Red means rejected. Bold arrows and text are confirmed. H1 and H3 are partially confirmed.

Table 21. Hypotheses

H1	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Being Away* which, in turn, positively influences the restorative potential of the environment.	*Partly supported*
H1a	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Escape* which, in turn, positively influences the restorative potential of the environment.	*Rejected*
H1b	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Novelty* which, in turn, positively influences the restorative potential of the environment.	***Supported***
H2	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Coherence* which, in turn, positively influences the restorative potential of the environment	*Rejected*
H3	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Compatibility* which, in turn, positively influences the restorative potential of the environment.	*Partially supported*
H3a	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Compatibility – Ability* which, in turn, positively influences the restorative potential of the environment.	***Supported***
H3b	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Compatibility – Expectation* which, in turn, positively influences the restorative potential of the environment.	*Rejected*
H4	A nature environment (presence of plants) in comparison to a non-nature environment (absence of plants) brings the restorative characteristic of *Fascination* which, in turn, positively influences the restorative potential of the environment.	***Supported***
H5	The presence of restorative characteristics in a nature environment (presence of plants) in comparison to the lack thereof in a non-nature environment (absence of plants) brings the restorative effect of *Pleasure*.	*Rejected*
H6	The presence of restorative characteristics in a nature environment (presence of plants) in comparison to the lack thereof in a non-nature environment (absence of plants) brings the restorative effect of *Environmental Preference*.	***Supported***
H7	The presence of restorative characteristics in a nature environment (presence of plants) in comparison to the lack thereof in a non-nature environment (absence of plants) brings the restorative effect of *Restoration*.	*Rejected*

5 Discussion

This study examined whether plants at the office, effectuating a more natural environment, bring office employees restoration from mental fatigue and stress as mediated by restorative characteristics. In this research plants have proven to be a beautiful and fascinating addition to the meeting room (*Fascination*). People feel a sense of being physically away because of the plants (*Being Away – Novelty*) and the meeting room with plants fulfils the needs of the individual better (*Compatibility – Ability*). In turn, the presence of these restorative characteristics resulted in a Preference for the environment with plants. This means plants enhance the restorative potential of the office environment through the restorative effect Environmental Preference. The presence of the restorative effects of psychophysiological Restoration and Pleasure is not sustained in this study. Fascination showed to be a mediator of Restoration. Furthermore, Environmental Preference was found to mediate the effect of Restoration too.

The increased sense of Fascination and Being Away – Novelty in the plant situation in both studies is supported by the work of Nordh, Hartig, Hagerhall, and Fry (2009). Plants are a pleasant and interesting addition to the meeting room with people's attention effortlessly drawn to the greenery, in line with Evensen et al. (2015, 2017). Plants are the only decoration in the otherwise plain white- and grey-coloured environment. The black carpet does not help to bring Fascination either. The intervention ensured plants were in every angle of the room making them visually unavoidable. Without plants the room would be similar to the workplace not evoking curiosity or attention. The presence of a sense of Being Away – Novelty in the plant condition (as supported by i.e. Pals, 2012) is caused by the person physically leaving one's workplace, stepping away from the computer screen to literally go to another place where there is social interaction (meeting) and greenery. A break from individual work. Plants bring enough change from the desk, where one spends hours a day, to have beneficial effects. This supports the idea that the physical environment (and workplace) affects a person (Taylor & Kuo, 2011).

Furthermore, Study 1 showed increased Compatibility – Ability in the plant photo. An individual determines one's own needs and desires. Biophilia may give rise to a (unconscious) need for nature (Ulrich, 1993) which is now fulfilled by plants as is the desire for more decoration. Furthermore, plants fulfil the need for privacy by covering up part of the glass wall looking into the open office area lowering

distraction. The lack of Compatibility – Expectation may derive from the fact that expectations and rules in a work situation are not solely attributed to the person, but are set based on the line of work, company vision, management, and organisational culture. People know what is expected at an office in a meeting room regardless of whether they work at an office themselves. Therefore, one's answers may have been based on assumed expectations, what you should do, instead of personal opinion. Design or plants may not affect expectations in a work environment, but expectations are affected by the group. On the contrary, needs and abilities are based on the individual. The items on Ability seem to leave more openness for personal judgement and therewith a difference in answering. This may have resulted in Compatibility to come in two different forms in this study; Ability and Expectation.

Plants are common and greenery is a trend. People have plants at home and society interest evolves around sustainability, the environment, and well-being. There are many start-ups making greenery in office environments their business. Plants have been at offices for some time now. People even expect plants to be there. The lack of a significant difference in Coherence means that the image of a meeting room as clean and functional is not disturbed by the presence of plants. Even with the addition of plants the meeting room remains coherent and harmony is not disrupted. Plants are no odd addition. People can still focus with no higher need for cognitive endeavour (Kaplan, 2001) which is desirable to keep a functional office environment. The addition of nature through water, sound or smell could be considered weird or as a distraction which could lead to different results. As the presence of Compatibility – Ability shows, plants make the meeting room more compatible with the needs and abilities of the person resulting in a fit between the environment and the person. However, plants being normal and common in any environment may be another reason why plant do not influence expectations.

Even though people experienced a sense of physically being away, the lack of feeling psychologically away may be attributed to the idea that even though in a different environment, one is still at work (either behind a desk or in a meeting). How employees experience the office in general may have a strong, lasting impact on how they assess the meeting room. Furthermore, in a meeting there is no time to daydream and possibly no desire for creativity as there is work to do. You cannot just feel free from other people's demands and expectations or turn away from obligations. You need to work

together. There is a reason for the meeting. It is part of your work, your daily routine, which you cannot allow yourself to escape from. Employees pay attention and effort into the task and not the environment. This may lessen the chance of restorative effects resulting from effortless attention to the surroundings. The disparity in results between the two dimensions of Being Away, which are closely related (Kaplan & Kaplan, 1989; Pals, 2012), may also be attributed to the questions asked. Respondents complained about the items on Being Away – Escape of the PRCQ not being adequate for an office environment, whereas validity and reliability are proven. To summarise, Figure 21 shows a visualisation of the results of the hypotheses for restorative characteristics.

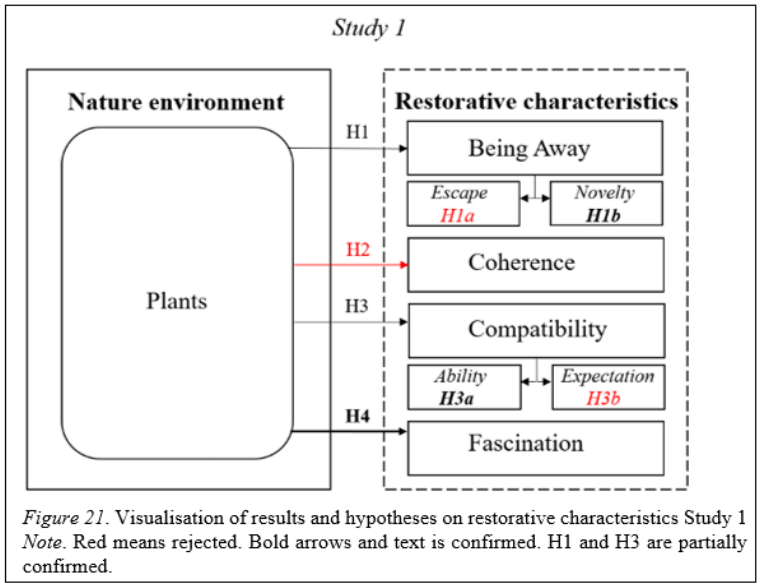

Figure 21. Visualisation of results and hypotheses on restorative characteristics Study 1
Note. Red means rejected. Bold arrows and text is confirmed. H1 and H3 are partially confirmed.

The positive effect of plants is visible in the higher scores for Desire and Grade in both studies as well as for Choice in Study 1. The fact that this research is conducted may have already brought positive effects as employees feel supported and cared for by the employer (Bjørnstad, Patil, & Raanaas, 2016). Nevertheless, even though all effects are closely related, not every restorative effect is present in this study (Pals, Steg, Dontje, Siero, & Van der Zee, 2014; Staats, Kievit, & Hartig, 2003; Ulrich, 1993). Participants evaluate the plant condition as more appealing and stimulating – Environmental Preference – in line with prior research (Hartig et al., 2011, Laumann, Gärling, & Stormark, 2001; Van den Berg, Koole, & Van der Wulp, 2003). Pals (2012) showed that when Fascination is present, Environmental Preference is present too just like in this study. The Preference for an environment with plants can be a result of the presence of restorative characteristics and is likely to occur because of the deep connection humans have with nature; biophilia. Plants are associated with growth and newness. People are unconsciously drawn to elements of nature and evaluate natural environments over built environments (Pals et al., 2014; Wilson, 1984). Some participants deliberately opted for a meeting room because of the plants in it. In general, people like plants. That is why they prefer the plant situation.

The absence of several restorative characteristics may have negatively affected or even prevented the presence of Restoration and Pleasure in this study. Participants do not have a more positive affective response (i.e. joy or happiness) to the plant condition. Some participants stated the fullness of the room to be annoying instead of enjoyable. Maybe some participants disliked the type, size or colour of the plants used resulting in a negative affective response and therewith lack of Pleasure. Earlier events or experiences that day as well as mood may influence Pleasure. With regards to '*Twentse nuchterheid'*, the no-nonsense and down-to-earth mentality of Dura Vermeer employees in Hengelo, people are not really expressive and will not quickly complain which may lead to more neutral and positive answering in general. This may be the overall attitude in the construction industry too. Furthermore, Pleasure at work may be inevitably limited or at least lower than in leisure environments. Usually, there is a clear goal of a meeting which is often not Pleasure in case of a work situation. The content of the meeting or the people involved can influence restorative effects. A serious topic or heated argument influences one's emotions and state of mind. Humans are social creatures who are affected by others. If when entering the meeting room someone is talking about the plants as meaningless, annoying or useless this may negatively influence your attitude before forming your own opinion. The same goes for a positive reaction. Because the questionnaire was filled-out after the meeting took place, this can be influential.

The lack of both physiological and psychological Restoration could be due to people experiencing no or little mental fatigue and stress, the plant environment not being stimulating enough, or the impact of other environmental factors. Measurements on a group-level and the influence of other people could have affected the results too. Furthermore, participants were measured while doing their job. They had to focus and use their mental capacity instead of having the time to relax, look around and restore energy. Plants may be seen as irrelevant information with an eye to the task which may hinder and disturb a person rather than lower mental fatigue at that time. That could be the reason why the slight differences in physical features at the start, supporting a micro restorative experience after seeing nature, do not last over time. It makes sense that people were not experiencing Restoration as they just had an intense work session, especially since psychological Restoration was measured at the end of the meeting. It could also be that restorative effects are not that strong because the participants are used to the office, and the

meeting room, as this is part of their daily environment. The sole addition of plants may not have turned the room into a different environment for Restoration to occur. More or different elements of nature may be needed to achieve the desired effects. Moreover, some participants said to perceive the plants as unnecessary and meaningless.

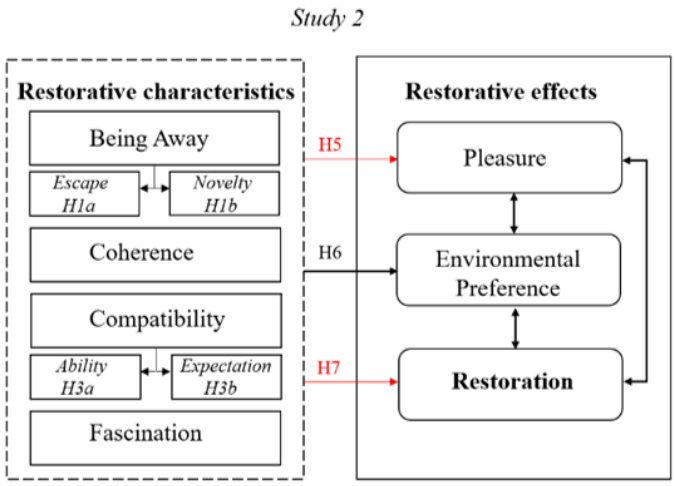

Figure 22. Visualisation of results and hypotheses on restorative effects Study 2
Note. Red means rejected. Bold arrows and text is confirmed. H1 and H3 are partially confirmed.

Others seemed less receptive to new well-being initiatives. This can be a pitfall of the no-nonsense mentality which sometimes blocks openness to new things, especially when the approach is less rational focussing on feelings and emotions. It could also be that exposure to nature may not bring restoration for people who do not experience mental fatigue and stress. Possibly, more active interaction with plants, like touching or smelling them, is needed for Restoration to occur. There are multiple plausible factors of influence as it is not a lab situation. Maybe prior research is right and the beneficial effects of plant do not exist outside a lab (e.g. Cummings & Waring, 2019). In closing, Figure 22 shows a visualisation of the results of the hypotheses for restorative effects.

In sum, this study showed that introducing plants as a physical element of nature to the office environment of Dura Vermeer Hengelo results in the presence of the restorative characteristics Being Away – Novelty, Compatibility – Ability and Fascination which in turn result in Environmental Preference for the plant condition. In this research psychophysiological Restoration and Pleasure were not sufficiently proven. Maybe Kaplan (1995) was right that all restorative characteristics need to be present before Restoration from mental fatigue and stress is achieved. However, the current study strengthens the scarce yet promising evidence that nature benefits human beings. The fact that the sole addition of plants to an urban, built environment brings positive effects already shows the broader potential of nature. Nature elements are indeed better than non-nature elements (Berto, 2014; Ulrich et al., 1991) as people have a preference (Pals, 2012) for more biophilic design. Humans are drawn to

elements of nature (Deng & Deng, 2018) and there is a deep connection between human beings and nature; biophilia. Research using photographs is enough to establish benefits resulting from greenery as supported by Berto (2005) and Hartig et al. (2003). Therefore, real-life exposure and outdoor nature are no necessity (Gray & Birrell, 2014). As for restorative effects, all effects are interrelated. In spite of the lack of Pleasure and Restoration in this research, plants alone bring Environmental Preference which makes it plausible to believe that other elements of nature or using more nature in the environment will bring all restorative effects. This study only focussed on one Indoor Environmental Quality (IEQ) factor – *biophilia and views* – whereas a more holistic view thereon can further improve the working environment. All IEQ factors, like noise and acoustics as well as office layout, need to be optimal without distractions. This may result in High Performance Green Buildings and strengthen the found benefits of nature through biophilic design. The restorative potential of the office environment is enhanced through one single physical change to the environment. Through plants, a bit of outside was brought inside. Nature ensures increased restorative potential in an urban environment. Nature can be the vitamin G (green) to enhance well-being and even prevent Sick Building Syndrome (SBS). This is crucial information. With 90% of our time (still increasing and emphasizing the need for change) being spend indoors, nature needs to be brought inside. In this research plants bring Environmental Preference which supports the belief that nature can do so much more for people. Nature can be a coping strategy to at least bring benefits and eventually even diminish the growing problem of increased mental fatigue and stress among the population starting at a younger age every day.

5.1 Limitations, implications, and future research recommendations

5.1.1 Limitations of the research

One limitation of this study is that the effects measured cannot be solely contributed to the individual as measurements were based on actual work in the form of meetings which usually consist of two or more people. Each person is likely to be influenced by the others who were present during the meeting, for example by discussing the presence of plants in advance which may have influenced answering afterwards. Secondly, a field experiment is not the same as a lab experiment which means that alternative explanations, instead of plants, cannot simply be ruled out even though many aspects are controlled for.

Another limitation may be the generalisability of this study. Even though results are similar in Study 1 and Study 2, most participants live in Overijssel and claim location Hengelo is different from the other Dura Vermeer locations country-wide with '*Twentse nuchterheid'* (the no-nonsense mentality) likely to affect results. Additionally, organisational culture within a construction firm may be different from other industries as well. The use of a wearable device comes with another limitation; the baseline may differ per individual which makes it difficult to see whether the effect is strong or not without point zero (in a between-subject design) and the possible use of for instance medication affecting results. Results can be skewed by differences within the individual which is difficult to control for even though it is a single blind experiment with participants unaware of the experimental intervention.

5.1.2 Theoretical implications and future research recommendations

This study contributes to the field of environmental psychology, specifically restorative environments research, by strengthening the scarce yet promising results from previous work on the effect of plants in the office environment. Plants work and do have beneficial effects in the form of providing Fascination, a sense of Being Away, Compatibility, and Environmental Preference. Added value is in the use of complementary research methods for physiological as well as psychological effects and the detailed description of the environment (and meeting room) therewith enabling replication. This research considered the ART and the SRT proving its suitability specifically to the office environment. The PRCQ was used for the creation of the questionnaires in both studies. Similar outcomes were achieved, however, certain items and constructs are doubtable for the office environment. Even though it was stated that the PRCQ can be used in all types of environments, Being Away – Escape did not prove to be suitable here. Moreover, Compatibility fell apart into two dimensions (*Ability* and *Expectation*) which was not the case in prior work on restorativeness. Pals (2012) has indicated Compatibility to be a broad concept already. More research is needed to strengthen the foundation for these newly developed dimensions of Compatibility and the PRCQ may have to be reconsidered to see if the instrument is really suitable for an office environment which is rather different than a zoo.

As plants alone may not be enough to achieve a full account of Restoration with participants indicating a desire for more decoration in the meeting room still, it would be interesting to use a more

holistic design in future research to test whether 'the more nature, the better' is actually true. A within-factor design could be used to measure the effect of an increasingly nature-oriented office design over time. One could add multiple elements of nature that speak to different senses to get a more multisensory research. Additionally, to find out more about the psychological and physiological effects of plants, it may be helpful to prepare an experiment using three rooms; one with plants, one where the indoor environmental quality is based on the presence of plants without the actual plants being there, and a control room. More field research is needed to see whether effects are indeed only sustained in a lab. Finally, with an eye to the generalisability of the results of this study, it would be interesting to replicate the experiment at other Dura Vermeer locations or even in other industries.

5.1.3 Practical implications

It is useful to inform policy makers, occupational health professionals, environmental planning and design professionals as well as the general public on what works to establish and preserve environmental restorative quality. Plants benefit economic, environmental and societal sustainability as well as public health. Both governments and businesses can achieve effects in the form of rising productivity and increased satisfaction plus cost savings through decreased absenteeism and reduced employee turnover. Sick leave and job stress can be diminished or potentially prevented. A win-win situation can be created for the employer through support leading to an optimal workforce and a good reputation as well as for the employee in the form of an optimal working environment and a listening ear. This study helps in establishing guidelines and regulations for research on the use of plants in an office environment. Knowing that nature works enables the design of a healthy environment benefitting well-being and health of society at large. Even if effects are small at first, with a lot of time being spent at the office, on the long run these effects may accumulate and strengthen.

6 Conclusion

This research tested whether plants at the office, therewith effectuating a more natural environment, bring restoration from mental fatigue and stress as mediated by restorative characteristics among office employees. This study shows that plants as a physical element of nature are a beautiful and interesting addition to the meeting room (*Fascination*). People feel physically away (*Being Away – Novelty*) and the meeting room is more in line with the needs of the individual (*Compatibility – Ability*). The presence of these restorative characteristics resulted in an Environmental Preference for the plant condition which adds to the restorativeness of the meeting room. Not only Fascination, but also Environmental Preference showed to be a mediator of Restoration. Even though all restorative effects are interrelated, the restorative effects of Pleasure and psychophysiological Restoration as a result of plants were not sufficiently proven. Plants therefore do have a positive effect, but in this study the minimal level of Restoration (only through Environmental Preference) implies little to no lowered mental fatigue and stress among office employees at Dura Vermeer Hengelo. The indoor office climate was healthy and in line with the benchmark. In this study, plants have shown to only affect the indoor office climate through slightly enhancing the humidity level, but more research is needed. This study contributes to the promising evidence that nature benefits human beings. The benefits deriving from the sole addition of plants to a built environment may indicate a broader potential of nature.

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8 Appendices

8.1 Appendix A Qualtrics survey instrument Study 1

Beste respondent,

Alvast bedankt voor uw deelname! U wordt uitgenodigd om deel te nemen aan een onderzoek in het kader van mijn afstudeerscriptie voor de Master Marketing Communication & Design. Dit onderzoek wordt uitgevoerd vanuit de Universiteit Twente, faculteit Behavioural, Management and Social Sciences (BMS). Het onderzoek richt zich op het verbeteren van medewerkerswelzijn binnen een kantooromgeving. Deze vragenlijst tracht uw mening in kaart te brengen ten aanzien van een vergaderruimte op een foto.

Het invullen van deze vragenlijst zal ongeveer 5-7 minuten duren en is geheel anoniem. Er zijn geen fysieke, juridische of economische risico's verbonden aan uw deelname. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt uw deelname op elk gewenst moment stoppen. De gegevens worden uitsluitend gebruikt voor dit afstudeeronderzoek. Dit onderzoek is beoordeeld en goedgekeurd door de ethische commissie van de faculteit BMS. Voor de betrouwbaarheid van het onderzoek wordt u verzocht de vragenlijst individueel en niet in overleg met anderen in te vullen. Probeer zo volledig mogelijk alle vragen te beantwoorden. Voor vragen of opmerkingen kunt u op elk gewenst moment contact opnemen met de onderzoeker via onderstaand mailadres.

U mag nu met de vragen beginnen. Succes!

Lobke Elzinga

Ik wil deelnemen aan deze enquête:

- ○ Ja
- ○ Nee

→

Wat is uw geslacht?

- ◯ Man
- ◯ Vrouw
- ◯ Ik antwoord liever niet

Wat is uw leeftijd? (in jaar)

Wat is uw leeftijd? (in jaar)

In welke provincie woont u?

- ◯ Drenthe
- ◯ Flevoland
- ◯ Friesland
- ◯ Gelderland
- ◯ Groningen
- ◯ Limburg
- ◯ Noord-Brabant
- ◯ Noord-Holland
- ◯ Overijssel
- ◯ Utrecht
- ◯ Zeeland
- ◯ Zuid-Holland
- ◯ Ik woon niet in Nederland
- ◯ Ik antwoord liever niet

In wat voor omgeving woont u?
Hier is een 1 zeer ruraal, 2 ruraal, 3 enigszins ruraal, 4 neutraal, 5 enigszins urbaan, 6 urbaan, 7 zeer urbaan.

	1	2	3	4	5	6	7	
Rurale omgeving (=natuur)	○	○	○	○	○	○	○	Urbane omgeving (=stedelijk)

Welke burgerlijke staat komt het meest overeen met uw situatie?

- ○ Single, nooit getrouwd
- ○ In een relatie
- ○ Getrouwd, geregistreerd partnerschap
- ○ Weduwnaar/weduwe
- ○ Gescheiden
- ○ Anders, namelijk
- ○ Ik antwoord liever niet

Wat is uw hoogst voltooide opleiding waar u ook een diploma van heeft?

- ○ Geen
- ○ Basisonderwijs
- ○ Vbo, Mavo
- ○ Havo, VWO, MBO
- ○ Hoger Beroepsonderwijs (HBO)
- ○ Wetenschappelijk Onderwijs (WO)
- ○ Anders, namelijk
- ○ Ik antwoord liever niet

Hoeveel uur werkt u (gemiddeld genomen) per week?

Hoeveel uur daarvan werkt u (gemiddeld genomen) in een kantooromgeving per week?

→

Random photo 1 no-plant condition

UNIVERSITY OF TWENTE.

Bekijk onderstaande foto aandachtig. Deze foto geeft een vergaderruimte weer en vormt de basis voor alle vragen in deze enquête.

Met welke drie woorden zou u deze vergaderruimte omschrijven?

→

<u>OR</u> random photo 2 plant-condition

UNIVERSITY OF TWENTE.

Bekijk onderstaande foto aandachtig. Deze foto geeft een vergaderruimte weer en vormt de basis voor alle vragen in deze enquête.

Met welke drie woorden zou u deze vergaderruimte omschrijven?

