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A cross-cultural study on perceived lighting quality and occupants' well-being between UK and South Korea

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ABSTRACT

The path leading from lighting quality through preference and mood to human health and well-being was defined as the 'Appraisal Path' by Veitch et al. This study aims to investigate the appraisal path under uncontrolled cafes, and to compare the results between daylit and non-daylit cases as well as the cultural differences between the UK and South Korea. A daylit café and a non-daylit café were chosen for the field survey both in London and Seoul. Then, customers' experiences and feelings in the cafes were investigated by using a customized questionnaire, in terms of quality of lighting, feelings, attractiveness, satisfaction and eye discomfort. 66 customers (49 for daylit, 17 for non-daylit) were randomly selected and questioned in London and 102 customers (62 for daylit, 40 for non-daylit) participated in the field survey in Seoul. As a result, four different appraisal paths were found. No significant relationship was found between perceived lighting quality and perceived eye discomfort at daylit cafes in both London and Seoul. On the other hand, it was found that perceived lighting quality was a key determinant factor on perceived eye discomfort regardless of the cultural differences at non-daylit cafes. However, there was a significant cultural difference in factors affecting perceived lighting quality.

1. Introduction

Lighting is often regarded as one of the highest consumers of electricity in buildings [1] and therefore it is important for energy-efficient building design to displace the need for electricity used in indoor lighting. However, sustainable approaches should not only focus on environmental and economic benefits but also on social benefits such as enhancing occupants' comfort and health as well as improving the overall quality of life [2]. Since the late 1990's, the CIE (*Commission Internationale de l'Éclairage*) has shifted its emphasis from lighting for visibility to a more broad definition of lighting quality, encompassing human needs, architectural integration and economic constraints including energy [3]. Many lighting research studies have established clear relationships between the lit environment and visual performance and visual comfort that are reflected in present-day lighting recommendations [4]. Also, many studies of lighting control systems have demonstrated positive impacts on overall energy reduction in use [5,6] and these are brought together by the rapid improvements in lamp, ballast and luminaire technology [7].

However, it seems as if an understanding of the effects of indoor lighting quality on occupants' various behaviour that leads to health and well-being is still vague. In particular, questions remain as to the possibility that lighting conditions might be further improved beyond the visual task recommendation level to the point at which they could become positive contributors to employee productivity, mood and well-being [8].

Several investigations have pointed out the effects of light distribution and the availability of individual control on human behavioural outcomes. In terms of lighting distribution, several studies have suggested that the use of both direct and indirect lighting were preferred over direct-only systems [9–11]. Surveys consistently reported a preference for individual control of indoor environmental elements and the positive effects in the work environment on both energy consumption and office workers' moods. For example, with regard to HVAC studies, Fisk and Almeida [12] reported that sensor-based demand-controlled ventilation (SBDCV) offered better control of indoor pollutant concentrations, and lower energy use. Several studies from Singapore and Denmark indicated that a personalised ventilation (PV) system not only reduced total energy consumption but also provided better thermal comfort [13–15].

In terms of lighting research, Boyce et al. [9] found that individually controllable lighting conditions were rated as more

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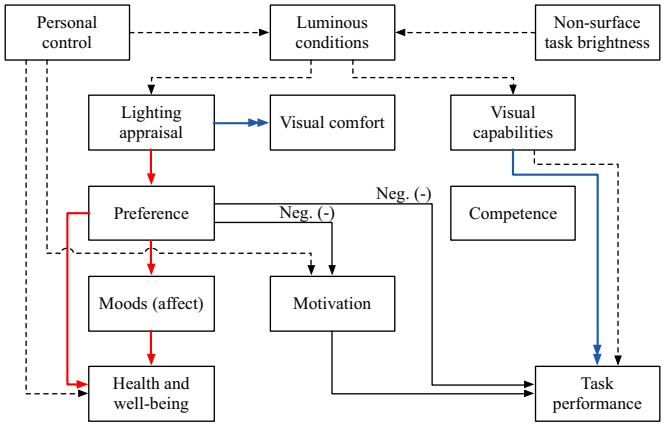

Fig. 1. The modified linked mechanisms map suggested by Veitch et al. [17]. Note: The map shows lighting condition test results with dotted lines, and mediated regression test results with solid lines. Red solid lines show the APPRAISAL path, and Blue solid lines with double-headed arrows show the VISION path.

comfortable by a larger percentage of people than conventional fixed conditions. However, Veitch and Newsham [16] reported no simple effects of individual control over lighting on task performance, mood, or satisfaction. Later, they reanalysed the data from participants *without* control and found that people whose working conditions were more close to their personal preference showed improved mood and higher ratings of lighting satisfaction and overall environmental satisfaction [17].

