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Title:

Benefits of quiet workspaces in open-plan offices – Evidence from two office relocations

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Benefits of quiet workspaces in open-plan offices – Evidence from two office relocations

ABSTRACT:

The problems of open-plan offices are widely known. However, the factors explaining these effects have received less attention. The aim of this study was to investigate the role of office distractions in the emergence of other problems, and to examine the benefits of quiet workspaces in open-plan offices. Two organizations moved from private offices to open-plan offices that differed in the number and variety of quiet rooms. Survey data was gathered once before (N=65 and 64) and once after the office relocation (N=135 and 71). Perceived distractions increased in both organizations after the relocation. However, negative effects on environmental satisfaction, perceived collaboration and stress only emerged in the open-plan office where the number of quiet rooms was low. Increased distractions mediated the effects on collaboration and stress. Quiet workspaces, and the perceived ease of access to them, are associated with environmental perceptions, perceived collaboration and employee stress in open-plan offices.

Keywords: open-plan office, environmental satisfaction, privacy, distraction, stress, office design

1 INTRODUCTION

The problems experienced in open-plan offices have been widely documented in the literature (e.g., Bodin Danielsson & Bodin, 2008; De Croon, Sluiter, Kuijer & Frings-Dresen, 2005; Haapakangas, Helenius, Keskinen & Hongisto, 2008; Kim & de Dear, 2013; Lee, Lee, Jeon, Zhang & Kang, 2016; Pejtersen, Allermann, Kristensen & Poulsen, 2006). Open-plan offices are associated with various environmental complaints, particularly noise and lack of privacy (Bodin Danielsson & Bodin, 2009; Brookes & Kaplan, 1972; De Croon et al., 2005; Pejtersen et al., 2006). The problems are not restricted to environmental dissatisfaction but extend to the psychological and physical well-being of office workers (Bergstrom, Miller, & Horneij, 2015; Bodin Danielsson & Bodin, 2008; Herbig, Schneider, & Nowak, 2016), their interpersonal relations (De Croon et al., 2005; Bodin Danielsson, Bodin, Wulff & Theorell, 2015) and work performance (Kaarlela-Tuomaala, Helenius, Keskinen, & Hongisto, 2009). Moving into an open-plan office generally increases dissatisfaction with the environment (Brookes & Kaplan, 1972; Kaarlela-Tuomaala et al., 2009; Sundstrom, Herbert, & Brown, 1982; Zalesny & Farace, 1987) and may impair interpersonal relations (Kaarlela-Tuomaala et al., 2009; Oldham and Brass, 1979; Zalesny & Farace, 1987) and perceived health (Bergstrom et al., 2015).

There has been less research to specify *why* open-plan offices have these effects. Open-plan offices represent a heterogeneous group of work environments that vary substantially in their spatial and functional features (Bodin Danielsson, Chungkham, Wulff, & Westerlund, 2014). Therefore, defining a space as an open-plan office is not sufficient for predicting its effects on workers. For example, the perception of office noise depends on room acoustic details which vary greatly between workplaces (e.g., Haapakangas, Hongisto, Eerola, & Kuusisto, 2017; Seddigh, Berntson, Jönsson, Danielson, & Westerlund, 2015), demonstrating the need to investigate the role of specific features within the broad category of open-plan offices.

The effects of the office environment on workers likely depend on several factors and mechanisms which may also compete with and counteract each other. This complexity may explain why, in some cases, the consequences of moving into an open-plan office can also be positive (Allen & Gerstberger, 1973; Meijer, Frings-Dresen, & Sluiter, 2009; Spreckelmeyer, 1993). A deeper understanding of these phenomena would be important theoretically but it would also help office designers to identify elements that are critical for the positive perception of workspaces.

One way of examining the effects of office design more deeply is to identify intervening variables, i.e. factors that mediate or moderate the relation between the office environment and different outcomes. *Mediation* refers to mechanisms through which the independent variable (e.g., office type) indirectly affects the dependent variable, answering ‘how’ and ‘why’ the effect occurs. *Moderating* variables, in turn, affect the direction or strength of the relation between the independent and dependent variable, answering ‘when’ or ‘under what conditions’ the effect occurs (for more information on mediation and moderation, see Baron & Kenny, 1986; Hayes, 2013).

1.1 The stress perspective on office environments

In order to identify factors that may explain the negative – and positive – effects of open-plan offices, it is useful to examine office conditions with concepts from work stress research (De Croon et al., 2005; Herbig et al., 2016; Vischer, 2007). Applying such theories to work environments, Vischer (2007) defines workspace stress as discomfort that is produced when the work environment does not support the performance of work tasks but places excessive demands on workers, in spite of their coping efforts. A mismatch between the worker and work environment is, thus, at the heart of workspace stress.

The job demands-resources model of work stress (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) can also be applied to work environments. The model defines job demands as elements that require continuous physical or psychological effort which is associated with physiological and psychological costs. Environmental demands can increase self-reports of negative affect, and

impact motivation, performance and social relations negatively (McCoy & Evans, 2005). In order to cope with demands, individuals need resources, i.e. elements that support the achievement of work goals, reduce job demands and their negative physiological and psychological effects and stimulate personal development (Demerouti et al., 2001; Schaufeli & Bakker, 2004). The concepts of this model are compatible with Vischer's (2007) formulations of workspace stress.

The most often mentioned demands – or stress factors – in open-plan offices are lack of privacy, noise and other distractions (e.g., Bodin Danielsson & Bodin, 2009; Brookes & Kaplan, 1972; De Croon et al., 2005; Pejtersen et al., 2006; Sundstrom, Town, Rice, Osborn & Brill, 1994). Privacy refers to a sense of control over access to oneself or one's group (Altman, 1975). Perceived privacy is decreased by insufficient architectural visual and auditory isolation (Sundstrom, Burt & Kamp, 1980), making the individual susceptible to distractions. In offices, distractions mostly result from co-workers presence and behaviour, such as conversations (Banbury & Berry, 2005; Kaarlela-Tuomaala et al., 2009; Pierrette, Parizet, Chevret & Chatillon, 2015; Sundstrom et al., 1994) and movement in the space (Hongisto, Haapakangas, Varjo, Helenius & Koskela, 2016). Office noise is associated with physiological stress reactions (Evans & Johnson, 2000) and psychological costs (Haapakangas, Hongisto, Hyönä, Kokko & Keränen, 2014; Jahncke, Hygge, Halin, Green, & Dimberg, 2011), matching the definition of job demands by Demerouti et al. (2001).

Office distractions represent a possible mediating mechanism for the negative effects of open-plan offices because they are consistently observed in open-plan offices and co-occur with other complaints (e.g., Haapakangas et al., 2008; Pejtersen et al., 2006; Pierrette et al., 2015). This assumption is in line with the traditional sociotechnical approach to open-plan offices (Oldham & Brass, 1979) which assumes that removing physical barriers leads to perceived loss of privacy and autonomy which, in turn, elicits other negative consequences. Laboratory studies on the effects of office noise represent one line of research that supports this view (e.g., Haapakangas et al., 2014; Jahncke et al., 2011).

The role of distractions in other problems has been explored in a few field studies. The studies examining structural equation or mediation models have linked distraction-related variables to job satisfaction (Veitch, Charles, Farley & Newsham, 2007), self-rated health (Lee et al., 2016) and emotional exhaustion (Herbig et al. 2016; Laurence, Fried, & Slowik, 2013). However, all of these studies have been restricted to cross-sectional data. Showing that outcome variables are affected by *a change* in perceived office distractions would provide stronger evidence for the mediating role of distractions. A study by Sundstrom et al. (1994) is a rare example which demonstrated that environmental and job satisfaction decreased among employees who experienced an increase in noise after an office relocation, but not among others.

Based on the reviewed findings, we explore the assumption that office distractions mediate negative changes in other variables following a move to an open-plan office. In other words, an office relocation is expected to increase perceived distractions which, in turn, are expected to influence other outcomes negatively. This indirect effect through the mediator is represent as path *ab* in Figure 1a.