→

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de foto)

	Helemaal niet mee eens	Niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Mee eens	Helemaal mee eens
In de vergaderruimte zijn veel mooie dingen te zien	○	○	○	○	○	○	○
In de vergaderruimte zijn veel boeiende dingen te zien	○	○	○	○	○	○	○
In de vergaderruimte wordt mijn nieuwsgierigheid geprikkeld	○	○	○	○	○	○	○
In de vergaderruimte zijn veel dingen die makkelijk mijn aandacht trekken	○	○	○	○	○	○	○
In de vergaderruimte valt veel te ontdekken	○	○	○	○	○	○	○

→

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de foto)

	Helemaal niet mee eens	Niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Mee eens	Helemaal mee eens
De vergaderruimte is heel anders dan mijn dagelijkse omgeving	○	○	○	○	○	○	○
In de vergaderruimte doe ik hele andere dingen dan ik normaal gesproken doe	○	○	○	○	○	○	○
In de vergaderruimte zijn veel dingen te zien die nieuw voor mij zijn	○	○	○	○	○	○	○
De vergaderruimte is uniek	○	○	○	○	○	○	○
De vergaderruimte is vernieuwend	○	○	○	○	○	○	○
De vergaderruimte is origineel	○	○	○	○	○	○	○

→

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de foto)

	Helemaal niet mee eens	Niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Mee eens	Helemaal mee eens
In de vergaderruimte kan ik even mijn verplichtingen vergeten	○	○	○	○	○	○	○
In de vergaderruimte heb ik het gevoel er even helemaal uit te zijn	○	○	○	○	○	○	○
In de vergaderruimte hoef ik even geen rekening te houden met wat anderen van mij verwachten	○	○	○	○	○	○	○
In de vergaderruimte voel ik mij verlost van mijn dagelijkse routine	○	○	○	○	○	○	○

→

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de foto)

	Helemaal niet mee eens	Niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Mee eens	Helemaal mee eens
De vergaderruimte is overzichtelijk	○	○	○	○	○	○	○
Alles wat ik in de vergaderruimte zie past goed bij elkaar	○	○	○	○	○	○	○
Alles wat ik in de vergaderruimte zie hoort hier thuis	○	○	○	○	○	○	○

→

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de foto)

	Helemaal niet mee eens	Niet mee eens	Enigszins mee oneens	Noch eens noch oneens	Enigszins mee eens	Mee eens	Helemaal mee eens
De vergaderruimte sluit goed aan bij wat ik op dit moment graag wil doen	○	○	○	○	○	○	○
De vergaderruimte biedt mij de informatie waar ik behoefte aan heb	○	○	○	○	○	○	○
In de vergaderruimte kan ik doen wat ik leuk vind	○	○	○	○	○	○	○
In de vergaderruimte weet ik wat ik wel en niet mag doen	○	○	○	○	○	○	○
In de vergaderruimte weet ik hoe ik me moet gedragen	○	○	○	○	○	○	○
Wat je in de vergaderruimte kunt zien sluit aan bij mijn verwachtingen	○	○	○	○	○	○	○
Wat je in de vergaderruimte kunt doen sluit aan bij mijn verwachtingen	○	○	○	○	○	○	○

→

Hoe zou u de vergaderruimte beoordelen? Geef een rapportcijfer

Zeer negatief										Zeer positief
0	1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○	○

Als u een vergaderruimte zou moeten kiezen, hoe waarschijnlijk is het dat u deze vergaderruimte kiest?
Hierbij is een 1 helemaal niet waarschijnlijk, 2 niet waarschijnlijk, 3 enigszins niet waarschijnlijk, 4 neutraal, 5 enigszins waarschijnlijk, 6 waarschijnlijk, 7 bijzonder waarschijnlijk.

	1	2	3	4	5	6	7	
Helemaal niet waarschijnlijk	○	○	○	○	○	○	○	Bijzonder waarschijnlijk

Hoe graag zou u in deze vergaderruimte willen werken?
Hierbij is een 1 helemaal niet, 2 niet, 3 enigszins niet, 4 neutraal, 5 enigszins wel, 6 wel, 7 helemaal wel.

	1	2	3	4	5	6	7	
Helemaal niet	○	○	○	○	○	○	○	Helemaal wel

Wat zou u aan deze vergaderruimte willen toevoegen om de ruimte te verbeteren?

→

Bedankt voor uw tijd om aan deze enquête deel te nemen. Uw antwoord is geregistreerd.

In dit onderzoek '*The Green Office*' zag u een foto van een vergaderruimte met of zonder planten. Uw mening ten aanzien van de vergaderruimte op de foto werd in kaart gebracht om de invloed van natuur, specifiek planten, binnen een kantooromgeving te meten. Heeft u vragen en/of opmerkingen m.b.t. uw deelname aan dit onderzoek, dan kunt u bij de onderzoeker terecht via onderstaand mailadres:

8.2 Appendix B Coding scheme questionnaire Study 1

Table B1. Coding scheme questionnaire – Study 1

Coding scheme questionnaire			
Respondent ID			
ID		None	Nominal
Introduction text			
	Beste respondent, alvast bedankt voor uw deelname! U wordt uitgenodigd …	None	Nominal
Q1	Ik wil deelnemen aan deze enquête	{1, Ja}…	Scale
Demographics			
Q2	Wat is uw geslacht?	{1, Man}…	Scale
Q3	Wat is uw leeftijd?	None	Nominal
Q4	In welke provincie woont u?	{1, Drenthe}…	Scale
Q5	In wat voor omgeving woont u?	{1, Rurale omgeving (=in de natuur, op het platteland)}…	Scale
Q6	Welke burgerlijke staat komt het meest overeen met uw situatie?	{1, Single, nooit getrouwd}…	Scale
Q6_6_TEXT	Burgerlijke staat anders	None	Nominal
Q7	Wat is uw hoogst voltooide opleiding (waar u ook een diploma van heeft)?	{1, Geen}…	Scale
Q7_7_TEXT	Opleiding anders	None	Nominal
Q8	Hoeveel uur werkt u (gemiddeld genomen) per week?	None	Nominal
Q9	Hoeveel uur daarvan werkt u (gemiddeld genomen) in een kantooromgeving per week?	None	Nominal
Photo condition			
Q10	Met welke drie woorden zou u deze vergaderruimte omschrijven?	None	Nominal
Fascination			
Q11_1	FAS.1 In de vergaderruimte zijn veel mooie dingen te zien	{1, Helemaal niet mee eens}…	Scale
Q11_2	FAS.2 In de vergaderruimte zijn veel boeiende dingen te zien	{1, Helemaal niet mee eens}…	Scale
Q11_3	FAS.3 In de vergaderruimte wordt mijn nieuwsgierigheid geprikkeld	{1, Helemaal niet mee eens}…	Scale
Q11_4	FAS.4 In de vergaderruimte zijn veel dingen die makkelijk mijn aandacht trekken	{1, Helemaal niet mee eens}…	Scale
Q11_5	FAS.5 In de vergaderruimte valt veel te ontdekken	{1, Helemaal niet mee eens}…	Scale
Being Away – Novelty			
Q12_1	BAN.1 De vergaderruimte is heel anders dan mijn dagelijkse omgeving	{1, Helemaal niet mee eens}…	Scale
Q12_2	BAN.2 In de vergaderruimte doe ik hele andere dingen dan ik normaal gesproken doe	{1, Helemaal niet mee eens}…	Scale
Q12_3	BAN.3 In de vergaderruimte zijn veel dingen te zien die nieuw voor mij zijn	{1, Helemaal niet mee eens}…	Scale
Q12_4	BAN.4 De vergaderruimte is uniek	{1, Helemaal niet mee eens}…	Scale
Q12_5	BAN.5 De vergaderruimte is vernieuwend	{1, Helemaal niet mee eens}…	Scale
Q12_6	BAN.6 De vergaderruimte is origineel	{1, Helemaal niet mee eens}…	Scale
Being Away – Escape			
Q13_1	BAE.1 In de vergaderruimte kan ik even mijn verplichtingen vergeten	{1, Helemaal niet mee eens}…	Scale
Q13_2	BAE.2 In de vergaderruimte heb ik het gevoel er even helemaal uit te zijn	{1, Helemaal niet mee eens}…	Scale

Q13_3	BAE.3 In de vergaderruimte hoef ik even geen rekening te houden met wat anderen van mij verwachten	{1, Helemaal niet mee eens}…	Scale
Q13_4	BAE.4 In de vergaderruimte voel ik mij verlost van mijn dagelijkse routine	{1, Helemaal niet mee eens}…	Scale
Coherence			
Q14_1	COH.1 De vergaderruimte is overzichtelijk	{1, Helemaal niet mee eens}…	Scale
Q14_2	COH.2 Alles wat ik in de vergaderruimte zie past goed bij elkaar	{1, Helemaal niet mee eens}…	Scale
Q14_3	COH.3 Alles wat ik in de vergaderruimte zie hoort hier thuis	{1, Helemaal niet mee eens}…	Scale
Compatibility – Ability			
Q15_1	COA.1 De vergaderruimte sluit goed aan bij wat ik op dit moment graag wil doen	{1, Helemaal niet mee eens}…	Scale
Q15_2	COA.2 De vergaderruimte biedt mij de informatie waar ik behoefte aan heb	{1, Helemaal niet mee eens}…	Scale
Q15_3	COA.3 In de vergaderruimte kan ik doen wat ik leuk vind	{1, Helemaal niet mee eens}…	Scale
Compatibility – Expectation			
Q16_1	COE.1 In de vergaderruimte weet ik wat ik wel en niet mag doen	{1, Helemaal niet mee eens}…	Scale
Q16_2	COE.2 In de vergaderruimte weet ik hoe ik me moet gedragen	{1, Helemaal niet mee eens}…	Scale
Q16_3	COE.3 Wat je in de vergaderruimte kunt zien sluit aan bij mijn verwachtingen	{1, Helemaal niet mee eens}…	Scale
Q16_4	COE.4 Wat je in de vergaderruimte kunt doen sluit aan bij mijn verwachtingen	{1, Helemaal niet mee eens}…	Scale
Judgement of room			
Q17	Hoe zou u de vergaderruimte beoordelen? Geef een rapportcijfer	{0, Zeer negatief}…	Scale
Q18	Als u een vergaderruimte zou moeten kiezen, hoe waarschijnlijk is het dat u deze vergaderruimte kiest?	{1, Helemaal niet waarschijnlijk}…	Scale
Q19	Hoe graag zou u in de vergaderruimte willen werken?	{1, Helemaal niet}…	Scale
Q20	Wat zou u aan deze vergaderruimte willen toevoegen of veranderen om de ruimte te verbeteren?	None	Nominal
Conclusion statement			
	Einde vragenlijst. Bedankt voor uw tijd om aan deze enquête deel te …	None	Nominal

8.3 Appendix C Factor analysis Study 1

8.3.1 Appendix C1 Principal component analysis Study 1

Table C1. Principal component analysis round 1 – Study 1

Construct	Item	Factor				
		1	2	3	4	5
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations			.74		
	BAE.2 In the meeting room I feel that I am away from everything			.80		
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations			.78		
	BAE.4 When I am in the meeting room I feel free from my daily routine			.83		
Being Away – Novelty (BAN)	BAN.1 The meeting room is very different than my daily environment					-.64
	BAN.2 In the meeting room I am engaged in activities that differ from my daily activities					
	BAN.3 There are many things to see in the meeting room that are new to me	.54				
	BAN.4 The meeting room is unique	.61				
	BAN.5 The meeting room is novel	.71				
	BAN.6 The meeting room is original	.71				
Coherence (COH)	COH.1 The meeting room is well organised		.71			
	COH.2 Everything I see in the meeting room goes well together		.76			
	COH.3 Everything I see in the meeting room belongs there		.70			
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment		.59			
	COM.2 In the meeting room I can find the information I need		.54			
	COM.3 In the meeting room I can do things I like					.55
	COM.4 I know what I can and cannot do in the meeting room				.79	
	COM.5 I know how to behave in the meeting room				.78	
	COM.6 What I can see in the meeting room fits with my expectations				.59	
	COM.7 What I can do in the meeting room fits with my expectations				.67	
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.75				
	FAS.2 There are many interesting things to see in the meeting room	.77				
	FAS.3 Being in the meeting room makes me wonder about many things	.76				
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.69				
	FAS.5 There is much to discover in the meeting room	.80				

Table C2. Principal component analysis round 2 – Study 1

Construct	Item	Factor				
		1	2	3	4	5
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations			.73		
	BAE.2 In the meeting room I feel that I am away from everything			.79		
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations			.77		
	BAE.4 When I am in the meeting room I feel free from my daily routine			.82		
Being Away – Novelty (BAN)	BAN.3 There are many things to see in the meeting room that are new to me				.58	
	BAN.4 The meeting room is unique				.76	
	BAN.5 The meeting room is novel				.75	
	BAN.6 The meeting room is original				.70	
Coherence (COH)	COH.1 The meeting room is well organised		.60			
	COH.2 Everything I see in the meeting room goes well together		.73			
	COH.3 Everything I see in the meeting room belongs there		.71			
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment		.72			
	COM.2 In the meeting room I can find the information I need		.69			
	COM.3 In the meeting room I can do things I like		.58			
	COM.4 I know what I can and cannot do in the meeting room					.85
	COM.5 I know how to behave in the meeting room					.83
	COM.6 What I can see in the meeting room fits with my expectations		.55			.53
	COM.7 What I can do in the meeting room fits with my expectations					.64
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.78				
	FAS.2 There are many interesting things to see in the meeting room	.82				
	FAS.3 Being in the meeting room makes me wonder about many things	.66				
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.79				
	FAS.5 There is much to discover in the meeting room	.78				

Table C3. Principal component analysis round 3 – Study 1

Construct	Item	Factor				
		1	2	3	4	5
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations			.74		
	BAE.2 In the meeting room I feel that I am away from everything			.79		
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations			.77		
	BAE.4 When I am in the meeting room I feel free from my daily routine			.83		
Being Away – Novelty (BAN)	BAN.3 There are many things to see in the meeting room that are new to me				.58	
	BAN.4 The meeting room is unique				.76	
	BAN.5 The meeting room is novel				.75	
	BAN.6 The meeting room is original				.70	
Coherence (COH)	COH.1 The meeting room is well organised		.61			
	COH.2 Everything I see in the meeting room goes well together		.73			
	COH.3 Everything I see in the meeting room belongs there		.71			
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment		.72			
	COM.2 In the meeting room I can find the information I need		.69			
	COM.3 In the meeting room I can do things I like		.59			
	COM.4 I know what I can and cannot do in the meeting room					.88
	COM.5 I know how to behave in the meeting room					.86
	COM.7 What I can do in the meeting room fits with my expectations					.61
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.78				
	FAS.2 There are many interesting things to see in the meeting room	.82				
	FAS.3 Being in the meeting room makes me wonder about many things	.66				
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.79				
	FAS.5 There is much to discover in the meeting room	.78				

Table C4. Principal component analysis round 4 – Study 1

Construct	Item	Factor				
		1	2	3	4	5
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations		.78			
	BAE.2 In the meeting room I feel that I am away from everything		.80			
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations		.76			
	BAE.4 When I am in the meeting room I feel free from my daily routine		.83			
Being Away – Novelty (BAN)	BAN.3 There are many things to see in the meeting room that are new to me			.62		
	BAN.4 The meeting room is unique			.83		
	BAN.5 The meeting room is novel			.76		
	BAN.6 The meeting room is original			.72		
Coherence (COH)	COH.1 The meeting room is well organised				.73	
	COH.2 Plants belong in this kind of environment				.83	
	COH.3 Everything I see in the meeting room goes well together				.80	
Compatibility (COM)	COM.4 I know what I can and cannot do in the meeting room					.88
	COM.5 I know how to behave in the meeting room					.89
	COM.7 What I can do in the meeting room fits with my expectations					.59
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.82				
	FAS.2 There are many interesting things to see in the meeting room	.86				
	FAS.3 Being in the meeting room makes me wonder about many things	.67				
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.77				
	FAS.5 There is much to discover in the meeting room	.78				

8.3.2 Appendix C2 Exploratory factor analysis Study 1

Table C5. Exploratory factor analysis round 1 – Study 1

Construct	Item	Factor						
		1	2	3	4	5	6	7
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations			.78				
	BAE.2 In the meeting room I feel that I am away from everything			.81				
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations			.75				
	BAE.4 When I am in the meeting room I feel free from my daily routine			.81				
Being Away – Novelty (BAN)	BAN.1 The meeting room is very different than my daily environment							.58
	BAN.2 In the meeting room I am engaged in activities that differ from my daily activities							.82
	BAN.3 There are many things to see in the meeting room that are new to me				.58			
	BAN.4 The meeting room is unique				.81			
	BAN.5 The meeting room is novel				.79			
	BAN.6 The meeting room is original				.74			
Coherence (COH)	COH.1 The meeting room is well organised		.70					
	COH.2 Everything I see in the meeting room goes well together		.79					
	COH.3 Everything I see in the meeting room belongs there		.72					
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment						.76	
	COM.2 In the meeting room I can find the information I need						.61	
	COM.3 In the meeting room I can do things I like						.80	
	COM.4 I know what I can and cannot do in the meeting room					.87		
	COM.5 I know how to behave in the meeting room					.88		
	COM.6 What I can see in the meeting room fits with my expectations		.68					
	COM.7 What I can do in the meeting room fits with my expectations		.57			.51		
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.76						

	FAS.2 There are many interesting things to see in the meeting room	.83
	FAS.3 Being in the meeting room makes me wonder about many things	.67
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.81
	FAS.5 There is much to discover in the meeting room	.78

Table C6. Exploratory factor analysis round 2 – Study 1

Construct	Item	Factor						
		1	2	3	4	5	6	7
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations			.79				
	BAE.2 In the meeting room I feel that I am away from everything			.80				
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations			.73				
	BAE.4 When I am in the meeting room I feel free from my daily routine			.83				
Being Away – Novelty (BAN)	BAN.3 There are many things to see in the meeting room that are new to me				.60			
	BAN.4 The meeting room is unique				.82			
	BAN.5 The meeting room is novel				.77			
	BAN.6 The meeting room is original				.73			
Coherence (COH)	COH.1 The meeting room is well organised		.71					
	COH.2 Everything I see in the meeting room goes well together		.81					
	COH.3 Everything I see in the meeting room belongs there		.73					
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment							.76
	COM.2 In the meeting room I can find the information I need							.57
	COM.3 In the meeting room I can do things I like							.83
	COM.4 I know what I can and cannot do in the meeting room						.87	
	COM.5 I know how to behave in the meeting room						.87	
	COM.6 What I can see in the meeting room fits with my expectations		.66					

	COM.7 What I can do in the meeting room fits with my expectations		.52			.56	
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.78					
	FAS.2 There are many interesting things to see in the meeting room	.85					
	FAS.3 Being in the meeting room makes me wonder about many things	.67					
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.80					
	FAS.5 There is much to discover in the meeting room	.78					

Table C7. Exploratory factor analysis round 3 – Study 1

Construct	Item	Factor					
		1	2	3	4	5	6
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations		.79				
	BAE.2 In the meeting room I feel that I am away from everything		.80				
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations		.74				
	BAE.4 When I am in the meeting room I feel free from my daily routine		.83				
Being Away – Novelty (BAN)	BAN.3 There are many things to see in the meeting room that are new to me			.61			
	BAN.4 The meeting room is unique			.82			
	BAN.5 The meeting room is novel			.77			
	BAN.6 The meeting room is original			.73			
Coherence (COH)	COH.1 The meeting room is well organised				.76		
	COH.2 Everything I see in the meeting room goes well together				.82		
	COH.3 Everything I see in the meeting room belongs there				.73		
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment					.80	
	COM.2 In the meeting room I can find the information I need					.63	
	COM.3 In the meeting room I can do things I like					.80	
	COM.4 I know what I can and cannot do in the meeting room						.88

	COM.5 I know how to behave in the meeting room		.88
	COM.7 What I can do in the meeting room fits with my expectations		.58
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.78	
	FAS.2 There are many interesting things to see in the meeting room	.85	
	FAS.3 Being in the meeting room makes me wonder about many things	.67	
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.80	
	FAS.5 There is much to discover in the meeting room	.78	

8.3.3 Appendix C3 Factor analysis per separate construct Study 1

Table C8. Factor analysis Being Away – Escape (BAE) – Study 1

Construct	Item	Factor
		1
Being Away – Escape (BAE)	BAE.1 In the meeting room I can forget about my obligations	.81
	BAE.2 In the meeting room I feel that I am away from everything	.86
	BAE.3 When I am in the meeting room I don't have to worry about other peoples' expectations	.73
	BAE.4 When I am in the meeting room I feel free from my daily routine	.85

Table C9. Factor analysis Being Away – Novelty (BAN) – Study 1

Construct	Item	Factor	
		1	2
Being Away – Novelty (BAN)	BAN.1 The meeting room is very different than my daily environment		.76
	BAN.2 In the meeting room I am engaged in activities that differ from my daily activities		.78
	BAN.3 There are many things to see in the meeting room that are new to me	.69	
	BAN.4 The meeting room is unique	.79	
	BAN.5 The meeting room is novel	.90	
	BAN.6 The meeting room is original	.88	

Table C10. Factor analysis Coherence (COH) – Study 1

Construct	Item	Factor
		1
Coherence (COH)	COH.1 The meeting room is well organised	.79
	COH.2 Everything I see in the meeting room goes well together	.87
	COH.3 Everything I see in the meeting room belongs there	.78

Table C11. Factor analysis Compatibility (COM) – Study 1

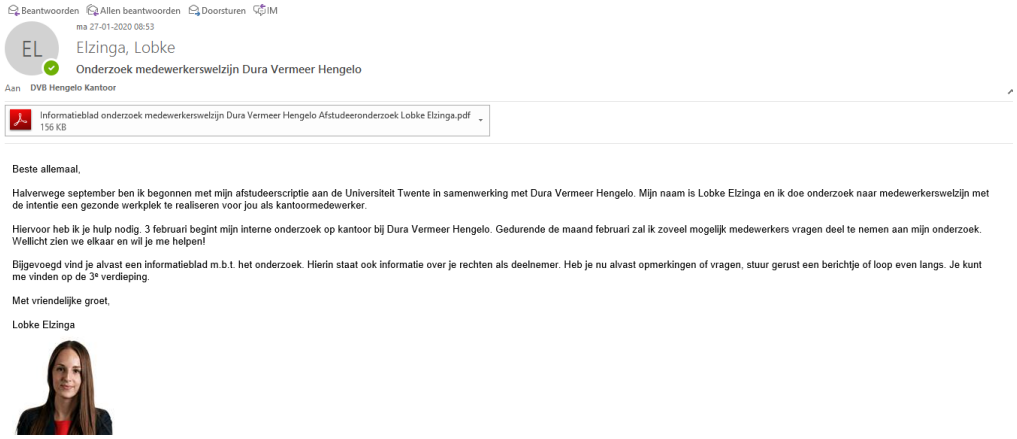
Construct	Item	Factor	
		1	2
Compatibility (COM)	COM.1 The meeting room matches with what I want to do at this moment		.88
	COM.2 In the meeting room I can find the information I need		.78
	COM.3 In the meeting room I can do things I like		.75
	COM.4 I know what I can and cannot do in the meeting room	.85	
	COM.5 I know how to behave in the meeting room	.84	
	COM.6 What I can see in the meeting room fits with my expectations	.61	
	COM.7 What I can do in the meeting room fits with my expectations	.71	

Table C12. Factor analysis Fascination (FAS) – Study 1

Construct	Item	Factor
		1
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.84
	FAS.2 There are many interesting things to see in the meeting room	.88
	FAS.3 Being in the meeting room makes me wonder about many things	.77
	FAS.4 There are many things in the meeting room that attract my attention effortlessly	.77
	FAS.5 There is much to discover in the meeting room	.83

8.4 Appendix D Motivation email and information sheet Study 2

8.4.1 Appendix D1 Motivation email Study 2



Beantwoorden Allen beantwoorden Doorsturen IM

ma 27-01-2020 08:53

EL

Elzinga, Lobke

Onderzoek medewerkerswelzijn Dura Vermeer Hengelo

Aan DVB Hengelo Kantoor

Informatieblad onderzoek medewerkerswelzijn Dura Vermeer Hengelo Afstudeeronderzoek Lobke Elzinga.pdf
156 KB

Beste allemaal,

Halverwege september ben ik begonnen met mijn afstudeerscriptie aan de Universiteit Twente in samenwerking met Dura Vermeer Hengelo. Mijn naam is Lobke Elzinga en ik doe onderzoek naar medewerkerswelzijn met de intentie een gezonde werkplek te realiseren voor jou als kantoormedewerker.

Hiervoor heb ik je hulp nodig. 3 februari begint mijn interne onderzoek op kantoor bij Dura Vermeer Hengelo. Gedurende de maand februari zal ik zoveel mogelijk medewerkers vragen deel te nemen aan mijn onderzoek. Wellicht zien we elkaar en wil je me helpen!

Bijgevoegd vind je alvast een informatieblad m.b.t. het onderzoek. Hierin staat ook informatie over je rechten als deelnemer. Heb je nu alvast opmerkingen of vragen, stuur gerust een berichtje of loop even langs. Je kunt me vinden op de 3e verdieping.

