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A visual ergonomics intervention in mail sorting facilities: Effects on eyes, muscles and productivity

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ABSTRACT

Visual requirements are high when sorting mail. The purpose of this visual ergonomics intervention study was to evaluate the visual environment in mail sorting facilities and to explore opportunities for improving the work situation by reducing visual strain, improving the visual work environment and reducing mail sorting time. Twenty-seven postmen/women participated in a pre-intervention study, which included questionnaires on their experiences of light, visual ergonomics, health, and musculoskeletal symptoms. Measurements of lighting conditions and productivity were also performed along with eye examinations of the postmen/women. The results from the pre-intervention study showed that the postmen/women who suffered from eyestrain had a higher prevalence of musculoskeletal disorders (MSD) and sorted slower, than those without eyestrain.

Illuminance and illuminance uniformity improved as a result of the intervention. The two post-intervention follow-ups showed a higher prevalence of MSD among the postmen/women with eyestrain than among those without. The previous differences in sorting time for employees with and without eyestrain disappeared. After the intervention, the postmen/women felt better in general, experienced less work induced stress, and considered that the total general lighting had improved. The most pronounced decreases in eyestrain, MSD, and mail sorting time were seen among the younger participants of the group.

1. Introduction and background

A literature search for studies on longitudinal lighting interventions and eyestrain in a non-computer environment was performed but no internationally published peer reviewed articles were found. Aarås et al. (1998,2001) performed a large ergonomic intervention study of video display units (VDU) operators, which included lighting. They found that lighting and optometry are of crucial importance in reducing musculoskeletal disorders (MSD). Both mail sorting and VDU work is visually demanding, and a good visual environment is important for health and wellbeing.

1.1. Visual ergonomics and lighting

When vision is unsatisfactory, the body adapts to a posture aimed at improving it: "The eyes lead the body" (Anshel, 2005). The frequency of musculoskeletal pain among people with incorrect lenses in their glasses is higher than among those with correct lenses. A single vision lens or a work progressive lens is better for working with computers than a regular progressive lens (Horgen, 2003). People with eyestrain often also report musculoskeletal complaints (Knave et al., 1985). Studies show that an optic correction for near distance work affects the accommodation and vergence, which reduces muscle activity in the head, neck, and shoulder region (Lie and Watten, 1985, 1994; Richter, et al., 2010a,b). This means that a pair of working glasses adjusted for correct working posture and distances can reduce muscle strain. There are also differences in eyestrain within a working day: The amount usually increases when the same type of work is performed (Boyce et al., 2005).

The visual environment can change the mood of people, which can alter their behaviour (Boyce, 2004). Human performance can

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be affected by lighting via three routes, namely through the visual system, the circadian system, and the perceptual system (Boyce, 2003). Visual fatigue can be multifactorial, induced and/or supported by psychological factors, as well as the intensity and duration of the visual strain, the perceived situation and the physiopathological characteristics of the individual visual apparatus (Piccoli et al., 2003). An increase in illuminance within relevant ranges will often result in improved visual performance. According to Veitch (2001), a working area should have uniform illuminance while the surrounding areas should be non-uniform, but not causing glare. Glare can lower productivity as reported in a study by Horgen et al. (2007). A luminance contrast that is too high will cause visual fatigue due to continuous readaptation of the eyes; too low and it will result in a dull and non-stimulating working environment (CIE 2002). If a worker can change the level of illuminance at the workplace, productivity increases, environmental satisfaction improves, and energy savings are obtained (Boyce et al., 2006b; Juslén et al., 2007b).

There are many different mechanisms involved in enhancing human performance by light, visual comfort, visual ambience, interpersonal relationships, and the change process (Juslén and Tenner, 2005). According to Boyce et al (2006b) there are correlations between productivity and eye fatigue, and direct/indirect lighting systems can enhance motivation and attention during the working day. Based on present knowledge, the work related ocular/visual disorders and disturbances reported in the literature have a multifactorial origin, namely, task characteristics, environmental conditions and individual characteristics (Piccoli et al., 2003). To enhance productivity and wellbeing, and to reduce eyestrain, the visual environment has to be considered by providing good lighting conditions and good visibility of the tasks (Boyce et al., 2006a). Illuminance is one way to influence productivity. It may be an underlying cause of improved visual performance and have positive psycho-biological effects (Juslén et al., 2007a).

