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The association between office design and performance on demanding cognitive tasks

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ABSTRACT

The physical office environment has been shown to be associated with indicators of both health and performance. This study focuses on how memory performance is affected in normal working conditions compared to a quiet baseline (with low amount irrelevant stimuli) in different office types, including cell offices, small open-plan offices, medium-sized open-plan offices and large open-plan offices. The results showed that the drop in performance from the quiet baseline to normal working conditions was higher in larger, compared to smaller, open-plan offices. However, contrary to our hypothesis we found that cell offices might have negative effects on performance comparable to those of large open-plan offices. These results indicate that employees in small open-plan offices, in comparison to large, have better possibilities to conduct cognitively demanding tasks and that cell offices might not be as advantageous as previously thought.

1. Introduction

1.1. Backgrounds

The choice of office design depends for many organizations on both economic incentives and ideas about performance. Although research shows mixed results (De Croon, Sluiter, Kuijer, & Frings-Dresen, 2005), it is a widespread idea that communication improves in open-plan offices in comparison to cell offices. With the easily calculated workspace cost constituting the second largest financial overhead for most organizations (McCoy & Mitchell, 2005) it is common that managerial boards consider more dense workspaces at times of office relocation. Although it has been suggested that the office design may explain up to 15% of employees' performance (Leaman & Bordass, 1999), measures of performance for white-collar workers are usually more difficult to assess than workspace costs. This impedes estimation of the financial consequences of removing the walls and implementing an open-plan office design.

Nevertheless, open-plan office environments have been associated with lower employee satisfaction, decreased internal work motivation (De Croon et al., 2005; Oldham & Brass, 1979) and higher levels of distraction (Seddigh, Berntson, Bodin Danielson, & Westerlund, 2014). Results have also shown that employees in cell offices report being less distracted compared to employees in open-plan offices (McElroy & Morrow, 2010; Seddigh et al., 2014). These results indicate that respondents' self-reported performance and well-being is negatively affected by open-plan office designs. Seddigh et al. (2014) also observed a dose-response tendency between the size of the open-plan office and self-rated health and performance outcomes. This relationship implies that larger open-plan office environments may have a more negative effect on employees in comparison to smaller ones, which possibly might be due to a higher prevalence of irrelevant stimuli as the number of people working in open-plan offices increases.

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Although surveys can be used to assess general subjective performance they are dependent on the individuals' ability to recall and reflect on past behaviours. People might also have different criteria for what is a good or bad performance. The more specific aspect the items try to capture and the longer time in between behaviours of interest and the administration of the survey, the better recall and devotion is required from the respondent to make a valid evaluation of his or her performance. Therefore survey responses may be confounded. These factors risk to mask any existing relation between the size of the open-plan office and performance and could possibly explain why only a trend towards such a relation was found in the aforementioned study by Seddigh et al. (2014).

Consequently, in order to capture the effects of office design on employee performance other measurements are needed. In this respect, behavioural tests, such as specific cognitive tests that require higher cognitive processes, can capture the immediate effect of irrelevant stimuli on task completion in a much more objective manner. In the present study we therefore used a cognitively demanding task called immediate free recall with a repeated within-subjects design with the aim to investigate the effect of office design during normal working conditions, in comparison to quiet baseline conditions, on employees' performance on cognitively demanding tasks.

1.2. Irrelevant stimuli and performance

Several lines of research have suggested that arousal or contextual events affect work performance (Cohen, 1978; Yerkes & Dodson, 1908; Zajonc, 1965). The social facilitation theory of Zajonc (1965) suggests that arousal usually is associated with improved performance when the task is simple and with impaired performance when the task is demanding. Also recent research within neuroscience suggests the benefit of arousal for conducting simple tasks (Faisal, Selen, & Wolpert, 2008; McDonnell & Ward, 2011). Thus, when working with a fairly simple task, the stimulation from a noisy environment would cause arousal and could actually help the individual improve his or her performance. However, arousal is suggested to have a negative effect on performance if the individual is conducting a difficult or demanding task. From a different perspective Cohen (1978) suggests that cognitive overload compels humans to focus their limited attention capacities on those stimuli that are most important for task completion and devote less focus on less relevant stimuli. In contrast to simple tasks, demanding tasks require more elaborative processing which cannot be mastered when the load on the attention resources are already high. Consequently, while irrelevant stimuli are less prone to induce cognitive overload when the task is simple, the theory suggests that performance on a demanding task will drop due to depletion of processing capacity.

