An experience sampling approach to the workplace environment survey

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Abstract

Purpose: The purpose of this study was to pilot test the effectiveness of the experience sampling approach for measuring employee satisfaction with the workplace environment. Additionally, we also aimed to explore which aspects of environmental comfort have the strongest impact on momentary wellbeing and productivity.

Design/Methodology/Approach: Fifteen knowledge workers in an open-plan office environment were sent a brief survey (measuring environmental comfort, momentary wellbeing, and perceived productivity) each day over an 11-day study period, and provided 78 individual survey responses in total.

Findings: All but one of the measures on the survey had low test-retest reliability, indicating that employees' experiences of environmental comfort varied significantly each time they completed the survey. Additionally, higher environmental comfort was associated with improved wellbeing and productivity.

Practical implications: The results suggest that an experience sampling approach to the workplace occupant survey is justified to better capture the temporal variability in experiences of environmental comfort. The results also suggest that improving environmental comfort, particularly by reducing the level of distractions, will enable employees to work more productively.

Originality/Value: To our knowledge, this is the first field study which has attempted to directly address limitations in traditional occupant surveys by using an experience sampling approach rather than a one-time-only questionnaire.

It has been suggested that the most effective workplaces of the future will be maintained in a state of "perpetual beta", able to repeatedly adapt to occupants' requirements in a cycle of continuous improvement (Usher, 2018). This necessitates the implementation of a feedback loop between those responsible for maintaining the building and those who occupy it. Indeed, seeking feedback from workplace end-users regarding the perception of the physical workplace environment is a core component of the post-occupancy evaluation (POE) process (Oseland, 2018), ostensibly aimed at identifying and resolving any issues in the workplace that might be negatively affecting employee wellbeing and/or productivity.

Traditionally, such data has been collected via occupant surveys, such as the Occupant IEQ (Indoor Environmental Quality) Survey (Zagreus *et al.,* 2004), the BUS (Building Use Studies) occupant survey (Leaman, 2010), the BOSSA (Building Occupants Survey System Australia) Time-Lapse survey (Candido *et al.*, 2016), or the Leesman Index (Leesman Index, 2018). The exact items used differ from survey to survey, but generally the questions assess occupants' satisfaction with different components of IEQ (e.g., air quality, thermal comfort, visual comfort, acoustic comfort) and with the overall suitability of the workplace environment (e.g., office layout, office furnishings, office cleanliness).

In theory, the POE should provide architects and/or facilities managers with the occupiers' perceptions of indoor environment quality and the suitability of the building's furnishings, and feed into practical strategies aimed at supporting the goal of continuous improvement (Zimmerman and Martin, 2001). However, workplace researchers have highlighted various limitations of occupant surveys, and have called for new approaches to be considered (Candido *et al.*, 2016; Deuble and de Dear, 2014; Li *et al.,* 2018). In particular, two notable concerns relate to insufficient contextual information and a lack of clarity regarding the extent to which satisfaction with the workplace environment is related with actual job performance.

Lack of Context

Occupant surveys tend to be administered at one time only, usually six to twelve months following the occupation of a new or renovated workplace. Deuble and de Dear (2014) argue that this approach is of limited practical utility as responses are too general and can be biased by various non-building-related factors.

First, there is the issue regarding the lack of spatio-temporal specificity. When respondents are asked to report their experience of a particular sensation over a lengthy period of time, a single response is not able to account for the fact that this sensation might fluctuate markedly at different times and/or in different locations around the workplace. As such, individual responses tend to be aggregated (i.e., representing the average of the sum total of experiences in the workplace), and are of limited instrumental utility to practitioners who wish to correlate them directly with time- and location-bound physical environment data.

The relatively long timeframe also increases the possibility that the responses are contaminated by different forms of bias. In particular, recall bias (i.e., inaccuracies in the memories of past events) may limit the extent to which the feedback accurately reflects the actual workplace environment. Furthermore, it has been observed that occupant surveys are often used as a vehicle for airing negative views about general workplace issues that are completely unrelated to the office itself (e.g., complaints about management, bullying), presumably most commonly in organisations with ineffectual mechanisms for reporting such grievances via human resources. As such, responses can also be biased by the organisational context.

