# Do plants in an office improve perceptions of wellbeing and work effectiveness? The case of a call centre

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**Abstract.** Numerous empirical studies based on attention restoration theory have shown that plants in the workplace have the potential to have a positive impact on the wellbeing and effectiveness of workers. This study examines the impact of introducing plants into a call centre environment on the employees. A repeated-measures design with a sample of 32 call centre employees revealed a significant improvement in physical measurements of indoor environmental quality but no significant improvements in employees' perceptions. These results are discussed in the context of the call centre work environment.

**Keywords.** Indoor plants; work engagement; wellbeing; green ergonomics.

## 1. Introduction

The positive impacts of plants on indoor environments are well documented in the literature (Evenson et al., 2013; Pearson-Mims & Lohr, 2000). In particular, plants have a beneficial influence on air quality. As part of the photosynthesis process, plants absorb carbon dioxide ($CO_2$) from the air and to transpire water vapour and release oxygen as a by-product, thus cleaning, enriching, and humidifying the air simultaneously. These qualities would be particularly beneficial in indoor environments with little circulation of air from the outside or where the ambient environment is particularly dry. Also, the ability of plants to remove airborne volatile organic compounds (e.g. formaldehyde, benzene, toluene, and xylenes), and thus further clean the air, is also well known (Cruz et al., 2014; Orwell et al., 2006; Yang et al., 2009). In addition to the positive impact of plants on indoor air quality it has also been shown that occupants of office environments with plants report reduced ill-health symptoms (e.g. Fjeld, 2000; Lohr & Pearson-Mims, 2000). It has also been hypothesised that plants offer psychological restoration benefits. Much of this work is based on Ulrich's (1984) work on the presence of natural environments in a hospital setting. The theoretical basis for psychological benefits emerges from Kaplan's (1995) attention restoration theory (ART) that suggests that natural environments provide elements of fascination as well as psychological distance from current stressors that together enables a person to psychologically 'recharge'. Some researchers have therefore argued that plants in an indoor environment provide a distraction and psychological distance from stressful work tasks and therefore provide opportunities for workers to de-stress (Bringslimark et al., 2007). Within the field of ergonomics, the question of whether plants can provide benefits for workers is part of what Thatcher (2013) calls 'green ergonomics'. Green ergonomics considers design issues for reciprocal relationships between humans and nature (i.e. workers benefitting from the presence of plants in the office environment).

Pearson-Mims and Lohr (2000) noted that despite widespread claims that indoor plants in office environments improved employee morale, increased productivity, and reduced absenteeism, there was (at that time) very little empirical research that supported these claims. For example, Lohr et al. (1996) found that a short-term exposure (10 to 15 minutes) to plants in an experimental setting (a windowless laboratory) improved reaction time, reduced blood pressure, and participants reported feeling more attentive. Larsen et al. (1998) on the other hand, found in another laboratory study that the lowest productivity level was reported in the condition with the most number of plants (although this condition was rated as the most visually attractive).

Since the late 1990's, numerous studies have reported that plants generally do improve working conditions and occupant perceptions of wellbeing. The laboratory evidence appears to present good evidence that plants have beneficial impacts. Lohr and Pearson-Mims (2000) found that people were more likely to tolerate physically stressful conditions for longer (i.e. to keep their hand in an ice-bucket) in the presence of plants while Fjeld (2000) found that the presence of plants improved physical health symptoms (specifically reduced headaches, fatigue, dry and itchy skin, and runny or itchy noses). Shibata and Suzuki (2004) found that female students performed better in the presence of a single pot plant, but not male students. Dijkstra et al. (2008) presented pictures of rooms with plants and no plants to participants and found that the plant condition (pictures of rooms with plants) reduced levels of perceived stress. Knight and Haslam (2010) conducted a study comparing a lean 'office' environment with an experimenter decorated 'office' (including plants), a self-decorated 'office', and a self-decorated 'office' that was then redecorated by the experimenter. Their results indicated that participants felt greater organisational identification, psychological and physical comfort, job satisfaction, and higher work productivity in the enriched (i.e. experimenter decorated) and empowered (self-decorated) conditions, compared to the lean and disempowered (self-decorated and then re-organised by the experimenter) conditions. In the second part of Knight and Haslam's (2010) study they repeated the laboratory study with actual office workers (although they were still effectively under experimental conditions as they were removed from their normal place of work). In this second part they found that workers in the empowered and enriched conditions reported greater organisational identification, increased psychological and physical wellbeing, higher job satisfaction, greater work productivity, and higher organisational citizenship behaviours. However, since the presence of plants only formed one part of their study it is difficult to identify the independent influence of plants alone. Finally, Raanaas et al. (2011) found that participants in the experimental plant condition improved their attentional capacity in comparison to participants in a control group.