Yet another line of research is that on working memory. Demanding tasks rely on a set of cognitive processes also called executive functions (EF). EFs refer to a set of top-down mental processes needed for concentration and attention, and consequently also for performance. There are three core EFs: inhibition, working memory and cognitive flexibility (Diamond, 2013). Inhibition concerns the capacity to suppress responses (or neural activations). Working memory reflects the ability to maintain representations in a highly activated state, consciously available for processing and manipulation. Cognitive flexibility concerns the ability to shift attention between different sets (e.g. different rules of responding). These functions enable many demanding mental processes such as reading, staying focused, shifting focus when needed, understanding complex information or resisting temptations (Diamond, 2013; Miyake & Friedman, 2012). When these functions are not heavily loaded by demanding work tasks, more cognitive resources are available to suppress irrelevant stimuli. However, when the task is complex and cognitively demanding, less capacity is available to suppress irrelevant stimuli, which increases the risk for being distracted, leading to poorer performance (Lavie, Hirst, de Fockert, & Viding, 2004).

Thus, these theoretical frameworks suggest that work in open-plan offices, may decrease performance of demanding tasks, whereas such environments may stimulate or at least not intervene with the completion of simple tasks.

1.3. The distinction between laboratory and field research

Indeed, laboratory researchers have studied the demands put on cognition by irrelevant stimuli such as noise and irrelevant speech, but also other environmental stressors, such as heat, and visual distractions, by asking the respondent to conduct different types of cognitive tasks during exposure to these stressors (Bell, 1978; Berti & Schröger, 2001; Chen, Dai, Sun, Lin, & Juang, 2007; Clausen & Wyon, 2008; Hygge & Knez, 2001; Jahncke, Hygge, Halin, Green, & Dimberg, 2011; Knez & Hygge, 2002; Liebl et al., 2012; Loewen & Suedfeld, 1992; Witterseh, Wyon, & Clausen, 2004). Some of them have simulated conditions of open-plan office environments in laboratory settings (Jahncke et al., 2011; Liebl et al., 2012; Witterseh et al., 2004). In general these results indicate that exposure to higher levels of heat, visual distraction, irrelevant speech and noise is associated with decrements in cognitive performance and negatively impact tasks relying on the same working memory processes (Jahncke et al., 2011; Jones & Morris, 1992; Smith-Jackson & Klein, 2009; Szalma & Hancock, 2011). Furthermore, classical studies of working memory performance have also shown this vulnerability to disturbances (Repovs & Baddeley, 2006).

However, the generalizability of experimental findings to real office environments and office workers could be questioned due to several reasons. In fact in a review article Purvanova (2014) presented results that clearly show that experimental research investigating the performance of virtual teams often find the opposite results to field research. The contradicting results are suggested to arise because such experiments are often conducted on undergraduate students during a short period of time. In the field the respondents are highly trained professionals who work together for longer periods (Purvanova, 2014). These findings are also related to research investigating the topic of this article. Laboratory studies may for example not be able to account for coping strategies that individuals may develop after long-term exposure in order to stay focused despite high levels of irrelevant stimuli, which would attenuate the negative effect of distractions. Furthermore, laboratory studies could mimic a few aspects such as noise and temperature, but certainly not the social aspects of the environment.

1.4. The present study

To overcome these problems, we used a repeated within-subjects design to study the immediate memory performance of office workers. By doing so the strength of methods used in laboratories are complemented with the ecological validity of field studies, thus investigating how normal working conditions in different office types affect performance on complex/cognitively demanding tasks.

For the purpose of this study we used a test called immediate free recall that has been shown to be a reasonably valid test assessing working memory (Unsworth, Spillers, & Brewer, 2010). Immediate free recall enables the calculation of primary memory, secondary memory and a total score. According to Unsworth et al. (2010), primary memory is needed to actively maintain information over the short term while secondary memory is needed to