In response, various workplace researchers have argued that these issues can be overcome by replacing or supplementing the traditional occupant surveys with 'right-here-right-now' assessments, conducted multiple times over an extended period and combined with objective building performance data (Candido *et al.*, 2016; Choi and Lee, 2018; Deuble and de Dear, 2014; Li *et al.*, 2018; Oseland, 2018). By restricting responses to a narrow timeframe and asking respondents to report their current location, the feedback collected can provide the spatio-temporal specificity that is not possible using traditional questionnaires. Additionally, by using specific language and encouraging respondents to see the value of engaging in the feedback process, the risk of responses being contaminated by more general grievances is also reduced. As such, the first aim of the present study was to pilot test a methodology for repeatedly measuring occupants' perceptions of the workplace environment, capturing how they feel 'right now' rather than in general (hereafter referred to as the "experience sampling methodology"; Fisher and To, 2012).

Relationship to Job Performance

The second limitation of traditional occupant surveys concerns the extent to which satisfaction with the workplace environment can be regarded as a useful measure from the perspective of the occupying organisation. Environmental comfort *in general* is commonly posited as a determinant of overall job performance (Haynes, 2012; Roskams and Haynes, 2019; Vischer, 2007), however there is still limited evidence regarding which aspects of environmental comfort *in particular* are most strongly related to individual productivity. This reflects the fact that academic workplace research has tended to be segmented by specialism and multivariable studies are less common (Sander *et al.*, 2019). From a practical perspective, this is problematic because organisations have limited budgets for workplace

improvements and are forced to prioritise between different possible interventions, but have limited research evidence to guide these decisions.

The few exceptions to this, which have directly tested different aspects of environmental comfort as predictors of perceived productivity, have tended to highlight the importance of the behavioural environment in particular (i.e., the ability to regulate interactions and distractions). For example, Haynes (2007) demonstrated that the behavioural environment had a stronger impact on perceived productivity than the physical environment (i.e., satisfaction with indoor environment and office furnishings). Similarly, other studies have highlighted that the most important environmental determinants of productivity include satisfaction with acoustics and privacy (Candido *et al.,* 2016; Veitch *et al.,* 2007), and satisfaction with concentration, privacy, and communication (Groen *et al.*, 2018). Thus, it can be generally concluded that productivity is best supported when distractions are minimised without restricting the occupant's ability to engage in useful interactions.

However, the fact that these data came from occupant surveys means that they too share the aforementioned contextual limitations (i.e., lack of spatio-temporal specificity, possibility of response bias). Thus, it is necessary to explore whether the findings are consistent when the experience sampling approach is adopted. To our knowledge, only Lamb and Kwok's (2016) study has employed a longitudinal design of this type. They found that self-reported work performance was predicted by noise annoyance and lighting satisfaction, but not by thermal comfort. However, their operationalisation of environmental stress was restricted to these three variables, and the possible effects of other components of environmental comfort was not explored.

As such, the second aim of this study was to use the experience sampling approach to explore a wider range of environmental comfort variables (encompassing multiple aspects of

both the physical and the behavioural environment) in relationship to momentary productivity. It was expected that each component of environmental comfort would be positively associated with productivity, and that satisfaction with distractions in particular would have the strongest effect.

Additionally, we also tested the extent to which the different components of environmental comfort were associated with two measures of affective wellbeing: psychological comfort (on a scale from highly anxious to highly comfortable) and enthusiasm (on a scale from highly depressed to highly enthusiastic) (Warr, 2013). The measures which have tended to be used in extant research (e.g., self-rated health, job satisfaction, presenteeism; Hanc *et al.*, 2018) may also face the limitations associated with aggregation over time, which is why we chose to use emotion-based momentary measures instead. Given that wellbeing and productivity tend to be related to each other (Zelenski *et al.*, 2008), we again predicted that the components environmental comfort would be positively associated with psychological comfort and enthusiasm, and that distractions would have the strongest impact.