There are very few studies that have reported on the impact of plants in an actual work setting. In a longitudinal study (across a whole year) Evenson et al. (2014) found that the presence of plants reduced self-reported health complaints as the study progressed, but these differences were not statistically different from a control group. The sample sizes were quite small (N=15 for the experimental condition and N=7 for the control condition) which may have contributed to the lack of statistical significance. In a three-part field study, Nieuwenhuis et al. (2014) found that enriched offices (office spaces with direct line of sight to plants) were superior to lean offices (without direct line of sight to plants). In study 1, the participants were in the same open-plan office and the two conditions were separated by natural dividers (i.e. cabinets). The results showed improved concentration, perceived air quality, and perceived productivity in the enriched offices. In study 2, the participants were on two different office floors. The participants in the enriched condition reported greater workplace satisfaction, perceived air quality, and work engagement, but not objective productivity. The third study was actually a laboratory-type study with participants being asked to come into a controlled office space for the data collection. In study 3, Nieuwenhuis et al. (2014) were most interested in gathering data on objective work performance. This study found that participants in the enriched condition produced significantly better objective work performance than participants in the lean condition.

Quite a number of studies have also shown indirect evidence for the positive influence of plants through correlational studies. Bringslimark et al. (2007) found that the number of plants in the workplace were related to decreased absenteeism and improved perceived productivity. This result was found to be robust after controlling for several personal variables (e.g. gender and age), the workplace environment (e.g. noise, light conditions, air quality, and temperature), and psychosocial workplace factors (e.g. work demands, job control, and social support). Dravigne et al. (2008) found that perceptions of life quality and job satisfaction were

correlated with the presence/absence of plants (and windows) in office spaces. In a large survey study, Largo-Wight et al. (2011) found that contact with nature at work (note that this included plants but also included external views, sounds of nature, and pictures) was negatively associated with stress and general health complaints. Bjørnstad et al. (2016) also found that contact with nature (although not necessarily just with plants) was associated with lower job stress, fewer health complaints, and reduced absenteeism. They also found that perceived organisational support mediated these relationships.

## 2. Methods

This study reports on a longitudinal, repeated-measures design looking at whether the presence of indoor plants might ameliorate the anticipated negative impact of call centre work on call centre employees.

### *2.1 Research setting*

The organisation was a large IT company that provided software and hardware services for clients in Africa, Europe, and the Middle East. The specific office area chosen for this study was an inbound call centre where employees provided customer assistance from phone and email queries. This office area was open plan and air-conditioned (air circulation only) with a total area of 1018m$^2$. Altogether, 120 employees worked in this office area. The employees in one part of the office area worked in shifts in a 24-hour operation. The work of call centre employees is often characterised as highly stressful, with restrictive job characteristics (e.g. repetitive work, low job advancement opportunities, and high levels of performance monitoring), and emotionally demanding (Mellor et al., 2015). As a result, employee turnover, absenteeism, and psychological burnout are often high in these types of work environments. Molino et al. (2016) found that the adverse effects of call centre work were worse for inbound call centre employees who dealt with customer assistance queries (as was the case in this sample) compared to information services. It should also be mentioned that during the course of the data collection one of the call centre supervisors had their employment terminated. It is likely that this event may have had a negative impact on the employees. The study was conducted during the winter months.

### *2.2 Sample*

Paper copies of the questionnaires were distributed to all 120 employees. There were 72 questionnaires returned for the no-plants condition and 74 questionnaires returned for the plants condition. However, only 32 questionnaires could be matched (based on employee number) from the pre- to the post-measure. The matched sample was preferred because it allowed a repeated-measures design which gives much better statistical power than independent groups because you are able to partial-out the variance of some of the confounding variables (i.e. respondent-level biases) as each person acts as their own control. In the matched sample there were 21 male and 11 female respondents. The mean age was 31.62 years (SD=10.83). The mean tenure was 3.50 years (SD=4.44), suggesting a highly skewed tenure with most respondents having worked in the call centre for a relatively short period of time. Respondents reported that they spent an average of 7.89 hours (SD=1.14) at their desk each day.

### *2.3 Procedure*

At the start of the study all existing plants were removed from the office space and the indoor environmental quality (IEQ) monitors were installed. During the sixth week the first administration of the questionnaire (no-plants condition) took place. The questionnaire was paper-based in order not to interfere with the employees' normal email-based work.