The outcomes that are considered in this study include satisfaction with the work environment as a whole (later: environmental satisfaction), which is considered an essential behavioural response to the physical environment (Vischer, 2007). As interpersonal relations can deteriorate after an office relocation (Kaarlela-Tuomaala et al., 2009; Oldham and Brass, 1979; Zalesny & Farace, 1987), perceived quality of collaboration (later: collaboration) is examined as an interpersonal variable that is relevant to the achievement of work goals and, thus, to workspace stress (Vischer, 2007). The perception of interpersonal relations is expected to be associated with perceived distractions because the latter largely result from co-workers' behaviour. Self-reported stress (later: stress symptoms) is used to assess the psychological costs of environmental demands. The following hypothesis is proposed.

Hypothesis 1. The negative effects of an office relocation (i.e., moving from private offices to an open-plan office) on environmental satisfaction, collaboration and stress symptoms are mediated by increased distractions (path a_1b_1 in Figure 1a).

The literature also includes views of open-plan layout as a resource. This assumption is central to the social relations approach (Oldham & Brass, 1979) which proposes that the absence of walls facilitates interaction in open-plan offices, eliciting other positive changes in work behaviour and employee perceptions. In this framework, the facilitated interaction is the mediating factor – the assumed cause for other positive effects. While open and shared workspaces continue to be favoured on the basis of such assumptions, the majority of studies has either found no evidence of such environment-interaction relation or has observed negative effects on interpersonal variables (Bodin Danielsson et al., 2015; De Croon et al., 2005; Kaarlela-Tuomaala et al., 2009; Kim & de Dear, 2013; Oldham & Brass, 1979; Pejtersen et al., 2006; Sundstrom et al., 1980). Evidence from Kim and de Dear (2013) suggests that the increase of noise and decrease in privacy outweigh any benefits related to the ease of communication in open-plan offices.

Interpersonal relationships are also associated with psychological symptoms independently of the physical environment. Poor interpersonal relations are associated with psychological and somatic symptoms (Frone, 2000; Lahtinen, Sundman-Digert, & Reijula, 2004) whereas social support has several positive roles in decreasing both the perception of stress and its negative effects (Viswesvaran, Sanchez & Fisher, 1999). Assuming that increased distractions impair collaboration (Hypothesis 1), stress symptoms could be increased not only because of distractions, but because of the deterioration in interpersonal relations. To our knowledge, this mechanism – involving both distractions and collaboration as mediators – has not been considered by any previous study. On the other hand, an office relocation could be expected to improve collaboration based on the social relations approach (Oldham & Brass, 1979). This might, in turn, decrease stress symptoms due to

increased social support (Karasek & Theorell, 1990; Viswesvaran et al., 1999). The following hypotheses are proposed to examine these possibilities.

Hypothesis 2. An increase in stress symptoms following an office relocation (i.e., moving from private offices to an open-plan office) is mediated by a negative effect of increased distractions on collaboration (path $a_1a_3b_2$ in Figure 1b).

Hypothesis 3. A reduction of stress symptoms following an office relocation is mediated by improved collaboration (path a_2b_2 in Figure 1b).

1.2 The role of office design

The design of office spaces contributes to the demands and resources created by the environment. Assuming distractions as a central source of demands, the provision of quiet workspaces is one way of increasing the resources needed by an individual. Such spaces tend to be included in modern office designs, referred to as activity-based (Appel-Meulenbroek, Groenen & Janssen, 2011) or flexible offices (van der Voordt, 2004). These offices provide a variety of workspaces for different activities, such as team work, concentration, speech privacy and impromptu collaboration.

Anonymous desks are typically used to facilitate workspace switching.

Quiet workspaces, such as soundproof booths or rooms, can also be adopted in more traditional open-plan offices. From the point of view of workspace stress (Vischer, 2007), the provision of such workspaces may improve the fit between the worker needs and work environment through several ways. The use of quiet rooms might increase functional comfort (i.e., the extent to which the environment supports work-related activities, Vischer, 2007), possibilities for coping with adverse environmental conditions (Lazarus & Folkman, 1984) and the perception of control over the environment (Lee & Brand, 2005). Perceived control over the work environment is assumed to decrease the effects of environmental demands (Vischer, 2007) and it is positively associated with social relations, environmental satisfaction and job satisfaction (Lee & Brand, 2005).

The benefits of quiet workspaces have not been directly investigated in open-plan offices. Some evidence from activity-based offices suggests that providing enclosed spaces for concentration is critical for environmental satisfaction in such offices (Brunia, De Been, & van der Voordt, 2016). The provision of quiet workspaces might also partly explain why activity-based offices generally yield better results in terms worker satisfaction and well-being than traditional open-plan offices (e.g., Bodin Danielsson & Bodin, 2009; Kim, Candido, Thomas, & de Dear, 2016). However, these results may as well stem from other differences between the office types. In addition, most employees do not actively switch workspace (Appel-Meulenbroek et al. 2011; Hoendervanger, De Been, Van Yperen, Mobach & Albers 2016). This might undermine the potential benefits of quiet work areas in open-plan offices.

In sum, the potential benefits of additional quiet workspaces are little-researched and unclear. Applying the frameworks of workspace stress (Vischer, 2007) and the job demands-resources model (Demerouti et al., 2001), we consider quiet rooms as a potential resource that may increase the fit between worker needs and the environmental conditions and increase the possibilities to cope with adverse environmental conditions. The following hypothesis is proposed.

Hypothesis 4. An open-plan office with more quiet rooms yields better results in terms of perceived distractions, environmental satisfaction, collaboration, and stress symptoms than an office with less quiet rooms.

Workers likely differ in their need for quiet workspaces due to differences in, e.g., noise sensitivity and working styles (Appel-Meulenbroek et al., 2011; Pierrette et al., 2015). Thus, the worker-work environment fit (Vischer, 2007) is not determined solely by the existence of quiet workspaces, but by an individual's perception of these spaces in relation to his/her needs. The following hypothesis is proposed.

Hypothesis 5. Workers, who perceive a better match between their needs for quiet rooms and the availability of such workspaces, experience higher environmental satisfaction, less distractions and stress symptoms, and better collaboration than workers who perceive a mismatch between quiet rooms and their needs.

1.3 The aims

This study is based on two case studies where workers moved from private offices (i.e., rooms of one person) to an open-plan office. In the initial analyses, the relocation resulted in environmental dissatisfaction in one organization, but not in the other, prompting this study to further examine the reasons behind different end-results.

Combining data from these case studies, the aim of this study is to investigate the role of distractions and quiet workspaces in explaining the effects of an office relocation on workers.

2 METHODS

2.1 Participating organizations

The data were initially gathered in response to the request of the organizations to monitor the environmental change, independent of each other. The respondents were informed that the data could be used for scientific research. The organizations later gave written consents for the use data in the present study.

Both organizations were from the Finnish public sector. Organization A belongs to a ministry of the government and works with the development of policies, public administration and legislation in its field of expertise. Of its 400 employees, nearly 190 belonged to the units involved in the office relocation. With approximately 130 employees, Organization B provides information services, such as data registers, for public authorities and companies. Both organizations were influenced by the Finnish Government Premises Strategy (2005) in which the target for the use of space in renovated

buildings was 25 m² per person. Enhancing collaboration and modernising the way of working were other goals in both organizations.

2.2 Procedure and the office relocation

The timeline of the office relocation and the study is shown in Figure 2. Questionnaire surveys were conducted twice: before the relocation (Time 1) and after the relocation (Time 2). Data was gathered by the researchers using an internet-based survey tool. Room acoustic measurements were conducted at both offices after the relocation.

In Organization A, the employees worked initially in four different buildings. One of the buildings was renovated and the employees from the other facilities moved there. The units that occupied the building moved to a temporary open-plan office for the renovation period. Before the renovation (Time 1), most employees had private rooms. A minority of employees worked in open-plan offices or shared office rooms. At Time 2, all employees had a fixed desk in an open-plan office. More flexible working was encouraged and the ICT and management were developed to support this. The relocation coincided with organizational changes during which some employees (39% of Time 2 respondents) moved to another unit.

