# Psychological perceptions matter: Developing the reactions to the physical work environment scale

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## Abstract:

There is clear research evidence that physical work environments (i.e., material spaces and objects) influence employee performance and wellbeing. As a result, these environments have received significant attention from both practitioners and researchers. However, the outcomes of these applied initiatives and research studies are difficult to compare because they often lack a common framework or are focused exclusively on the objective qualities of the workspace (e.g., lighting, acoustics) without considering the human element. In this article, we outline a series of studies conducted to examine employees' psychological reactions to the physical work environment. A three-part framework for these reactions is proposed, and a supporting measure is developed and validated. This new measure, the Reactions to the Physical Work Environment Scale (RPWES), assesses key cognitive, emotional, and relational responses of employees to their physical work environment. The RPWES provides the foundation for a broader understanding of the impact of the physical work environment on employees. Implications for theory and practice are discussed.

**Keywords:** Physical environment | Workspace design | Psychological reactions | Collaboration | Empowerment

## Article:

## 1. Introduction

The space in which employees work is no longer viewed as an incidental context; rather, organizations are exploring ways of using the work environment to support employee performance and well-being [1]. The importance of employees' reactions to the physical environment has been recognized since at least the time of the Hawthorne experiments [2], but the practical and theoretical attention paid to the environment has increased greatly in recent years [1,3]. This increased attention highlights the need for better theory and new frameworks to understand the effects of the physical work environment on employees, since the nature of work and the environments in which it is conducted have altered dramatically [4,5]. For example, job

design is now viewed as "encapsulating the processes and outcomes of how work is structured, organized, experienced, and enacted" [6]; p. 418), bringing the role of the physical work environment sharply into focus.

As exemplified by Google's $1 billion UK headquarters [7], physical workspace is the second largest expense for most organizations [8] and can influence productivity by as much as 20% [9]. Accordingly, many organizations are experimenting with workplace design [10,11,12] and are exploring ways of using the work environment to support employee performance [1,13] and pursue economic savings [4]. For example, some organizations are designing their workplaces to resemble the layout of cities, with major avenues, a town square, and a variety of zones to motivate employees to move around the building and share information [14]. Nevertheless, other organizations have attempted to make the workplace an enjoyable location by including gaming spaces and relaxation areas [15]. Organizations are also realizing the need to balance collaboration spaces with quiet or private areas that allow employees to focus and concentrate [16]. Both privacy and interpersonal communication have been examined as critical issues for organizations to address in designing workplaces [17], since some modern workplace designs have been linked to increases in sickness absence [18], deterioration in perceived health [19], and reduced job satisfaction [20].

Despite a significant investment of time and money in workplace design, only one in four employees report working in an optimal environment, and common initiatives such as open plan offices have resulted in more than half of employees reporting feeling disturbed by others when attempting to focus [21]. Efforts to increase interaction and collaboration may result in increased distraction, reducing individuals' ability to focus at work [19,20,22]. Mixed results of this sort reflect the fact that there is no organizing framework for understanding employees' responses to their physical work environment. Too often, applied efforts and research studies adopt unique and potentially incompatible approaches, preventing the development of a cumulative body of knowledge [3]. Therefore, the aim of our overall study is to advance future research on the physical work environment by developing a theory-based conceptualization and measure of employee reactions to the work environment.

We present four studies that develop and validate a measure of employee psychological reactions to the physical work environment. Using a psychological approach (i.e., examining how employees perceive the physical environment) allows the measure to be applied across a variety of environments. The framework and the measure can serve as the foundation for an integrative understanding of how individuals react to physical work environments.

## 2. Physical work environment

The physical work environment encompasses the nature and arrangement of all the material objects and stimuli that people encounter in their work, including elements such as building design, room size and shape, furnishings, and equipment, as well as ambient conditions such as sound, lighting or air quality [1,23,24,25,26,27]. The physical work environment is a central part of organizational life, one that influences beliefs about oneself, coworkers, and the organization [28]. Indeed, even subtle environmental cues influence self-concept and behavior [29,30]. For example, Knight and Baer [31] found that the use of stand-up desks, rather than traditional seated

ones, led to better information elaboration, increased arousal, and decreased idea territoriality and ultimately improved team performance (see also [32,33].

Because no general framework exists for comprehensively describing employees' reactions (e.g., judgements, emotions, cognitive functioning) to their work environment, most research has focused on isolated aspects of the environment, such as privacy, lighting, or noise (for reviews, see Refs. [1,3,33]. Moreover, studies have focused on the relationships among environmental variables and outcomes without an underpinning theory to explain why or how effects occur [1,34,35]. The studies that do draw on theory have used a variety of models and frameworks [36]. As a result, reviewers consistently note that current empirical findings are inconsistent, sometimes contradictory, and insufficient to guide practice [3,37]. In sum, empirical research has demonstrated the importance of discrete aspects of the physical work environment (e.g., furnishings or workspace layout), but without a comprehensive understanding of the different ways in which employees think about and respond to their environment, it is difficult to make a reliable connection between changes in the environment and changes in employee behavior.

