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Windows, view, and office characteristics predict physical and psychological discomfort

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ABSTRACT

Office employees spend a lot of time inside buildings, where the physical conditions influence their well-being and indirectly influence their employers' business performance. With data from a field study conducted in the Netherlands in April to May 2003, we used path analysis to further elucidate the relationship between personal (gender and seasonality of mood shifts), building (view type, view quality, window distance, and social density), and perceived environmental conditions (light quality, and office impression) and physical and psychological discomfort, sleep quality, and environmental utility. The results show that window views, which that are rated as being more attractive, are beneficial to building occupants by reducing discomfort. However, being close to a window and rating the lighting as being of lower quality can result in thermal and glare problems (environmental utility). Reduced discomfort at work can improve sleep quality, indicating that physical conditions at work influence home life.

1. Introduction

Office employees spend most of their waking time inside the buildings in which they work (Leech, Nelson, Burnett, Aaron, & Raizenne, 2002; Schweizer et al., 2007). To the extent that environmental conditions influence health and well-being, workplace conditions are important contributors. The effects on individuals can carry through to influence organizational performance, making the work environment an indirect influence on measures of organizational productivity (Veitch, Charles, & Newsham, 2004).

Among the architectural or interior design characteristics that define the office experience are the proximity of a window to the individual's desk, the characteristics of the view outside the window, and the number of people who share the office (its social density). Although preferences for windows are well established (as are discussed below), and the restorative value of natural views are well-known, we know of no investigations that have tested an integrated model of the effects of these variables on both immediate comfort and discomfort in the office with after-work effects on any measure of well-being. Accordingly, this study reports a re-analysis of a survey conducted as part of a field study concerning architectural influences on office lighting (Aries, 2005). Here, we examined the effects of window view, office social density, and individual differences on employees' discomfort at work and sleep quality at home. The analysis used Hedge's conceptual framework for Sick Building Syndrome [SBS] (Hedge, Burge, Robertson, Wilson, & Harris-Bass, 1989), which includes individual differences and architectural characteristics to determine SBS symptoms, as starting point for our model. Our model hypothesized that certain individual and architectural factors may directly and indirectly – through perceived environmental conditions – lead to physical and psychological discomfort in an office space (see Fig. 1).

The individual factors in this study were gender, age, and seasonality of mood. Architectural factors included were the distance from a window, the view type and view quality, and the social density of the office. The perceived environmental conditions were office impressions and lighting quality. The outcome measures were self-reported physical and psychological discomfort, sleep quality, and environmental utility (thermal and glare problems). The literature review will focus on these variables.

Many investigators have examined the effects of lighting quality in an indoor space and its effects on the work performance, comfort, and satisfaction of occupants (e.g., Chung & Burnett, 2000; Veitch, 2001b; Veitch & Newsham, 1998) including outcomes that we have labelled environmental utility (see below). In addition to these visually mediated psychological effects, light has non-visual effects on physiology (Commission Internationale de l'Eclairage (CIE), 2004; Veitch, 2001a). Light controls the human biological

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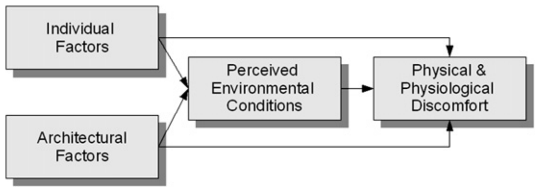

Fig. 1. Basic model.

clock and is, therefore, an important regulator of the human physiology and performance. Regular patterns of light and dark exposure each day are necessary to regulate circadian rhythms, including sleep-wake cycles (CIE, 2004; Veitch, 2001a). The co-ordination of these cycles contributes to sleep quality. Sleep has powerful restorative effects on the body and poor sleep quality has adverse effects on physical and mental health (e.g., Haack & Mullington, 2005; Kuppermann et al., 1995; Meerlo, Sgoifo, & Suchecki, 2008). We are not aware of other studies that look at spill-over effects of day-time office conditions on night-time sleep, but we hypothesized that such effects should occur. Office conditions will influence daily patterns of light and dark exposure, which will influence circadian regulation (CIE, 2004). In addition, Akerstedt et al. (2002) showed that "high work demands and physical effort at work are risk indicators for disturbed sleep, while high social support is associated with reduced risk". We predicted that conditions that reduce exposure to windows, such as increased distance to the window, could also reduce sleep quality.

Individual differences also influence sleep quality. Increased need for sleep is one of the symptoms of seasonal affective disorder, along with depressed mood, carbohydrate craving, and lethargy (CIE, 2004; Veitch, 2001a). Murray et al. (2006) suggested that a depressed person could have a more negative impression of his/her surroundings, as a consequence of dysregulation between internal (circadian or annual) rhythms. We further predicted that sleep quality would vary in relation to whether individuals reported experiencing seasonal mood changes.