In Organization B, the employees had private rooms in a spacious office building at Time 1. The organization moved to another building which was renovated before the move. In the new office, the majority of employees had a fixed workstation in an open-plan office but a few top managers had private offices.

In both organizations, the management made efforts to support personnel and increase employee participation during the change. The planning of the workspaces was, however, conducted without major participation by the employees. Remote work was more usual in Organization A before and after the office change but remote work was also adopted in Organization B. In both organizations, employees were allowed to personalize their workstations before and after the office relocation.

2.3 Workspaces in the new offices

Table 1 shows information about the workspace variety and space efficiency of the offices at Time 1 and Time 2. Layouts of the new offices are shown in Figure 3. The building of Organization A included altogether 11 open-plan areas. Each open-plan area was 6.5 metres wide and 18 - 28 metres long (17 to 26 workstations per area). The room height was 2.6 metres, except 3.6 metres on the ground floor. The workstations were arranged in groups of three and were completely open at the back (Figure 4). The screen height separating three workstations was 130 cm. In Organization B, two floors accommodated altogether 10 open-plan areas. Each of them was six metres wide and 6 - 32 meters long (4 to 24 workstations per area). The room height was 3.0 metres. The workstations were located on the window side of the passageways, two side-by-side (Figure 4). Screen height between workstations was 160 cm. The screens were sound-absorbing from the floor to a height 130 cm and transparent above.

The number and variety of alternative workspaces was higher in Organization A at Time 2 (Figure 3, Table 1). The differences concern particularly the provision of quiet rooms. There were several non-assigned rooms for quiet work near each open-plan office on each floor in Organization A. The design of these workspaces varied, including rooms of one, two and four users, and phone booths. The new office of Organization B included only one room for quiet work with workstations for eight users. This workspace was located at one end of the building and was meant to be used by employees from both floors. Space-efficiency was substantially higher in Organization B (Table 1.)

2.4 Participants

At Time 1, ninety-two employees participated in the survey in Organization A and 66 in Organization B. The corresponding response rates were 52% and 59%, respectively. At Time 2, one hundred thirty-five employees participated in Organization A (response rate 74%) and 85 in Organization B (response rate 65%). The differences between the Time 1 and Time 2 response rates are likely related to the environmental change: At Time 2, the respondents were likely more

motivated to evaluate their current work environment because the results could be used in its further development. The employees who worked in shared rooms or open-plan offices at Time 1 (27 participants in Organization A, two participants in organization B) or in private offices at Time 2 (one participant in organization B) were excluded from the study. Of the remainder, 42 participants (age: $M=51.0$, $SD=8.8$; 71.4% females) returned both surveys in Organization A and 49 participants in Organization B (age: $M=52.7$, $SD=10.1$; 66.7% females). These samples were used for the within-participants analyses of the change between Time 1 and Time 2. The samples used in the analyses of all respondents at Time 1 and Time 2 included 65 and 135 respondents in Organization A, and 64 and 71 respondents in Organization B, respectively. Descriptive statistics for the respondents are shown in Table 2.

2.5 Questionnaire measures

The original surveys covered several themes, including demographic data, work demands, mobility and multi-locational working (inside and outside the office), indoor environment, noise sources, visual and acoustic privacy, decoration, comfort, psychosocial environment, symptoms, use and perceptions of office spaces and perceptions of the office change. Many of the questions were adopted from Hongisto et al. (2016). As the studies were initially conducted independent of each other, the surveys differed slightly between the organizations. The items that did not provide additional information for the research questions of this study are not reported in the results.

For the purposes of the present paper, the items related to distractions, privacy, crowding, collaboration and stress were first identified (23 items). Principal component analysis with an oblique promax rotation was then used to reduce the number of variables. As the initial analyses produced different factor solutions between Time 1 and Time 2, variables were excluded until a consistent solution with adequate Cronbach's alphas for both organizations at both time points was extracted from 13 variables. Three composite variables were formed by averaging the included items (Table 3). *Environmental satisfaction* was not included in the principal component analysis

because it has been used as a single item in the literature (e.g., Hongisto et al., 2016). It was measured with one item (“How satisfied are you with your work environment as a whole?”) on a 7-point Likert scale (1 = Not at all satisfied, 7 = Very satisfied).

The variable labelled as *distractions* included six items measuring noise, other distractions and perceived privacy, focusing on the conditions at the respondent’s workstation. In addition, the disturbance of different *noise sources* was rated (Table 4) but these were not included in the composite variable due to differences between Time 1 and Time 2 questionnaires. *Collaboration* measured the perceived efficiency and pleasantness of collaboration in the office environment with three items. *Stress symptoms* included four items which did not refer to the work environment but measured recent complaints related to well-being.

The perceptions and use of alternative workspaces in the new office were measured with several items. The *need for quiet rooms* was measured with the question “Have you experienced the need to move from your desk to a more peaceful environment, e.g. for a task requiring concentration or a private discussion?” (1 = No; 2 = Only exceptionally; 3 = Yes, regularly). The *perceived accessibility of quiet rooms* was measured with one statement with a 5-point Likert scale (“If I cannot concentrate on my work at my own desk I can easily move to a quieter place.” 1 = Completely disagree, 5 = Completely agree). The frequency of *the use of alternative workspaces* was rated for six purposes, including personal phone calls, work-related phone calls, confidential conversations between supervisor and employee, scheduled meetings, impromptu meetings and tasks requiring concentration (1 = Never, 2 = Seldom, 3 = Every now and then, 4 = Often). A score for the *overall use of alternative workspaces* was formed as the sum of all ratings (max. 24), but *the use of workspaces for concentration* was also analysed separately.

Work characteristics were measured with two items. *Concentration requirements* were measured with a statement “The job involves periods of total concentration”. *Need for interaction* was measured with a statement “The job requires continuous interaction with other employees”.

Unfortunately, different response scales were used in the organizations (Organization A: 1 = Never, 4 = Very often; Organization B: 1 = Not at all, 5 = Very much) and in Organization A work characteristics were only assessed at Time 2.

In Organization A, the *benefits of the ICT to one's work in the new office* were assessed at Time 2 with a statement “The ICT eases and supports my work in these workspaces” (1 = Completely disagree, 5 = Completely agree).

2.6 Room acoustic design and measurements

Room acoustic design is applied in open-plan offices to improve speech privacy and decrease distraction by noise. Room acoustic measurements were conducted in both open-plan offices at Time 2 according to an international standard (ISO 3382-3, 2012). Table 5 shows the main outcomes, which are the distraction distance r_D , the spatial decay rate of A-weighted speech level $D_{2,s}$ [dB], the A-weighted level of speech at a 4-meter distance $L_{A,S,4m}$ [dB] and the background noise level caused by building services, $L_{A,B}$. The r_D is the most essential for the perception of noise (Haapakangas et al., 2017). The r_D describes how far from a single speaker the speech is distracting. Shorter distances indicate better acoustic conditions. The values of r_D have varied between 2.5 and 20 metres in different offices (Haapakangas et al., 2017; Keränen & Hongisto, 2013). Values below 8 metres can be considered good.

The room acoustic design of the open-plan offices included a sound-absorbing ceiling (class A, ISO 11654) with 80 % coverage and soft full-area carpet in both organizations. In Organization B, wall absorbents (Class A) were casually installed along the passageways and on the gable walls. Neither office included sound masking. Information on room dimensions and screens is provided in Section 2.3.

2.7 Statistical analysis

Statistical analyses were conducted with IBM SPSS Statistics 23 (Armonk, NY: IBM Corp).

Principal component analysis was used for forming composite variables (see Section 2.5).

Hypotheses 1-4 were examined with the repeated measures data, i.e. respondents who participated in both surveys. A quasi-experimental analysis of the effects of the office relocation was conducted including within-participants comparisons between Time 1 and Time 2 for both organizations using the Wilcoxon Signed Rank Test, and between-groups comparisons of the organizations at both times using the Mann-Whitney U Test. Non-parametric tests were chosen due to non-normality and skewness of variables. Effect size estimates were calculated using the formula $r = z/\sqrt{N}$ (Cohen, 1988) and can be interpreted as small ($r = .1$), medium ($r = .3$) or large ($r = .5$). The Kruskal-Wallis Test was used for the comparison of multiple groups, followed by paired comparisons with Bonferroni corrections. The associations between the perception of quiet rooms and the outcome variables (Hypothesis 5) were explored with all Time 2 respondents using correlations and between-groups comparisons.