The Present Study

To summarise, the purpose of the present study was to pilot the use of the experience sampling methodology to assess employees' momentary perceptions of the workplace environment, and to test the extent to which these were associated with wellbeing and productivity. On the basis of past research, it was hypothesised that:

$H_{1:}$ Higher levels of environmental comfort will be associated with higher ratings of (a) psychological comfort; (b) enthusiasm; and (c) productivity.

H_2: The behavioural environment, particularly distractions, will be more strongly associated with each of the outcome variables than the physical environment.

Method

Site

The study was conducted at the office site of a large facilities management provider in the United Kingdom. The office had a predominantly open-plan design, with an 'activity-based working' concept in which employees did not have assigned workstations. The office was divided into different 'neighbourhoods' for each business unit, so employees generally used different workspaces within their neighbourhood each day. One neighbourhood within the office, containing 58 workstations as well as bookable meeting rooms and informal break-out areas (see Figure 1), was selected as the pilot study area.

INSERT FIGURE 1 HERE

Participants

Forty-seven employees on the business unit's e-mail distribution list were contacted with an invitation to participate in the study. Additionally, information leaflets were placed on desks within the study area, and the primary investigator verbally communicated information about the study whilst in the office. All of the employees within the business unit were knowledge workers, employed in various administrative, analytical, and management roles. No incentives were offered for participation. Overall, 15 employees (9M

6F) volunteered to participate (~20% of regular employees in the study area). Participants' age ranged between 24 and 47 (M = 31.3).

Materials

A workplace evaluation survey was created to capture participants' momentary assessments of environmental comfort, wellbeing, and productivity. The items on the survey were designed to correspond to traditional occupant surveys, although slight alterations were made to item wordings to capture momentary (rather than general) perceptions. Additionally, in accordance with guidelines suggesting daily assessments should take no longer than three minutes (Fisher and To, 2012), we reduced the questionnaire length by using a lower number of items than would be found on traditional occupant survey. The full list of items, including summary statistics for each scale, is shown in Table 1. Briefly, the different sections on the questionnaire included:

Identification code. Participants generated a unique identification code using the first letter of their surname, their birth month, and the first two letters from their birthplace. This enabled their responses to be linked from one time to the next, without compromising their right to anonymity.

Work location. Participants viewed Figure 1 and selected their current workstation (or chose 'Other' if they were working at a different location). This enabled their responses to be a linked to a specific location and a corresponding set of physical environment data. These data were not used in the present study, but will be reported in a separate paper regarding the development of a methodology for predicting subjective environmental comfort using objective environmental data.

Physical environment. Five items were adapted slightly from the Occupant IEQ Survey (Zagreus *et al*., 2004), so that they captured perceptions in the past half hour rather than in general. Specifically, respondents rated their satisfaction with *air quality, temperature, humidity, light,* and *natural daylight.*

Three original items were also included to measure *indoor environmental control,* including control over temperature, light, and noise. The Cronbach's alpha for this scale indicated good internal consistency ($\alpha = 0.88$).

Three items were taken from Lee and Brand (2005) to measure control over the workspace, including control over the general appearance, the extent to which the workspace can be personalised, and the availability of different workspaces. The internal consistency of this scale was questionable ($\alpha = 0.6$), but improved to good ($\alpha = 0.81$) by dropping the item relating to workspace availability. As such, *control over workspace appearance* and *workspace availability* were considered separately in the analyses.

Behavioural environment. The behavioural environment was originally conceptualised as the extent to which distractions and interactions had been experienced in the preceding half hour. To measure distractions, four items were taken from Lee and Brand's (2005) measure, including items relating to auditory distractions, too much noise, visual distractions, and privacy. Additionally, one item relating to the perception of crowding was taken from Haynes (2008). The internal consistency of this scale was poor ($\alpha = 0.58$), but improved to good ($\alpha = 0.84$) by dropping the item relating to privacy. As such, *distractions* and *privacy* were considered separately in the analyses.