## 3. Reactions to the physical work environment

We propose that developing a consistent and generalizable theoretical framework that examines the dimensions of employees' reactions to work environments will enhance our understanding of this phenomenon. Organizational scholars already know how to conceptualize and measure employee perceptions of task and relational characteristics of jobs (e.g. [38,39,40], but we do not have a systematic way to conceptualize and measure employee perceptions of the physical work environment. Our understanding of the dimensions of employee reactions to task and relational job characteristics has allowed the development of a large body of research on the performance and well-being implications of these characteristics (e.g., [41,42]. The lack of such a framework for understanding employee reactions to the physical environment has inhibited the development of knowledge about how the physical environment may predict similarly important outcomes in terms of work attitudes or work performance.

We suggest that to be useful, an approach to conceptualize employee reactions to work environments must be broader than specific reactions to the nearly infinite number of environmental aspects that may vary (color, furnishings, density, lighting, greenery, art, acoustics, etc.). Instead, we identify a more generic suite of employee reactions focusing on the employees' thoughts and perceptions to provide a unifying link between the vast array of environmental features that one might study and employee outcomes. Whether it is an ergonomic feature (e.g., desks, chairs), a physical feature (e.g., plants, layout) or an ambient feature (e.g., lighting, air quality), any organizational or individual outcome linked to that environmental feature depends on how employees perceive, evaluate and respond to it. As such, employee reactions are the linchpin in understanding the behavioral effect of any environmental feature.

Moreover, focusing on employee reactions acknowledges the role of individual differences in work behavior and work outcomes. For example, while some employees may prefer open plan offices, others may prefer isolated spaces. Likewise, some may prefer natural environmental features, while others prefer an industrial ambiance. To understand the effects of a work

environment, one must begin with individual reactions rather than focusing solely on objective aspects of that work environment.

Integrating and extending previous approaches, we focus on the well-established psychological framework of cognitive, affective, and relational factors that influence employees at work [43]. Each of these factors is known to have important implications for employee outcomes [40,44]. These three types of reactions provide a straightforward means of studying employee responses to the environment and one that incorporates the elements that previous research on the physical environment has shown to be important (e.g., [31,33,45].

3.1. Cognitive reactions

Cognition is the process by which we acquire understanding and knowledge through our thoughts, experiences and senses [46]. Most work tasks require a variety of different cognitive functions [47], including attending, perceiving, thinking, remembering, and decision-making [46]. For example, modern knowledge work requires employees to attend to specific tasks by gathering, analyzing and making decisions using multiple sources of information [48]. The design and structure of the physical work environment plays a role in supporting cognitive functions [49]. When any of these cognitive processes are interrupted, inefficiency and mistakes increase [47]. The ability to concentrate and direct attention shapes judgment and behavior [50,51], influencing a range of outcomes, including task performance and decision making [52,53,54,55]. As a result, being able to engage freely in required cognitive activities to focus on a task without interruption or distraction is an essential foundation for effective work [46,47]. Moreover, recent data suggest that requirements for concentration and focus at work are increasing [21,56].

In developing a framework to understand employees' cognitive reactions to work environments, we propose the dimension of Focus, or the ability to concentrate on relevant tasks. Focus is the most fundamental cognitive reaction that can be influenced by the physical environment, and there is no doubt that physical work environments can greatly enhance or detract from an employee's focus [57,58,59]. For example, noise distraction has been found to be among the most significant negative features of open plan work environments, compromising the ability of employees to sustain focus and concentrate on their work [20,60,61]. Veitch [62] suggests that the design and layout of the physical work environment may increase demands on employees through attributes such as high density or low privacy, both of which increase distractions. When considerable effort is required to focus due to environmental distractions, resources are depleted [62,63], and, as such, difficulty in focusing is likely to increase stress and strain, undermine performance, and increase errors. However, it is possible that other aspects of workplace design, such as views of nature or access to daylight, may replenish resources even in the presence of distractors [62]. Employee perceptions of their ability to focus on their work is likely to be an important cognitive dimension of employee responses to their physical work environment.

3.2. Affective reactions

Affect is an encompassing construct that incorporates both mood and emotion. There is extensive evidence about the importance of affect at work and its subsequent influence on work attitudes

and behaviors [64]. For example, positive affect has been shown to increase cognitive flexibility [65], creative problem solving [66], organizational commitment and helping behaviors [67], and performance [68].

Affective reactions at work influence both behavior and attitudes [67,69]. Some specific affective reactions (anger, frustration) have been linked to objective features of the physical work environment (e.g. [36,70], but the growing literature on organizational aesthetics suggests that perceiving beauty is an important factor [71,72]. Previous research has established the role and importance of aesthetic functions within the physical environment [73].

In our framework of psychological affective reactions to the work environment, we propose the dimension of Sense of Beauty. This dimension involves employees' noncognitive (emotional) responses to the work environment [28]. When people perceive beauty, they experience positive affect [71]. White [72]; in reviewing the relevance of aesthetics to organizations, finds that the experience of beauty is an essential, constitutive element of organizations and has important implications in organization theory; it is universal and necessary. The design of a physical work environment to elicit a sense of beauty can produce positive feelings, behaviors and cognitions [74]. The appreciation of beauty has been demonstrated to increase well-being [71]. Research has also shown that the degree to which the physical work environment has a pleasing and attractive appearance shapes trust formation in organizations [75]. An aesthetically pleasing environment that evokes a sense of beauty may provide an experience that is restorative [76]. Researchers have suggested that preference for beautiful environments may play a role in attracting people to restorative environments and retaining them for a longer time than would otherwise be the case, allowing them to recover from attentional fatigue and stress [77,78,79]. As such, we propose that sense of beauty is an essential and previously neglected aspect of employee affective reactions to the physical work environment.