Mediation analyses (Figure 1) were conducted within participants to determine whether a change in one variable (e.g., distractions) mediated the effect of office relocation on the outcome variable (e.g., stress symptoms). A path-analytic approach was applied using ordinary least squares (OLS) regression as illustrated by Montoya and Hayes (2017). The MEMORE macro for SPSS (Montoya & Hayes, 2017) was used to produce estimates of indirect (ab) and direct (c') effects based on difference scores (Time 2 - Time 1). Unstandardized coefficients are reported. The direct effect refers to the effect of X on Y that is not explained by the mediator. Bias-corrected bootstrap 95% confidence intervals (CI) for indirect effects were generated using 5,000 bootstrap samples. Mediation is established (i.e., statistically significant) when the bootstrapped 95% CI does not include zero. Mediation analyses were conducted also on nonsignificant findings because the lack of an overall effect does not exclude the possibility of mediated effects (MacKinnon, Krull, &

Lockwood, 2000). Mahalanobis distance with $p < .001$ was calculated to identify multivariate outliers before mediation analyses.

3 RESULTS

3.1 Preliminary analyses and descriptive results

Background information on the respondents is shown in Table 2. The organizations differed in terms of the education level ($p < .001$) and the length of service in the organization ($p < .01$) but were similar in terms of other demographic characteristics. The respondents that dropped out after Time 1 did not differ in terms of demographic factors or outcome variables from those who completed both surveys.

To characterize the perceived conditions in the open-plan offices, different sources of distraction and their correlations with the composite variable ‘distractions’ are shown in Table 4. The room acoustic measurement results in Table 5 indicate that the room acoustic quality was poor and very similar in both organizations. Table 6 presents correlations between the key outcome variables.

3.2 Effects of office relocation

Descriptive statistics and the results for comparisons between Time 1 and 2 are shown in Table 7.

The within-participant comparisons showed that, in Organization A, the relocation from private offices to an open-plan office resulted in increased distractions ($p < .001$). The effect can be considered large ($r = .47$). A small-to-medium-sized decrease was observed in stress symptoms ($p = .038$, effect size $r = .23$). Environmental satisfaction and collaboration did not change on average (both p 's $> .05$). However, a closer examination of the pattern of ranks (Wilcoxon Signed Ranks Test) showed two opposing patterns: Nearly half of the respondents (47-48%) experienced a decrease in these outcomes whereas, for 31-34% of the respondents, environmental satisfaction and collaboration improved.

In Organization B, a negative change was observed in all outcome variables. Environmental satisfaction ($p < .001$) and collaboration deteriorated ($p < .001$) while distractions ($p < .001$) and stress symptoms ($p = .006$) increased. Based on the effect size estimates (Table 7), the changes in distractions and environmental satisfaction were large while the other changes were of medium size. The comparisons between the organizations at Time 2 showed that all outcomes were more negative in Organization B compared with Organization A (all p 's $< .05$, Table 8). These differences do not reflect pre-existing differences as there was rather a tendency towards more positive perceptions in Organization B at Time 1 (Table 7).

3.3 Mediation analyses

3.3.1 Simple mediation models

The results of the simple mediation analyses (Figure 1a) are reported in Table 9. Mediation analyses were conducted separately for both organizations because the results of the office relocation differed between them (see Section 3.2).

Increased distractions mediated the decrease in environmental satisfaction in both organizations, that is, environmental satisfaction deteriorated due to increased distractions. The direct effects of office relocation on environmental satisfaction remained significant in both organizations but were of opposite directions (Org. A: $c' = 0.98$; Org. B: $c' = -1.39$). This means that, in Organization A, environmental satisfaction was also increased by unknown factors whereas, in Organization B, there were additional factors contributing to impaired satisfaction.

The relocation also impaired collaboration indirectly through increased distractions in both organizations. The direct effects were nonsignificant, suggesting that increased distractions were the primary mechanism for negative changes in collaboration.

Stress symptoms were increased due to increased distractions in Organization B. This indirect effect was not observed in Organization A. The direct effect was significant, suggesting that stress symptoms decreased in Organization A independently of changes in distractions.

In sum, the findings supported Hypothesis 1, as increased distractions mediated other outcomes in five out of six analyses.

3.3.2 Serial mediation model

A serial mediation model with distractions and collaboration as mediators (Figure 1b) was applied to test Hypotheses 2 and 3. In Organization A, no indirect effects on stress symptoms through the mediators were observed. The decrease in stress symptoms remained significant ($c' = -0.27$, $p = 0.02$), suggesting that it was independent of changes in distractions and collaboration. Thus, Hypotheses 2 and 3 were not supported in Organization A.

In Organization B, the effect of office relocation on stress symptoms was mediated by a serial path from distractions to collaboration ($a_1a_3b_2 = 0.19$, 95% bootstrap CI: 0.01-0.55) but not by either mediator alone, supporting Hypothesis 2.

3.3.3 Tests of alternative mediation models

As mediation models test a particular causal order, it is recommended to repeat the analyses with alternative orders of variables to rule out competing explanations (Hayes, 2013). This procedure supported the results from the serial mediation analyses and most of the simple models. Only the assumption that increased distractions mediate impaired environmental satisfaction was not supported.

3.4 The use and perception of quiet rooms

Finally, the use and perception of quiet rooms in the open-plan offices was explored with all Time 2 respondents. The overall use of alternative workspaces for a variety of purposes ($U = 1182.5$, $p < .001$), and the use of quiet rooms for concentration ($U = 2378.0$, $p < .001$) was more frequent in

Organization A. The perceived accessibility of quiet rooms correlated positively with environmental satisfaction (A: $r_s=.60$, B: $r_s=.62$, $p<.001$) and collaboration (A: $r_s=.56$, B: $r_s=.56$, $p<.001$) and negatively with distractions (A: $r_s= -.61$, B: $r_s= -.74$, $p<.001$) and stress symptoms (A: $r_s= -.28$, $p<.01$, B: $r_s= -.65$, $p<.001$). In other words, the employees who perceived they could easily switch to a quiet room when needed, tended to rate the outcome variables more positively.

To explore the relationship between the worker-work environment match and the different outcomes (Hypothesis 5), we formed three groups by combining information on the need for quiet rooms and the perceived accessibility of the rooms. The first group, labelled as ‘low need’, comprised respondents who did not experience a need to move to a quiet room, or did so only irregularly. Forty-one percent of respondents in Organization A and nearly 46 percent in Organization B belonged to this group. The respondents who reported a regular need for quiet rooms and perceived easy access to such workspaces were coded as the ‘matched need’ group (49% of respondents in Organization A, 9% in organization B). The third group (‘mismatched need’) comprised respondents who did not agree they could easily move to a quiet room despite regularly needing one (10% in Organization A, 45% in organization B).

The non-parametric Kruskal-Wallis Test showed that the three groups differed in all outcome variables in both organizations. As the general pattern in Figure 5 and Table 10 shows, the results are more negative for the ‘mismatched need’ group in comparison to the two other groups. These results support Hypothesis 5. The ‘low need’ and ‘matched need’ groups did not differ from each other.

Further analyses showed that the ‘mismatched need’ group was characterized by higher concentration demands than the ‘low need’ group (A: $p<.05$, B: $p<.001$). It should be noted that in Organization B, in which work demands were measured at Time 1 and Time 2, concentration demands did not increase after the relocation ($p>.05$). Thus, the perception of concentration demands of work at Time 2 does not seem to have been confounded by increased environmental

distractions. In Organization A, the ‘mismatched need’ group found the ICT less supportive for working in the new office than the other groups ($p < .05$).