For interactions, two items were adapted slightly from Haynes' (2008) measure, including interactions relating to work and for social purposes. However, these items showed

weak correlation ($r = 0.18$), and so *work-related interactions* and *social interactions* were also analysed separately.

Wellbeing. Eight items were taken from the Institute of Work Psychology Multi-Affect Indicator (Warr, 2013), to measure momentary affective wellbeing in terms of two dimensions. Four items measured *depression-enthusiasm* ($\alpha = 0.82$), and four items measured *anxiety-comfort* ($\alpha = 0.86$). For all items, participants rated the extent to which they had experienced that emotion in the previous half hour.

Productivity. Finally, one original item was used to measure the perceived impact of the workplace on the respondent's *productivity* in the previous half hour.

Procedure

The workplace evaluation survey was e-mailed to each participant for 11 consecutive working days. To ensure responses were collected at different times of day, a random number generator was used to randomly assign the time of each survey invitation, with four possible options: 10:00 a.m., 11:30 a.m., 1:30 p.m., or 3:00 p.m. The survey had no expiry time, meaning that in theory respondents could complete the survey at any time they chose. However, in practice, the online survey platform showed that respondents tended to either complete the survey within an hour of the invitation or did not respond at all on that day.

In total, 78 complete surveys were returned across the 11-day study period (response rate ~47%). The mean number of completed surveys per respondent was 5.2, although this varied notably, ranging from one (in the case of one participant who primarily worked from a different office but expressed an interest in the study on the day of attending the site) to 14 (in

the case of a participant who responded to all survey invitations, and also elected to complete three additional surveys).

Results

Because the data had a nested structure (repeated measurement occasions within participants), data were analysed using a multilevel linear modelling approach, following the procedure outlined in Field, Miles and Field (2012). Multilevel linear modelling is an extension of linear regression, which entails the estimation of both fixed effects and random effects. As such, the analysis can test whether the effects of the predictors on the outcomes vary between different participants. An additional advantage is that it is capable of accounting for uneven sample sizes per unit (i.e., different number of survey responses per participant), including situations where there is only one observation for the higher-level unit (Bell *et al.*, 2008), as was the case in our study for the participant who only provided one response.

All data analysis was conducted using the RStudio software (R Studio Team, 2016), using the *nlme* package (Pinheiro *et al.,* 2017) for fitting and comparing multilevel models, and the *MuMIn* package (Barton, 2018) for calculating estimates of pseudo-R^2 values for the final models. All regression models were fitted using the restricted maximum likelihood estimation method.

Descriptive Statistics

Table 1 shows the mean ratings and standard deviations of each component of environmental comfort, wellbeing, and productivity. As shown, ratings of IEQ were

generally slightly higher than the midpoint of the 7-point scale, indicating moderate satisfaction. However, aspects of the physical environment relating to control over workspace appearance and over environmental conditions were rated lower, reflecting workspace policies discouraging personalisation and the use of personal comfort devices. The behavioural environment was more supportive than disruptive, with participants reporting relatively high levels of interactions and low levels of distractions. In terms of the outcomes, slightly higher than midpoint ratings tended to be given for each of depression-enthusiasm, anxiety-comfort, and productivity.

The intraclass correlation coefficient (ICC) was calculated for each of the outcome measures. The ICC measures the proportion of total variance that is due to variance between participants, and can therefore be used as a measure of test-retest reliability (i.e., the extent to which the participant gave similar responses each time they completed the survey). According to Cicchetti's (1994) guidelines, ICC > 0.6 is the minimum criteria for 'good' test-retest reliability. The only measure that met these criteria was workspace availability (*ICC* = 0.67), with most measures showing very poor test-retest reliability, particularly satisfaction with temperature (*ICC* = 0.08) and distractions (*ICC* = 0.06). This suggests that there was significant intra-individual variability in responses for each item, highlighting the fact that these momentary experiences tended to temporally fluctuate as a result of various contextual factors. This suggests that they are more appropriately measured using the repeated survey rather than the one-time-only questionnaire, supporting the use of the experience sampling approach.