Met vriendelijke groet,

Lobke Elzinga

Figure D1. Motivation email – Study 2

Tekst:

Beste allemaal,

Halverwege september ben ik begonnen met mijn afstudeerscriptie aan de Universiteit Twente in samenwerking met Dura Vermeer Hengelo. Mijn naam is Lobke Elzinga en ik doe onderzoek naar medewerkerswelzijn met de intentie een gezonde werkplek te realiseren voor jou als kantoormedewerker.

Hiervoor heb ik je hulp nodig. 3 februari begint mijn interne onderzoek op kantoor bij Dura Vermeer Hengelo. Gedurende de maand februari zal ik zoveel mogelijk medewerkers vragen deel te nemen aan mijn onderzoek. Wellicht zien we elkaar en wil je me helpen!

Bijgevoegd vind je alvast een informatieblad m.b.t. het onderzoek. Hierin staat ook informatie over je rechten als deelnemer. Heb je nu alvast opmerkingen of vragen, stuur gerust een berichtje of loop even langs. Je kunt me vinden op de 3^{e} verdieping.

Met vriendelijke groet,

Lobke Elzinga

Attached: information sheet as part of informed consent form

8.4.2 Appendix D2 Information sheet Study 2

UNIVERSITEIT TWENTE.
FACULTY OF BEHAVIOURAL, MANAGEMENT AND SOCIAL SCIENCES

Informatieblad voor onderzoek naar medewerkerswelzijn Dura Vermeer Hengelo

Doel van het onderzoek

U wordt uitgenodigd om deel te nemen aan een onderzoek in het kader van mijn afstudeerscriptie voor de Master Marketing Communication & Design. Dit onderzoek wordt uitgevoerd door Lobke Elzinga vanuit de Universiteit Twente, faculteit Behavioural, Management and Social Sciences (BMS), in samenwerking met Dura Vermeer Hengelo. Het doel van dit onderzoek is het in kaart brengen en verbeteren van medewerkerswelzijn binnen de kantooromgeving van Dura Vermeer te Hengelo. Dit onderzoek tracht uw mening in kaart te brengen ten aanzien van de vergaderruimtes – de OFADs.

Hoe gaan we te werk?

U neemt deel aan een onderzoek waarbij informatie zal worden vergaart door:

- U te vragen een meetinstrument (Empatica E4 Wristband) te dragen zolang u in de vergaderruimte bent. Deze wearable device meet het volgende: hartslag, beweging, lichaamstemperatuur en huidgeleiding;
- U een korte vragenlijst voor te leggen welke u schriftelijk kunt invullen. Hierin zullen vragen gesteld worden over hoe u zich voelt in de vergaderruimte en over enkele demografische aspecten. Vragen bestaan uit statements met antwoorden op basis van een 7-puntsschaal van helemaal niet mee eens tot helemaal mee eens. Een voorbeeld van een typische vraag die u zal worden gesteld: "*In de vergaderruimte kon ik me goed concentreren".*

Er is geen specifieke taak. Data wordt verzameld tijdens (wearable) en na afloop van (vragenlijst) het werk dat u doet in de vergaderruimte. Er wordt een sensor (of logger) geplaatst in de vergaderruimte die de temperatuur, CO_2, en luchtvochtigheid in de ruimte meet. Specifiek op de tweede verdieping wordt ook geluid en fijnstof (VOC) gemeten.

Potentiële risico's en ongemakken

- Er zijn geen fysieke, juridische of economische risico's verbonden aan uw deelname aan deze studie. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt uw deelname op elk gewenst moment stoppen.

Vergoeding

U ontvangt voor deelname aan dit onderzoek geen vergoeding. Door deel te nemen aan dit onderzoek zal inzicht verkregen worden in het medewerkerswelzijn op kantoor binnen Dura Vermeer Hengelo. Het bredere doel van dit onderzoek is het creëren van een optimalere werkomgeving voor de kantoormedewerkers van Dura Vermeer Hengelo.

Vertrouwelijkheid van gegevens

Uw privacy is en blijft maximaal beschermd. Er wordt op geen enkele wijze vertrouwelijke informatie of persoonsgegevens van of over u naar buiten gebracht, waardoor iemand u zal kunnen herkennen. Uw werkgever heeft te kennen gegeven geen belang te hebben bij de datasets. Dit betekent dat individuele data enkel zichtbaar is voor de onderzoeker en de werkgever niet zal kunnen achterhalen welke data behoort tot welk individu. Bij de start van het onderzoek krijgt u direct een nummer toegekend om uw gegevens verder te anonimiseren. Gegevens zoals opleidingsniveau of leeftijd worden in een categorie geplaatst. Bijvoorbeeld: leeftijd = tussen 25-35 jaar. In het uiteindelijke rapport zullen slechts algemene conclusies en resultaten in de vorm van gemiddeldes en aantallen zichtbaar zijn. Dit uiteindelijke rapport zal zichtbaar zijn voor uw werkgever, de Universiteit Twente, en wordt na overleg met Dura Vermeer gepubliceerd in de databank van de UT.

In een publicatie zullen anonieme gegevens of pseudoniemen worden gebruikt. De data van de Empatica E4 Wristband, formulieren en andere documenten die in het kader van deze studie worden gemaakt of verzameld, worden opgeslagen op een beveiligde locatie bij de Universiteit Twente en op de beveiligde (versleutelde) gegevensdragers van de onderzoeker.

De onderzoeksgegevens worden bewaard voor een periode van 10 jaar. Uiterlijk na het verstrijken van deze termijn zullen de gegevens worden verwijderd. De onderzoeksgegevens worden indien nodig (bijvoorbeeld voor een controle op wetenschappelijke integriteit) en alleen in anonieme vorm ter beschikking gesteld aan personen buiten de onderzoeksgroep. Tot slot is dit onderzoek beoordeeld en goedgekeurd door de ethische commissie van de faculteit BMS.

Vrijwilligheid

Deelname aan dit onderzoek is geheel vrijwillig. U kunt als deelnemer uw medewerking aan het onderzoek te allen tijde stoppen, of weigeren dat uw gegevens voor het onderzoek mogen worden gebruikt, zonder opgaaf van redenen. Het stopzetten van deelname heeft geen nadelige gevolgen voor u. Tevens kunt u tot 2 dagen (bedenktijd) na het experiment alsnog de toestemming intrekken die u heeft gegeven om gebruik te maken van uw gegevens. In deze gevallen zullen uw gegevens uit onze bestanden worden verwijderd en vernietigd.

Als u besluit om te stoppen met deelname aan het onderzoek, of als u vragen of klachten heeft, of uw bezorgdheid kenbaar wilt maken, of een vorm van schade of ongemak vanwege het onderzoek, neemt u dan alstublieft contact op met de onderzoeksleider:

Contactgegevens: Lobke Elzinga

Voor bezwaren met betrekking tot de opzet en of uitvoering van het onderzoek kunt u zich ook wenden tot de Secretaris van de Ethische Commissie van de faculteit Behavioural, Management and Social Sciences op de Universiteit Twente via ethicscommittee-bms@utwente.nl. Dit onderzoek wordt uitgevoerd vanuit de Universiteit Twente, faculteit Behavioural, Management and Social Sciences. Indien u specifieke vragen hebt over de omgang met persoonsgegevens kun u deze ook richten aan de Functionaris Gegevensbescherming van de UT door een mail te sturen naar dpo@utwente.nl.

Tot slot heeft u het recht een verzoek tot inzage, wijziging, verwijdering of aanpassing van uw gegevens te doen bij de Onderzoeksleider. Wilt u inzicht in de resultaten van dit onderzoek dan kunt u contact opnemen met de onderzoeker via bovengenoemde gegevens.

8.5 Appendix E Informed consent form Study 2

Toestemmingsformulier voor onderzoek naar medewerkerswelzijn Dura Vermeer Hengelo

Door dit toestemmingsformulier te ondertekenen erken ik het volgende:

1. Ik ben voldoende geïnformeerd over het onderzoek door middel van een separaat informatieblad. Ik heb het informatieblad gelezen en heb daarna de mogelijkheid gehad vragen te kunnen stellen. Deze vragen zijn voldoende beantwoord.

2. Ik neem vrijwillig deel aan dit onderzoek. Er is geen expliciete of impliciete dwang voor mij om aan dit onderzoek deel te nemen. Het is mij duidelijk dat ik deelname aan het onderzoek op elk moment, zonder opgaaf van reden, kan beëindigen. Ik hoef een vraag niet te beantwoorden als ik dat niet wil.

Naast het bovenstaande is het hieronder mogelijk voor verschillende onderdelen van het onderzoek specifiek toestemming te geven. U kunt er per onderdeel voor kiezen wel of geen toestemming te geven.

3. Ik geef toestemming om de gegevens die gedurende het onderzoek bij mij worden verzameld te verwerken zoals is opgenomen in het bijgevoegde informatieblad. Deze toestemming ziet dus ook op het verwerken van mijn persoonlijke gegevens.	JA ☐	NEE ☐
4. Ik heb dit formulier gelezen en begrepen. Al mijn vragen zijn naar mijn tevredenheid beantwoord en ik ben vrijwillig akkoord met deelname aan dit onderzoek.	JA ☐	NEE ☐

Naam Deelnemer: Naam Onderzoeker:

Handtekening: Handtekening:

Datum: Datum:

8.6 Appendix F Debriefing email Study 2

Tekst:

Beste allemaal,

Allereerst bedankt voor jullie tijd en deelname aan mijn afstudeeronderzoek! Dankzij jullie inzet (108 deelnemers) is er veel data verzameld. Het daadwerkelijke onderzoek op kantoor is nu afgerond. De komende weken staan in het teken van data-analyse en resultaten schrijven. Wanneer het gehele onderzoek is afgerond word je hiervan op de hoogte gesteld. Zo kan iedereen de resultaten inzien wanneer gewenst.

In dit onderzoek '*The Green Office'* heb je plaatsgenomen in een OFAD ruimte op verdieping 1, 2, 3, of 4 met of zonder planten. Je mening t.a.v. de vergaderruimte waar je heb gezeten werd in kaart gebracht om de invloed van natuur, specifiek planten, binnen een kantooromgeving te meten. De wetenschap stelt namelijk dat natuur een positieve invloed heeft op je mentale gesteldheid en concentratie. Dit is zichtbaar in zowel fysiologische als psychologische methoden, vandaar de combinatie van meetinstrumenten. Het overkoepelende thema in mijn onderzoek is de toename van stress in onze huidige prestatiemaatschappij, voornamelijk onder kantoormedewerkers en op steeds jongere leeftijd. Ik test of natuur, planten, inderdaad zogeheten herstelcapaciteit bieden (vernieuwde energie voor betere concentratie en minder mentale vermoeidheid).

Deze informatie, de planten en daarmee natuur als interventie, is in eerste instantie achterwege gelaten om je niet op voorhand te beïnvloeden. Heb je als gevolg van deze nieuwe informatie vragen en/of opmerkingen m.b.t. deelname aan dit onderzoek, stuur me gerust een berichtje of loop even langs (3e verdieping).

Voor nu, nogmaals bedankt!

Met vriendelijke groet,
Lobke Elzinga

8.7 Appendix G Overview details per meeting Study 2

Fill-out: Format (sensor) data during experiment

Group/measurement number (hoeveelste meting):

Number of people:

Questionnaire/wearable numbers involved:

Logger number:

Date:

Day: Mo Tu We Th Fr

Start time:

End time:

Duration:

Type of meeting/work: information exchange, brainstorm, decision-making, discussion, planning

Floor:

Room:

Condition:

Weather Twente (KNMI – Updated every 10 minutes):

Temperature outside:

https://www.knmi.nl/nederland-nu/weer/waarnemingen

Sensor data

Minute	Temperature	Humidity	CO_2	VOC	Sound	Utilisation
0						
10						
20						
30						
40						
50						
60						
Average						

Remarks:

8.8 Appendix H Floor plan Dura Vermeer Hengelo

8.8.1 Appendix H1 Floor plan without sensors

Focus is on green areas.