Completion of the questionnaire was clearly indicated as voluntary. In order not to influence the outcomes of the study, respondents were informed that the study was about workplace attitudes. At the start of the seventh week the plants were installed (plant condition). A total of 28 screen planters and 16 large pot plants were installed in the office space. The plant density was therefore one plant unit for every 23m$^2$ of office space. The plants used were *Sanserveria trifasciata* (mother-in-laws tongue), *Chamaedorea seifrizii* (reed palm), *Aglaeonema* (silver bay), and *Phlebodium aureum* (golden serpent fern). The plants were selected because of their suitability for indoor environments, their ability to convert $CO_2$ into oxygen even under low-light conditions, their ability to filter volatile organic compounds, and their perceived aesthetics. In the 24-hour operation of the office area the employees also used a large-screen visual display so that all employees in this section had immediate access to the network state. It was therefore not possible to install screen planters in this area. Instead, this area had the greatest concentration of large pot plants. At the end of the twelfth week the second administration of the questionnaire (plant condition) took place. The following week the plants and IEQ monitors were removed and the original plants were returned. The employees were then debriefed about the purpose of the study.

### *2.4 Instruments*

The questionnaires consisted of five scales with appropriate psychometric properties. Psychological wellbeing was assessed using the 7-item Warwick-Edinburgh Mental Well-being Scale (SWEMWBS) short version (Stewart-Brown et al., 2009). Physical wellbeing was assessed using Hedge et al.'s (1996) 15-item Sick Building Syndrome scale that assessed the frequency of physical symptoms using a 4-point frequency. Perceptions of the physical work environment were assessed using Hedge et al.'s (1996) 14-item scale where participants specified the frequency of physical work characteristics within their work environment on a 4-point frequency scale. Engagement with work was assessed through the 9-item Utrecht Work Engagement Scale (Schaufeli et al., 2006) scored on a 7-point Likert-type scale. Perceived productivity was assessed on a single item asking "On a scale of 0-100 percent (where 100% is full capacity), rate how well you have been working over the last month in relation to your full capacity" (Thatcher & Milner, 2016). In addition, respondents were asked to indicate the most important contributor to the perceived productivity in an open-ended format.

As objective, quantitative measures, the IEQ was assessed using SE Controls' NV LogIQ Room Controller that collected data on $CO_2$, indoor temperature, and humidity. In order to ensure optimal coverage of the office, four NV LogIQ Room Controllers were installed in separate locations within the office space. Data points were recorded every hour from each device for the duration of the study.

### *2.5 Analysis*

Independent t-tests were used to compare the IEQ measures pre- and post- introduction of the plants. To account for the non-independence of the before- and after-plant assessments, matched-pair t-tests were used.

## 3. Results

The results are separated into the objective physical measurements of the objective IEQ and the results from the questionnaire battery.

### *3.1 Objective IEQ*

The results for changes in temperature, humidity, and $CO_2$ are given in Table 1. The data for $CO_2$ was non-normal, skewed, and leptokurtic. The $CO_2$ data were therefore transformed using a log-linear transformation for the matched-pairs t-test. Temperature ($t(3421)=12.96$,

$p<0.01$), humidity ($t(3102)=9.49$, $p<0.01$), and $CO_2$ ($t(3418)=5.71$, $p<0.01$) all decreased significantly from the no-plants to the plants condition. As predicted, the plants condition significantly improved the actual IEQ. While humidity levels were not expected to decrease, these levels were still well within expected limits (ASHRAE, 2013). A possible explanation for the decrease in humidity and temperature may have been weather fluctuations as winter progressed. In this geographical location winter months are drier (and colder) than Summer months. However, weather patterns cannot account for the significant decrease in average $CO_2$ levels in the plants condition. It should be noted though, that the $CO_2$ concentrations in this office were above the ASHRAE (2013) recommended level of 945 ppm for both the no-plants and plants conditions.

*Table 1. Matched-pairs t-test results for IEQ.*

| | Time 1 Mean (SD) | Time 2 Mean (SD) | t-statistics | p |
|---|---|---|---|---|
| Temperature | 24.62 (1.24) | 23.98 (1.38) | 12.96 | <0.01** |
| Humidity | 32.44 (4.25) | 30.70 (4.81) | 9.49 | <0.01** |
| $CO_2$ | 1116.83 (634.90) | 969.74 (511.05) | | |
| LogN $CO_2$ | 6.87 (0.55) | 6.76 (0.47) | 5.71 | <0.01** |

Note. Temperature was measured in degrees Celcius; humidity was measured as percentage relative humidity; $CO_2$ was measured as air concentration in parts per million (ppm); LogN $CO_2$ is the natural log of the $CO_2$ measure.