Based on the literature, it seems that although changes in some components of the lit environment affect occupants' or employees' behaviours, the path from the lit environments to employees' behavioural outputs is not clear compared to other elements of indoor environmental quality. It is argued that there have been only a few formal attempts to develop relevant analytical descriptions of a linkage between the physical variables of the lit environment and various human behavioural outcomes [18].

One attempt to link the lit environment and the psychological effects of light and lighting was the introduction of the *linked mechanisms* map. The concept of the linked mechanisms map was introduced as a well-conducted research tool that aims to provide practical guidance on developing such linkages. Boyce et al. [9] conducted a field simulation study to test the effects of lighting systems on performance and well-being and the hypotheses concerning the linked mechanisms were confirmed. Later, Veitch, Newsham, and Jones [17] reanalysed the data reported by Boyce et al. [9] and built a conceptual model from a series of mediated linked regressions. The conceptual model is shown in Fig. 1 and proposes two paths: the APPRAISAL PATH and the VISION PATH.

In particular, the appraisal path was the most strongly supported in their study. This path led from the appraisal of *lighting quality* toward judgements of the *preference* of the space. This, in turn, led to an improvement of *mood* (*affect*), which in turn predicted end-of-day physical and visual *health* and *well-being*. In the present study, health and well-being was defined as the sum of measured environmental satisfaction and perceived eyestrain. In summary, the appraisal path suggests that better perceived lighting quality results in better occupants' moods and well-being by affecting various psychological responses.

Although the appraisal path shows a complete psychological pathway from lighting quality to occupants' health and well-being, it is still not clear what elements of lighting quality particularly affect each psychological response. Also, the effects of daylighting on employees' psychological responses were not considered in the study. Moreover, the study was conducted in a controlled experimental space, which might not represent the real world situation.

The *present* study starts from questioning the above statements and expands the idea to analyse the possible cultural differences between the UK and South Korea regarding the role of perceived lighting quality on occupants' psychological well-being.

The hypotheses proposed in the paper are as follows:

Hypothesis 1: There is a difference in the appraisal path between controlled and uncontrolled indoor environments.

Hypothesis 2: There is a difference in the appraisal path between daylit and non-daylit indoor spaces.

Hypothesis 3: There is a cultural difference in the appraisal path between the UK and South Korea.

2. Research methods

2.1. Field survey

The study involved two field surveys which were conducted in London, UK, from 27th July 2012 to 9th August 2012; the other was conducted in Seoul, South Korea, from 25th September 2012 to 10th October 2012. In order to test Hypothesis 2, one daylit café and one non-daylit café were surveyed in each country. In total, four different indoor cafes were chosen for the field surveys and their floorplans and physical features are demonstrated and summarized in Fig. 2 and Table 1 respectively.

2.2. Respondents

Respondents were randomly selected during the field survey. In total 178 respondents took part in the field survey in London and Seoul. In both field surveys, customers who worked with their laptops after at least half an hour staying in the café were asked complete a questionnaire in order to provide enough adaptation time for the indoor luminous condition. From 27th July 2012 to 9th August 2012, a total of 66 respondents participated in the field survey study in London. Overall 102 respondents took part in the field survey from 25th September 2012 to 10th October 2012 in Seoul. Table 2 shows the number of the respondents in this study.

2.3. Survey method and questionnaire design

Respondents were given a four-page questionnaire regarding their experience and feelings in the cafes. There was a total of 22 questions in the survey, which can be broken down into six groups: general information about the respondents (4 items), perceived lighting quality (7 items), perceived mood (2 items), perceived appearance (1 item), perceived environmental satisfaction with the physical environments (4 items) and perceived eye discomfort (4 items). Table 3 summarizes dependent variables used in the five categories (excluding the general information).

To test the effectiveness of the questionnaire, a pilot study was carried out from 23rd to 24th July 2012 in London. Participants in the pilot group consisted of twelve people, with a mix of job roles, educational background, and proficiency in English. Half of them had an educational background of lighting designer or architectural designer. The questionnaire was updated following comments from the pilot group.

2.4. Variable definitions

- *Lighting quality*: Seven questions were asked of respondents to self-report their scale of perceived lighting quality by using a five-point Likert scale, ranging from "Strongly disagree" to "Strongly agree". The variables were chosen and modified from the Office Lighting Survey [19]. Label: LQ_*