The desire for natural light, rather than electric light, is one of the reasons why windows are so important to building occupants. Windows are openings for flows – inward and outward – of air, light, and sound, and are, therefore, often elements that influence the indoor environment most (Tregenza & Loe, 1998). Preferences for windows are well established (Farley & Veitch, 2001; Finnegan & Solomon, 1981). A window view provides information about time and weather, decreases the feeling of claustrophobia, and can have a positive contribution to eye health by providing a distant horizon at which to gaze. We predicted that proximity to a window would lead to improved office impressions.

Windows can bring both positive and negative experiences: access to view and daylight, but also glare and thermal discomfort. A good view should normally include the foreground and the skyline (Littlefair, 1996), but care needs to be taken to control the glaring effects of the sky. Several authors (e.g., Fisk et al., 1993; Küller & Wetterberg, 1996; Veitch, Geerts, Charles, Newsham, & Marquardt, 2005; Yildirim, Akalin-Baskaya, & Celebi, 2007) showed more health problems and complaints among occupants farther from the window. However, on closer analysis the relationship was revealed to be more complex. Veitch et al. (2005) found that satisfaction with lighting was lower the further one was from a window; however, overall environmental satisfaction showed a quadratic relationship, being highest when one could see a window but did not sit beside it. Satisfaction with ventilation (primarily thermal comfort) was lowest for people beside the window (Charles, Veitch, Newsham, Marquardt, & Geerts, 2006).

Moving further from the window also means decreasing the size of the largest potential glare source. On the other hand, Chauval, Collins, Dogniaux, and Longemore (1982) found that discomfort glare (from daylight) appears to be tolerated to a much higher degree if there is a pleasant view from the window causing the glare. Osterhaus (2001) wondered whether glare problems become less of an issue or could be ignored when office rooms are provided with a pleasant window view. In contradiction, the desire for daylight – or at least direct sunlight – is sometimes limited abruptly when it causes visual discomfort. People will close their blinds and leave them closed, even when the source of discomfort is long gone (Drucker-Colin, 1995). We predicted that problems with glare and heat gain would be lower for people farther from the window (As described below, we conceptualized this relationship in the positive direction in a concept we called *environmental utility*).

Of all characteristics of windows perhaps the most interesting is the view. Markus (1967) found that the further occupants were from a window the less satisfied they were with the view, and the more they desired to sit nearer a window. The preference of people for natural over built or urban views is shown in many window studies (e.g., Chang & Chen, 2005; Hartig, Evans, Jamner, Davis, & Garling, 2003; Tennessen & Cimprich, 1995; Ulrich, 1984). Natural scenes are advantageous to human health because they provide an opportunity for recovery from mental fatigue (Berman, Jonides, & Kaplan, 2008; Kaplan, 1995). We predicted that urban views would result in more discomfort and poorer office impressions; suburban and rural views, containing greenery, should reduce discomfort and improve office impressions. However, another way to characterize view is in terms of its aesthetic quality; not all urban views are alike, nor are all natural views equally attractive. We obtained quality ratings of the views, and predicted that higher-quality views would result in fewer discomfort complaints and better office impressions.

The physical arrangement of the office environment influences the level and type of social interaction between employees (Danielsson & Bodin, 2008; Duval, Charles, & Veitch, 2002). Density is an objective measure that is sub-divided into a measure of social density and a measure of spatial density (Hayduk, 1983). In an office setting, social density refers to the number of occupants in an office, regardless of its floor area. Spatial density refers to the floor area per person, for example, m^2 per occupant in an office (Duval et al., 2002). Chao, Schwartz, Milton, and Burge (2003) reported that higher social density was associated with more health complaints, and Brasche, Bullinger, Morfeld, Gebhardt, and Bischof (2001) found that this was especially true for women. Danielsson and Bodin (2008) reported that the lowest health status was found in medium-sized and small open-plan offices; the best health was among employees in cell offices and flex offices. Social density may also influence environmental satisfaction in a room. According to Duval et al. (2002) occupants of socially dense offices may perceive themselves as having less privacy because they have fewer behavioural choices and more interferences, which in turn leads to environmental dissatisfaction. We predicted that people in offices with fewer occupants would report fewer problems.

The predicted relationships are shown together in Fig. 2.

2. Method

2.1. Research design

This study was a cross-sectional survey of occupants in office buildings in the Netherlands. Participants completed a questionnaire concerning their experience in the office, with a focus on