INSERT TABLE 1 HERE

Main Analyses

Multilevel analyses were conducted to explore the extent to which the different components of environmental comfort predicted depression-enthusiasm, anxiety-comfort, and productivity. For each of the three outcome variables, the need for a multilevel analysis was assessed by comparing an intercept-only regression model with a regression model in which the intercept was allowed to vary across different participants. An analysis of variance was used to compare the goodness-of-fit of the two models. In all three cases the reduction in the log-likelihood ratio was significant ($p < 0.0001$), indicating that multilevel analyses were appropriate.

Subsequently, a forward-selection model building process was followed to test the hypotheses. To determine the order in which variables should be entered during this process, a series of simple linear random-intercept models were created to explore the bivariate relationships between each explanatory variable and each outcome (shown in Table 2). The *t*-values were noted in each case, and variables were entered in order from strongest to weakest relationship with the outcome. Model fit statistics were compared after the creation of each new model, and different subsets of predictors were tested when there was no significant improvement in model fit. For purposes of conciseness, only the final model which best fit the data (indicated by the lowest Bayesian Information Criterion value) is reported here.

INSERT TABLE 2 HERE

Depression-Enthusiasm. The simple regressions revealed that seven of the explanatory variables were significantly associated with depression-enthusiasm at the bivariate level. In order from strongest to weakest, the bivariate relationships indicated that higher momentary enthusiasm was associated with higher satisfaction with air quality (p = 0.001), lower levels of distractions (p = 0.004), more individual environmental control (p = 0.01), more control over workspace appearance (p = 0.02), higher satisfaction with light intensity (p = 0.02), higher satisfaction with humidity (p = 0.04), and higher satisfaction with daylight (p = 0.05).

The model-building procedure was followed, and the final model with the lowest BIC ($F(1, 60) = 314.91$, $p < 0.0001$) retained two predictors. Higher momentary enthusiasm was predicted by higher satisfaction with air quality (p = 0.02) and also by lower levels of distractions, although this latter effect was marginally above the threshold for statistical significance (p = 0.055). The pseudo-r^2 estimate for this model indicated that approximately 11.8% of the variance in depression-enthusiasm was accounted for by these two predictors (*marginal R_GLMM*^{2} = 0.118).

Anxiety-Comfort. The simple regressions revealed that higher momentary comfort was significantly associated with lower levels of distractions (p = 0.0054), higher satisfaction with air quality (p = 0.02), higher satisfaction with daylight (p = 0.02), more control over workspace appearance (p = 0.02), higher satisfaction with light intensity (p = 0.04), and more individual environmental control (p = 0.05). However, the model-building procedure showed that the model which best fit the data was the original model predicting anxiety-comfort from distractions only ($F(1, 61) = 337.15$, $p < 0.0001$). The pseudo-r^2 estimate for this model indicated that approximately 6.5% of the variance in anxiety-comfort was predicted by distractions (*marginal R_GLMM*^{2} = 0.065).

Productivity. The simple regressions revealed that nine of the explanatory variables were significantly associated with productivity at the bivariate level. Higher ratings of productivity were associated with lower levels of distractions, more individual environmental control, higher control over workspace appearance, higher satisfaction with air quality, higher satisfaction with humidity (all p-values < 0.0001), higher satisfaction with light intensity (p = 0.001), higher satisfaction with daylight (p = 0.005), higher satisfaction with temperature (p = 0.006), and higher workspace availability (p =0.02).

The model-building process was followed, and the final model with the lowest BIC retained three predictors ($F(1, 59) = 482.2$, $p < 0.001$). In this model, higher momentary productivity was predicted by lower levels of distractions (p = 0.0026), higher ratings of control over workspace appearance (p = 0.0091), and higher satisfaction with air quality (p = 0.039). The pseudo-r^2 estimate for this model indicated that approximately 35% of the variance in productivity was accounted for by the three predictors (*marginal* R_GLMM^2 = 0.35).

Discussion

The aim of this study was to pilot test a methodological framework for measuring satisfaction with the workplace environment using an experience sampling approach, and to test the extent to which environmental comfort was associated with momentary wellbeing and productivity. The results are discussed below, along with the practical implications and limitations of the research.