Figure H1. Floor plan without sensors – Study 2

8.8.2 Appendix H2 Floor plan with sensors

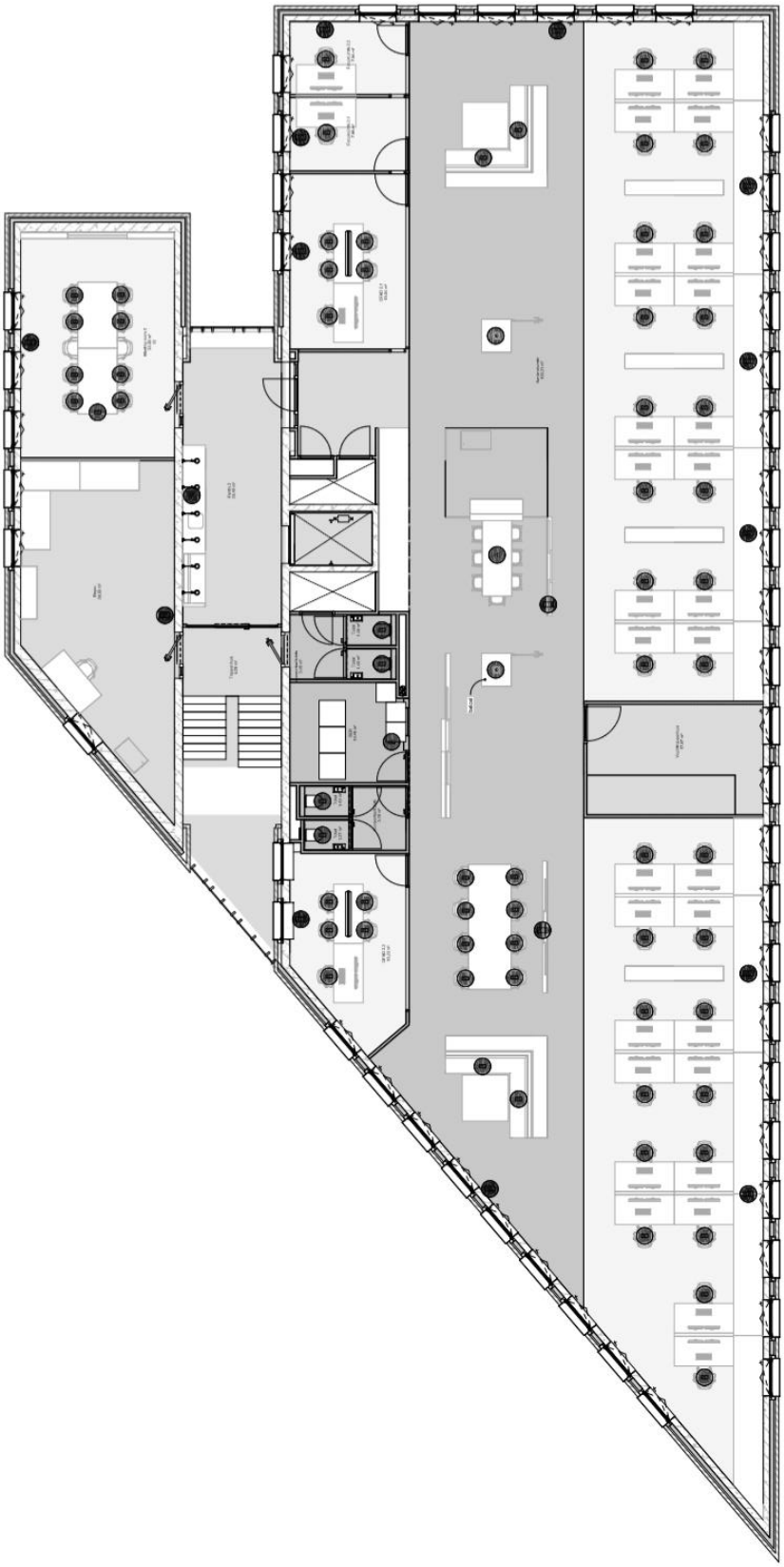


Figure H2. Floor plan with sensors – Study 2

8.9 Appendix I Floor plan meeting rooms Dura Vermeer Hengelo

8.9.1 Appendix I1 OFAD 'De Steiger' (Room 1)

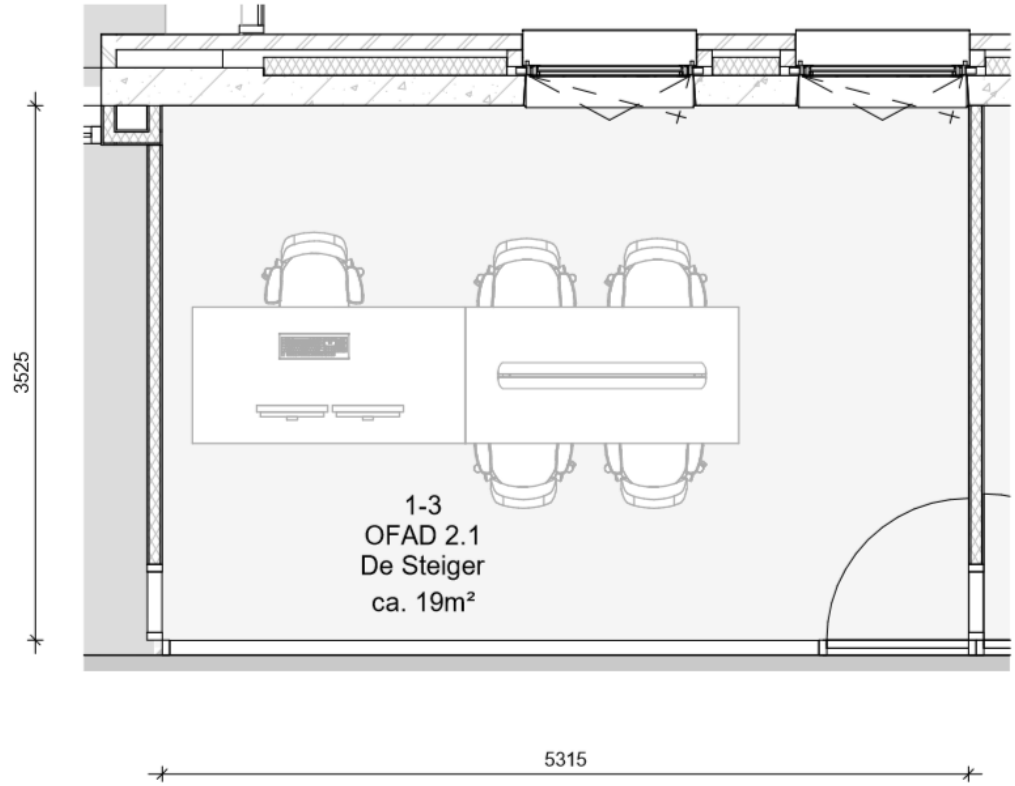


Figure I1. Floor plan OFAD 'De Steiger' (room 1) – Study 2

8.9.2 Appendix I2 OFAD 'De Hamer' (Room 2)

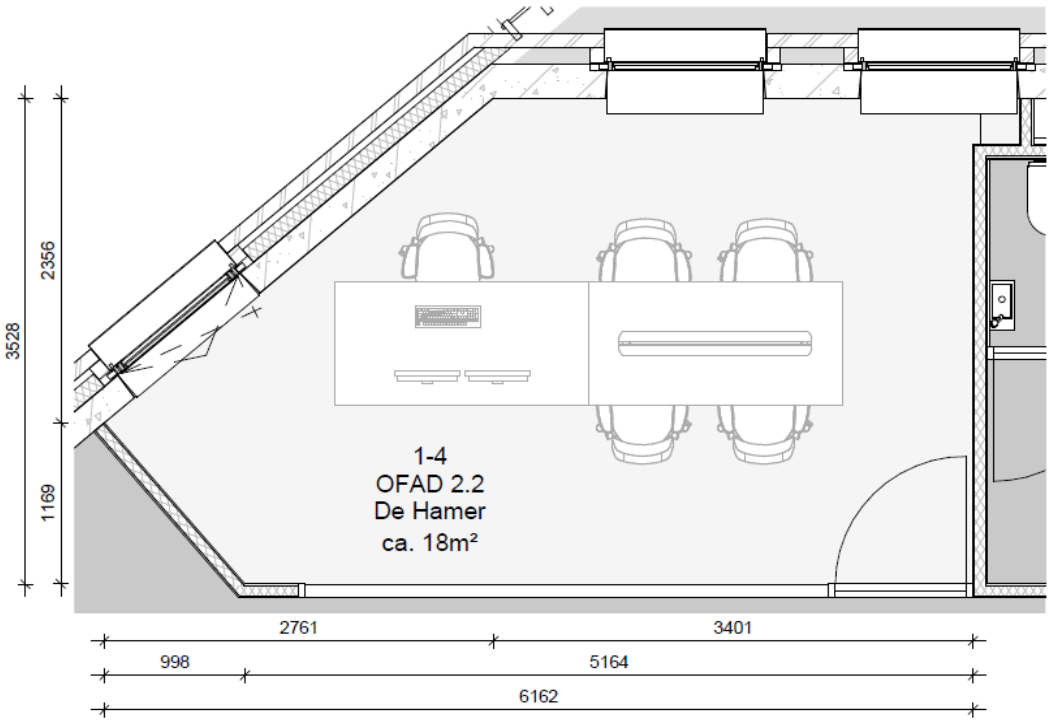


Figure I2. Floor plan OFAD 'De Hamer' (room 2) – Study 2

8.10 Appendix J Meeting rooms impression – photographs

8.10.1 Appendix J1 OFAD 'De Steiger' photo impression (Room 1)

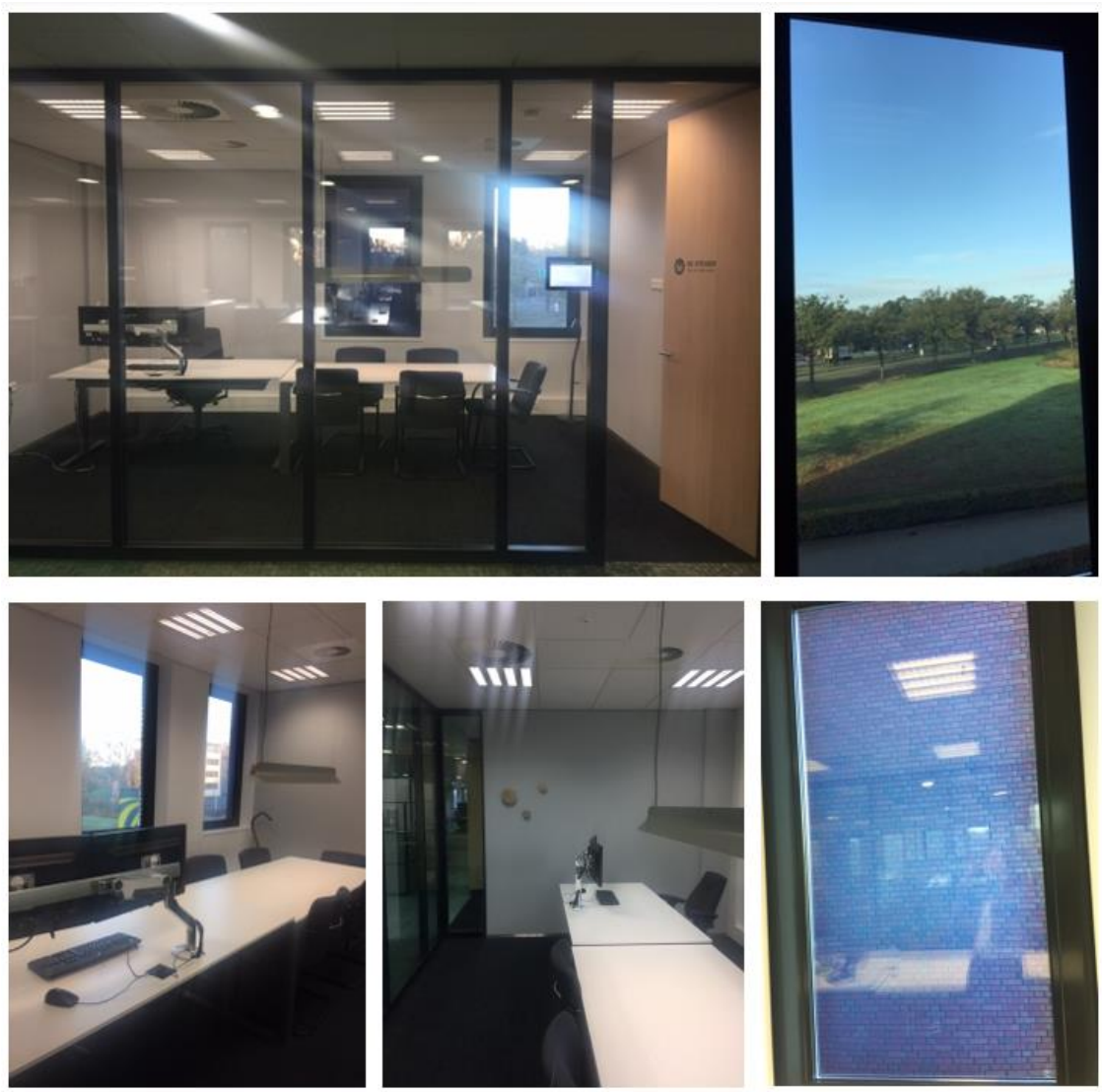


Figure J1. OFAD 'De Steiger' (room 1) photo impression – Study 2

8.10.2 Appendix J2 OFAD 'De Hamer' photo impression (Room 2)

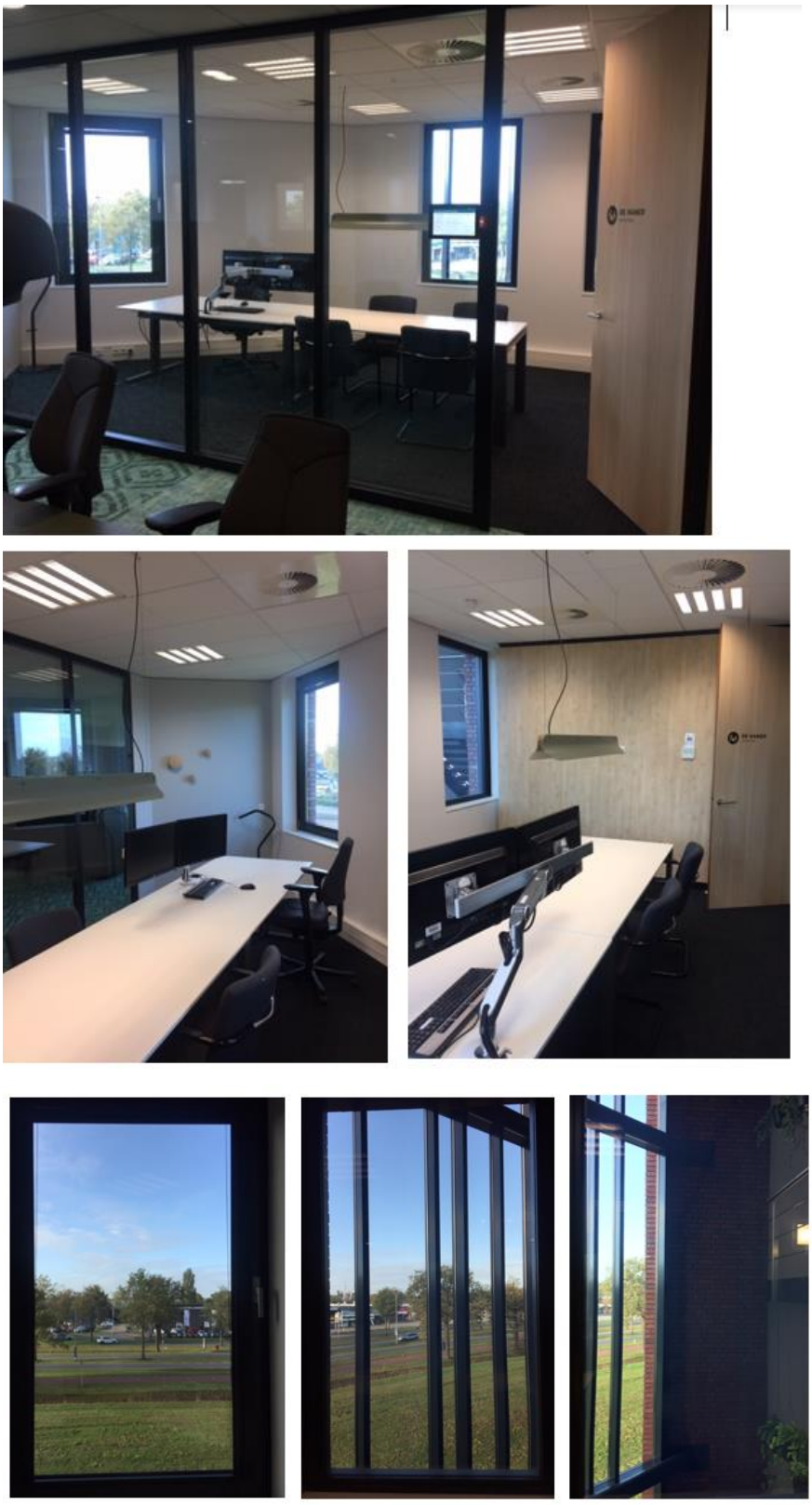
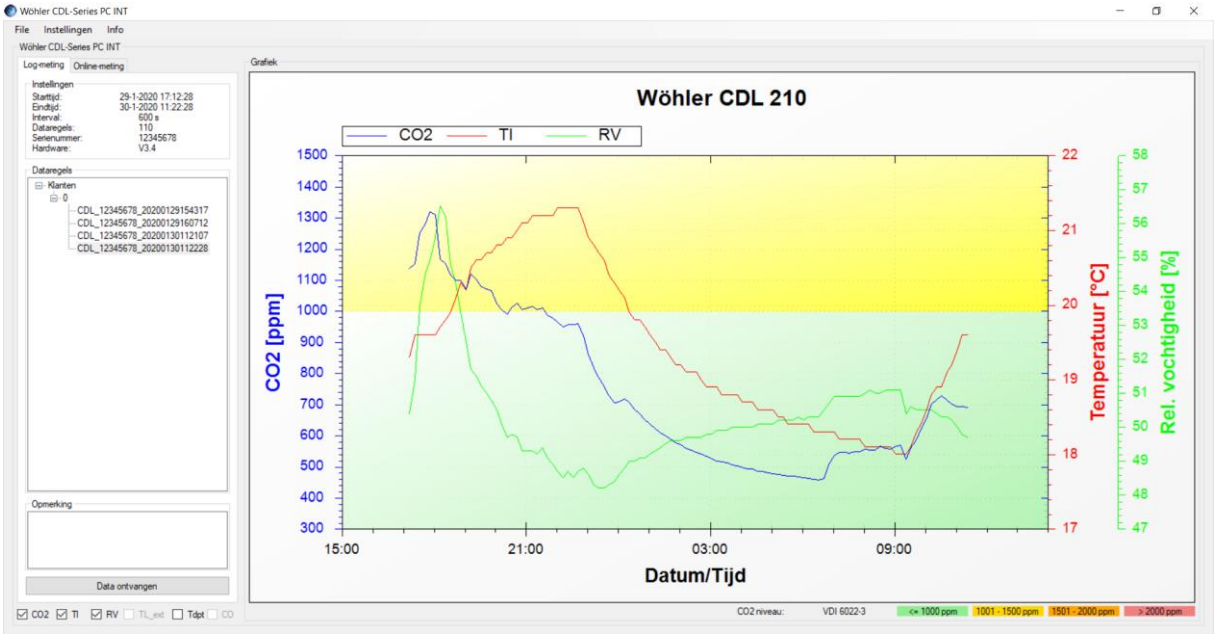


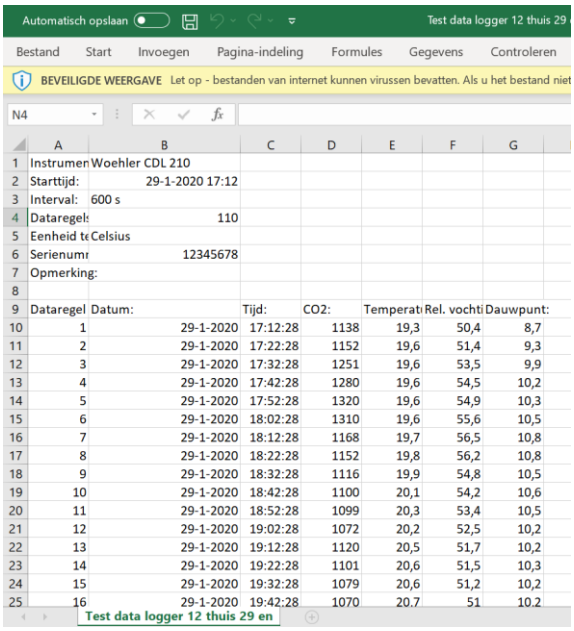
Figure J2. OFAD 'De Hamer' (room 2) photo impression – Study 2

8.10.3 Appendix J3 OFAD plant condition versus OFAD no-plant condition

Figure J3. OFAD plant versus no-plant condition photo impression – Study 2

8.11 Appendix K Example output data loggers





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3	Interval:	600 s					
4	Dataregels	110					
5	Eenheid te	Celsius					
6	Serienumr	12345678					
7	Opmerking:						
8							
9	Dataregel	Datum:	Tijd:	CO2:	Temperati	Rel. vochti	Dauwpunt:
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11	2	29-1-2020	17:22:28	1152	19,6	51,4	9,3
12	3	29-1-2020	17:32:28	1251	19,6	53,5	9,9
13	4	29-1-2020	17:42:28	1280	19,6	54,5	10,2
14	5	29-1-2020	17:52:28	1320	19,6	54,9	10,3
15	6	29-1-2020	18:02:28	1310	19,6	55,6	10,5
16	7	29-1-2020	18:12:28	1168	19,7	56,5	10,8
17	8	29-1-2020	18:22:28	1152	19,8	56,2	10,8
18	9	29-1-2020	18:32:28	1116	19,9	54,8	10,5
19	10	29-1-2020	18:42:28	1100	20,1	54,2	10,6
20	11	29-1-2020	18:52:28	1099	20,3	53,4	10,5
21	12	29-1-2020	19:02:28	1072	20,2	52,5	10,2
22	13	29-1-2020	19:12:28	1120	20,5	51,7	10,2
23	14	29-1-2020	19:22:28	1101	20,6	51,5	10,3
24	15	29-1-2020	19:32:28	1079	20,6	51,2	10,2
25	16	29-1-2020	19:42:28	1070	20,7	51	10,2

Figure K1. Example output data loggers – Study 2

8.12 Appendix L Additional data logger data Study 2

8.12.1 Appendix L1 Data per climate feature for both conditions – unoccupied

Table L1. Data per climate feature for both conditions, unoccupied – Study 2

Day	Time	CO_2 (ppm)		Temperature (°C)		Humidity (%)		Sound (dB)		VOC (ppm)	
		Plant	No-Plant	Plant	No-Plant	Plant	No-Plant	Plant	No-Plant	Plant	No-Plant
Saturday	00:00	469.61	457.17	20.68	20.27	33.74	30.77	38	38	313	338
	01:00	464.50	451.39	20.61	20.23	33.96	31.01	38	38	327	332
	02:00	458.39	446.50	20.55	20.18	34.15	31.23	38	38	331	339
	03:00	447.39	441.50	20.51	20.16	34.26	31.54	38	38	335	341
	04:00	435.33	436.89	20.48	20.11	34.52	31.85	38	38	353	345
	05:00	431.28	432.39	20.43	20.07	34.80	32.09	38	38	372	350
	06:00	426.72	429.28	20.43	20.01	34.95	32.32	38	38	386	381
	07:00	442.50	425.83	20.40	20.00	35.21	32.50	38	38	394	381
	08:00	420.83	424.39	20.34	20.01	35.66	32.62	38	38	402	387
	09:00	418.50	421.45	20.33	20.06	36.35	32.62	38	38	404	384
	10:00	415.83	417.61	20.33	20.12	36.95	32.53	38	38	414	385
	11:00	413.05	414.61	20.38	20.10	37.47	32.56	38	38	408	393
	12:00	410.50	411.61	20.40	20.05	37.76	32.78	38	38	396	418
	13:00	408.95	409.50	20.40	20.08	37.71	33.06	38	38	337	528
	14:00	407.50	407.00	20.40	20.14	38.03	33.36	38	38	368	921
	15:00	406.00	404.83	20.40	20.07	38.17	33.84	38	38	409	1,236
	16:00	405.72	403.33	20.39	20.06	38.24	34.44	38	38	437	1,117
	17:00	405.44	406.45	20.33	19.99	38.34	34.82	38	38	424	771
	18:00	405.39	406.84	20.29	19.92	38.33	34.98	38	38	496	950
	19:00	405.56	405.61	20.21	19.86	37.98	34.98	38	38	476	836
	20:00	407.00	403.72	20.20	19.81	37.64	34.79	38	38	480	817
	21:00	407.83	403.67	20.18	19.79	37.51	34.58	38	38	504	970
	22:00	407.72	402.72	20.12	19.72	37.38	34.53	38	38	520	1,006
	23:00	406.94	403.05	20.11	19.68	37.26	34.46	38	38	546	1,085
Sunday	00:00	405.89	402.94	20.10	19.66	37.16	34.46	38	38	537	1,207
	01:00	405.67	402.17	20.06	19.63	37.19	34.48	38	38	570	1,224
	02:00	405.83	403.28	20.00	19.62	37.12	34.55	38	38	551	1,234
	03:00	405.89	403.94	20.00	19.58	37.15	34.65	38	38	552	1,329
	04:00	405.05	403.39	19.98	19.57	37.32	34.72	38	38	583	1,218
	05:00	404.61	401.89	19.93	19.55	37.25	34.73	38	38	560	1,136
	06:00	403.89	400.55	19.89	19.52	37.49	34.81	38	38	550	1,100
	07:00	403.39	398.39	19.88	19.48	37.74	35.00	38	38	560	1,329
	08:00	402.78	397.50	19.86	19.50	38.09	35.19	38	38	548	1,512
	09:00	402.94	395.78	19.83	19.52	38.56	35.43	38	38	577	1,554
	10:00	403.67	398.11	19.83	19.56	39.00	35.54	38	38	587	1,761
	11:00	403.89	401.33	19.83	19.56	39.38	35.65	38	38	623	1,878
	12:00	403.61	401.05	19.83	19.57	39.62	35.77	38	38	620	1,849
	13:00	403.00	400.89	19.81	19.76	39.72	35.69	38	38	603	2,173
	14:00	402.17	400.72	19.80	19.63	39.98	36.00	38	38	626	2,309
	15:00	401.78	399.72	19.80	19.61	40.18	36.35	38	38	652	2,423
	16:00	401.33	399.39	19.80	19.50	40.29	36.82	38	38	701	2,533
	17:00	400.72	399.39	19.77	19.48	40.70	37.27	38	38	798	2,550
	18:00	400.44	398.83	19.76	19.42	41.03	37.72	38	38	934	2,639
	19:00	402.50	399.72	19.68	19.47	41.27	37.90	38	38	1,083	2,233
	20:00	405.61	401.50	19.68	19.41	41.26	38.07	38	38	1,197	1,605
	21:00	407.44	401.78	19.64	19.32	41.46	38.23	38	38	1,402	1,167
	22:00	408.06	402.39	19.60	19.26	41.51	38.35	39	38	1,524	972
	23:00	408.60	402.78	19.59	19.23	41.52	38.39	38	38	1,421	843
Average		413.07	410.10	20.10	19.77	37.88	34.58	38.02	38	587.31	1,141.44

8.12.2 Appendix L2 Graphs per climate feature for both conditions – unoccupied

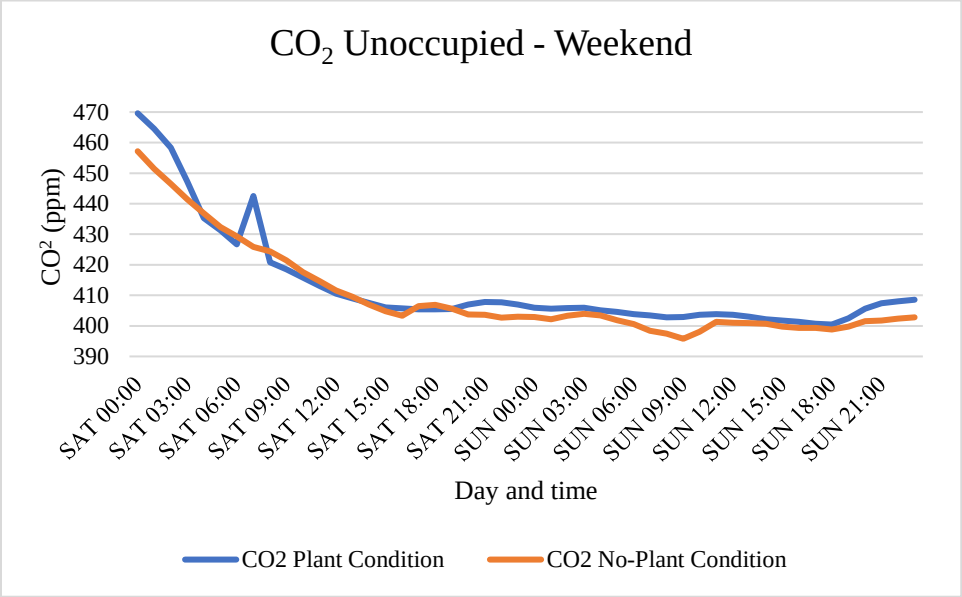


Figure L1. CO_2 unoccupied weekend both conditions – Study 2

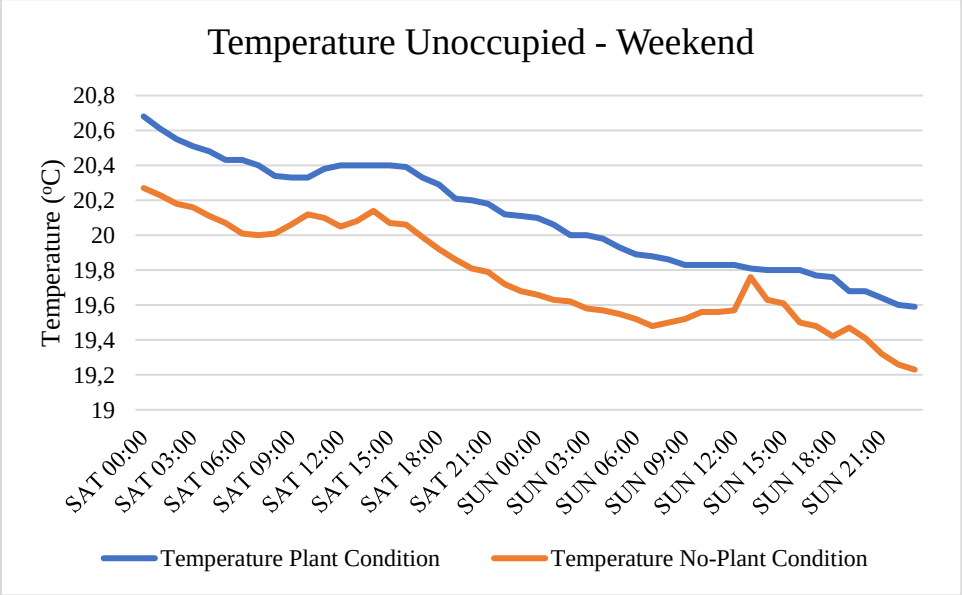


Figure L2. Temperature unoccupied weekend both conditions – Study 2

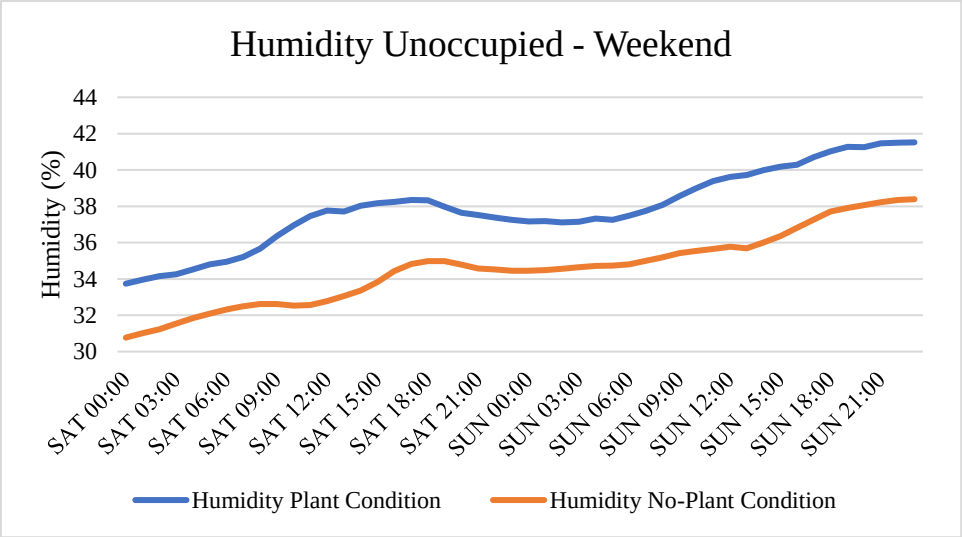


Figure L3. Humidity unoccupied weekend both conditions – Study 2

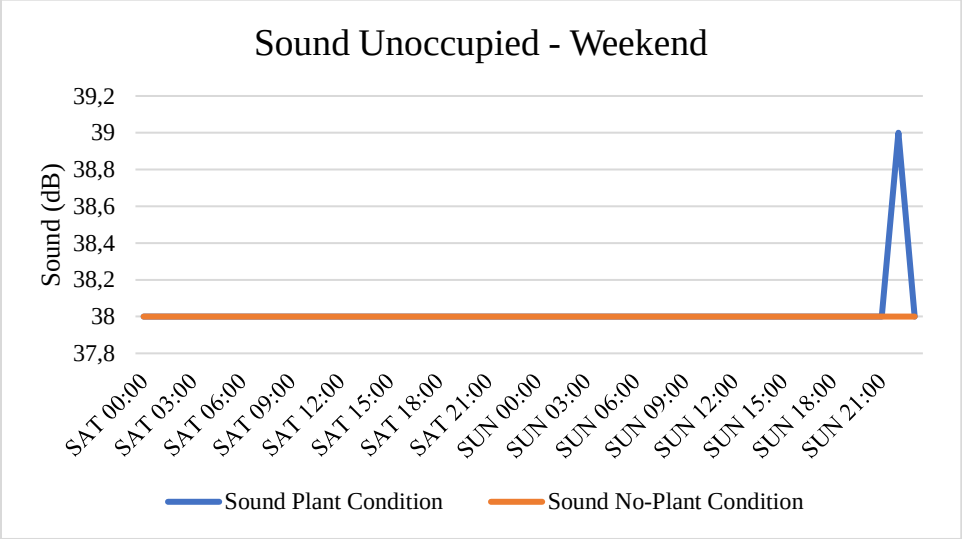


Figure L4. Sound unoccupied weekend both conditions – Study 2

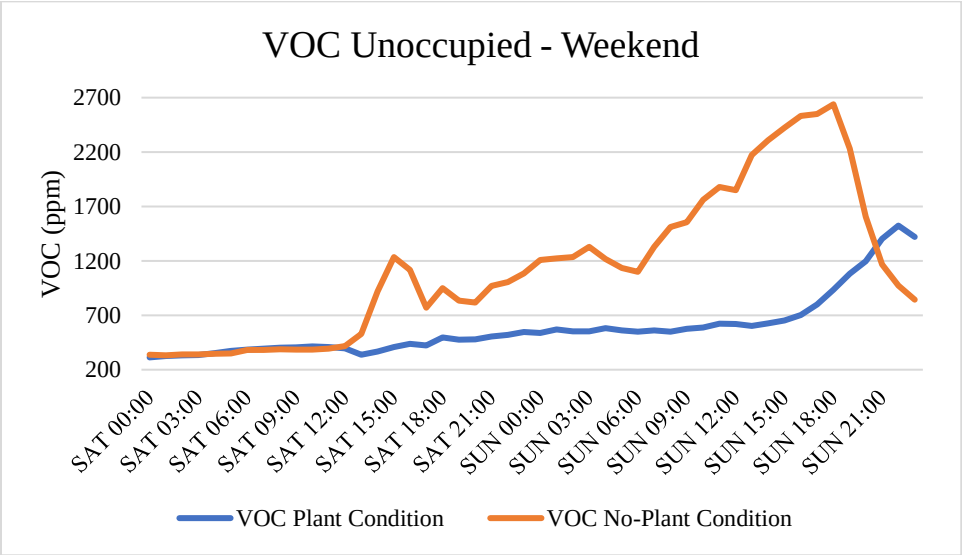


Figure L5. VOC unoccupied weekend both conditions – Study 2

8.12.3 Appendix L3 Data of indoor climate features per working week for both conditions

Table L2. Data of indoor climate features per working week (1) for both conditions – Study 2