4 DISCUSSION

The purpose of this study was to examine the role of distractions and quiet workspaces in explaining the effects of an office relocation on workers. Applying concepts from work stress research (Demerouti et al., 2001; Vischer 2007), distractions were considered as environmental demands whereas quiet rooms were viewed as potential resources that could decrease negative reactions to the work environment.

A quasi-experimental analysis of two office relocations showed that moving from private offices to an open-plan office resulted in several negative outcomes in the organization where the number of quiet rooms was low. Increase in perceived distractions mediated the negative effects of office relocation on collaboration and stress symptoms, i.e., collaboration and stress symptoms were affected due to increased distractions. Extensive provision of quiet workspaces, as well as the match between the employee needs and the perceived ease of access to such spaces, was associated with less distractions, less stress symptoms, higher satisfaction with the environment and better perception of collaboration.

4.1 The role of distractions

According to the present results, office distractions can be considered as environmental demands that may lead to other negative effects in open-plan offices. Noise, co-workers’ conversations and lack of speech privacy emerged as the main environmental complaints in both offices (Table 4). The room acoustic measurement results were poor in both offices, suggesting that the speech of a single worker was likely distracting to all workers occupying the same office space. These results are in line with previous evidence portraying the acoustic environment as a key source of dissatisfaction in open-plan offices (Bodin Danielsson & Bodin, 2009; Kaarlela-Tuomaala et al., 2009; Pejtersen et

al., 2006; Veitch et al., 2007). The negative outcomes observed in Organization B are similar to previous office relocation studies (e.g., Oldham & Brass, 1979; Bergstrom et al., 2015; Kaarlela-Tuomaala et al., 2009). The observed relations between distractions, collaboration and stress symptoms support the view that office distractions contribute to job demands in open-plan offices. To date, only a few studies have examined distraction-related variables as a possible mechanism explaining other outcomes in open-plan offices (Herbig et al., 2016; Laurence et al., 2013). The present study extended these findings to within-participant changes in a context of an environmental change, suggesting that office distractions contribute to the emergence of stress symptoms and the deterioration of collaboration in open-plan offices. Thus, Hypothesis 1 was supported. The mediating role of distractions was further supported by the finding that this mechanism emerged in both organizations despite their different overall results. These results are compatible with the sociotechnical approach to open-plan offices which views the decrease in privacy as an explaining factor for other negative effects (Oldham & Brass, 1979).

Perceived distractions and environmental satisfaction were highly associated in the open-plan offices (Table 6). Thus, a mediation model does not seem appropriate for describing their relation. Distractions and environmental satisfaction may have rather measured the same aspects of the open-plan offices. Satisfaction with privacy and acoustic conditions seems to have a larger impact on environmental satisfaction than other environmental factors (Kim & de Dear, 2013; Veitch et al., 2007). The strength of the relationship between distractions and environmental satisfaction may have been increased by the research context where an increase in distractions took place.

The results supported Hypothesis 2, showing that stress symptoms increased due to the association between increased distractions and impaired collaboration, not due to increased distractions alone. From the point of view of the job demands-resources model (Demerouti et al., 2001), the negative effects on stress symptoms were, thus, related to both increased demands (distractions) and decreased resources (collaboration). Multiple mechanisms have not been tested in previous studies

although Herbig et al. (2016) tested several mediators separately. Our study demonstrates the importance of considering parallel mediators, as it can further specify the mechanisms involved and enable a simultaneous test of different explanations.

While the results support the view that distractions can lead to impaired collaboration and stress symptoms, the exact mechanisms still remain unclear. Collaboration might have been diminished because of impaired inter-personal relations (Bodin Danielsson et al., 2015) or simply because interaction was decreased, for example, due to a concern of disturbing others (Parkin, Austin, Pinder, Baguley, & Allenby, 2011). In addition, impaired collaboration may not be a source of stress but may rather reflect diminished social support that moderates the effects of environmental and other stressors (Karasek & Theorell, 1990; Viswesvaran et al., 1999). The associations between distractions, interpersonal variables and employee well-being should be further examined in other studies.

Positive effects of the office relocation were also observed. Stress symptoms decreased in Organization A and environmental satisfaction and perceived collaboration improved among a minority of respondents. These changes are compatible with the social relations approach (Oldham & Brass, 1979). It is possible that open-plan offices provide job resources in some circumstances or for specific subgroups, even though most studies have not observed such effects on a general level (De Croon et al., 2005; Kim & de Dear, 2013; Pejtersen et al., 2006). However, the mechanisms explaining these changes were not identified. Hypothesis 3 was not supported as enhanced collaboration did not explain the decrease in stress symptoms in Organization A. It is, therefore, also possible that the observed positive changes originated from other coinciding factors. Future studies should attempt to identify factors that explain positive outcomes in open-plan, and activity-based, offices. Longitudinal studies should also include the investigation of possible subgroups because the average results may mask opposite patterns, as demonstrated by our study.

4.2 Benefits of quiet workspaces

The results supported the benefits of quiet rooms, in line with Hypothesis 4. The physical differences between the studied open-plan offices were obvious (Table 1, Figure 3): the workers in Organization A had multifold quiet rooms, different types of quiet workspaces and a shorter distance to these spaces compared to Organization B. Despite the increase in perceived distractions, no other negative changes emerged in Organization A whereas all outcomes deteriorated in Organization B. This pattern of results suggests that quiet workspaces operate as a moderating factor between office conditions and their effects on employees.

These results supports the view of quiet workspaces as a job resource that enables better coping and improves the worker-work environment fit in open-plan offices. Brunia et al. (2016) have drawn similar conclusions on the design of flexible offices. Our findings are also consistent with Hoendervanger et al. (2016) who showed that the frequency of workspace switching is not associated with environmental satisfaction as such. In the light of the present results, the match between the need for quiet spaces and the perceived availability of such workspaces seems more critical for employee outcomes. Thus, the results support Hypothesis 5.

In addition to the physical office features, the match between the worker needs and quiet workspaces was associated with some individual and job-related differences. Higher concentration demands were associated with a mismatch between the worker needs and perceived accessibility of quiet workspaces. Other studies have also observed that employee responses to low privacy and office distractions may be modified by concentration requirements (Seddigh, Berntson, Bodin Danielsson & Westerlund, 2014) and task complexity (Block & Stokes, 1989; Maher & Hippel, 2005). Over 40% of employees did not regularly need quiet rooms. This finding may reflect individual differences in inhibitory ability (Maher & Hippel, 2005), noise sensitivity (Pierrette et al., 2015) and personal preferences in workspace use (Appel-Meulenbroek et al., 2011) as well as job-related differences in task variety (Hoendervanger et al., 2016) and mobility patterns (Greene &

Myerson, 2011). The perception of the ICT was also associated with the outcomes. The flexible switching of workspaces relies on successful implementation and use of advanced ICT (e.g., Blok, Groenesteijn, Schelvis, & Vink, 2012; van der Voordt, 2004). It is possible that difficulties in adopting new work styles and acquiring relevant technical skills may have prevented some workers from benefiting from the office design.

4.3 Limitations

The limitations of our study are related to field experiments in general. As in all relocation studies, causal inferences are weakened by the possibility of confounding factors. The analyses on the use and perception of quiet rooms (Section 3.4, Hypothesis 5) are based on correlational data and describe associations, not causal relations. The mediation analyses provide support for several assumed causal paths but these methods do not as such prove causality. The limitations of our research design are particularly relevant for the few positive effects observed in Organization A as there may be other explanations for the findings. Our study has advantages over earlier mediation studies based on cross-sectional data (e.g., Herbig et al., 2016) but the design could be further improved by including a third measurement point (Time 3) and examining whether increased distractions at Time 2 would mediate any long-term effects, such as stress symptoms.

Only two organizations from the public sector were examined which restricts the generalizability of the conclusions. On the other hand, the inclusion of two comparable organizations is also a strength because relocation studies typically involve only one workplace.