Suitability of Methodological Framework

Overall, the study supported the utility of an experience sampling approach to the occupant survey. The only measure for which participants tended to give broadly similar responses on each measurement occasion was workspace availability, which is understandable given that neither the number of workspaces nor the number of people who needed to access the office changed during the study period. For the other measures, the low test-retest reliability demonstrates that participants' responses differed notably each time the survey was taken. This was particularly true for satisfaction with temperature and distractions, for which there were very high levels of intra-individual variability. These findings support the contention that satisfaction with different aspects of the workplace environment varies on a momentary basis as a result of contextual factors, and thus the aggregated responses provided by one-time-only occupant surveys are insufficient.

The experience sampling methodology adopted in the study provides a suitable foundation for a more appropriate approach to the occupant survey. By recording the exact time and location of each survey response, researchers and practitioners will be able to explore the contextual factors which affect employees' momentary experiences of environmental comfort, wellbeing, and productivity. This will also help to prompt more immediate and effective remedial action in the event that the workplace environment is misaligned to the occupants' needs.

However, it should be noted that both the initial uptake (~20%) and subsequent completion rate of daily surveys (~47%) was low. Although we had not intended that the methodology in this study be directly translated into practice, the low response rate nonetheless raises an important concern that will need to be dealt with if the experience sampling approach is to be utilised effectively in real workplaces.

Several factors might help to explain the low response rates. Although these comments were not recorded formally, many employees expressed regret to the primary investigator that they simply did not have enough time to complete the surveys (even though the average completion time was five minutes), indicating that they had a busy workload and needed to prioritise other activities. Additionally, it is also possible that our use of a web-based survey with e-mail reminders also discouraged responses, as it required participants to open the email and navigate to the webpage.

To address these limitations so that the repeated sampling approach can be effectively implemented in practice, we suggest several strategies. First, practitioners may wish to consider using purpose-built experience sampling mobile applications to deliver the survey, where reminders can be automatically delivered using push notifications. This would further reduce the response burden on employees, increasing the likelihood of a response. Secondly, it would be useful to shorten the survey even further and/or only send a subset of the overall survey on each measurement occasion, as well as sending the survey out less frequently overall (e.g., only twice per week). Again, this would reduce the response burden, ensuring that continued participation is more likely in the longer term.

Finally, incentives should be considered. Whilst monetary incentives have often been used to improve participation in experience sampling studies, this may not be appropriate for organisations looking to integrate these measures into daily workplace life. Instead, we suggest that it is more important to ensure that survey responses form part of a continuous feedback loop driving continuous workplace improvements, which rarely happens in practice currently (Deuble and de Dear, 2014). By visibly demonstrating to employees that they have the power to instigate positive change by engaging with the feedback process, it is more likely that they will respond to subsequent survey reminders.

Relationship to Wellbeing and Productivity

We had predicted that higher levels of environmental comfort in general would be associated with higher levels of wellbeing and productivity, and that aspects of the behavioural environment (especially distractions) in particular would have the strongest impact upon the outcomes. These hypotheses were partially supported by the data. At the bivariate level, nine out of the twelve components of environmental comfort were significantly associated with at least one of the outcomes. Whilst many of these associations were no longer significant when predictors were entered into the models concurrently, the data nonetheless provided evidence that each of the outcomes was significantly predicted by at least one component of environmental comfort.

As expected, lower perceived distractions were strongly associated with higher ratings of perceived productivity, and were also significantly associated with higher ratings of psychological comfort and enthusiasm. This highlights the crucial importance of enabling effective job performance by minimising distractions in the workplace environment, in accordance with previous research (Candido *et al.,* 2016; Groen *et al.,* 2018; Haynes, 2008; Veitch *et al.*, 2007). Interruptions disrupt the state of concentration, leading to higher stress and frustration, and more errors made during work (Mark *et al*., 2008). The same mechanism may also explain the associations with comfort and enthusiasm, given that productivity and wellbeing tend to be inter-related (Zelenski *et al.,* 2008). As such, we conclude that the crucial challenge for workplace practitioners is designing and maintaining workplaces in which distractions are minimised.