3.3. Relational reactions

Relational factors in psychological theory examine the role of interpersonal interactions and interdependencies at work [43]. Relatedness is one of three basic needs in self-determination theory that lead to enhanced motivation and mental health [80]. Moreover, success in modern workplaces is often driven by how well individuals interact with each other and with the organization [81]. For example, project-based teams are frequently used in organizations and are tasked with solving multidisciplinary problems, requiring them to work interdependently with a range of different stakeholders to achieve outcomes [82]. Consistent with the increasingly interdependent nature of work, work designs requiring employees to work together to achieve goals have increased by 50% in the past two decades [82]. The physical work environment significantly influences with whom and how often one interacts (e.g., [3,83,84,85]; Oldham et al., 1995 [86];) and, as such, plays a vital role in supporting or detracting from interdependent work. When the design of the physical work environment facilitates a sense of belonging, individuals are likely to feel connected to a larger whole beyond themselves. For example, a key factor in the success of the coworking space provider WeWork has been building a strong sense of community, largely through the design of the physical work environment [87].

The final factor in the proposed framework is <u>Connectedness</u>, which incorporates the relational aspects of psychological reactions. The experience of connection involves the extent to which the environment facilitates a sense of community and a feeling of belonging to the organization [11,88]. Connectedness is an important reaction that the physical work environment may inhibit or enhance. The more the work environment fosters encounters, conversations, and engagement with others, the more employees feel that they are part of the larger social group, that they know others, and that they are jointly part of a greater whole, supporting the innate need of human beings to belong [89]. A physical work environment that facilitates more frequent and higher quality contact with others leads to improved communication and task-related assistance [90,91], increased job satisfaction [92], and more social support [44]. As such, a sense of connectedness is likely to be an important precursor to many other outcomes, including collaboration, cohesion, and even self-worth, which in turn influence organizational outcomes such as performance, citizenship, retention, commitment, and creativity [43].

Guided by our three-dimensional theoretical framework of employee reactions to the work environment (Focus, Sense of Beauty and Connectedness), we conducted four studies to develop and test a measure of these reactions for use in future research. In our studies, we surveyed organizations undertaking knowledge work. As such, the types of work environments included open plan office work areas, work spaces that included some private offices within the workplace as well as common areas such as reception areas, meeting rooms, kitchens and lounge areas. Our goal was to test the generalizability of the measure across a range of different (but broadly similar) work environments from similar industries. The purpose of the studies was to assess psychological reactions to the physical environment, given that no two people will perceive the space in the same way.

Study 1 involved pilot tests with three different samples to develop and refine a pool of items. In Study 2, an initial survey was developed to assess the dimensional structure of the measure and to enable preliminary convergent validity testing. Study 3 further confirmed the dimensional structure of the measure and tested its predictive validity for work outcomes. Finally, the fourth study introduced a longitudinal component in a quasi-experimental design, using a sample of employees who changed physical work locations between pre- and posttests. The results of Study 4 demonstrated that the measure reflects reactions to one's specific environment rather than stable individual differences between employees.

In all studies, we followed best practices in scale development as suggested by Ref. [93] and De Vellis [94]: (1) define the construct; (2) generate an item pool; (3) determine the measure format; (4) expert review of initial item pool; (5) pilot test; (6) administer scale to development pool; (7) refine the scale using item analysis; and, (8) evaluate the scale, including factor structure (to ensure the robustness of the final scale), reliability (to ensure respondents answered the items from the scales consistently), and validity (to ensure the scale measures the constructs as outlined). Analyses were conducted using SPSS (v24) and R (3.5).

## 4. Study 1: scale development

### 4.1. Delphi interviews

We began our scale development with semistructured Delphi interviews [95] of six workplace designers who assisted companies with the creation, implementation, and management of their physical work environments. We used a Delphi interview process to gain knowledge from experts because theoretical consensus was lacking [95,96]. The designers' work experience and expertise gave them unique insights into how employees respond to work environments. The interviewees had between 9 and 40 years of experience working with firms in different industries around the world, including leading global organizations such as the BBC, Apple, the British Library, Barclays, and Boeing.

We asked interviewees to describe the most important features of the physical work environment, discuss which employee needs and responses they felt were most important, give examples of work environment aspects that they had found create successful outcomes, and suggest key problems related to the design of the physical work environment. The thematic analysis of their responses supported the focus, sense of beauty and connectedness framework proposed above. Initial interpretations were fed back to participants to gain further insight [95,96]. For example, the interviewees noted that problematic workplaces tended to be noisy ones where employees were constantly interrupted and had no place to escape distractions, whereas workplaces that promoted effective work performance offered a choice of areas in which to work, including visual and auditory privacy. Interviewees also noted that ineffective workplaces were often ugly and unappealingly functional in their design, while more successful workplaces had an intimate, attractive feel. Finally, interviewees commented that unsuccessful workplaces often caused employees to feel isolated from their colleagues and their organizations, while effective workplaces were designed in a way that made it easy for individuals to locate and connect with others and the organization.