A few issues related to the office design should also be mentioned. First, some of the differences in the results may also be related to space-efficiency. Organization B experienced a larger change in the amount of space and had higher space-efficiency (i.e., less space per person) at the new office (Table 1). As satisfaction with the amount of space is a key determinant of workspace satisfaction (Kim & de Dear, 2013), differences in space-efficiency may contribute to the observed dissatisfaction in Organization B and the different outcomes between the organizations. However,

space-efficiency is not completely independent of the key variable 'distractions' because distractions caused by co-workers are increased when more people are occupying the same space.

Finally, the measure for distractions focused on workstations where the workers spent most of their time. However, distractions may also be perceived in quiet rooms. This might affect environmental perceptions and other outcomes, and the use of such workspaces. It is possible that the quiet workspace of eight users in Organization B was not perceived as private as the smaller rooms provided in Organization A. Future studies should pay more attention to the design and conditions of quiet rooms, not only their number.

4.4 Practical implications

The results can be applied to the design of open-plan and activity-based offices. Addressing worker needs for privacy is essential for the positive perception of the work environment. The worker-work environment fit can be supported by an office design which includes plenty of quiet workspaces. Attention should be paid to the ease of workspace switching which requires that quiet workspaces are located near all workstations. Developing the ICT hardware and applications and supporting employees to adopt more mobile working styles may also be necessary.

However, the possibility to use quiet workspaces may not provide sufficient privacy for all workers, particularly if the concentration requirements of the job are high. Other arrangements, such as long-term reservations of quiet rooms, might be a means to improve possibilities for concentration in such cases.

As office distractions are mainly auditory, room acoustic design is also needed to improve the work conditions in open-plan offices (Haapakangas et al., 2014, 2017; Hongisto et al., 2016). The provision of quiet workspaces and room acoustic design should not be viewed as alternatives but used in combination.

5 Conclusions

Distractions are a central source of environmental demands in open-plan offices. Relocation from private office rooms to an open-plan office can have negative effects on perceived distractions, environmental satisfaction, perceived collaboration and stress symptoms. However, providing quiet workspaces that are easily accessible decreases and possibly prevents these problems. Employee needs for concentration and privacy should have more priority in the design of open-plan offices.

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FIGURES AND TABLES

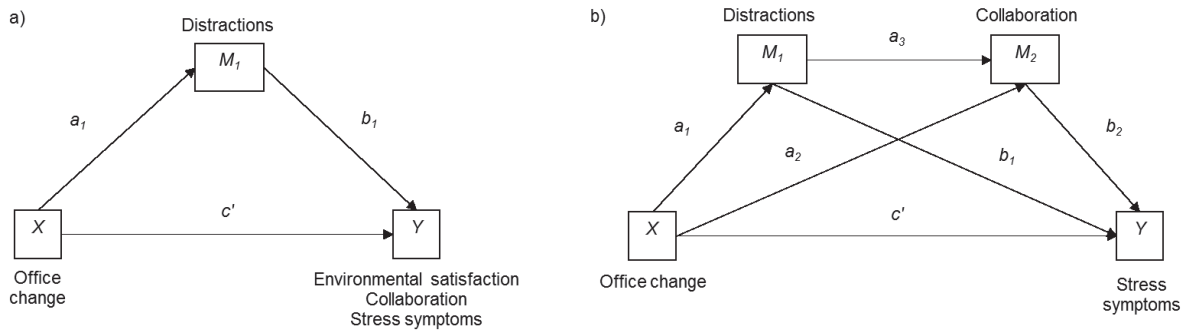


Figure 1. The simple mediation model (a) and the serial mediation model with two mediators and three mediated paths (b) that are examined in this study. The models test indirect path(s) for the effect office relocation (X) on the outcome variable (Y) through a change in the mediator(s). c' = direct effect, controlling for the mediator(s).

TIMELINE

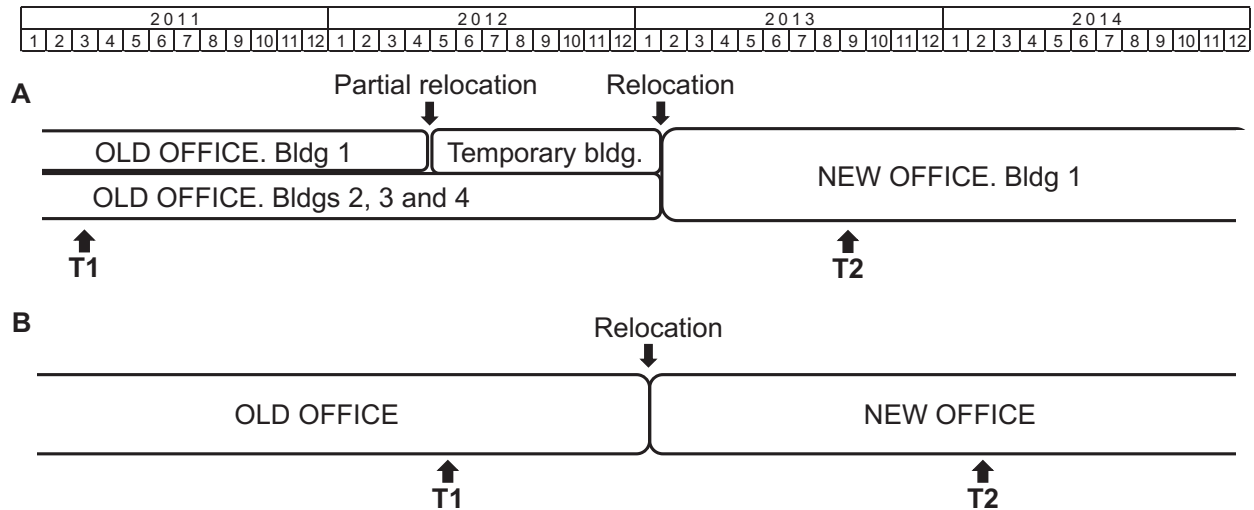


Figure 2. The timeline of the office relocation (i.e., moving from private offices to an open-plan office) and data gathering in Organizations A and B. Time 1 and Time 2 surveys are indicated with T1 and T2.