Whilst we had generally considered distractions arising from the physical and behavioural environment (e.g., irrelevant background speech, movement in visual field), it

should also be acknowledged that distractions and disruption may also arise from the "digital environment" (e.g., e-mail notifications, malfunctioning software). Therefore, employees may be distracted even when the workplace itself is optimised. As such, in future research it would also be useful to explore the potential impact of digital distractions and how these can be mitigated, in a bid to provide workplace environments which are even more conducive to productive work.

Satisfaction with air quality also emerged as an important component of environmental comfort, and was positively associated with enthusiasm and productivity. When considered in relation to previous research indicating that concentration levels are highest when airborne pollutants are minimised (Zhang *et al.,* 2016), this suggests that office occupants are capable of detecting sub-optimal air quality. Thus, given that not all organisations have the resources to perform continuous physical measurements of airborne pollutants, these findings suggest that repeated surveys might be a suitable alternative (albeit a less detailed one) for assessing indoor air quality.

Finally, the finding that perceived control over workspace appearance also predicted productivity might be related to the fact that employees place high value on being able to determine the appearance of their working area, as this confers a sense of familiarity and comfort in the workplace (Brunia and Hartjes-Gosselink, 2009; Wells, 2000). Control over the workspace has been increasingly undermined in recent years by non-territorial workplace concepts such as activity-based working, in which employees are prohibited from personalising their workspace in a bid to encourage them to switch workstations more regularly. The results here suggest that organisations should consider whether and how these office concepts can be applied without conflicting with the important psychological need for territoriality and identity expression in the workplace. For example, Babapour (2019) suggested that a sense of ownership can be maintained within activity-based offices through

personalisation at the group level, rather than the individual level. This would be an interesting proposition for future researchers to explore.

The most important limitation to consider with respect to the findings concerns the low overall sample size (15) and number of observations (78). The practical implications of this limitation have already been discussed, but from a theoretical perspective it is important to note that the low sample size raises the possibility that the study lacked sufficient power for detecting statistically significant results. Indeed, this may explain why predictions regarding privacy and interruptions were not supported in our data, contrary to previous research (Groen *et al.*, 2018; Haynes, 2008), and why certain effects were significant at the bivariate level but not in the multivariable analyses. As such, these findings should only be viewed as tentative early indicators until additional research with significantly larger sample sizes has been undertaken.

Similarly, it should also be acknowledged that the study took place within a single zone of one workplace. From the research perspective, this limits the extent to which we can generalise the findings to workplaces with different features. For example, all of the workspaces we studies were within an open-plan layout with low architectural privacy, so we could not test the effects of working in more enclosed areas. Additionally, the temperature and humidity within the office was generally maintained within comfort guidelines, so it is not clear if the same findings will generalise to offices with poorer environmental quality. As such, it will be important to conduct future research within a greater quantity and diversity of workplaces, as well as with a greater number of employees.

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Figure 1: The floorplan of the study area, which contained 58 non-assigned workstations

Table 1: Each of the scales on the questionnaire, including the full wording for all individual items, the mean (M), standard deviation (SD) and intraclass correlation coefficient (ICC) of each scale, and the Cronbach's alpha (α) for all multi-item scales.