Akashi and Boyce (2006) showed that energy could be saved through an increase in colour temperature (from 3500 K to 6500 K) and a reduction of illuminance in offices from 500 to 360 lux from the general lighting for work tasks. This did not have any long-term impact on the visual performance, though. The workers did increase their use of task lighting at their desks, but this only had a little impact on the overall energy consumption.

Another visual ergonomics factor is the size of the printed text. Words written in lower case with an initial capital letter are easier to detect than words with only lower case or capital letters (Phillips et al., 1977; Phillips, 1979). Texts set in serif typeface, such as Times New Roman, are recommended because they are easy to read (MacLeod, 2000). In a study by Horgen et al. (2007), the size of the text also affects productivity in computer work. The recommended minimum size is 12 points, which represents a visual acuity of 20/60, depending on the screen size.

1.2. Kansei engineering

Kansei engineering is usually used when developing new products (Nagamachi, 1989; Schütte, 2005), such as cars, chairs, etc. To develop a new product within a specific area requires knowledge about what the customer wants and the feelings and experiences that are attractive to customers. Kansei words can be used to rate the importance of feelings and experiences. Kansei words are often adjectives where the participants grade the answer on a scale, usually from 1–7. The answer alternatives are, for example, between "I fully agree" and "I disagree completely".

1.3. Studies with postmen/women[2]

Postmen usually work in poorly lit facilities where they are exposed to glare, flicker from the luminaries, and poor ergonomics. The demands on sorting speed are high and so is static load on the upper body (Jennum et al., 1982; Jørgensen et al., 1989).

Wheatley (2002), focusing on muscle and skeletal symptoms among a limited group of postmen, found that four out of eight experienced some sort of eye discomfort. Analysis of data from the appendix of her report confirmed that postmen with eye discomfort often had a higher prevalence of muscular problems.

In another limited pilot study on postmen ($n = 6$), the impact of new lighting and labelling on productivity was investigated in two different districts (Kiviloog, 2003). This study included three categories of postmen, those sorting at a fixed district, those sorting at many different districts, and beginners/substitutes. After the introduction of new lighting, an average time improvement of 1–2 s/letter was found depending on the district. However, this was a small study and a Hawthorne effect may have been present.

1.4. The purpose of this study

The purpose of this visual ergonomics intervention study was to evaluate the visual environment in mail sorting facilities and to explore opportunities for improving the work situation by reducing visual strain, improving the visual work environment and reducing mail sorting time. The hypothesis was that incorrect lighting and incorrect power in lenses may cause eyestrain and affect workers' general wellbeing, and that visual problems may contribute to MSD, all of which may affect productivity. To improve the visual environment, the lighting should have a more uniform illuminance, higher illuminance and less glare in combination with better labelling.

2. Material and methods

2.1. Postmen's work

The work postmen carry out at the Swedish Post Office includes handling, sorting and delivery of mail. This study focuses on manual sorting of mail into sorting racks. From 2 to 4 h a day, the postmen sort several different types of letters. Every address/household has its own compartment. The number of sorting racks for each district varies between three and seven depending on its size (Fig. 1).

2.2. The locations – lighting conditions before the intervention

The participating postmen worked at five different locations in a middle-sized town in Sweden. Two of the post offices had naked fluorescent tubes as general lighting. The third and fourth had luminaries, the louvers of which were too few and too far apart. The fifth had luminaries with prismatic covers. All of the general lighting had the old type of conventional magnetic ballasts. At one of the offices, the daylight from windows facing south disturbed the postmen in their work when they were facing the windows.

2.3. The participants

The postmen were informed that participation was completely voluntary and would take place during working hours.

[2] Four postwomen were included in the study, two of whom dropped after the intervention. For the sake of brevity, the term "postmen" will be used in the rest of the article.