### *3.2 Perceptions of IEQ*

The results for each of the scales in the questionnaire battery are given in Table 2. The only statistically significant difference was a decrease in work engagement ($t(30)=2.92$, $p<0.01$) from the non-plants to the plants condition. Part of the explanation is contained in the respondents' explanation for their perceived productivity. In the no-plants condition the most common responses explaining their perceived productivity were for intrinsic motivators (N=8) and work characteristics (N=9). Only two respondents indicated IEQ as a reason for their perceived productivity. Similarly, in the plants condition the most common responses were for intrinsic factors (N=9) and work characteristics (N=10). Again, only two respondents indicated IEQ as their reason for their perceived productivity. At the point when the questionnaire battery was being collected in the plants condition, one respondent commented to one of the researchers, "Look they have tried to make it look pretty for you", while pointing at the plants.

*Table 2. Matched-pairs t-test results for wellbeing and effectiveness measures.*

| | Time 1 Mean (SD) | Time 2 Mean (SD) | t-statistics | p |
|---|---|---|---|---|
| Psychological wellbeing | 3.65 (0.59) | 3.58 (0.64) | 0.67 | 0.51 |
| Physical wellbeing | 2.96 (0.53) | 2.98 (0.58) | -0.30 | 0.77 |
| Perceptions of workplace conditions | 3.17 (0.63) | 3.25 (0.55) | -0.84) | 0.41 |
| Work engagement | 4.23 (1.06) | 3.69 (1.18) | 2.92 | <0.01** |
| Perceived productivity | 83.60 (13.53) | 81.32 (18.72) | 0.64 | 0.53 |

## 4. Discussion and Conclusion

Despite significant improvements in the objective IEQ, the perceptions from respondents were that there were no significant improvements in wellbeing and effectiveness. In fact, the only significant difference indicated that respondents were less likely to feel engaged with their work. Another indicator of low work engagement is that despite the relatively good response rates (i.e. 60% response rate in the no-plants condition and 62% response rate in the plants condition), less than half of these submissions could be matched, suggesting a large employee turnover rate during the relatively short duration of the study. These results are directly contradictory to the majority of laboratory (Fjeld, 2000; Knight & Haslam, 2010; Raanaas et al., 2011) and office field studies (Evenson et al., 2014; Nieuwenbuis et al., 2014) that have been published since 1999, and do not support Kaplan's (1995) attention restoration theory. Shibata and Suzuki (2004) found positive work effectiveness benefits of plants for female respondents only. It is therefore possible, given that the majority of the sample were male (66%), that the lack of significant positive effects may be due to the gender distribution in the sample. Given the data presented here, a more likely explanation may be the research setting itself. Bagnara and Marti (2001) have described call centres as "modern factories" (p. 223) and as examples of "toxic organisations" (p. 226). As Bjørnstad et al. (2016) noted, perceived organisational support plays an important link between the environmental interventions and wellbeing and effectiveness outcomes. Given the problems this call centre had with supervisory practices during the course of data collection it is likely that supervisory support may have been poor. It was initially thought that given the negative work conditions under which call centre employees have to operate (Mellor et al., 2015; Molino et al., 2016), one might expect that any positive intervention would help ameliorate the negative aspects of call centre work. However, the results from this study revealed that respondents had taken a much more cynical view of the plant intervention, suggesting that it was management manipulation rather than a genuine attempt at improving environmental work conditions. Several studies have suggested that there are interactive effects between physical work conditions and psychosocial factors (Kraatz et al., 2013; Widanarko et al., 2014). The findings from these previous studies as well as the results of this study serve as a warning that investments in improving physical working conditions (i.e. the introduction of plants into the work environment) may not pay dividends without simultaneous efforts to improve the conditions of the actual work as well as the psychosocial work environment (e.g. supervisory support). Finally, Bringslimark et al. (2009) warn that a range of results from the experimental literature (they reviewed mostly laboratory studies) have also produced a mixed set of findings when it comes to the psychological benefits of plants. This is because the studies have varied considerably on factors such as the number of plants being introduced, the length of exposure to the plants, the type of experimental contexts, and the type of outcome measures.

The limitations of this study also bear mentioning. The sample size (N=32), despite the tight study design (repeated-measures design under controllable conditions), is still relatively small. It would be difficult to generalise these results to other organisational settings, even within the same organisation. While some of the laboratory studies have suggested that there may be immediate positive effects (ten to fifteen minutes in the case of Lohr et al. (1996); fifteen minutes in the case of Larsen et al. (1998); five minutes in the case of Knight and Haslam (2010)) our study was similar to Nieuwenhuis et al. (2014) who allowed three weeks of exposure to the plant condition. Other studies such as Evenson et al. (2013) and Fjeld (2000) had at least one year's exposure to plants. It is possible that a longer exposure to the plants may produce a different set of results. The length of exposure in order to realise positive benefits is still an open question.

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