## 4.2. Initial item development

Based on interviewee comments, existing measures (e.g. [20], and a review of the literature supplemented by follow-up discussions with the interviewees, we generated a pool of 31 items to reflect the three reactions to the physical work environment (i.e., focus, sense of beauty, connectedness). These items were sent to a purposive sample of 40 respondents selected for their geographic distribution and diversity of physical work environments. Twenty-four individuals responded (60% response rate). The sample was 61% male, with a modal age of 35–44 years, and represented a variety of occupations and nationalities. The participants completed an online survey using the 31 items to report their reactions to the physical environment in which they worked.

The correlation patterns suggested that the proposed three-factor structure was present in the data. However, not all items correlated as expected. Using these results and in reference to the literature, we revised and retained 21 items reflecting the three reactions to the physical work environment.

## 4.3. Item refinement

In the final pilot study, the revised 21 items were administered in two different organizations: a national scientific research organization and a multinational architecture and design firm. With

the support of the management in each organization, 120 employees were invited to complete an online survey reporting their reactions to the physical work environment via an invitation from an administration officer in each of the two organizations. The participants were also invited to provide qualitative feedback on items that were unclear at the end of the online survey. Fifty-four employees responded (45% response rate). The sample was 57% male and had a modal age of 35–44 years. Using an exploratory factor analysis and participant feedback, a final list of 12 items was developed, four for each of the three reactions to the physical work environment. We named the 12-item scale that emerged from these studies the Reactions to the Physical Work Environment Scale (RPWES).

## 5. Study 2: validity and reliability testing

The aim of the second study was to examine the internal structure and reliability of the new 12-item measure, as well as testing the construct validity of the new measure with other related constructs.

### 5.1. Sample

The business network database LinkedIn was used to invite 500 individuals to complete an online survey. The final sample consisted of 185 respondents (37% response rate), with a modal age of 35–44 years. More than half (62%) were male, and most respondents had more than 10 years' work experience. The respondents were located in North America, Europe, Asia, and the Asia-Pacific region, representing a wide range of industries. Although all of the respondents were knowledge workers, their physical work environments were in offices that included traditional private offices, open-plan offices, activity-based working spaces, coworking spaces, and serviced offices.

### 5.2. Measures

Construct validity testing was conducted to confirm that the RPWES could be differentiated from existing and related constructs. *Psychological Empowerment* is a motivational construct manifested in four cognitions about one's work [97]: meaning (value or purpose perceived in work), competence (belief in one's ability to perform a task), self-determination (experience of autonomy or choice), and impact (one's ability to influence work outcomes). Such thoughts about work tasks should be related to, but distinct from, reactions to the physical work environment. Similarly, the survey included a measure of *current mood* to distinguish reactions to the environment from more general feelings.

#### *5.2.1. RPWES*

The RPWES consisted of the 12 items from Study 1. The respondents were asked to consider 'the physical environment where you work' and responded using ratings from 1 (*strongly disagree*) to 5 (*strongly agree*). All items are presented in Table 1.

**Table 1.** Study 2 exploratory factor analysis reactions to physical work environment scale (RPWES).

| Item | Factor 1 Focus | Factor 2 Beauty | Factor 3 Connection |
|---|---|---|---|
| *Focus* | | | |
| Allows me to concentrate when I need to | **.81** | .37 | .12 |
| Allows me to control distractions to my work | **.88** | .15 | .10 |
| Makes it easy for me to focus on my work | **.91** | .25 | .10 |
| Helps to concentrate my attention | **.85** | .29 | .11 |
| *Sense of beauty* | | | |
| Is beautiful | .28 | **.82** | .26 |
| Is attractive | .35 | **.80** | .35 |
| Is stylish | .33 | **.81** | .27 |
| Is visually pleasing | .30 | **.79** | .38 |
| *Connectedness* | | | |
| Allows me to feel a sense of belonging to the organization | .24 | .24 | **.70** |
| Allows me to feel connected | .08 | .29 | **.65** |
| Allows me to feel part of the organization | .04 | .13 | **.90** |
| Allows me to see myself as a member of a community to which I belong | .04 | .22 | **.67** |
| Eigenvalue | 6.67 | 2.21 | 1.07 |
| Cumulative percentage of variance explained | 55.63 | 74.07 | 83.00 |

n = 128; maximum likelihood extraction with orthogonal rotation. Primary factor loading in bold.

### 5.2.2. Psychological empowerment

This was measured with Spreitzer's [97] 12-item measure, assessing all four dimensions. Example items include 'I am confident in my ability to do my job' (competence) and 'I can decide on my own how to go about doing my work' (self-determination). The participants used a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

### 5.2.3. Mood

The participants' state affect was measured using the Positive and Negative Affect Scale [98]. The scale contains 20 items, with 10 assessing positive affect (e.g., 'excited') and 10 assessing negative affect (e.g., 'scared'). The participants rated each item with regard to 'how you feel right now' on a scale from 1 (*very slightly*) to 5 (*extremely*).

### 5.2.4. Importance of work environment

To assess whether respondents were influenced by individual differences in their attentiveness to the physical environment, the survey included a three-item measure of the importance of the environment ('My physical work environment is important to me', 'My physical work environment affects how I work', and 'Where I work is important to me'). Respondents used a scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). This measure was developed by the authors.