	CO_2 (ppm)		Temperature (°C)		Humidity (%)		Occupancy (%)	
	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
MON 07:00	474.00	456.17	19.80	19.92	48.05	49.63	0	0
MON 08:00	527.70	532.17	20.80	21.45	42.90	42.80	0	0
MON 09:00	819.30	594.33	21.10	21.33	43.85	42.48	100	100
MON 10:00	666.30	642.00	21.40	21.48	42.73	42.93	100	100
MON 11:00	690.20	638.83	21.20	23.15	42.48	38.50	100	100
MON 12:00	656.20	616.50	21.60	23.47	40.58	36.90	0	100
MON 13:00	646.30	608.50	21.80	23.40	39.13	36.05	0	100
MON 14:00	666.00	600.50	22.20	23.37	37.92	35.32	0	100
MON 15:00	738.70	603.83	22.80	23.42	35.35	33.33	0	0
MON 16:00	715.50	721.67	22.30	23.52	34.67	33.32	0	100
MON 17:00	604.70	574.00	21.50	23.08	34.07	32.48	0	0
MON 18:00	443.80	496.83	20.90	22.65	34.38	32.12	0	0
TUE 07:00	414.00	427.67	20.50	21.57	37.00	33.85	0	0
TUE 08:00	442.33	588.00	20.50	21.80	36.73	32.18	0	100
TUE 09:00	495.00	1,269.67	20.00	22.58	37.53	36.07	0	100
TUE 10:00	974.50	1,254.67	20.90	22.68	37.63	36.15	100	100
TUE 11:00	1,165.33	1,086.67	21.80	22.23	37.63	35.63	100	100
TUE 12:00	1,030.33	1,011.33	22.60	22.40	34.97	34.65	0	0
TUE 13:00	686.00	602.50	22.10	21.42	31.62	32.40	100	100
TUE 14:00	715.33	642.00	21.10	21.48	34.07	32.82	100	100
TUE 15:00	685.00	578.17	21.70	21.68	33.03	32.40	100	0
TUE 16:00	594.83	513.17	21.90	21.62	32.32	32.38	0	100
TUE 17:00	535.67	577.50	21.50	22.15	32.27	31.90	0	100
TUE 18:00	490.50	444.83	21.00	21.50	32.45	31.73	0	0
WED 07:00	443.83	431.67	20.10	21.03	31.38	28.45	0	0
WED 08:00	465.17	458.83	20.10	21.15	29.72	27.58	0	0
WED 09:00	581.17	524.67	20.30	21.00	29.87	27.50	0	0
WED 10:00	770.83	578.83	20.50	21.32	31.88	28.32	100	0
WED 11:00	710.67	594.33	21.10	20.93	30.38	29.43	100	0
WED 12:00	624.50	500.67	22.50	20.97	27.25	28.07	0	0
WED 13:00	583.67	721.83	23.00	21.65	26.67	29.52	0	100
WED 14:00	583.67	705.83	24.40	21.65	24.45	29.37	0	100
WED 15:00	603.33	707.33	23.80	21.77	24.52	29.35	0	100
WED 16:00	579.83	610.83	22.60	21.82	26.57	28.28	0	0
WED 17:00	532.17	492.83	21.60	21.68	27.22	27.25	0	0
WED 18:00	505.83	469.67	21.10	21.37	28.25	27.78	0	0
THU 07:00	445.33	434.83	20.53	20.95	29.28	28.10	0	0
THU 08:00	556.67	687.17	20.43	21.87	30.03	29.77	0	100
THU 09:00	690.17	755.33	21.15	22.70	30.28	29.58	100	100
THU 10:00	672.17	631.67	21.38	22.63	30.45	29.02	0	0
THU 11:00	664.83	559.00	21.77	22.65	31.00	29.23	0	0
THU 12:00	671.00	568.17	22.18	22.63	31.23	29.92	0	0
THU 13:00	908.83	666.33	22.43	22.82	33.22	30.92	100	100
THU 14:00	723.83	744.67	21.70	23.18	32.80	30.08	0	100
THU 15:00	589.00	650.83	20.75	22.93	32.67	30.08	0	100
THU 16:00	675.67	670.00	20.58	23.32	34.07	29.57	100	100
THU 17:00	571.83	553.50	20.43	22.98	33.43	29.17	0	0
THU 18:00	509.33	457.00	20.18	22.32	33.60	29.57	0	0
FRI 07:00	464.33	455.17	20.72	21.10	31.05	29.53	0	0
FRI 08:00	480.00	467.50	20.20	20.93	30.77	29.27	0	0
FRI 09:00	649.67	553.17	21.63	21.88	29.40	28.18	0	100
FRI 10:00	690.17	529.83	22.05	21.78	28.03	26.50	0	100
FRI 11:00	737.67	502.17	22.72	21.23	28.13	26.17	100	0
FRI 12:00	550.33	496.50	23.57	21.37	24.75	25.93	100	0
FRI 13:00	561.50	469.83	26.73	20.75	21.47	26.15	100	0
FRI 14:00	507.00	439.33	27.15	20.58	20.47	26.23	100	0
FRI 15:00	466.00	433.00	25.10	20.35	22.17	26.52	100	0
FRI 16:00	453.25	433.75	24.00	20.20	23.08	26.73	0	0
FRI 17:00	574.67	554.17	21.37	20.72	26.75	29.47	0	0
FRI 18:00	478.83	440.17	20.75	20.70	27.27	27.50	0	0

Table L3. Data of indoor climate features per working week (2) for both conditions – Study 2

	CO_2 (ppm)		Temperature (ºC)		Humidity (%)		Sound (dB)		VOC (ppm)		Occupancy (%)	
	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
MON 07:00	406	448	20.30	20.70	41.20	38.58	38	39	389	668	0	0
MON 08:00	470	599	20.50	20.90	40.97	39.62	40	43	343	847	0	100
MON 09:00	464	1,099	20.60	22.30	40.22	41.90	40	49	287	1,520	0	100
MON 10:00	827	797	21.60	22.00	40.65	38.98	44	39	391	691	100	0
MON 11:00	744	661	21.80	21.40	38.78	37.02	39	39	210	349	100	0
MON 12:00	616	628	21.40	21.40	36.63	35.00	39	39	126	157	0	0
MON 13:00	570	632	21.40	21.40	35.97	35.00	39	39	153	183	0	0
MON 14:00	595	636	21.50	21.50	35.15	33.98	39	39	148	174	0	0
MON 15:00	587	627	21.60	21.60	34.13	33.00	39	38	134	136	0	0
MON 16:00	601	593	21.50	21.50	34.00	33.00	39	38	169	139	0	0
MON 17:00	551	502	21.50	21.00	34.05	33.00	39	38	183	135	0	0
MON 18:00	494	506	21.20	20.80	34.83	33.68	39	39	194	242	0	0
TUE 07:00	400	464	20.00	20.90	37.73	34.20	38	38	343	317	0	0
TUE 08:00	406	504	20.00	20.90	37.97	34.62	39	38	348	335	0	100
TUE 09:00	743	925	20.40	21.50	35.40	36.02	40	46	200	602	100	100
TUE 10:00	883	1,373	21.30	22.50	34.90	38.30	43	46	164	1,115	100	100
TUE 11:00	870	1,258	22.00	22.60	34.00	37.40	40	51	173	761	100	100
TUE 12:00	888	1,446	22.20	22.90	34.00	38.72	40	50	163	1,189	100	100
TUE 13:00	791	994	22.00	22.40	33.72	35.02	40	43	156	512	100	100
TUE 14:00	708	1,262	21.70	22.60	32.63	36.38	38	50	139	603	100	100
TUE 15:00	537	1,403	21.50	22.70	31.90	36.63	38	49	129	701	100	100
TUE 16:00	479	719	21.40	21.90	31.88	31.53	38	38	131	144	100	100
TUE 17:00	446	592	21.30	21.20	31.07	30.37	38	39	133	130	0	0
TUE 18:00	415	535	21.10	20.90	30.62	30.18	38	38	130	157	0	0
WED 07:00	401	447	20.30	20.90	32.00	29.57	38	39	152	177	0	0
WED 08:00	420	808	20.50	21.70	31.87	32.03	39	48	151	421	0	100
WED 09:00	987	1,271	22.00	22.60	33.90	35.55	50	50	367	1,054	100	100
WED 10:00	809	1,231	22.00	22.80	32.97	35.60	39	47	305	1,011	0	100
WED 11:00	719	1,251	21.40	22.80	32.37	36.02	40	49	260	1,039	0	100
WED 12:00	749	1,281	21.40	22.80	32.23	35.68	43	47	253	1,068	0	100
WED 13:00	904	898	22.10	22.40	32.98	32.70	45	44	309	508	100	100
WED 14:00	800	1,652	21.70	23.10	32.02	37.33	40	52	338	1,376	0	100
WED 15:00	731	1,543	21.50	23.30	31.98	37.52	39	50	295	1,626	0	100
WED 16:00	756	702	21.60	22.50	31.55	30.92	39	39	335	281	0	100
WED 17:00	694	597	21.60	21.60	31.00	30.00	39	39	275	143	0	0
WED 18:00	534	539	21.20	21.30	30.73	30.00	38	38	185	156	0	0

THU 07:00	400	444	20.60	20.80	32.87	31.05	38	38	188	214	0	0
THU 08:00	409	591	20.80	21.20	32.98	32.47	38	45	200	339	0	100
THU 09:00	430	1,106	20.80	22.40	33.27	37.55	38	51	200	1,299	0	100
THU 10:00	563	1,114	21.10	23.00	34.48	38.65	39	50	285	1,528	100	100
THU 11:00	668	624	21.50	22.20	35.00	35.42	40	38	364	633	100	0
THU 12:00	554	495	21.50	22.50	35.00	33.48	39	39	330	426	0	0
THU 13:00	492	570	21.30	22.90	35.00	33.02	39	41	345	425	0	0
THU 14:00	519	641	21.20	23.10	35.90	34.20	39	39	395	503	0	0
THU 15:00	665	624	21.60	22.80	36.78	35.33	46	41	543	652	0	100
THU 16:00	623	615	21.50	22.50	37.00	36.00	39	39	571	820	0	100
THU 17:00	529	553	21.50	22.00	37.00	36.00	38	38	582	806	0	0
THU 18:00	474	501	21.10	21.80	37.68	36.00	39	39	582	747	0	0
FRI 07:00	430	456	20.90	20.90	39.00	37.75	39	38	603	932	0	0
FRI 08:00	460	469	21.10	20.70	39.03	38.15	40	38	672	1,056	0	0
FRI 09:00	753	470	22.00	20.80	40.20	38.12	44	38	893	1,028	0	0
FRI 10:00	566	478	21.70	21.00	40.00	38.18	38	38	746	1,016	0	0
FRI 11:00	930	564	22.70	21.10	41.67	39.57	51	44	1,181	1,344	100	100
FRI 12:00	849	998	23.20	22.50	40.70	41.35	42	52	1,042	2,055	100	100
FRI 13:00	653	770	22.30	22.60	39.07	39.23	39	43	619	1,202	100	0
FRI 14:00	674	801	21.90	22.60	39.00	39.05	43	48	536	1,048	100	0
FRI 15:00	788	860	22.20	22.70	38.22	38.87	42	45	528	1,160	0	0
FRI 16:00	661	595	21.90	21.90	37.48	36.27	39	39	400	498	0	0
FRI 17:00	598	539	21.80	21.50	36.25	35.77	38	38	301	392	0	0
FRI 18:00	459	489	21.60	21.20	35.15	35.00	38	38	194	339	0	0

Table L4. Data of indoor climate features per working week (3) for both conditions – Study 2

	CO_2 (ppm)		Temperature (ºC)		Humidity (%)		Occupancy (%)	
	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
MON 07:00	436.50	429.33	20.78	20.40	33.15	33.45	0	0
MON 08:00	655.83	667.17	21.10	20.72	33.40	33.25	100	0
MON 09:00	678.17	1,176.67	20.82	21.50	34.00	35.83	0	100
MON 10:00	773.00	1,161.83	20.72	21.65	35.23	35.82	100	100
MON 11:00	788.17	1,033.67	20.78	21.60	34.93	35.42	0	100
MON 12:00	773.67	788.33	20.65	21.28	34.43	33.03	0	100
MON 13:00	815.67	747.17	20.78	20.25	34.50	33.93	100	100
MON 14:00	897.83	776.83	21.25	20.15	33.70	34.43	100	100
MON 15:00	806.17	880.50	21.87	20.22	32.90	35.90	0	100
MON 16:00	792.50	823.33	21.78	20.60	32.05	34.08	0	100
MON 17:00	685.33	684.50	21.77	20.32	31.08	33.05	0	0
MON 18:00	590.50	568.33	21.53	19.45	31.15	34.12	0	0
TUE 07:00	563.67	479.17	21.10	19.65	35.70	37.77	100	0
TUE 08:00	1,076.83	584.67	21.62	21.08	38.75	34.80	100	0
TUE 09:00	1,575.83	741.17	22.02	21.08	41.00	35.60	0	0
TUE 10:00	1,248.5	1,105.00	21.83	21.05	39.25	37.53	0	100
TUE 11:00	974.67	1,459.50	21.32	21.27	37.77	39.37	0	0
TUE 12:00	974.67	942.67	21.12	21.15	37.80	36.27	0	0
TUE 13:00	800.67	759.00	21.53	21.17	35.17	34.27	100	0
TUE 14:00	706.83	719.33	21.60	20.95	34.02	34.60	0	0
TUE 15:00	690.17	693.00	21.67	20.92	34.08	34.73	0	0
TUE 16:00	674.67	701.17	21.72	21.08	33.43	33.95	0	0
TUE 17:00	598.83	593.83	21.87	21.05	31.38	32.47	0	0
TUE 18:00	533.33	525.67	21.38	20.78	31.20	32.20	0	0
WED 07:00	436.00	438.67	20.80	20.78	37.97	31.45	0	0
WED 08:00	999.00	446.50	22.00	20.68	40.38	30.58	100	0
WED 09:00	1,075.00	537.67	22.20	20.78	40.37	30.48	0	0
WED 10:00	793.00	727.00	21.60	20.57	38.67	32.62	100	0
WED 11:00	873.00	936.00	21.70	20.82	38.95	33.45	100	0
WED 12:00	736.00	801.83	21.30	20.85	37.11	32.20	0	0
WED 13:00	843.00	676.83	21.60	20.50	36.45	31.33	100	0
WED 14:00	884.00	712.67	22.40	20.67	35.65	31.00	100	0
WED 15:00	865.00	861.50	22.50	21.47	35.10	29.58	100	0
WED 16:00	839.00	673.50	22.30	20.98	34.67	28.52	100	0
WED 17:00	603.00	589.67	21.30	20.67	33.33	27.86	0	0
WED 18:00	511.00	525.83	20.80	20.38	33.00	27.75	0	0
THU 07:00	421.00	445.50	20.50	20.57	39.00	33.55	0	0
THU 08:00	725.00	519.83	21.60	21.00	40.85	34.08	100	0
THU 09:00	640.00	606.33	21.80	20.72	40.53	36.18	0	0
THU 10:00	597.00	675.67	21.50	20.47	41.00	37.77	0	0
THU 11:00	608.00	755.50	21.40	20.97	41.00	37.30	0	0
THU 12:00	618.00	673.67	21.50	20.92	40.87	36.78	0	0
THU 13:00	598.00	683.33	21.50	20.83	40.53	37.30	0	0
THU 14:00	637.00	828.50	21.50	21.58	40.12	36.78	0	100
THU 15:00	621.00	1,002.83	21.50	22.57	40.00	36.37	0	100
THU 16:00	621.00	972.00	21.60	20.58	40.00	36.17	0	100
THU 17:00	608.00	709.67	21.70	19.68	39.23	37.67	0	0
THU 18:00	498.00	562.17	21.50	20.25	38.90	37.10	0	0
FRI 07:00		443.00		20.53		32.83		0
FRI 08:00		455.17		20.95		30.62		0
FRI 09:00		529.83		20.65		31.07		0
FRI 10:00		571.17		20.98		30.33		0
FRI 11:00		524.17		20.53		30.92		0
FRI 12:00		560.83		20.43		31.45		0
FRI 13:00		1,049.17		21.73		33.55		100
FRI 14:00		1,062.00		22.58		32.42		100
FRI 15:00		770.33		21.85		31.45		100
FRI 16:00		571.83		21.15		30.70		100
FRI 17:00		500.67		20.80		30.98		0
FRI 18:00		474.33		20.70		31.30		0

Table L5. Data of indoor climate features per working week (4) for both conditions – Study 2

	CO_2 (ppm)		Temperature (ºC)		Humidity (%)		Occupancy (%)	
	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
MON 07:00	471.00	536.00	20.75	20.85	33.65	32.55	0	0
MON 08:00	467.67	494.67	20.28	21.15	30.32	29.17	0	100
MON 09:00	473.50	619.83	20.57	21.78	30.08	28.02	100	100
MON 10:00	807.83	731.17	21.05	21.22	31.25	29.30	100	0
MON 11:00	844.00	734.50	21.42	21.43	30.30	29.10	0	100
MON 12:00	628.67	645.17	21.43	21.67	29.47	27.97	0	100
MON 13:00	554.67	567.83	21.60	20.95	30.28	30.58	0	0
MON 14:00	686.83	746.67	21.18	21.33	33.80	34.17	100	100
MON 15:00	692.50	697.83	21.47	22.03	36.27	36.02	0	0
MON 16:00	609.00	718.00	21.25	22.77	37.88	37.13	0	100
MON 17:00	570.33	614.00	21.13	22.40	40.22	39.25	0	0
MON 18:00	507.33	495.50	21.25	21.67	40.47	40.33	0	0
TUE 07:00	427.17	414.67	20.28	21.32	40.67	37.85	0	0
TUE 08:00	643.00	611.00	20.92	21.83	38.78	37.30	100	100
TUE 09:00	891.67	1,095.83	21.17	22.67	40.20	38.57	100	100
TUE 10:00	1,057.83	1,165.67	21.45	22.65	41.03	38.68	100	100
TUE 11:00	990.67	1,294.00	21.90	22.63	38.77	39.18	0	100
TUE 12:00	827.33	995.83	22.60	21.95	33.73	37.08	0	100
TUE 13:00	701.17	672.67	24.37	21.57	26.83	31.58	100	100
TUE 14:00	831.33	693.50	22.53	21.78	29.20	30.15	100	100
TUE 15:00	692.33	654.17	22.47	21.83	29.57	29.72	100	100
TUE 16:00	599.00	636.20	22.07	22.02	28.83	29.22	0	0
TUE 17:00	574.50	675.33	21.03	21.02	31.75	32.63	0	0
TUE 18:00	494.17	546.83	20.82	20.35	32.27	32.73	0	0
WED 07:00	422.17	417.00	20.18	20.43	31.12	31.25	0	0
WED 08:00	494.83	456.33	20.20	20.87	31.42	31.00	0	100
WED 09:00	642.67	645.00	21.12	21.30	31.85	30.80	0	100
WED 10:00	659.17	707.33	21.83	21.32	31.27	30.75	100	0
WED 11:00	1,051.17	692.50	22.22	21.27	33.83	30.92	100	0
WED 12:00	792.17	669.50	22.17	21.10	32.42	31.43	0	0
WED 13:00	644.67	721.50	21.83	21.20	31.78	32.08	100	100
WED 14:00	631.50	769.00	21.65	21.30	31.48	31.97	0	100
WED 15:00	666.00	714.71	21.50	21.39	31.68	31.24	0	0
WED 16:00	641.83	667.17	21.15	21.07	31.95	31.27	0	0
WED 17:00	606.00	636.67	20.78	20.70	32.17	31.67	0	0
WED 18:00	534.00	565.83	20.72	20.48	32.20	31.98	0	0
THU 07:00	431.83	426.83	20.88	21.05	30.52	29.82	0	0
THU 08:00	986.50	443.00	21.52	20.55	32.97	29.58	100	0
THU 09:00	1,190.17	695.67	22.00	21.08	33.92	30.53	100	100
THU 10:00	662.00	843.00	21.88	22.25	30.63	29.47	0	100
THU 11:00	608.17	635.50	21.72	21.58	29.58	28.73	0	0
THU 12:00	636.83	622.17	21.47	21.88	29.45	28.08	100	0
THU 13:00	750.00	641.67	21.63	22.07	31.05	27.95	0	0
THU 14:00	733.50	639.50	21.48	22.27	31.42	28.05	0	0
THU 15:00	768.67	648.50	21.20	21.85	31.92	28.52	0	0
THU 16:00	908.00	636.50	21.58	21.87	32.42	28.60	0	0
THU 17:00	609.33	612.33	21.25	22.30	30.65	27.92	0	0
THU 18:00	522.17	525.17	21.02	21.57	29.90	28.15	0	0
FRI 07:00	433.00	507.50	20.55	20.88	29.63	28.80	0	100
FRI 08:00	572.50	636.67	20.70	20.92	30.48	29.17	0	0
FRI 09:00	1,244.83	650.50	21.80	21.18	34.43	28.72	0	0
FRI 10:00	1,234.50	806.50	22.88	21.48	33.78	29.72	0	100
FRI 11:00	1,081.83	986.50	24.08	21.87	30.12	30.82	100	100
FRI 12:00	937.43	891.67	24.06	21.58	28.99	31.02	100	100
FRI 13:00	1,141.33	853.83	24.13	21.40	31.33	31.27	0	100
FRI 14:00	725.17	846.67	22.80	21.65	28.37	30.60	0	100
FRI 15:00	592.33	838.83	21.65	21.73	28.62	29.77	0	0
FRI 16:00	702.83	683.00	21.32	21.23	28.87	28.38	0	0
FRI 17:00	597.83	615.17	20.93	20.85	27.73	28.20	0	0
FRI 18:00	524.33	539.00	20.93	20.63	28.07	28.22	0	0