Scale and item(s) used	M	SD	ICC
PHYSICAL ENVIRONMENT "Over the past half hour, how satisfied are you with the following elements of the indoor environment?" [1=Very dissatisfied, 7=Very satisfied"]			
[SATISFACTION WITH AIR QUALITY] "Air quality (i.e. stuffy/stale air, cleanliness, odours)"	**4.69**	**1.21**	**0.4**
[SATISFACTION WITH TEMPERATURE] "Temperature"	**4.5**	**1.47**	**0.08**
[SATISFACTION WITH HUMIDITY] "Humidity"	**4.72**	**1.17**	**0.15**
[SATISFACTION WITH LIGHT INTENSITY] "Amount of light"	**4.94**	**1.27**	**0.19**
[SATISFACTION WITH DAYLIGHT] "Amount of natural daylight"	**4.88**	**1.55**	**0.21**
"How well do the following statements describe how you are able to use your workplace today" [1=No, not at all, 7=Yes, very much so]			
[INDIVIDUAL ENVIRONMENTAL CONTROL, α = 0.88] "I am able to ensure that I am not too hot or cold while I am working"; "I am able to ensure that the lighting at the workplace suits my preferences"; "I am able to ensure that it not too quiet or noisy while I am working"	**3**	**1.37**	**0.26**
[CONTROL OVER WORKSPACE APPEARANCE, α = 0.81] "I determine the organisation/appearance of my work area"; "I can personalise my workspace"	**2.24**	**1.43**	**0.43**
[WORKSPACE AVAILABILITY] "The variety of workspaces needed for my job is available to me"	**4.85**	**1.61**	**0.67**
BEHAVIOURAL ENVIRONMENT "Over the past half hour, how accurately do the following statements describe your experience?" [1=No, never, 7=Yes, all the time]			
[DISTRACTIONS, α = 0.84] "I have experienced auditory distractions in my work area"; "I have experienced visual distractions in my work area"; "My work environment is too noisy"; "My working area feels crowded"	**3.36**	**1.63**	**0.44**
[PRIVACY] "I have adequate privacy in my primary, individual work area"	**5.46**	**1.04**	**0.16**
[WORK-RELATED INTERACTIONS] "I am able to easily contact all of the colleagues I need to interact with"	**5.46**	**1.04**	**0.16**
[SOCIAL INTERACTIONS] "My work environment is socially isolating*"	**5.55**	**1.34**	**0.43**
MOMENTARY WELLBEING "In the past half hour, I have felt…" [1=None of the time, 7=Always]			

[DEPRESSION-ENTHUSIASM, α = 0.82] "Enthusiastic"; "Depressed*"; "Inspired"; "Despondent*"	**4.5**	**1.25**	**0.48**
[ANXIETY-COMFORT, α = 0.86] "Calm"; "Anxious*"; "Relaxed"; "Worried*"	**4.46**	**1.34**	**0.49**

MOMENTARY PRODUCTIVITY

"In the past half hour, I would rate the impact of the workplace on my productivity as follows…"

[1=Very negative impact, 7=Very positive impact]

[PRODUCTIVITY] "Impact on productivity"	**4.33**	**1.39**	**0.29**

Table 2: Bivariate relationships between each explanatory variable and each outcome variable, with significant associations shown in bold and italics.

	Depression-Enthusiasm		**Anxiety-Comfort**		**Impact on Productivity**	
Explanatory Variable	***t***	***p***	***t***	***p***	***t***	***p***
Air Quality Satisfaction	***3.34***	***0.001***	***2.39***	***0.02***	***4.14***	***<0.0001***
Temperature Satisfaction	1.64	0.11	1.76	0.08	***2.87***	***0.006***
Humidity Satisfaction	***2.1***	***0.04***	1.81	0.08	***4.03***	***<0.0001***
Light Intensity Satisfaction	***2.28***	***0.03***	***2.12***	***0.04***	***3.45***	***0.001***
Daylight Satisfaction	***2.01***	***0.05***	***2.4***	***0.02***	***2.94***	***0.005***
Control over Workspace Appearance	***2.32***	***0.02***	***2.32***	***0.02***	***4.53***	***<0.0001***
Workspace Availability	1.01	0.32	0.85	0.4	***2.31***	***0.02***
Individual Environmental Control	***2.59***	***0.01***	***2.04***	***0.05***	***4.58***	***<0.0001***
Distractions	***-2.98***	***0.004***	***-2.9***	***0.005***	***-5.12***	***<0.0001***
Privacy	0.93	0.35	0.99	0.33	0.98	0.33
Work-related Interactions	0.83	0.41	-0.84	0.41	1.11	0.27
Social Interactions	0.19	0.85	-0.24	0.82	-1.38	0.17