### 5.3. Results and discussion

We initially assessed the RPWES for internal consistency using an Exploratory Factor Analysis within SPSS (V24), an accepted analytical method in scale development [94]. Factor analysis uses inter-item correlations to identify groups of items (i.e., factors) that evoked similar responses and which account for substantial amounts of the observed variance in participants' ratings. Using the RPWES items, the Kaiser-Meyer-Olkin sampling adequacy test statistic for the items of our scale was 0.90 (above the threshold of 0.60; [99], and Bartlett's [100] test of sphericity was significant (1713.48, df 66, $p < .01$), indicating that factor analysis was appropriate to test the structure of the scale. An exploratory factor analysis using maximum likelihood extraction explained 83.0% of the variance and suggested a clear three-factor solution. Table 1 provides the factor loadings of each item with each of the three factors identified in the data. A factor loading measures the strength of association between an item and an underlying factor. The results in Table 1 are good, as each item is strongly associated with one and only one factor. Descriptive statistics for the three factors of the RPWES and all other measures collected in this study are given in Table 2.

**Table 2.** Study 2 means, standard deviations, correlations, and reliability.

| Variable | Mean | SD | α | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Focus | 3.43 | 1.07 | .95 | | | | | | | | | |
| 2 Sense of beauty | 3.18 | 1.12 | .96 | .60** | | | | | | | | |
| 3 Connectedness | 3.45 | .89 | .86 | .30** | .57** | | | | | | | |
| 4 Psychological empowerment: Meaning | 6.15 | 1.01 | .93 | .30** | .36** | .41** | | | | | | |
| 5 Psychological empowerment: Competence | 6.18 | .71 | .86 | .27** | .24** | .21* | .44** | | | | | |
| 6 Psychological empowerment: Self-determination | 6.33 | .83 | .89 | .38** | .43** | .31** | .43** | .49** | | | | |
| 7 Psychological empowerment: Impact | 5.78 | 1.49 | .95 | .41** | .45** | .22* | .33** | .24** | .52** | | | |
| 8 Positive affect | 3.75 | .67 | .91 | .41** | .43** | .42** | .63** | .43** | .46** | .35** | | |
| 9 Negative affect | 1.52 | .50 | .86 | -.34** | -.28* | -.18* | -.19* | -.41** | -.32** | -.04 | -.36** | |
| 10 Importance of environment | 4.30 | .68 | .79 | .07 | -.02 | -.11 | .09 | .12 | -.11 | .03 | .04 | -.01 |

n = 128.
*p ≤ .05; **p ≤ .01.

All measures had good internal consistency, and the pattern of correlations supported the construct validity of the new measure. All aspects of psychological empowerment were significantly correlated with all dimensions of the RPWES (from $r = 0.21$ to $r = 0.45$, $p < .05$), as expected, indicating that the new measure has appropriate convergent validity with related constructs. At the same time, the fact that the correlations were small to moderate indicates discriminant validity. The RPWES was related to, but also clearly distinguishable from, empowerment.

Likewise, the correlations among the RPWES dimensions and mood were as predicted. In other words, it appears that when completing the RPWES, the respondents reported distinct reactions to their environment, rather than simply their mood at the time. In addition, all three dimensions of the RPWES had nonsignificant correlations with the importance of environment measure, suggesting that one's reactions are not directly influenced by how concerned one is with the physical environment.

Taken together, these results indicate that the RPWES three-factor framework of Focus, Sense of Beauty, and Connectedness offers a potentially useful and generalizable way to assess individual

reactions to the physical work environment. In a sample of culturally and occupationally diverse working adults, the RPWES had a strong factor structure, good internal reliability and appropriate relationships with related constructs.

**6. Study 3: predictive validity**

The aim of Study 3 was to begin to test the predictive validity of the RPWES initially established with correlations through SPSS (V24) and then using a Confirmatory Factor Analysis (using R v3.5). The outcome measures used in this study were Organizational Citizenship Behavior and Collaboration. Organizational Citizenship Behavior (OCB) involves actions that go beyond the requirements of one's formal employment role and contribute to performance [101]. OCB comprises actions that contribute to the maintenance of the organization's social system and have been described as behavioral manifestations of positive cooperation at work [102]. Examples of OCBs include helping others with their tasks, putting in extra effort at work, and promoting the organization. OCBs have been shown to predict a range of important outcomes including managerial ratings of employee performance, productivity, efficiency, customer satisfaction and turnover [103].

Previous findings [104] suggested that connectedness, not focus or sense of beauty, would predict OCB. Individuals are more likely to be cooperative and helpful when they feel a connection to the organization and the individuals in it, while there is no reason to believe that focus or sense of beauty would directly influence OCB.

The second variable we examined was collaboration. Collaboration refers to joint activity with one or more coworkers to accomplish goals, which is another important behavior in organizations [105]. Consistent with the increasingly interdependent nature of work, collaborative endeavors have increased by 50% in the past two decades [82], in part because collaboration contributes to competitive advantage [105], creativity [81], and success in complex tasks [106]. Previous studies [11,13] suggested that the work environment may influence collaboration by facilitating interaction and by enhancing the ability of workers to focus on tasks. As such, we predict that connectedness and focus, but not sense of beauty, should predict collaboration.

6.1. Sample and procedure

Employees in one European office of a multinational organization were invited to complete an online survey. Two hundred and eleven out of 290 employees completed the survey (response rate 77%). The mean age of the respondents was 31.8 years (*SD* 12.1), and two-thirds (66%) were male.