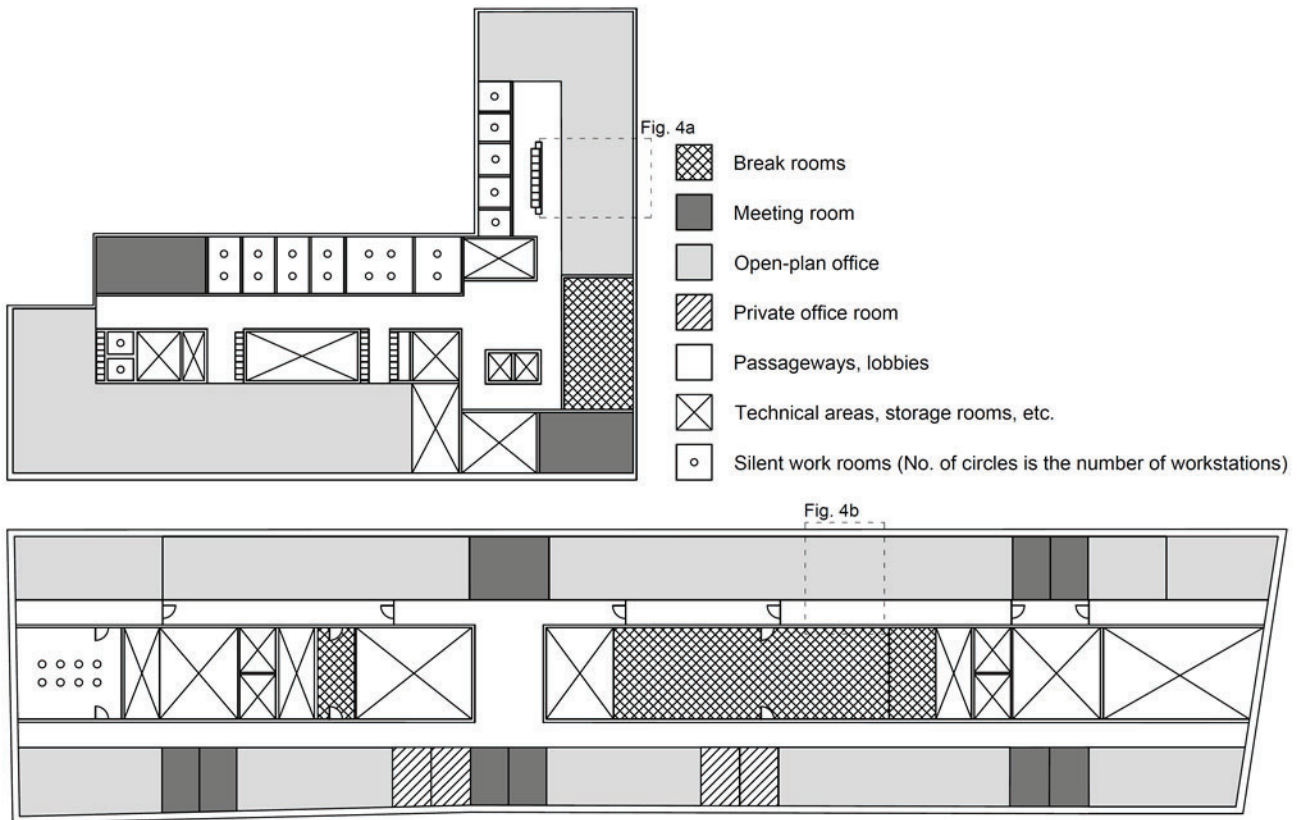


Figure 3. Schematic floor layout of organizations A (above) and B (below) after the relocation (Time 2). These layouts represent only a part of the total rented floor area. Mutual dimensions are in scale.

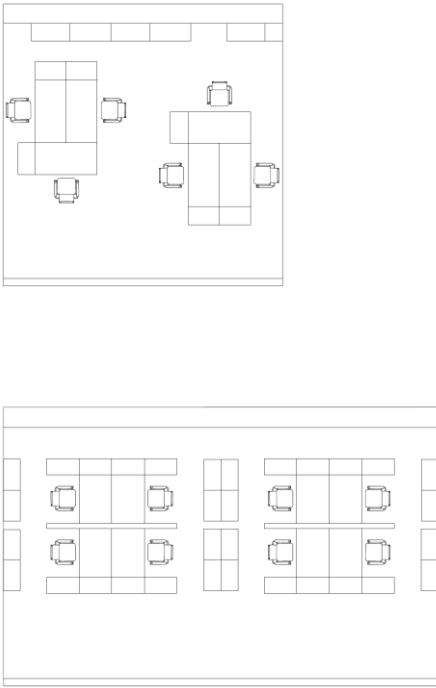


Figure 4. Workstation layout in the open-plan offices in organizations A (above) and B (below) after the relocation (Time 2). Mutual dimensions are in scale.

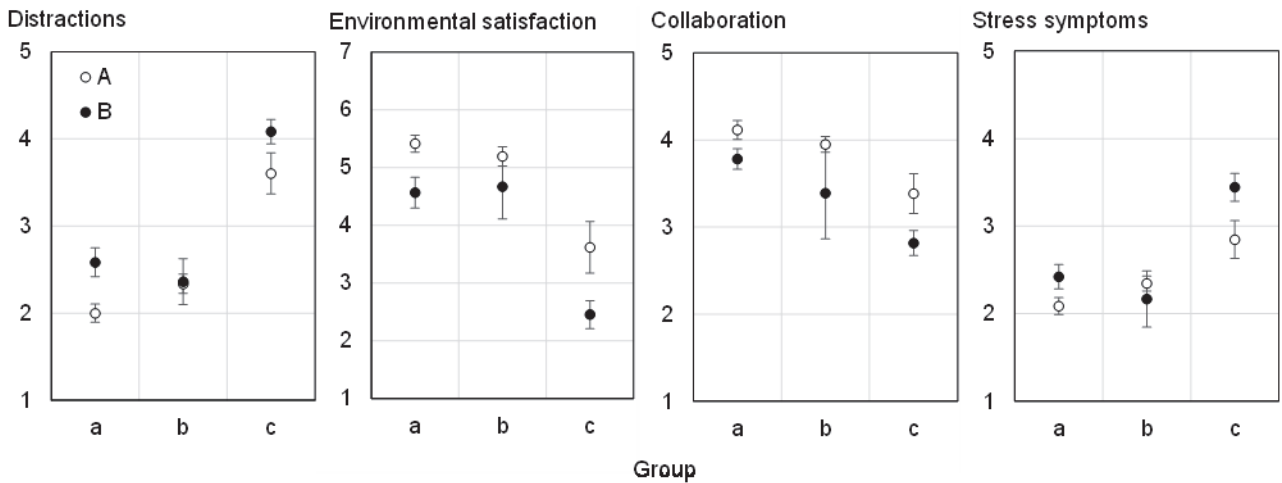


Figure 5. Means and standard errors for the groups differing in worker-work environment fit.

Groups: a = low need, b = matched need, c = mismatched need. The explanations of the groups are in Section 3.4. Results of statistical comparisons are reported in Table 10.

Table 1. Basic information on the offices before (T1) and after (T2) the relocation in Organizations A and B.

	Organization A		Organization B	
	T1*	T2	T1	T2
No. of workstations in open-plan offices	42	204	0	114
No. of workstations in private office rooms	169	0	115	4
No. of workstations in shared office rooms (2-3 employees/room)	41	4	0	0
No. of large meeting rooms (>6 persons)	21	16	13	5
No. of small meeting rooms	2	8	0	11
No. of team/creative work rooms	2	5	5	1
No. of quiet rooms (for concentration and privacy)	9	54	1	1
No. of workstations in quiet rooms	9	81	0	8
No. of break rooms	6	6	5	4
No. of floors	1, 1, 5 & 8	8	6	3
Space efficiency 1 (Square metres per person) **	47	36	54	25
Space efficiency 2 (Square metres per workstation)				
***	31	33	53	24

The table excludes subsidiary spaces such as storage rooms, sanitary, technical rooms and parking.

* Aggregate data of four different buildings in T1.

** The ratio of total rented area (including the subsidiary spaces) and the number of employees.

*** The ratio of total rented area and the number of workstations.

Table 2. Descriptive statistics for the study participants at Time 1 and Time 2.

Characteristic	<u>Organization A</u>		<u>Organization B</u>	
	Time 1	Time 2	Time 1	Time 2
N	65	135	64	71
Age, <i>M (SD)</i>	50.2 (10.1)	46.6 (10.3)	51.0 (10.3)	50.9 (10.8)
Age, range	27-67	22-65	28-65	30-67
Gender, % female	70.8	61.5	62.5	62.9
Education, % bachelor's degree or higher	87.7	89.7	63.4	65.8
Service in the organization, years, <i>M (SD)</i>	13.1 (11.7)	9.9 (9.6)	19.2 (13.6)	17.4 (13.1)
Supervisory position, %	15.4	11.3	23.1	20

Table 3. The composite variables of the study.

Variable	Cronbach's α			No. of items	Included items	Question	Scale
	Org.	T1	T2				
Distractions	A	0.82	0.91	6	Noise, sound conditions	A	a
	B	0.76	0.91		Lack of speech privacy	A	a
					Feeling that there are too many people occupying the space	A	a
					Movements in the field of vision (such as other people)	A	a
					There are many distractions here.	B	b
					I have sufficient privacy for working. ¹	B	b
Collaboration	A	0.77	0.88	3	The atmosphere is nice and relaxed here.	B	b
	B	0.86	0.81		It is easy to contact one's colleagues in this environment.	B	b
					The workplace is characterized by a cooperative spirit.	B	b
Stress symptoms	A	0.70	0.77	4	Tiredness	C	c
	B	0.79	0.87		Headache	C	c
					Problems with motivation	C	c
					Problems with concentration	C	c

Org.: organization, T1: Time 1, T2: Time

2

A: How much have you been negatively affected by the following work environment factors at your workstation recently?

B: How do you view the following statements concerning your work environment?

