A Survey of Factors Affecting Physical Discomfort at a Computer Workstation

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As the use of computers in this society accelerates, the need to design an effective human-computer interaction (HCI) becomes more important. However, prior research in HCI has investigated human factors and computer systems in isolation without considering the interrelationships between the two. This study attempts to bridge the two fields of studies by looking into the various factors that affect human performance in an office environment. Referring to Bailey (1982), this study categorizes the research variables into three main categories, i.e., human users, hardware factors, and the contexts in which they interact. It looks into the three factors in turn and analyzes how they affect human performance interactively. Specifically, vision, hearing, and touch are included as human factors, while visual display unit, keyboard as hardware factors. For environmental factors, physical contexts such as noise, lighting, and work space are considered as well as social contexts. A survey was conducted by sending out the questionnaires to companies from selected industries in Singapore. It was found that certain hardware factors such as positions of keyboard and monitor were associated with physical discomfort. Contextual factors such as lighting layout, sitting position, and colors of office wall were found to influence human performance. Further, an association between the background color and the degree of glare was also found, which influenced human vision. Future research implications are also discussed, applying the findings in this research.
the effect of color on human performance are also included.

**Research Questions**

The research model, adapted from Bailey (1982), is presented below in Figure 1.

Specifically, we were interested to find out whether users:

1. prefer keyboards with audible sensation when a switch has been operated (e.g., clicking sound)
2. prefer keyboards positioned at an angle to the horizontal
3. prefer the use of the three most central colors of the spectrum (yellow, green, or white) for characters and backgrounds colors of their monitors
4. who use the right tilt of angle of the screen and screen filter have less physical discomfort than those who do not
5. have environmental noise levels that may degrade their work performance
6. with light sources not directly above them experience higher level of glare compared to users with light sources directly above them
7. prefer chairs with adjustable height
8. have perceived crowdedness that are related to actual distance from the nearest staff, and
9. prefer soft environmental wall colors.

**Background to the Problems**

**Feel of the keyboard**

The sense of touch ranks third after vision and hearing as a communication channel for human-computer interaction purposes. This additional channel is useful in areas of high auditory noise to attract the user’s attention. Although touch is not used consciously in human-computer interaction, tactile feedback conveys important information (Downton 1991).

Touch is also closely associated with ergonomic design aspects of a system. For example, when using a keyboard or switch, it is very disconcerting if there is no obvious tactile or audible sensation that the switch has been operated. It is not uncommon for computer operators to complain that they do not like the feel of a particular keyboard. These complaints can be associated with the position and shape of the keys but are also directed at keyboards that require too much or too little pressure to operate the keys or have a ‘soggy’ feel to the key action (Gibson, 1988). If there is no obvious visual or auditory indication of the switch being operated then touch is the next most likely means of providing that feedback.

**Inclination of the keyboard**

The main problem that results from long term usage of the keyboard is fatigue in both finger muscles and back muscles. To operate the keys quickly, the typist must keep the hands parallel to the rows. These constrained postures often caused physical discomfort and in some cases, may even cause inflammations of tendons in the forearms of keyboard operators. Repetitive strain injuries (RSI), commonly involving the wrist, accounted for 52% of all workplace illnesses in 1989 (Randel, 1991). It has been suggested that adjustable keyboards with angled shelves (keyboard inclination) may reduce RSI (Armero, 1991).

**Color of monitor’s characters and background**

Although up to 8,000 different colors can be distin-

![Figure 1: The research model](image-url)
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