6.2. Measures

All respondents completed the RPWES and self-report measures of the two outcomes. The survey also included the three-item measure of the importance of the environment from Study 2 as a marker variable to assess common method bias [107].

*6.2.1. RPWES*

Respondents completed the RPWES from Study 2 (as described in Section 5.2.1).

*6.2.2. OCB*

Respondents completed Wayne, Shore and Lidens' [108] seven-item scale of Citizenship Behaviors (e.g., 'I help others with their work when they are absent, even if it is not my job to do so'), with anchors from 1 (*never*) to 7 (*always*).

*6.2.3. Collaboration*

To measure collaboration, the respondents completed Pinto and Pinto's [109] six-item scale (e.g., 'It is easy to brainstorm ideas'), with anchors from 1 (*never*) to 6 (*always*).

*6.2.4. Environmental importance*

Finally, the respondents completed the Importance of the Work Environment scale described in Study 2 (Section 5.2.4).

6.3. Results and discussion

Summary statistics for all scales are given in Table 3. All measures had good reliability (the scales performed consistently), and the predicted relationships emerged. In particular, consistent with Study 2 (Section 5), the importance of the work environment measure was not related to employee reactions to the work environment. This result is important in two regards. First, it corroborates the Study 2 finding that the three dimensions of reactions to the work environment are independent of the importance individuals place on their work environment. Second, it suggests that common method variance is unlikely to be a significant concern in these data [110].

**Table 3.** Study 3 means, standard deviations, correlations and reliability.

| Variable | Mean | SD | A | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| 1 Focus | 3.73 | 1.55 | .96 | | | | | |
| 2 Sense of beauty | 4.03 | 1.58 | .94 | .58** | | | | |
| 3 Connectedness | 5.07 | 1.11 | .90 | .47** | .57** | | | |
| 4 Collaboration | 4.82 | 1.13 | .91 | .51** | .51** | .60** | | |
| 5 Organizational citizenship behavior | 4.61 | 1.12 | .88 | .24** | .17* | .33** | .31** | |
| 6 Importance of environment | 6.24 | .75 | .79 | .00 | -.01 | .09 | -.01 | .19** |

n = 211.
*p ≤ .05; **p ≤ .01.

To further assess the performance of the RPWES, three steps were undertaken. Our first step was to perform a confirmatory factor analysis (CFA) using R (v3.5) to assess whether the data fit our hypothesized measurement model [111]. A maximum likelihood estimation (CFA) of the 12-item RPWES found that the predicted three-factor model fit the data well ($\chi^2 = 81.98$, df = 51, SRMR = 0.04, RMSEA = 0.05, CFI = 0.99; [112]. All of the fit measures were good, suggesting that the data supported our prediction of three factors. Moreover, when we compared alternative

models with our predicted model, all of the alternative models had poorer fits with the data (see Table 4). Each of the alternative models tested a different factor structure (e.g., Model 2 tested whether it was appropriate to combine Focus and Sense of Beauty together as one factor). Since all of the alternative models had worse fits, the data suggest that the predicted three-factor structure best reflects the data.

**Table 4.** Confirmatory factor analysis for RPWES†.

| | Model | $\chi^2$ | df | $\Delta\chi^2$ | SRMR | RMSEA | CFI |
|---|---|---|---|---|---|---|---|
| 1 | Three-factor scale: Focus, Sense of Beauty and Connectedness | 81.98 | 51 | | .04 | .05 | .99 |
| 2 | Two-factor scale: Connectedness and combined Focus + Sense of Beauty as one factor | 652.57 | 53 | 570.59*[a] | .12 | .23 | .75 |
| 3 | Two-factor scale: Focus and combined Sense of Beauty + Connectedness as one factor | 410.37 | 53 | 328.39*[a] | .12 | .18 | .85 |
| 4 | Two-factor scale: Sense of Beauty and combined Focus + Connectedness as one factor | 474.00 | 53 | 392.02*[a] | .15 | .19 | .83 |
| 5 | Five-factor model: Focus, Sense of Beauty, Connectedness, Collaboration and OCB | 419.56 | 265 | | .05 | .05 | .96 |
| 6 | Four-factor model: Model 5, except combining OCB + Sense of Beauty as one factor | 1070.02 | 269 | 650.46*[b] | .15 | .12 | .80 |
| 7 | Four-factor model: Model 5, except combining OCB + Connectedness as one factor | 883.35 | 269 | 463.79*[b] | .13 | .10 | .85 |
| 8 | Four-factor model: Model 5, except combining OCB + Focus as one factor | 1256.78 | 269 | 837.22*[b] | .16 | .13 | .76 |
| 9 | Four-factor model: Model 5, except combining Collaboration + Sense of Beauty as one factor | 963.94 | 269 | 544.38*[b] | .11 | .11 | .83 |
| 10 | Four-factor model: Model 5, except combining Collaboration + Connectedness as one factor | 668.49 | 269 | 248.93*[b] | .07 | .08 | .90 |
| 11 | Four-factor model: Model 5, except combining Collaboration + Focus as one factor | 989.03 | 269 | 569.47*[b] | .11 | .11 | .82 |
| 12 | Structural model: Focus, Sense of Beauty and Connectedness predicting Collaboration and OCB | 420.37 | 266 | | .05 | .05 | .96 |

†$\chi^2$, SRMR, RMSEA and CFI all provide measures of fit, reflecting how well the observed data match the predictions (see Ref. [112]).
n = 211; [a] compared to model 1; [b] compared to model 5.
*$p < .01$.