C: How often have you experienced any of the following symptoms or feelings recently?

a: 1 Not at all, 2 Only slightly, 3 To some extent, 4 To a great extent, 5 To a very great extent

b: 1 Strongly disagree, 2 More of less disagree, 3 Neither agree nor disagree, 4 More or less agree, 5 Strongly agree

c: 1 Never, 2 Only rarely, 3 Occasionally, 4 Often, 5 Very often

¹Reverse-

scored

Table 4. Distraction caused by different sources at the workstation and their correlation (Pearson's coefficient r) with the composite variable for distraction at Time 2.

Item	Organization A		Organization B	
	<i>M (SD)</i>	<i>r</i>	<i>M (SD)</i>	<i>r</i>
Noise, sound conditions (in general)*	2.5 (1.1)	0.87	3.3 (1.3)	0.9
Sound of air conditioning	1.3 (0.6)	0.27	1.7 (1.0)	0.36
Sound of office equipment	1.3 (0.6)	0.29	1.6 (0.9)	0.48
Phones ringing	1.9 (0.8)	0.45	2.2 (1.1)	0.65
Speech from nearby workstations	2.4 (1.1)	0.73	3.1 (1.3)	0.79
Speech from common spaces	1.9 (1.0)	0.56	2.7 (1.4)	0.73
Sound of footsteps	1.7 (0.9)	0.61	2.5 (1.3)	0.67
Sounds of others working	1.7 (0.9)	0.58	2.1 (1.2)	0.60
Too many people, crowdedness*	1.7 (1.0)	0.84	2.8 (1.5)	0.86
Other workstations too close	2.7 (1.3)	0.77	3.5 (1.4)	0.70
Movement in the field of vision*	2.0 (1.1)	0.84	2.9 (1.5)	0.87
Lack of speech privacy*	2.5 (1.2)	0.79	3.2 (1.4)	0.81

Scale: 1 Not at all, 5 Very much

* included in the composite variable 'distractions'

Table 5. Room acoustic measurement results of the open-plan offices of organizations A and B at Time 2. N = the number of measurements, M = mean of all measurements, R = the range of measured results. The quantities are explained in Section 2.6.

		A	B
	N	5	7
r_D [m]	M	14	12
	R	13 ... 15	11 ... 13
$D_{2,S}$ [dB]	M	8.0	7.5
	R	5.5 ... 8.5	7.0 ... 8.7
$L_{A,S,4m}$ [dB]	M	49	45
	R	47 ... 50	44 ... 47
$L_{A,B}$ [dB]	M	32	29
	R	31 ... 34	28 ... 30

Table 6. Associations between outcome variables at Time 1 (T1) and Time 2 (T2) in the within-subject samples in Organization A (n=42) and B (n=49). Pearson's correlation coefficients are reported.

Org.	Variable	1	2	3	4	5	6	7	8
A	1 Age (T1)								
	2 Environmental satisfaction (T1)	.34 *							
	3 Distractions (T1)	-.07	-.37 *						
	4 Collaboration (T1)	-.18	.44 **	-.34 *					
	5 Stress symptoms (T1)	-.14	-.55 ***	.52 ***	-.40 **				
	6 Environmental satisfaction (T2)	-.36 *	.17	-.10	.23	-.26			
	7 Distractions (T2)	.22	-.09	.37 *	-.04	.35 *	-.76 ***		
	8 Collaboration (T2)	-.18	.15	-.31 *	.23	-.33 *	.66 ***	-.72 ***	
	9 Stress symptoms (T2)	-.02	-.29	.42 **	-.27	.64 ***	-.47 **	.54 ***	-.58 ***
B	1 Age (T1)								
	2 Environmental satisfaction (T1)	.29							
	3 Distractions (T1)	-.13	-.14						
	4 Collaboration (T1)	.16	.61 ***	-.29 *					
	5 Stress symptoms (T1)	-.16	.04	.16	.04				
	6 Environmental satisfaction (T2)	.00	-.21	-.23	-.06	-.29 *			
	7 Distractions (T2)	-.12	.32 *	.16	.17	.32 *	-.83 ***		
	8 Collaboration (T2)	-.21	-.31 *	-.15	-.08	-.27	.67 ***	-.58 ***	

9	Stress symptoms (T2)	-0.09	.34 *	.03	.34 *	.49 ***	-.61 ***	.71 ***	-.58 ***
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* $p < .01$, ** $p < .01$, *** $p < .001$

Table 7. Within-participants comparisons between Time 1 and Time 2 in both organizations (N=42-49).

Variable	Time 1	Time 2	<i>z</i>	<i>p</i>	Effect
	<i>M (SD)</i>	<i>M (SD)</i>			size <i>r</i>
<u>Organization A</u>					
Distractions ¹	1.7 (0.6)	2.4 (1.0)	-4.30	<.001	0.47
Environmental satisfaction ²	5.1 (1.3)	4.8 (1.4)	-1.03	n.s.	0.12
Collaboration ¹	3.9 (0.8)	3.8 (0.8)	-1.38	n.s.	0.15
Stress symptoms ¹	2.4 (0.6)	2.2 (0.7)	-2.07	0.04	0.23
<u>Organization B</u>					
Distractions ¹	1.6 (0.6)	3.2 (1.2)	-5.67	<.001	0.58
Environmental satisfaction ²	6.2 (0.8)	3.7 (1.9)	-5.17	<.001	0.55
Collaboration ¹	4.1 (0.7)	3.4 (0.9)	-3.60	<.001	0.37
Stress symptoms ¹	2.5 (0.7)	2.8 (1.0)	-2.74	0.006	0.28

¹Scale 1-5, ²Scale 1-7

Table 8. The comparisons between the organizations at Time 1 and Time 2. Results are based on within-participants data (N=42-49). Means and standard deviations are reported in Table 7.

Variable	<i>U</i>	<i>z</i>	<i>p</i>	Effect size <i>r</i>
<u>Time 1</u>				
Distractions	846.5	-1.32	n.s.	0.14
Environmental satisfaction	450.5	-4.25	<.001	0.46
Collaboration	872.5	-1.11	n.s.	0.12
Stress symptoms	934.5	-0.6	n.s.	0.06
<u>Time 2</u>				
Distractions	636.0	-3.01	0.003	0.32
Environmental satisfaction	626.5	-2.81	0.005	0.30
Collaboration	738.5	-2.34	0.019	0.25
Stress symptoms	626.5	-3.10	0.002	0.33

Table 9. The results of the simple mediation models with increased distractions as the mediator.

Unstandardized coefficients with bootstrap 95% confidence intervals for the indirect effects (a_1b_1) and p-values for the direct effects (c') are reported. Statistically significant effects are indicated with a bold font.

Outcome	Organization A		Organization B	
	a_1b_1 (95% CI)	c' (p)	a_1b_1 (95% CI)	c' (p)
Environmental				
satisfaction	-1.23 (-1.92; -0.68)	0.98 (.002)	-1.17 (-2.04; -0.47)	-1.39 (<.001)
Collaboration	-0.41 (-0.75; -0.16)	0.26 (>.05)	0.74 (-1.48; -0.27)	0.02 (>.05)
Stress				
symptoms	0.09 (-0.05; 0.25)	-0.29 (.014)	0.59 (0.13; 1.17)	-0.19 (>.05)

Table 10. The statistical significance (p) and effect sizes (r) for the paired comparisons of the groups differing in worker-work environment fit (see Figure 9). Bonferroni corrections have been applied to p-values. Groups: a = low need, b = matched need, c = mismatched need. *p<.05, **p<.01, ***p<.001

Organization	Comparison	Environmental							
		Distractions		satisfaction		Collaboration		Stress symptoms	
		<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>
A	a vs. b	ns	0.19	ns	0.08	ns	0.15	ns	0.18
	a vs. c	***	0.56	***	0.47	**	0.38	*	0.35
	b vs. c	***	0.44	**	0.36	*	0.27	ns	0.22
B	a vs. b	ns	0.09	ns	0.03	ns	0.04	ns	0.12
	a vs. c	***	0.67	***	0.60	***	0.55	***	0.52
	b vs. c	**	0.57	**	0.49	ns	0.27	*	0.46