8.12.4 Appendix L4 Graphs of indoor climate features per working week for both conditions

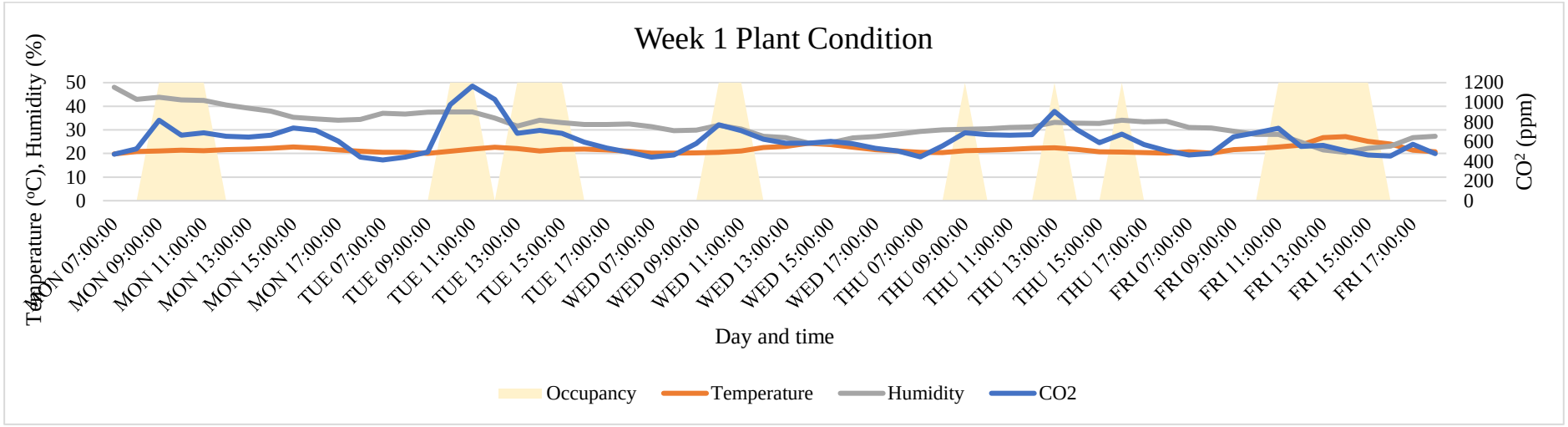


Figure L6. Week 1 Plant condition climate features – Study 2

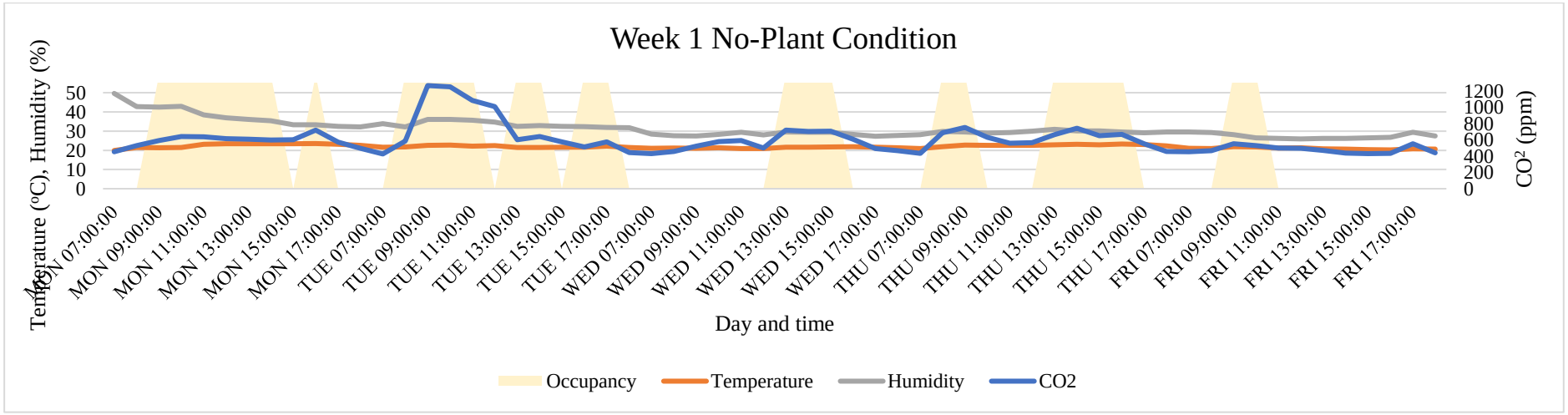


Figure L7. Week 1 No-plant condition climate features – Study 2

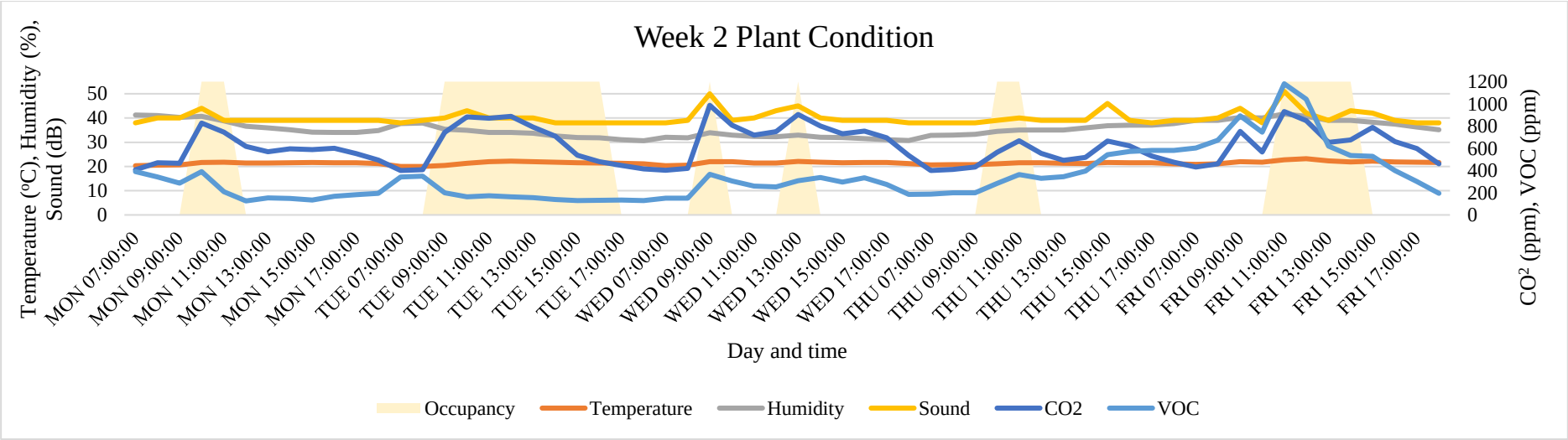


Figure L8. Week 2 Plant condition climate features – Study 2

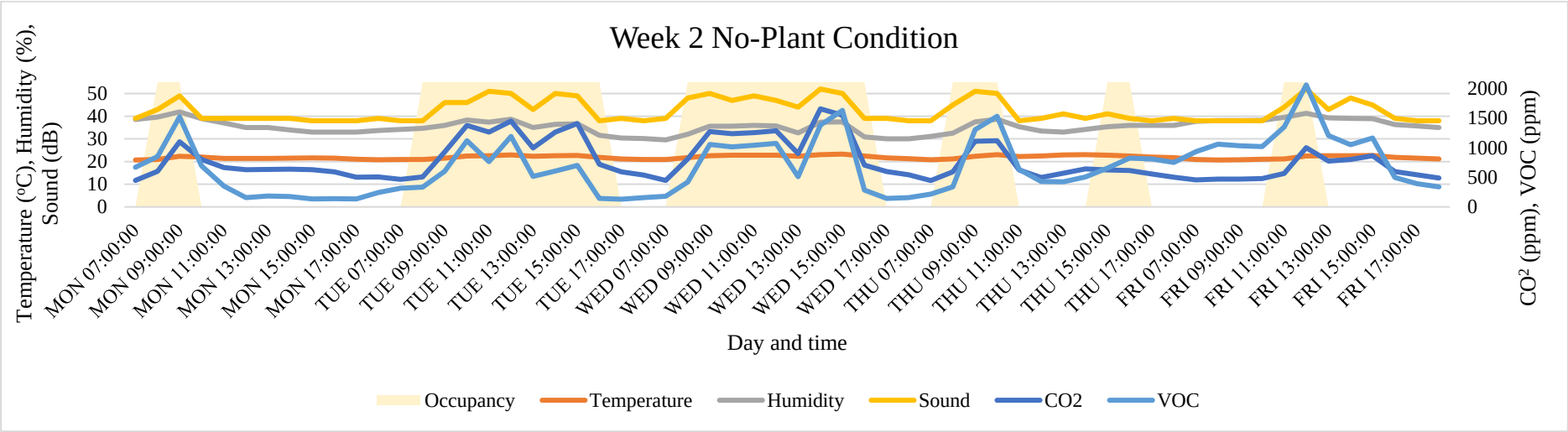


Figure L9. Week 2 No-plant condition climate features – Study 2

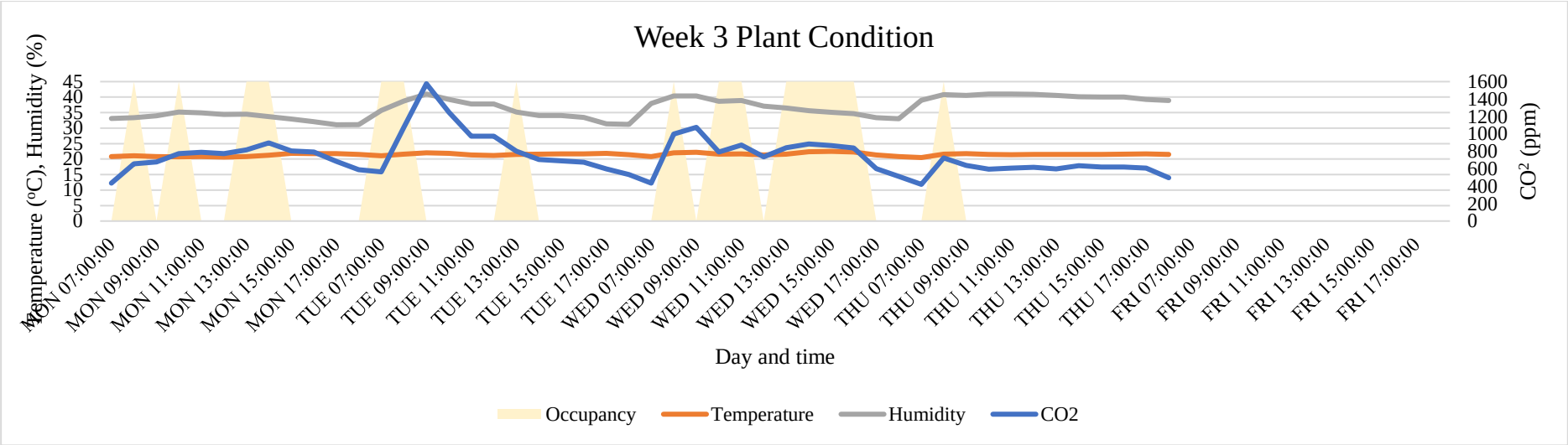


Figure L10. Week 3 Plant condition climate features – Study 2

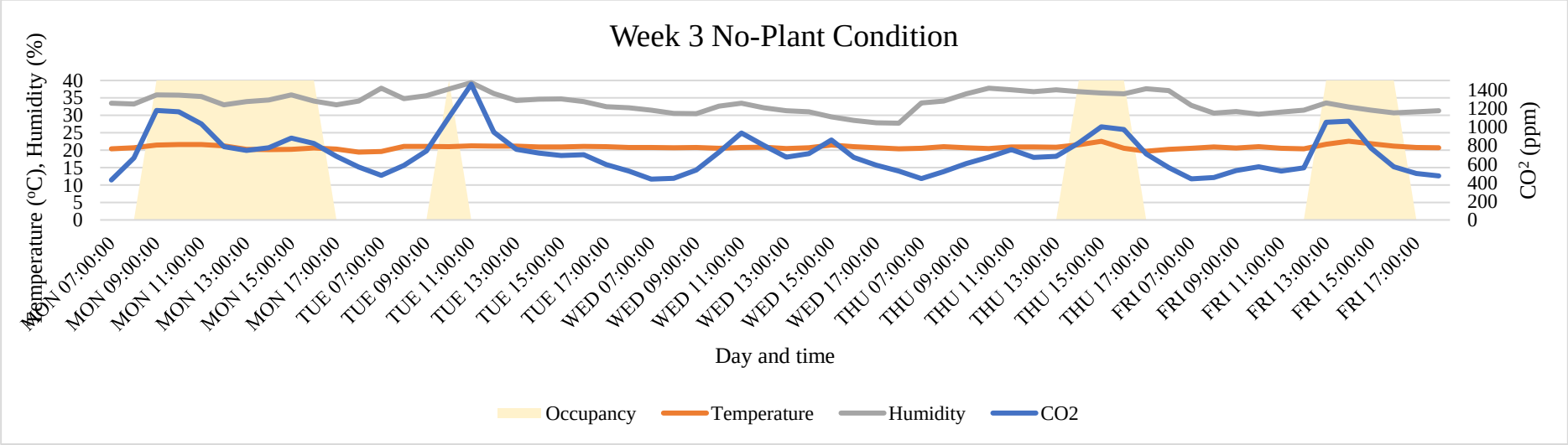


Figure L11. Week 3 No-plant condition climate features – Study 2

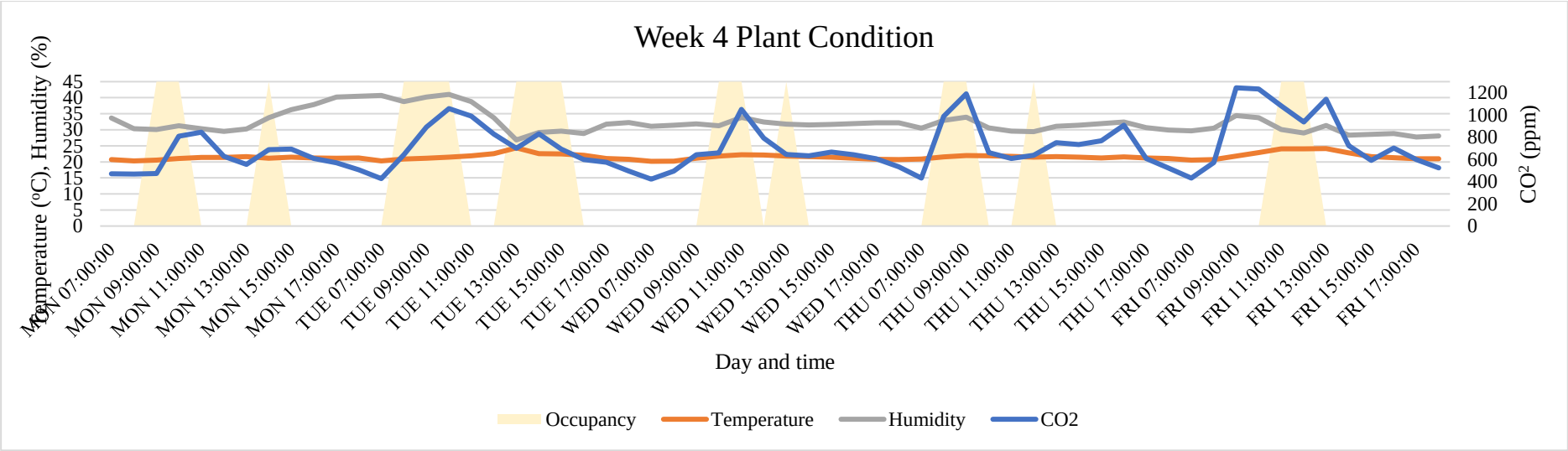


Figure L12. Week 4 Plant condition climate features – Study 2

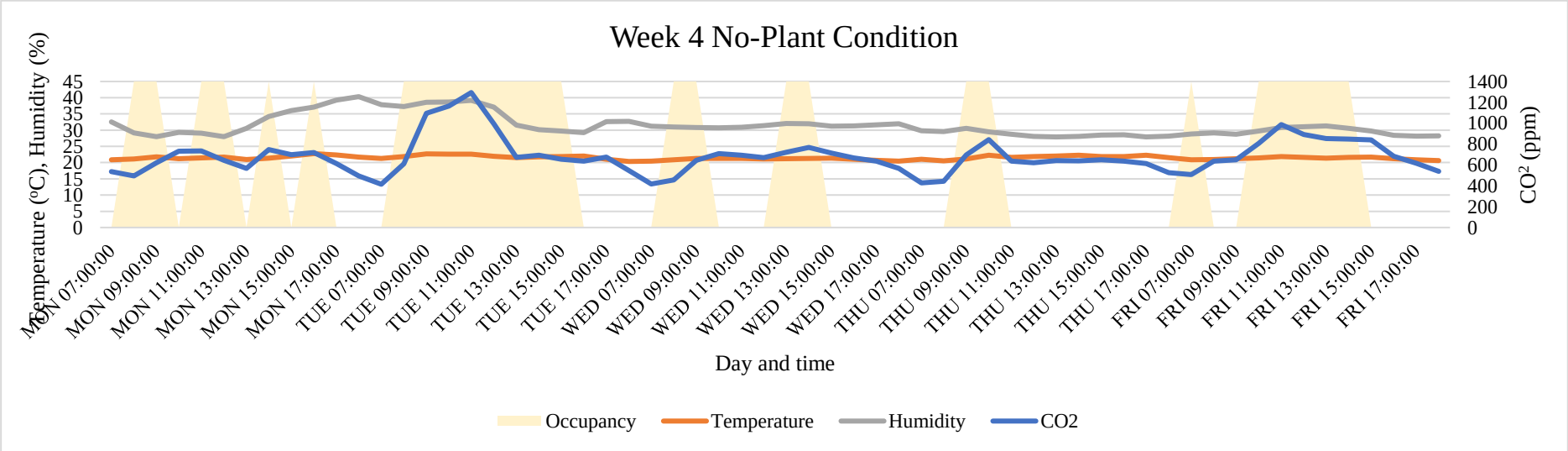


Figure L13. Week 4 No-plant condition climate features – Study 2

8.12.5 Appendix L5 Data of all hours in an average working week for both conditions

Table L6. All hours average working week for both conditions – Study 2

	CO_2 (ppm)		Temperature (°C)		Humidity (%)		Sound (dB)		VOC (ppm)		Occupancy (%)	
	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition	Plant Condition	No-Plant Condition
MON 07:00	446.88	467.38	20.41	20.47	39.01	38.55	38	39	389	668	0	0
MON 08:00	530.30	573.25	20.67	21.06	36.90	36.21	40	43	343	847	25	50
MON 09:00	608.74	872.46	20.77	21.73	37.04	37.06	40	49	287	1,520	50	100
MON 10:00	768.53	833.00	21.19	21.59	37.47	36.76	44	39	391	691	100	50
MON 11:00	766.59	767.00	21.30	21.90	36.62	35.01	39	39	210	349	50	75
MON 12:00	668.64	669.50	21.27	21.96	35.28	33.23	39	39	126	157	0	75
MON 13:00	646.66	638.88	21.40	21.50	34.97	33.89	39	39	153	183	25	50
MON 14:00	711.42	690.00	21.53	21.59	35.14	34.48	39	39	148	174	50	75
MON 15:00	706.09	702.29	21.94	21.82	34.66	34.56	39	38	134	136	0	25
MON 16:00	679.50	714.00	21.71	22.10	34.65	34.38	39	38	169	139	0	75
MON 17:00	602.84	593.63	21.48	21.70	34.86	34.45	39	38	183	135	0	0
MON 18:00	508.91	516.67	21.22	21.14	35.21	35.06	39	39	194	242	0	0
TUE 07:00	451.21	446.38	20.47	20.86	37.78	35.92	38	38	343	317	25	0
TUE 08:00	642.04	571.92	20.76	21.40	38.06	34.73	39	38	348	335	50	75
TUE 09:00	926.38	1,007.92	20.90	21.96	38.53	36.57	40	46	200	602	50	75
TUE 10:00	1,040.96	1,224.59	21.37	22.22	38.20	37.67	43	46	164	1,115	75	100
TUE 11:00	1,000.17	1,274.54	21.76	22.18	37.04	37.90	40	51	173	761	50	75
TUE 12:00	930.08	1,098.96	22.13	22.10	35.13	36.68	40	50	163	1,189	25	50
TUE 13:00	744.71	757.04	22.50	21.64	31.84	33.32	40	43	156	512	100	75
TUE 14:00	740.37	829.208	21.73	21.70	32.48	33.49	38	50	139	603	75	75
TUE 15:00	651.13	832.09	21.84	21.78	32.15	33.37	38	49	129	701	75	50
TUE 16:00	586.88	642.39	21.77	21.66	31.62	31.77	38	38	131	144	25	50
TUE 17:00	538.75	609.67	21.43	21.36	31.62	31.84	38	39	133	130	0	25
TUE 18:00	483.25	513.08	21.08	20.88	31.64	31.71	38	38	130	157	0	0

WED 07:00	425.75	433.59	20.35	20.79	33.12	30.18	38	39	152	177	0	0
WED 08:00	594.75	542.42	20.70	21.10	33.35	30.30	39	48	151	421	25	50
WED 09:00	821.46	744.59	21.41	21.42	34.00	31.08	50	50	367	1,054	25	50
WED 10:00	758.00	811.04	21.48	21.50	33.70	31.82	39	47	305	1,011	75	25
WED 11:00	838.46	868.46	21.61	21.46	33.88	32.46	40	49	260	1,039	75	25
WED 12:00	725.42	813.25	21.84	21.43	32.25	31.85	43	47	253	1,068	0	25
WED 13:00	743.84	754.54	22.13	21.44	31.97	31.41	45	44	309	508	75	75
WED 14:00	724.79	959.88	22.54	21.68	30.90	32.42	40	52	338	1,376	25	75
WED 15:00	716.33	956.64	22.33	21.98	30.82	31.92	39	50	295	1,626	25	50
WED 16:00	704.17	663.38	21.91	21.59	31.19	29.75	39	39	335	281	25	25
WED 17:00	608.79	579.04	21.32	21.16	30.93	29.20	39	39	275	143	0	0
WED 18:00	521.21	525.08	20.96	20.88	31.05	29.38	38	38	185	156	0	0
THU 07:00	424.54	437.79	20.63	20.84	32.92	30.63	38	38	188	214	0	0
THU 08:00	669.29	560.25	21.09	21.16	34.21	31.48	38	45	200	339	50	50
THU 09:00	737.59	790.83	21.44	21.73	34.50	33.46	38	51	200	1,299	50	75
THU 10:00	623.54	816.09	21.47	22.09	34.14	33.73	39	50	285	1,528	25	50
THU 11:00	637.25	643.50	21.60	21.85	34.15	32.67	40	38	364	633	25	0
THU 12:00	619.96	589.75	21.66	21.98	34.13	32.07	39	39	330	426	25	0
THU 13:00	687.21	640.33	21.72	22.16	34.95	32.30	39	41	345	425	25	25
THU 14:00	653.33	713.42	21.47	22.53	35.06	32.28	39	39	395	503	0	50
THU 15:00	660.92	731.54	21.26	22.54	35.34	32.58	46	41	543	652	0	75
THU 16:00	706.92	723.38	21.32	22.07	35.87	32.59	39	39	571	820	25	75
THU 17:00	579.54	607.13	21.22	21.74	35.08	32.69	38	38	582	806	0	0
THU 18:00	500.88	511.34	20.95	21.49	35.02	32.71	39	39	582	747	0	0
FRI 07:00	442.44	465.42	20.72	20.85	33.23	32.23	39	38	603	932	0	25
FRI 08:00	504.17	507.09	20.67	20.88	33.43	31.80	40	38	672	1,056	0	0
FRI 09:00	882.5	550.88	21.81	21.13	34.68	31.52	44	38	893	1,028	0	25
FRI 10:00	830.22	596.38	22.21	21.31	33.94	31.18	38	38	746	1,016	0	50
FRI 11:00	916.5	644.21	23.17	21.18	33.31	31.87	51	44	1,181	1,344	75	50
FRI 12:00	778.92	736.75	23.61	21.47	31.48	32.44	42	52	1,042	2,055	75	50
FRI 13:00	785.28	785.71	24.39	21.62	30.62	32.55	39	43	619	1,202	50	50
FRI 14:00	635.39	787.25	23.95	21.85	29.28	32.08	43	48	536	1,048	50	50
FRI 15:00	615.44	725.54	22.98	21.66	29.67	31.65	42	45	528	1,160	25	25
FRI 16:00	605.69	570.90	22.41	21.12	29.81	30.52	39	39	400	498	0	25
FRI 17:00	590.17	552.25	21.37	20.97	30.24	31.11	38	38	301	392	0	0
FRI 18:00	487.39	485.63	21.09	20.81	30.16	30.51	38	38	194	339	0	0

8.13 Appendix M Coding scheme questionnaire Study 2

Table M1. Coding scheme questionnaire – Study 2

Coding scheme questionnaire			
Respondent ID			
ID		None	Nominal
Introduction text			
	Beste respondent, alvast bedankt voor uw deelname! U wordt uitgenodigd …	None	Nominal
Filter Questions			
Q1	Wat is uw geslacht?	{1, Man}…	Scale
Q2	Wat is uw leeftijd?	None	Nominal
Q3	In welke provincie woont u?	None	Nominal
Q4	In wat voor omgeving woont u?	{1, Rurale omgeving (=natuur)}…	Scale
Q5	Hoeveel uur werkt u (gemiddeld genomen) per week?	None	Nominal
Q6	Hoeveel uur daarvan werkt u (gemiddeld genomen) in een kantooromgeving per week?	None	Nominal
Q7	Hoeveel werkdagen per werkweek gaat u (gemiddeld genomen) tijdens pauze of lunchtijd naar buiten?	None	Nominal
Q8	Waarom heeft u vandaag voor deze vergaderruimte gekozen?	None	Nominal
Q9	Kunt u vanaf uw positie in de vergaderruimte door een raam naar buiten kijken?	{1, Ja}…	Scale
Restorative Characteristics			
Q10_1	BAE.1 In de vergaderruimte voel ik mij verlost van mijn dagelijkse routine	{1, Helemaal niet mee eens}…	Scale
Q10_2	BAN.1 De vergaderruimte is uniek	{1, Helemaal niet mee eens}…	Scale
Q10_3	BAN.2 De vergaderruimte is vernieuwend	{1, Helemaal niet mee eens}…	Scale
Q10_4	COA.1 De vergaderruimte sluit goed aan bij wat ik op dit moment graag wil doen	{1, Helemaal niet mee eens}…	Scale
Q10_5	COA.2 In de vergaderruimte kan ik doen wat ik leuk vind	{1, Helemaal niet mee eens}…	Scale
Q10_6	COE.1 In de vergaderruimte weet ik hoe ik me moet gedragen	{1, Helemaal niet mee eens}…	Scale
Q10_7	COH.1 Alles wat ik in de vergaderruimte zie past goed bij elkaar	{1, Helemaal niet mee eens}…	Scale
Q10_8	FAS.1 In de vergaderruimte zijn veel mooie dingen te zien	{1, Helemaal niet mee eens}…	Scale
Q10_9	FAS.2 In de vergaderruimte zijn veel boeiende dingen te zien	{1, Helemaal niet mee eens}…	Scale
Environmental Preference			
Q11_1	PRE.1 Onaangenaam - Aangenaam	{1, Heel onaangenaam}…	Scale
Q11_2	PRE.2 Negatief – Positief	{1, Heel negatief}…	Scale
Q11_3	PRE.3 Onaantrekkelijk – Aantrekkelijk	{1, Heel onaantrekkelijk}…	Scale
Q11_4	PRE.4 Onplezierig – Plezierig	{1, Heel onplezierig}…	Scale
Q11_5	PRE.5 Niet stimulerend – Stimulerend	{1, Helemaal niet stimulerend}…	Scale
Pleasure			
Q12_1	PLE.1 Ongelukkig - Gelukkig	{1, Heel ongelukkig}…	Scale
Q12_2	PLE.2 Geïrriteerd – Blij	{1, Heel geïrriteerd}…	Scale
Q12_3	PLE.3 Ontevreden – Tevreden	{1, Heel ontevreden}…	Scale
Q12_4	PLE.4 Melancholisch, somber – Voldaan, vrolijk	{1, Heel melancholisch, somber}…	Scale
Q12_5	PLE.5 Verveeld – Ontspannen	{1, Heel verveeld}…	Scale
Q12_6	PLE.6 Wanhopig – Hoopvol	{1, Heel wanhopig}…	Scale
Restoration			

Q13_1	RES.1 In de vergaderruimte kon ik me goed concentreren	{1, Helemaal niet mee eens}…	Scale
Q13_2	RES.2 In de vergaderruimte kon ik me goed op mezelf richten	{1, Helemaal niet mee eens}…	Scale
Q13_3	RES.3 In de vergaderruimte kon ik eventuele spanning loslaten	{1, Helemaal niet mee eens}…	Scale
Q13_4	RES.4 In de vergaderruimte kon ik me ontspannen	{1, Helemaal niet mee eens}…	Scale
Q13_5	RES.5 In de vergaderruimte kreeg ik nieuwe energie	{1, Helemaal niet mee eens}…	Scale
Q13_6	RES.6 In de vergaderruimte voelde ik me energiek	{1, Helemaal niet mee eens}…	Scale
Judgement of room			
Q14	Hoe zou u de vergaderruimte beoordelen? Geef een rapportcijfer	{1, Zeer negatief}…	Scale
Q15	Hoe graag zou u in deze vergaderruimte willen werken?	{1, Helemaal niet}…	Scale
Q16	Wat zou u aan deze vergaderruimte willen toevoegen of veranderen om de ruimte te verbeteren?	None	Nominal
Conclusion statement			
	Einde vragenlijst. U mag de vragenlijst bij de onderzoeker inleveren. Bedankt …	None	Nominal

8.14 Appendix N Explanation and questionnaire Study 2

Hoe moet u deze vragenlijst invullen

Dit formulier laat enkele voorbeelden zien van vragen die u in de vragenlijst kunt tegenkomen. Vervolgens wordt aangegeven hoe u de betreffende vraag kunt beantwoorden.