The second step was a five-factor CFA of the RPWES with OCB and Collaboration. The model fit the data well ($\chi^2 = 419.56$, df = 265, SRMR = 0.05, RMSEA = 0.05, CFI = 0.96) and significantly better than any alternative models, which combined OCB with one of the RPWES factors or collaboration with one of the RPWES factors. These results further support the discriminant validity of the RPWES.

The final step was examining a structural model in which the three-factor RPWES predicted collaboration and OCB. The model fit the data well ($\chi^2 = 420.37$, df = 266, SRMR = 0.05, RMSEA = 0.05, CFI = 0.96) and revealed Focus as a significant predictor of collaboration ($\beta = 0.11$, $p = .02$), but not of OCB ($p = .32$). In contrast, Sense of Beauty was not consistently related to either collaboration ($p = .06$) or OCB ($p = .40$). Connectedness was a significant predictor of collaboration ($\beta = 0.46$, $p < .01$) and OCB ($\beta = 0.41$, $p < .01$). The fact that the three reactions to the physical work environment had significant relationships with these important

outcomes suggests the importance of those reactions, and the fact that each reaction had a different set of relationships with the outcomes gives further evidence of their discriminant validity and predictive utility.

**7. Study 4: replication and extension of predictive validity findings**

The aim of Study 4 was to examine the validity and utility of the RPWES following a change of physical work environment.

7.1. Sample and procedure

Ten months after Study 3, the 211 respondents from Study 3 were invited to complete a second survey. Six weeks before this second survey invitation, all respondents moved from several different previous locations into a newly constructed office. A new survey was conducted asking them to report on their psychological reactions to the new physical work environment. Seventy-four respondents completed the second survey (response rate 35%). The mean age of the respondents was 34.7 years (*SD* 6.7), and 61% were male. The respondents were matched between the first and second surveys using a unique numerical identifier.

To replicate and extend the findings in Study 3 (Section 6.3), the same measures were used in this study with the same individuals in the same jobs and work teams. The only change between surveys was their recent move to a new work location. Therefore, we contend that any observed changes should primarily reflect the change in their environment.

7.2. Measures

The survey included the RPWES and collaboration measures from Study 3 (Sections 6.2.1 RPWES, 6.2.3 Collaboration) measured on Likert scales ranging from *strongly disagree* (1) to *strongly agree* (7).

7.3. Results and discussion

Table 5 provides descriptive statistics for the study variables in the sample at both time points. All measures had good reliability, and there was clear evidence that individuals had different reactions to the two environments. The analysis of variance found that, on average, focus reactions significantly increased at the new location (M at T1 3.85 vs M at T2 4.69, $p < .05$), sense of beauty reactions increased (M at T1 3.97 vs M at T2 5.91, $p < .05$), while connectedness reactions did not change significantly. (M at T1 5.26 vs M at T2 5.39, $p < .05$).

Individual change scores for all variables were constructed and used in an ordinary least squares regression using SPSS (V24) to test whether the change in each individual's reactions predicted his or her change in collaboration (Table 6). Consistent with Study 3, both the change in focus ($\beta = 0.21$, $p = .08$) and the change in connectedness ($\beta = 0.23$, $p = .12$) were positively associated with the change in collaboration, while the change in sense of beauty was not ($\beta = 0.00$, $p =$ ns). The pattern of relationships thus replicated the previous findings, but in this case, they were change scores reflecting the effects of the new environment. That is, as expected, change in

individuals' collaboration reflected the changes in their focus and connectedness reactions prompted by the new office environment.

**Table 5.** Study 4 means, standard deviations, correlations, and reliability.

| | Variable | Mean | SD | α | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Focus Time 1 | 3.85 | 1.59 | .95 | | | | | | | |
| 2 | Focus Time 2 | 4.69 | 1.64 | .96 | .34** | | | | | | |
| 3 | Sense of Beauty Time 1 | 3.97 | 1.53 | .96 | .53** | .17 | | | | | |
| 4 | Sense of Beauty Time 2 | 5.91 | 1.09 | .93 | .16 | .46** | -.15 | | | | |
| 5 | Connectedness Time 1 | 5.26 | .99 | .90 | .51** | .16 | .55** | .06 | | | |
| 6 | Connectedness Time 2 | 5.39 | 1.15 | .92 | .10 | .55** | .03* | .55** | .23* | | |
| 7 | Collaboration Time 1 | 4.92 | 1.11 | .90 | .49** | .18 | .44** | .09 | .58** | .24* | |
| 8 | Collaboration Time 2 | 5.10 | 1.02 | .91 | .20 | .50** | .26* | .35** | .26* | .54** | .40** |

n = 74.
*p ≤ .05; **p ≤ .01.

**Table 6.** Summary of regression model.

| | Dependent Variable: Change in Collaboration |
|---|---|
| Constant | -.05 (.18) |
| Change in Focus | .21 (.08)** |
| Change in Sense of Beauty | .00 (.07) |
| Change in Connectedness | .23 (.12)* |
| F | 8.96 (3, 70)** |
| $R^2$ | .28 |

n = 74; standard errors in parentheses.
*p ≤ .05; **p ≤ .01.