Voorbeeld 1
Er zijn enkele meerkeuzevragen waarbij u een keuze kunt aangeven uit een aantal antwoordmogelijkheden door één bolletje in te kleuren dat staat bij het antwoord dat voor u van toepassing is. In onderstaand voorbeeld is het gegeven antwoord *Man.*

Vraag: Wat is uw geslacht?

- ● Man
- ○ Vrouw
- ○ Ik antwoord liever niet

Voorbeeld 2
Er zijn enkele open vragen waarbij u zelf het antwoord op moet schrijven. In onderstaand voorbeeld is het gegeven antwoord *40* uur.

Vraag: Hoeveel uur werkt u (gemiddeld genomen) per week?

40

Voorbeeld 3
Bij de meeste vragen gaat het om uw mening t.a.v. enkele uitspraken. U kunt aangeven in hoeverre u het eens bent met de uitspraak door het antwoord te omcirkelen dat het meest overeenkomt met wat u vindt. Een 1 betekent *helemaal niet mee eens*, een 2 betekent *niet mee eens*, een 3 betekent *enigszins mee oneens*, een 4 betekent *noch eens noch oneens*, een 5 betekent *enigszins mee eens*, een 6 betekent *mee eens,* een 7 betekent *helemaal mee eens*. In onderstaand voorbeeld is het gegeven antwoord *enigszins mee eens.*

Vraag: Geef aan in hoeverre u het eens bent met de volgende uitspraak:

1 In de vergaderruimte voel ik mij verlost van mijn dagelijkse routine

Helemaal niet mee eens 1 2 3 4 (5) 6 7 Helemaal mee eens

Voorbeeld 4
Er zijn enkele vragen waarbij een serie antwoorden wordt gegeven. Geef antwoord op basis van een 7-puntsschaal door één antwoord te omcirkelen in elke regel. Een 1 betekent ik voel me *heel ongelukkig* en een 7 is ik voel me *heel gelukkig*. Een 4 is *noch ongelukkig noch gelukkig*. Het ingevulde antwoord, een 6, betekent *gelukkig*. De 5 betekent *enigszins blij*. De 1 betekent *heel ontevreden.*

Vraag: Hoe voelt u zich in deze vergaderruimte? Ik voel me:

Ongelukkig	1	2	3	4	5	(6)	7	Gelukkig
Geïrriteerd	1	2	3	4	(5)	6	7	Blij
Ontevreden	(1)	2	3	4	5	6	7	Tevreden

N.B. Wanneer u per ongeluk een verkeerd antwoord heeft ingevuld dan kunt u het beste een streep door het foutieve antwoord zetten en daarna het juiste antwoord omcirkelen.

Respondentnummer: _____

Wearable nummer: _____

Introductie

Beste respondent,

Alvast bedankt voor uw deelname! U wordt uitgenodigd om deel te nemen aan een onderzoek dat wordt uitgevoerd in het kader van mijn afstudeerscriptie voor de Master Marketing Communication & Design. Dit onderzoek wordt uitgevoerd vanuit de Universiteit Twente in samenwerking met Dura Vermeer. Het doel van dit onderzoek is het in kaart brengen en verbeteren van medewerkerswelzijn binnen de kantooromgeving van Dura Vermeer Hengelo. Deze vragenlijst tracht uw mening in kaart te brengen ten aanzien van de omgeving waar u zich op dit moment bevindt – de OFAD.

Het invullen van deze vragenlijst zal ongeveer 5 minuten duren en is geheel anoniem. Er zijn geen fysieke, juridische of economische risico's verbonden aan uw deelname. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt uw deelname op elk gewenst moment stoppen. De gegevens worden uitsluitend gebruikt voor dit afstudeeronderzoek. Dit onderzoek is beoordeeld en goedgekeurd door de ethische commissie van de faculteit BMS. Voor de betrouwbaarheid van het onderzoek wordt u verzocht de vragenlijst individueel en niet in overleg met anderen in te vullen. Probeer zo volledig mogelijk alle vragen te beantwoorden. Gelieve slechts één antwoord per vraag te geven. Voor vragen of opmerkingen kunt u op elk gewenst moment contact opnemen met de onderzoeker.

Aan dit onderzoek mogen alleen medewerkers van Dura Vermeer deelnemen. Tevens mag u slechts eenmalig medewerking aan dit onderzoek verlenen.

U mag nu met de vragen beginnen. Succes!

Lobke Elzinga

Vragenlijst

Wat is uw geslacht?

- ○ Man
- ○ Vrouw
- ○ Ik antwoord liever niet

Wat is uw leeftijd? (in jaar)

- ○ _____
- ○ Ik antwoord liever niet

In welke provincie woont u?

- ○ _____
- ○ Ik antwoord liever niet

In wat voor omgeving woont u? Geef aan in hoeverre uw woonomgeving ruraal of urbaan is door <u>één</u> antwoord te omcirkelen.

Rurale omgeving (=natuur) 1 2 3 4 5 6 7 Urbane omgeving (=stedelijk)

Hoeveel uur werkt u (gemiddeld genomen) per week?

_____

Hoeveel uur daarvan werkt u (gemiddeld genomen) in een kantooromgeving per week?

_____

Hoeveel werkdagen per werkweek gaat u (gemiddeld genomen) tijdens pauze of lunchtijd naar buiten?

_____

Waarom heeft u vandaag voor deze vergaderruimte gekozen?

_____

Kunt u vanaf uw positie in de vergaderruimte door een raam naar buiten kijken?

- ○ Ja
- ○ Nee

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de ruimte waar u zich bevindt) door één antwoord te omcirkelen.

1 In de vergaderruimte voel ik mij verlost van mijn dagelijkse routine

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

2 De vergaderruimte is uniek

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

3 De vergaderruimte is vernieuwend

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

4 De vergaderruimte sluit goed aan bij wat ik op dit moment graag wil doen

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

5 In de vergaderruimte kan ik doen wat ik leuk vind

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

6 In de vergaderruimte weet ik hoe ik me moet gedragen

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

7 Alles wat ik in de vergaderruimte zie past goed bij elkaar

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

8 In de vergaderruimte zijn veel mooie dingen te zien

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

9 In de vergaderruimte zijn veel boeiende dingen te zien

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

Hoe ervaart u deze vergaderruimte?

Geef antwoord op basis van een 7-puntsschaal door één antwoord te omcirkelen. Ik evalueer deze vergaderruimte als:

Onaangenaam	1	2	3	4	5	6	7	Aangenaam
Negatief	1	2	3	4	5	6	7	Positief
Onaantrekkelijk	1	2	3	4	5	6	7	Aantrekkelijk
Onplezierig	1	2	3	4	5	6	7	Plezierig
Niet stimulerend	1	2	3	4	5	6	7	Stimulerend

Hoe voelt u zich in deze vergaderruimte?

Geef antwoord op basis van een 7-puntsschaal door één antwoord te omcirkelen. Ik voel me:

Ongelukkig	1	2	3	4	5	6	7	Gelukkig
Geïrriteerd	1	2	3	4	5	6	7	Blij
Ontevreden	1	2	3	4	5	6	7	Tevreden
Melancholisch, somber	1	2	3	4	5	6	7	Voldaan, vrolijk
Verveeld	1	2	3	4	5	6	7	Ontspannen
Wanhopig	1	2	3	4	5	6	7	Hoopvol

Geef aan in hoeverre u het eens bent met de volgende uitspraken (t.a.v. de ruimte waar u zich bevindt) door één antwoord te omcirkelen:

1 In de vergaderruimte kon ik me goed concentreren

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

2 In de vergaderruimte kon ik me goed op mezelf richten

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

3 In de vergaderruimte kon ik eventuele spanning loslaten

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

4 In de vergaderruimte kon ik me ontspannen

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

5 In de vergaderruimte kreeg ik nieuwe energie

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

6 In de vergaderruimte voelde ik me energiek

Helemaal niet mee eens 1 2 3 4 5 6 7 Helemaal mee eens

Hoe zou u de vergaderruimte beoordelen? Geef een rapportcijfer

Zeer negatief 1 2 3 4 5 6 7 8 9 10 Zeer positief

Hoe graag zou u in deze vergaderruimte willen werken?

Helemaal niet 1 2 3 4 5 6 7 Helemaal wel

Wat zou u aan deze vergaderruimte willen toevoegen of veranderen om de ruimte te verbeteren?

_____

Einde vragenlijst.

U mag de vragenlijst bij de onderzoeker inleveren.

Bedankt voor het invullen!

8.15 Appendix O Example output Empatica E4 wearable

Figure O1. Example output Empatica E4 wearable – Study 2

8.16 Appendix P Factor analysis Study 2

8.16.1 Appendix P1 Principal component analysis restorative characteristics Study 2

Multiple analyses were conducted before it was decided to discard the first item of Compatibility – Ability as part of the restorative characteristics to come up with a sensible factor model and increase construct validity. This item loaded in a different factor and, even though sufficiently high, had the lowest factor loading value (.68).

Table P1. Factor analysis round 1 – Study 2

Construct	Item	Factor					
		1	2	3	4	5	6
Being Away – Escape (BAE)	BAE.1 When I am in the meeting room I feel free from my daily routine				.85		
Being Away – Novelty (BAN)	BAN.1 The meeting room is unique		.74				
	BAN.2 The meeting room is novel		.91				
Coherence (COH)	COH.1 Everything I see in the meeting room goes well together						.94
Compatibility – Ability (COA)	COA.1 The meeting room matches with what I want to do at this moment			.68			
	COA.2 In the meeting room I can do things I like					.97	
Compatibility – Expectation (COE)	COE.1 I know how to behave in the meeting room			.84			
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.89					
	FAS.2 There are many interesting things to see in the meeting room	.92					

Table P2. Factor analysis round 2 – Study 2

Construct	Item	Factor					
		1	2	3	4	5	6
Being Away – Escape (BAE)	BAE.1 When I am in the meeting room I feel free from my daily routine						.95
Being Away – Novelty (BAN)	BAN.1 The meeting room is unique		.86				
	BAN.2 The meeting room is novel		.89				
Coherence (COH)	COH.1 Everything I see in the meeting room goes well together			.96			
Compatibility – Ability (COA)	COA.2 In the meeting room I can do things I like					.98	
Compatibility – Expectation (COE)	COE.1 I know how to behave in the meeting room				.98		
Fascination (FAS)	FAS.1 There are many beautiful things to see in the meeting room	.90					
	FAS.2 There are many interesting things to see in the meeting room	.92					

8.16.2 Appendix P2 Factor analysis for Compatibility separately Study 2

Table P3. Factor analysis Compatibility – Study 2

Construct	Item	Factor	
		1	2
Compatibility (COM)	COA.1 The meeting room matches with what I want to do at this moment	.71	
	COA.2 In the meeting room I can do things I like		.97
	COE.1 I know how to behave in the meeting room	.86	

8.17 Appendix Q Additional correlation analyses Study 2

The no-plant condition (Table Q1) shows higher correlation coefficients than the plant condition (Table Q2). In the no-plant condition positive significant inter-correlations are exactly the same as in the overall correlation table showing moderate relationships between variables. The strongest inter-correlation is .76, again for Environmental Preference and Grade. For the plant condition there are only three significant inter-correlations that show a moderate positive relationship; Pleasure and Restoration, Environmental Preference and Grade, Grade and Desire. Here the highest correlation value is .63 for Grade and Desire. Again, for restorative characteristics Fascination shows some correlation with Environmental Preference and Grade in both conditions. Interestingly, for Coherence the correlations are higher in the no-plant condition than in the plant condition.

Table Q1. Results of correlation analysis plant condition – Study 2

	FAS	BAN	BAE	COH	COA	COE	PLE	PRE	RES	Grade	Desire
FAS											
BAN	.01										
BAE	.39**	.34*									
COH	.14	.09	-.07								
COA	.07	.17	.06	.15							
COE	-.26	.02	-.10	.32*	.20						
PLE	.09	.20	-.02	.28	.15	.21					
PRE	.48**	.13	.24	.25	.26	.07	.53**				
RES	.27	.15	.23	.30*	.29*	.14	.62**	.54**			
Grade	.37**	.34*	.33*	.28	.16	-.02	.49**	.61**	.47**		
Desire	.23	.08	.09	.37**	-.03	.12	.24	.43**	.35**	.63**	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table Q2. Results of correlation analysis no-plant condition – Study 2

	FAS	BAN	BAE	COH	COA	COE	PLE	PRE	RES	Grade	Desire
FAS											
BAN	.45**										
BAE	.29*	.42**									
COH	.34*	.15	.06								
COA	.36**	.31*	.32*	.23							
COE	.15	-.17	-.02	.28*	.16						
PLE	.30*	.11	.29*	.34**	.17	.44**					
PRE	.49**	.41**	.31*	.56**	.34**	.34**	.69**				
RES	.39**	.17	.44**	.32*	.29*	.45**	.68**	.67**			
Grade	.48**	.31*	.24	.47**	.27*	.35**	.54**	.76**	.68**		
Desire	.27*	.05	.23	.40**	.37**	.18	.50**	.59**	.52**	.70**	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

8.18 Appendix R Additional regression analyses Study 2

8.18.1 Appendix R1 Multiple linear regression analysis Study 2

Multiple linear regression analysis is conducted. Table 19 presents the results to show which constructs predict the dependent variables, to estimate the model's strength, and the amount of variance it explains. The plant versus no-plant condition is added as a predictor causing a minimal rise in variance for all restorative effects even though the condition showed not to be a significant predictor of the respective effects. Just 22.3% ($F=4.03$, with $p<.001$) of variance in Pleasure can be explained by the restorative characteristics with the only predictor ($p<.01$) being Compatibility – Expectation with $\beta=.31$. The restorative characteristics account for 47.2% ($F=12.64$, with $p<.001$) of variance in Environmental Preference. Predictors of Environmental Preference are Compatibility – Expectation ($\beta=.16$), Coherence ($\beta=.27$), and Fascination ($\beta=.34$). For Restoration 35.6% of the variance is explained ($F=7.83$, $p<.001$) with the predictors Being Away – Escape ($\beta=.30$), Compatibility – Expectation ($\beta=.28$), and Fascination ($\beta=.21$). The highest explained variance, 61.0% ($F=14.84$, $p<.001$), is in Grade with Environmental Preference ($\beta=.46$) and Restoration ($\beta=.28$) as predictors. Finally, 38.9% of variance in Desire ($F=6.04$, $p<.001$) is explained by the research model with Coherence ($\beta=.20$) and Environmental Preference ($\beta=.37$) as predictors. Multiple linear regression analyses were conducted for both conditions separately as well. An outlay thereof can be found in Appendix R. The no-plant condition showed higher percentages of variance explained by the research model than the plant condition. Furthermore, the plant condition sometimes has no significant predictors when measuring the restorative effects as well as grade and desire, whereas the no-plant condition has at least two predictors for each effect.

Table R1. Results of multiple linear regression analysis – Study 2

Model		*B*	Std. Error	*β*	*t* value	Sig.
Pleasure	Constant	2.30	.60		3.82	.000
	BAE	.06	.05	.11	1.07	.287
	BAN	.04	.06	.07	.66	.512
	COA	.01	.06	.01	.08	.933
	COE	.24	.07	.31	3.25	.002
	COH	.13	.07	.19	1.91	.059
	FAS	.08	.07	.13	1.19	.237
	(NO)PLANT	.20	.15	.13	1.30	.196
	R^2	.223				
	df	7, 98				
	p	.001				
Environmental Preference	Constant	1.52	.60		2.53	.013
	BAE	.07	.05	.11	1.29	.201
	BAN	.10	.06	.15	1.64	.105
	COA	.06	.06	.08	1.02	.310
	COE	.15	.07	.16	2.08	.040
	COH	.22	.07	.27	3.36	.001
	FAS	.25	.07	.34	3.74	.000
	(NO)PLANT	-.10	.16	-.05	-.64	.522
	R^2	.472				
	df	7, 99				
	p	.000				
Restoration	Constant	1.83	.58		3.16	.002
	BAE	.16	.05	.30	3.24	.002
	BAN	-.02	.06	-.04	-.35	.725
	COA	.07	.06	.11	1.24	.217
	COE	.22	.07	.28	3.18	.002
	COH	.12	.06	.16	1.80	.076
	FAS	.14	.07	.21	2.13	.036
	(NO)PLANT	-.04	.15	-.03	-.27	.787
	R^2	.356				
	df	7, 99				
	p	.000				
Grade	Constant	.67	.80		.83	.408
	BAE	-.03	.07	-.04	-.45	.656
	BAN	.12	.08	.13	1.62	.110
	COA	-.06	.07	-.06	-.83	.409
	COE	.03	.10	.03	.34	.733
	COH	.09	.09	.08	1.01	.317
	FAS	.10	.09	.10	1.16	.250
	PLE	-.03	.16	-.02	-.15	.879
	PRE	.65	.15	.46	4.27	.000
	RES	.45	.16	.28	2.79	.006
	(NO)PLANT	.08	.20	.03	.41	.680
	R^2	.610				
	df	10, 95				
	p	.000				
Desire	Constant	1.29	.88		1.46	.149
	BAE	.04	.07	.05	.49	.624
	BAN	-.13	.08	-.16	-1.57	.119
	COA	.05	.08	.06	.63	.529
	COE	-.08	.11	-.07	-.80	.424
	COH	.20	.10	.20	2.12	.037
	FAS	-.04	.10	-.04	-.41	.681
	PLE	.05	.18	.04	.30	.766
	PRE	.46	.17	.37	2.73	.008
	RES	.27	.18	.19	1.51	.134
	(NO)PLANT	-.21	.22	-.09	-.96	.341
	R^2	.389				
	df	10, 95				
	p	.000				

8.18.2 Appendix R2 Regression analysis plant condition Study 2

Table R2. Regression analysis plant condition – Study 2

Model		*B*	Std. Error	*β*	*t* value	Sig.
Pleasure	Constant	3.26	.88		3.72	.001
	BAE	-.06	.08	-.13	-.76	.450
	BAN	.12	.09	.20	1.26	.213
	COA	.03	.08	.06	.40	.692
	COE	.12	.12	.17	1.08	.288
	COH	.11	.10	.16	1.03	.310
	FAS	.10	.11	.16	.91	.368
	R^2	.149				
	df	6, 41				
	p	.330				
Environmental Preference	Constant	2.63	.78		3.36	.002
	BAE	.02	.07	.05	.30	.769
	BAN	.04	.08	.07	.49	.624
	COA	.09	.07	.17	1.25	.219
	COE	.09	.10	.13	.88	.385
	COH	.07	.09	.11	.79	.436
	FAS	.31	.10	.47	3.09	.004
	R^2	.322				
	df	6, 42				
	p	.009				
Restoration	Constant	2.69	.82		3.29	.002
	BAE	.08	.08	.16	1.00	.325
	BAN	.02	.09	.03	.20	.841
	COA	.11	.07	.21	1.46	.151
	COE	.06	.11	.09	.56	.578
	COH	.14	.10	.23	1.49	.144
	FAS	.12	.10	.19	1.17	.249
	R^2	.232				
	df	6, 42				
	p	.072				
Grade	Constant	2.74	.97		2.83	.007
	BAE	.09	.08	.16	1.16	.254
	BAN	.15	.09	.21	1.68	.102
	COA	-.03	.08	-.04	-.34	.737
	COE	-.13	.11	-.15	-1.15	.256
	COH	.10	.10	.12	.98	.335
	FAS	.04	.11	.05	.34	.735
	PLE	.28	.19	.23	1.44	.158
	PRE	.47	.19	.40	2.49	.017
	RES	.01	.19	.01	.06	.955
	R^2	.540				
	df	9, 38				
	p	.000				
Desire	Constant	1.35	1.30		1.04	.306
	BAE	-.03	.10	-.05	-.30	.767
	BAN	.03	.12	.04	.27	.788
	COA	-.15	.10	-.21	-1.44	.159
	COE	.08	.15	.08	.54	.589
	COH	.23	.13	.27	1.79	.081
	FAS	.02	.15	.02	.10	.918
	PLE	-.23	.26	-.17	-.88	.385
	PRE	.46	.25	.36	1.85	.073
	RES	.32	.26	.24	1.25	.217
	R^2	.324				
	df	9, 38				
	p	.063				

8.18.3 Appendix R3 Regression analysis no-plant condition Study 2

Table R3. Regression analysis no-plant condition – Study 2

Model		*B*	Std. Error	*β*	*t* value	Sig.
Pleasure	Constant	2.20	.69		3.18	.003
	BAE	.15	.07	.27	2.10	.041
	BAN	.00	.09	-.00	-.01	.995
	COA	-.04	.09	-.07	-.51	.611
	COE	.31	.10	.39	3.09	.003
	COH	.14	.09	.20	1.56	.125
	FAS	.08	.10	.12	.85	.398
	R^2	.339				
	df	6, 51				
	p	.001				
Environmental Preference	Constant	.23	.72		.32	.749
	BAE	.09	.08	.13	1.18	.243
	BAN	.19	.09	.26	2.15	.036
	COA	.03	.09	.03	.28	.780
	COE	.25	.10	.25	2.42	.019
	COH	.33	.09	.38	3.65	.001
	FAS	.14	.10	.17	1.42	.163
	R^2	.538				
	df	6, 51				
	p	.000				
Restoration	Constant	1.12	.68		1.66	.103
	BAE	.24	.07	.40	3.45	.001
	BAN	-.03	.08	-.05	-.35	.729
	COA	.02	.08	.02	.19	.847
	COE	.34	.10	.39	3.44	.001
	COH	.10	.09	.13	1.15	.255
	FAS	.14	.09	.18	1.45	.154
	R^2	.463				
	df	6, 51				
	p	.000				
Grade	Constant	.32	1.10		.29	.776
	BAE	-.11	.11	-.11	-.99	.329
	BAN	.07	.13	.06	.54	.590
	COA	-.04	.12	-.03	-.35	.731
	COE	.05	.16	.03	.30	.766
	COH	.10	.14	.07	.69	.494
	FAS	.13	.14	.10	.96	.344
	PLE	-.18	.25	-.09	-.70	.489
	PRE	.73	.25	.48	2.95	.005
	RES	.68	.24	.39	2.77	.008
	R^2	.655				
	df	9, 48				
	p	.000				
Desire	Constant	.89	1.09		.81	.421
	BAE	.01	.11	.01	.05	.958
	BAN	-.28	.13	-.30	-2.17	.035
	COA	.26	.12	.25	2.13	.038
	COE	-.29	.16	-.23	-1.84	.071
	COH	.11	.14	.11	.82	.416
	FAS	-.02	.14	-.02	-.17	.863
	PLE	.20	.25	.13	.79	.431
	PRE	.54	.25	.43	2.20	.033
	RES	.29	.24	.20	1.20	.235
	R^2	.497				
	df	9, 48				
	p	.000				

8.19 Appendix S Additional wearable data Study 2

8.19.1 Appendix S1 Graphs wearable data per physical feature for both conditions Study 2

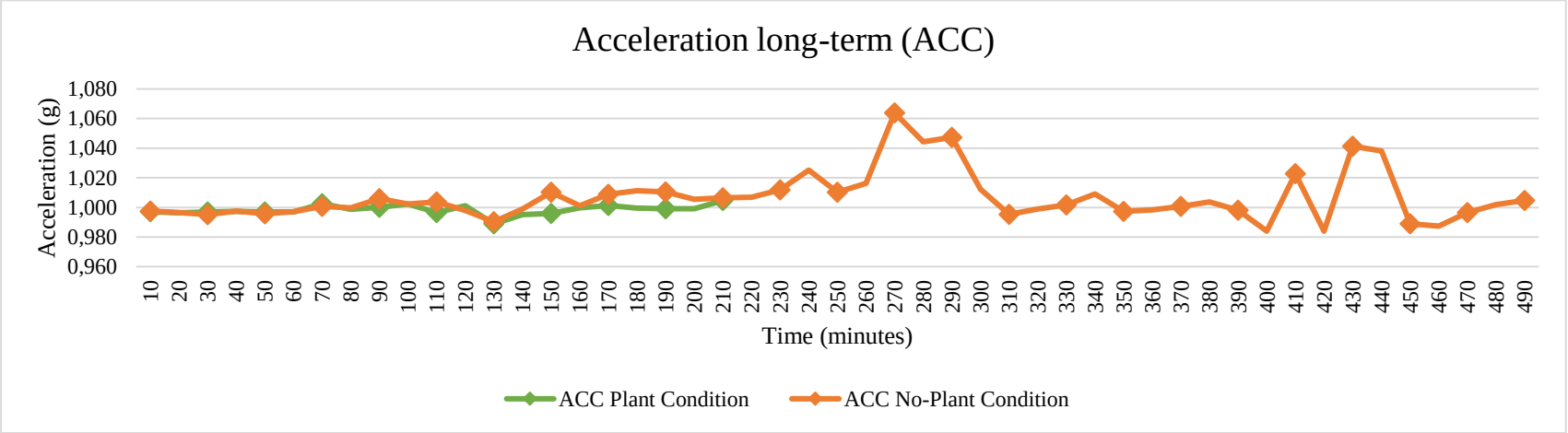


Figure S1. Acceleration long-term – Study 2

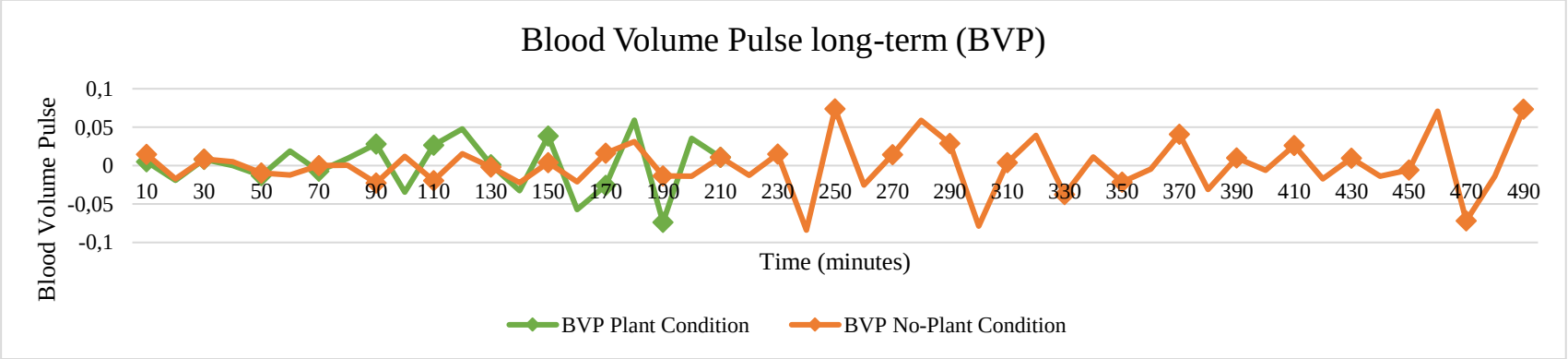


Figure S2. Blood Volume Pulse long-term – Study 2

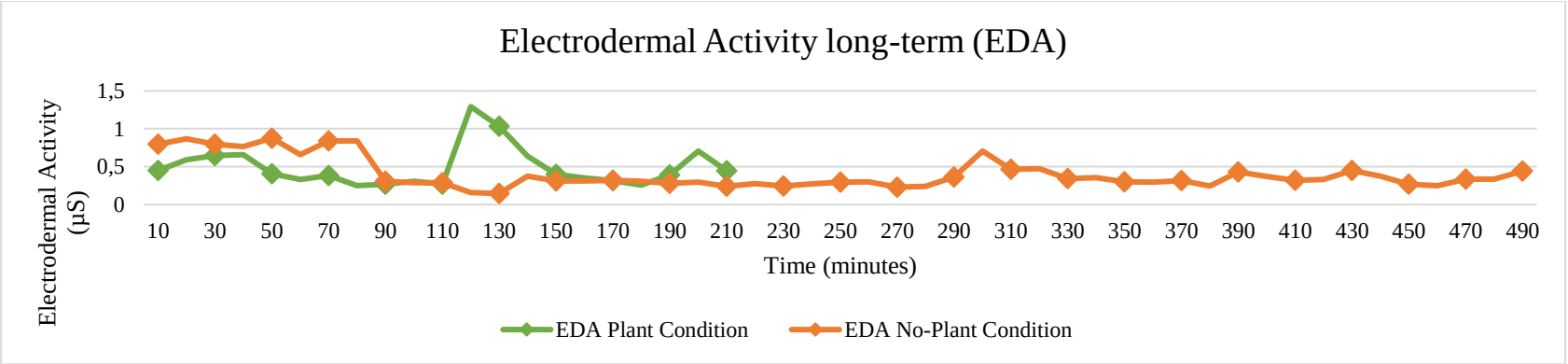


Figure S3. Electrodermal Activity long-term – Study 2

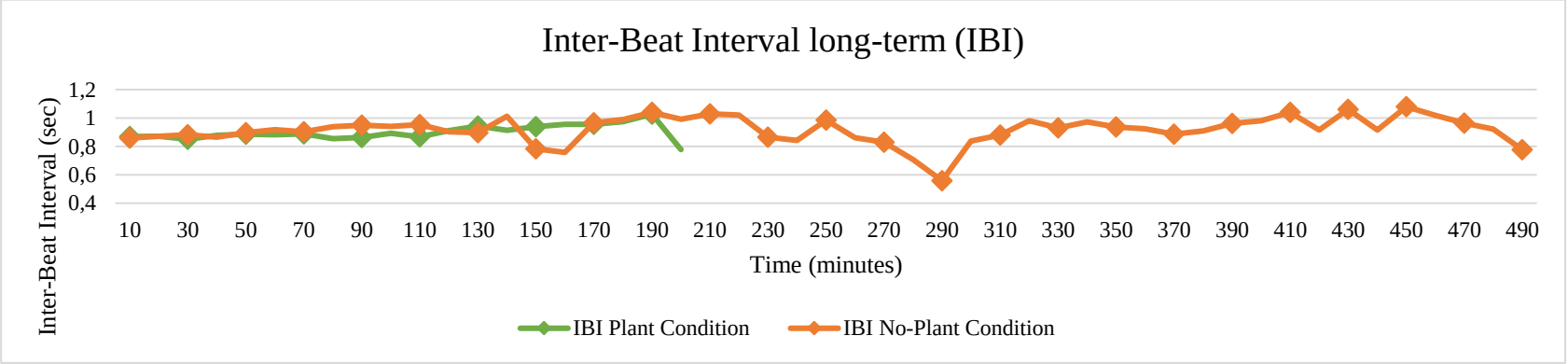


Figure S4. Inter-Beat Interval long-term – Study 2

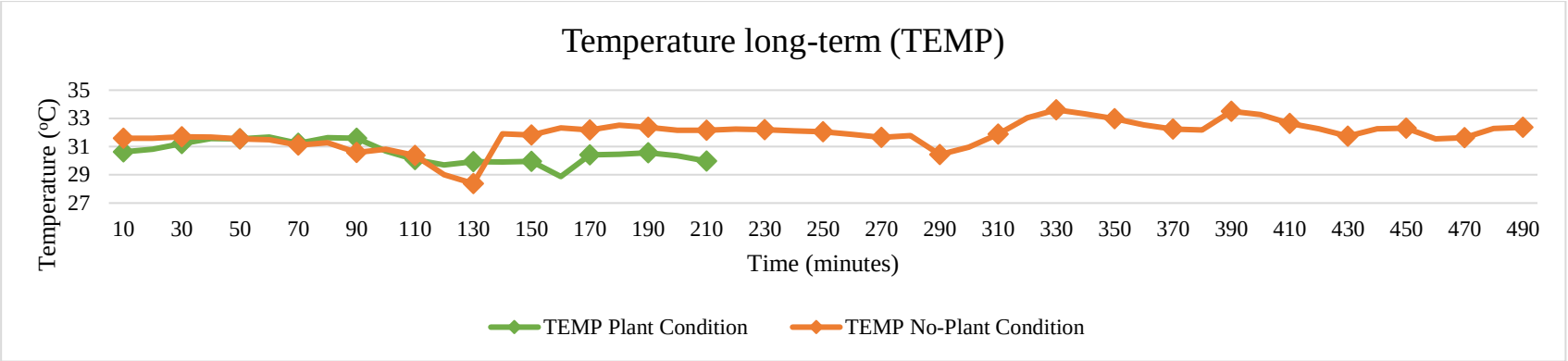


Figure S5. Temperature long-term – Study 2

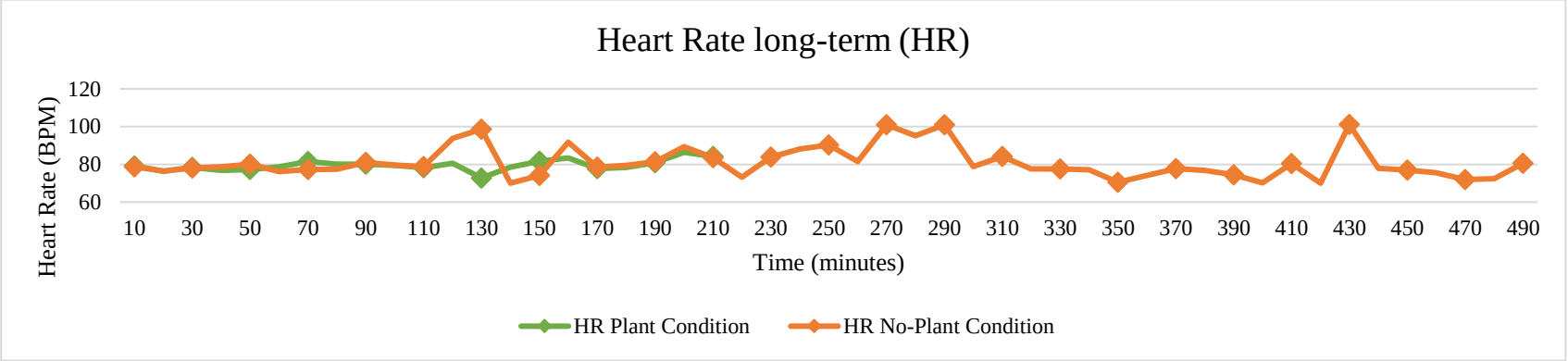


Figure S6. Heart Rate long-term – Study 2

8.19.2 Appendix S2 Tables wearable data per physical feature for both conditions Study 2

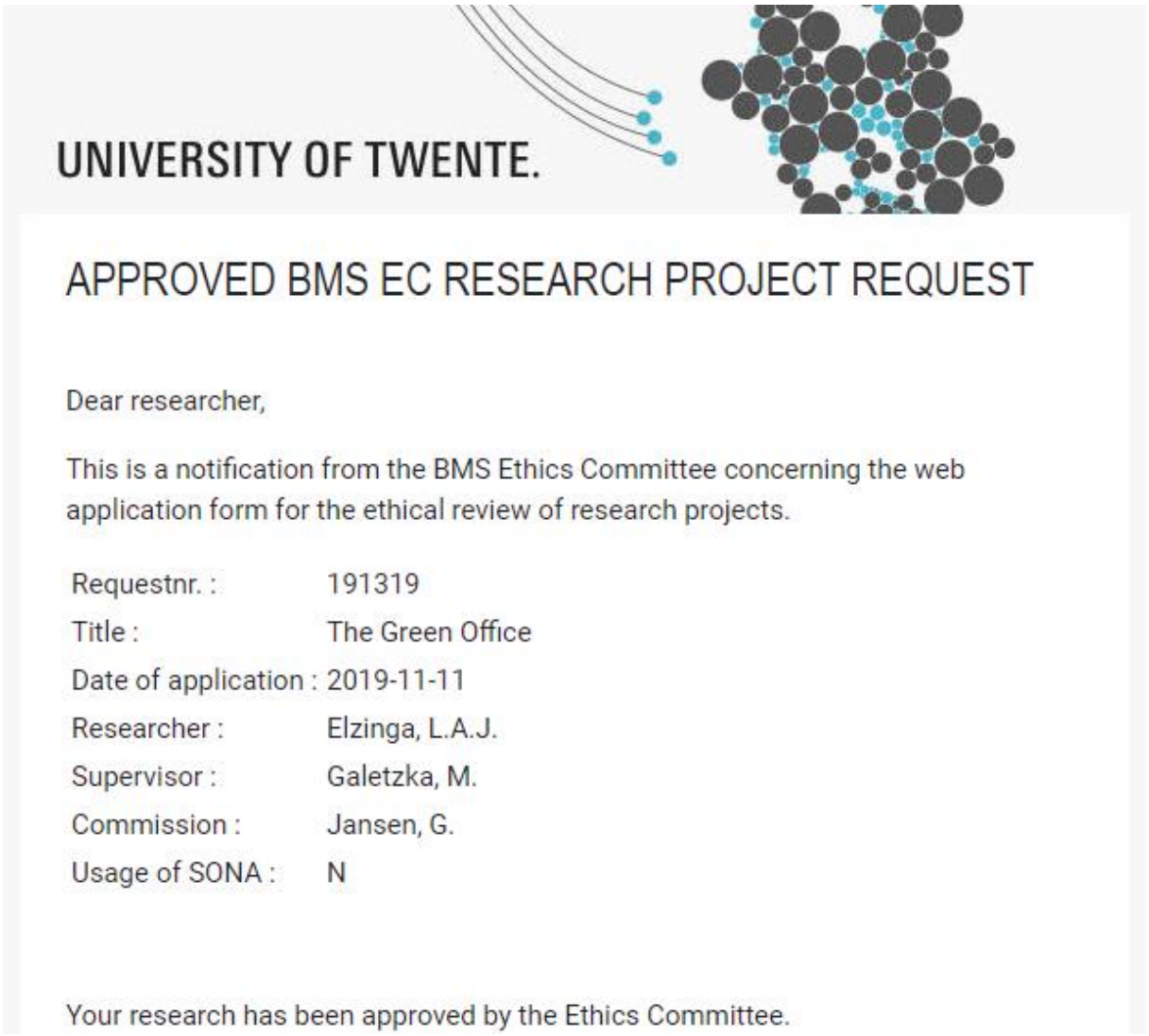
Table S1. Wearable data per physical feature for both conditions – Study 2

Time	Acceleration (g)				Blood Volume Pulse				Inter-Beat Interval (sec)			
	Plant condition	*N*	No-plant condition	*N*	Plant condition	*N*	No-plant condition	*N*	Plant condition	*N*	No-plant condition	*N*
10 ♦	0,997	44	0,998	49	0.005	44	0.015	49	0.868	39	0.859	43
20	0,996	44	0,997	50	-0.019	44	-0.017	50	0.871	39	0.871	45
30 ♦	0,997	39	0,995	50	0.008	39	0.009	50	0.851	37	0.881	44
40	0,997	32	0,998	51	0.000	32	0.005	51	0.878	30	0.865	44
50 ♦	0,997	30	0,996	44	-0.013	30	-0.010	44	0.887	29	0.897	41
60	0,997	26	0,997	38	0.019	26	-0.012	38	0.882	25	0.917	35
70 ♦	1,002	22	1,001	28	-0.007	22	0.000	28	0.889	18	0.902	28
80	0,999	18	1,000	25	0.009	18	0.001	25	0.855	16	0.939	24
90 ♦	1,000	16	1,006	15	0.028	16	-0.023	15	0.862	15	0.949	14
100	1,002	14	1,002	14	-0.035	14	0.012	14	0.892	12	0.941	12
110 ♦	0,996	8	1,004	11	0.027	8	-0.020	11	0.866	8	0.953	9
120	1,001	6	0,998	5	0.048	6	0.015	5	0.912	5	0.903	4
130 ♦	0,989	6	0,990	5	0.001	6	-0.002	5	0.943	6	0.896	4
140	0,995	6	0,999	2	-0.032	6	-0.022	2	0.913	6	1.012	2
150 ♦	0,996	6	1,010	2	0.039	6	0.004	2	0.938	6	0.784	2
160	1,000	6	1,001	2	-0.057	6	-0.021	2	0.956	4	0.758	2
170 ♦	1,001	4	1,009	2	-0.026	4	0.016	2	0.956	3	0.965	2
180	0,999	3	1,011	2	0.059	3	0.031	2	0.975	3	0.989	2
190 ♦	0,999	3	1,010	2	-0.074	3	-0.013	2	1.026	2	1.039	2
200	0,999	3	1,005	2	0.035	3	-0.014	2	0.777	1	0.991	2
210 ♦	1,005	3	1,006	2	0.011	3	0.011	2			1.029	2
220			1,007	2			-0.013	2			1.022	2
230 ♦			1,012	2			0.015	2			0.866	2
240			1,025	2			-0.084	2			0.842	2
250 ♦			1,010	2			0.074	2			0.984	2
260			1,016	2			-0.025	2			0.862	2
270 ♦			1,064	2			0.014	2			0.828	2
280			1,044	2			0.059	2			0.706	2
290 ♦			1,047	2			0.029	2			0.559	2
300			1,012	2			-0.079	2			0.837	2
310 ♦			0,995	2			0.004	2			0.880	2
320			0,999	2			0.039	2			0.982	2
330 ♦			1,002	2			-0.038	2			0.929	2
340			1,009	2			0.011	2			0.972	2
350 ♦			0,997	2			-0.022	2			0.937	2
360			0,998	2			-0.005	2			0.925	2
370 ♦			1,001	2			0.041	2			0.887	1
380			1,004	2			-0.031	2			0.910	1
390 ♦			0,998	1			0.010	1			0.962	1
400			0,984	1			-0.006	1			0.980	1
410 ♦			1,023	1			0.026	1			1.039	1
420			0,984	1			-0.017	1			0.915	1
430 ♦			1,041	1			0.010	1			1.061	1
440			1,038	1			-0.014	1			0.916	1
450 ♦			0,989	1			-0.006	1			1.079	1
460			0,987	1			0.071	1			1.018	1
470 ♦			0,997	1			-0.072	1			0.965	1
480			1,002	1			-0.014	1			0.923	1
490 ♦			1,005	1			0.074	1			0.777	1
Total average	.998	44	1.007	52	0.001	44	0.000	52	0.900	44	0.916	52

Time	Electrodermal Activity (µS)				Heart Rate (BPM)				Temperature (ºC)			
	Plant condition	*N*	No-plant condition	*N*	Plant condition	*N*	No-plant condition	*N*	Plant condition	*N*	No-plant condition	*N*
10 ♦	0.448	43	0.796	49	79.17	44	78.73	49	30.62	40	31.59	46
20	0.591	43	0.867	50	76.35	44	76.50	50	30.82	40	31.59	47
30 ♦	0.646	38	0.797	50	78.40	39	78.02	50	31.22	35	31.70	47
40	0.658	32	0.764	50	76.85	32	78.72	51	31.57	29	31.69	48
50 ♦	0.406	30	0.876	44	77.20	30	80.04	44	31.55	28	31.55	41
60	0.329	26	0.660	37	78.69	26	76.12	38	31.68	24	31.49	35
70 ♦	0.384	22	0.840	26	81.46	22	77.34	28	31.23	20	31.12	27
80	0.249	18	0.841	24	80.13	18	77.49	25	31.64	16	31.28	24
90 ♦	0.267	16	0.308	15	80.08	16	81.02	15	31.60	14	30.58	14
100	0.306	14	0.288	14	79.40	14	79.66	14	30.70	12	30.82	13
110 ♦	0.266	8	0.289	11	78.21	8	78.90	11	30.08	7	30.38	10
120	1.292	6	0.156	5	80.56	6	93.74	5	29.71	5	29.00	5
130 ♦	1.034	6	0.145	5	72.80	6	98.69	5	29.94	5	28.39	5
140	0.638	6	0.374	2	78.56	6	70.10	2	29.92	5	31.90	2
150 ♦	0.399	6	0.312	2	81.60	6	74.09	2	29.95	5	31.83	2
160	0.349	6	0.312	2	83.44	6	91.68	2	28.88	5	32.33	2
170 ♦	0.315	4	0.318	2	77.73	4	78.58	2	30.43	3	32.19	2
180	0.255	3	0.309	2	78.30	3	79.41	2	30.46	3	32.52	2
190 ♦	0.389	3	0.279	2	80.82	3	81.35	2	30.57	3	32.36	2
200	0.707	3	0.297	2	86.38	3	89.36	2	30.36	3	32.15	2
210 ♦	0.447	3	0.241	2	84.13	3	83.61	2	29.98	3	32.16	2
220			0.275	2			73.18	2			32.25	2
230 ♦			0.242	2			83.90	2			32.20	2
240			0.270	2			88.06	2			32.12	2
250 ♦			0.295	2			90.34	2			32.05	2
260			0.298	2			81.54	2			31.86	2
270 ♦			0.230	2			100.97	2			31.65	2
280			0.239	2			95.13	2			31.78	2
290 ♦			0.364	2			100.91	2			30.43	2
300			0.704	2			78.90	2			30.96	2
310 ♦			0.466	2			84.13	2			31.90	2
320			0.472	2			77.60	2			33.03	2
330 ♦			0.344	2			77.57	2			33.61	2
340			0.354	2			77.16	2			33.32	2
350 ♦			0.299	2			70.49	2			32.98	2
360			0.296	2			74.09	2			32.54	2
370 ♦			0.317	2			77.75	2			32.24	2
380			0.243	2			76.83	2			32.18	2
390 ♦			0.430	1			74.49	1			33.50	1
400			0.371	1			70.18	1			33.28	1
410 ♦			0.319	1			80.42	1			32.65	1
420			0.332	1			70.04	1			32.26	1
430 ♦			0.450	1			101.06	1			31.73	1
440			0.376	1			77.85	1			32.27	1
450 ♦			0.269	1			76.91	1			32.30	1
460			0.248	1			75.48	1			31.55	1
470 ♦			0.334	1			71.93	1			31.63	1
480			0.336	1			72.37	1			32.28	1
490 ♦			0.441	1			80.65	1			32.37	1
Total average	0.494	44	0.402	52	79.33	44	80.88	52	30.62	44	31.87	52

8.20 Appendix T Ethics Committee Approval

8.20.1 Appendix T1 Ethics Committee Approval Study 1



UNIVERSITY OF TWENTE.

APPROVED BMS EC RESEARCH PROJECT REQUEST

Dear researcher,

This is a notification from the BMS Ethics Committee concerning the web application form for the ethical review of research projects.

Requestnr. :	191319
Title :	The Green Office
Date of application :	2019-11-11
Researcher :	Elzinga, L.A.J.
Supervisor :	Galetzka, M.
Commission :	Jansen, G.
Usage of SONA :	N

Your research has been approved by the Ethics Committee.

Figure T1. Ethics Committee Approval – Study 1

8.20.2 Appendix T2 Ethics Committee Approval Study 2

UNIVERSITY OF TWENTE.

APPROVED BMS EC RESEARCH PROJECT REQUEST

Dear researcher,

This is a notification from the BMS Ethics Committee concerning the web application form for the ethical review of research projects.

Requestnr. :	191373
Title :	The Green Office 2
Date of application :	2019-11-27
Researcher :	Elzinga, L.A.J.
Supervisor :	Galetzka, M.
Commission :	Jansen, G.
Usage of SONA :	N

Your research has been approved by the Ethics Committee.

Figure T2. Ethics Committee Approval – Study 2