Given that two of the three reactions showed significant mean differences with the move to a new location, the RPWES responses appear to reflect genuine reactions to the environment rather than stable individual differences. At the same time, we did not find evidence of change in connectedness reactions. This result can be explained in three ways. First, it is possible that connectedness scores on the RPWES reflect individual differences rather than genuine reactions to the environment. Second, connectedness reactions may be more idiosyncratic than the other two reactions. Since ANOVA compares mean scores, if half of the group felt that the new space promoted connection more and the other half felt it promoted connection less, the net result would be no change in the mean (i.e., a nonsignificant ANOVA test). Finally, it may be that connectedness scores require more time to adjust. One's sense of beauty reaction is likely to be almost immediate, and the focus-related implications of a new environment should be revealed quite quickly. In contrast, it may take time for people to develop work routines in the new space and to understand those routines' implications for connection. Our data cannot distinguish between these three possible explanations, so further investigation is needed.

## 8. General discussion

There is no question that physical work environments can have powerful effects on individual behavior [31], but the mechanisms of such effects are not clearly established. In response to calls for progress in this regard [1,3], we have developed a theoretical framework reflecting three dimensions of psychological reactions to work environments [113,114]. We argue that these

three reactions are likely to mediate the relationship between the objective characteristics of the physical work environment and subsequent employee behavior.

Across four studies, diverse samples of working adults were used to refine a framework and associated measure: the Reactions to the Physical Work Environment Scale (RPWES). The measure performed well among respondents from multiple industries, continents, occupations, hierarchical levels, and work settings. It showed good psychometric properties and appropriate relationships with other constructs. The results suggest that the three-factor structure of reactions is an appropriate and useful one. The three reactions were shown to be distinct from perceptions of psychological empowerment, positive and negative mood, and the level of attention paid to the physical work environment. Moreover, the work environment reactions were related to important outcomes, including organizational citizenship behavior and collaboration.

The three-dimensional framework and associated RPWES provide the foundation for developing an integrated and unifying theory of how physical work environments influence organizational behavior and outcomes. Although many studies have examined the effects of specific environmental features such as noise or greenery, they have usually done so in atheoretical ways and failed to consider how the environment is perceived and why it subsequently influences behavior [1]. The RPWES and its framework can address this issue by providing a reliable and widely applicable means of assessing employees' reactions to their physical work environment as a whole or by isolating and manipulating specific objective characteristics such as density or natural light. By focusing on the important role of individual reactions and doing so with a consistent framework, future researchers can compare findings, identify similarities and differences, assess the impact of different environmental features, and thereby accumulate a body of knowledge that will be useful to organizations and designers.

## 9. Practical significance & limitations

Several implications for practice are apparent. Our studies have shown that individuals may view similar work environments differently. As such, the need to design work environments that provide options to cater to individual preferences is clear. As studies of open plan work environments have demonstrated [20], there is a need for workplaces that allow for individual choices, as well as differences in the types of work undertaken within organizations. The identification of the three reactions of the RPWES will assist designers of physical work environments to plan and deliver workspaces that optimize all three reactions. Presently, many workplaces are heavily focused on driving collaboration and interaction [13] at the expense of privacy and concentration. The RPWES framework highlights the importance of providing environments that support all three psychological reactions.

A limitation in our studies is the restricted sample we used (i.e., knowledge workers) on the generalizability of the scale. We specifically scoped our data collection around knowledge workers, and so further research is needed to generalize our findings to other contexts. Another limitation emerges from our methodology, in which all our data are based on self-report and largely cross-sectional data. Future research might assess the relationship between employee reactions to the work environment and objective measures such as absenteeism, sick leave, and turnover across different environments.

## 10. Future directions & conclusion

The RPWES establishes a framework for describing reactions to the physical work environment. Reactions provide the link between concrete features of the environment and employee behavior; they can explain how features such as equipment, color scheme and office layout may influence behavior and performance.

In terms of the antecedents of focus, research has shown that workplace environments vary in their ability to support attention, based in part on how much distraction is present and how much support the space provides for individuals to adjust the level of distraction they experience [58,59]. For example, noisy workplaces disrupt cognitive processing, leading to significant deterioration in concentration [57]. As such, investigating how levels of privacy, distraction, and environmental control in the physical work environment influence focus is an important next step that will have important implications for the design of workplaces.

With respect to the experience of a sense of beauty, scholars have shown that aspects of the physical work environment such as use of natural materials, particular colors, views, lighting, and plant life can create more positive appraisals of aesthetic surroundings (e.g., [115,116]. Indeed, given that the aesthetic experience of beauty is a universal human response [117], it is worth investigating which factors contribute to a sense of beauty in work places.

With regard to antecedents of connectedness, others have noted that a sense of territory and control within the physical work environment is associated with a sense of belonging or connection [88,118]. Given that many employees now have much smaller spaces and less control over them [1], the effect of modern trends in efficient office design such as activity-based working requires further investigation as to how they may support or detract from a sense of connectedness. Density, spatial layout, furniture placement, and design may all have implications for a sense of connectedness.

Billions of dollars are spent annually on building workplace environments. This research may support managers and organizations in making decisions about the type of environments that are most likely to support their goals. By understanding how employees react to the physical work environment, managers will be better able to address the cognitive, affective, and relational needs of employees.

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