Prospects for improved user productivity:  
A visual perspective

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ABSTRACT

Computer-related vision problems and complaints are common. Ergonomic improvements reduce such complaints by one third. All remaining problems are attributable to the visual limitations of the individual operator. These problems include poor ability to perform sustained near vision work, inadequate ocular-motor control, poor or inefficient control of focusing, aiming and teaming of the two eyes, inefficient processing of visual information, and other productivity-reducing effects of visually-induced stress. Optometric solutions are presented in this paper.
INTRODUCTION

A significant finding of the Panel on Impact of Video Viewing on Vision of Workers of the National Academy of Science was that "The symptoms of ocular discomfort and difficulty with vision reported by some workers who use VDTs appear to be similar to symptoms reported by people performing other near-visual tasks."

Computer-related vision changes and problems, as well as complaints about visual discomfort are common, yet poorly understood. Computer users, their managers, unions, and other groups lobbying for new laws regulating VDTs are functioning without adequate information.

Yet a rich body of clinical and research literature on vision does exist and explains the source of vision problems and changes in vision that afflict at least half of all computer users. More important, the literature presents and explains a variety of regimens that can halt or prevent those problems.

The purpose of this paper is to provide an overview of the literature and its clinical implications and to relate that information to the prospects for improving user productivity.

NEARPOINT VISION TASKS: A RECENT PROBLEM

Beginning about sixty years ago, optometrists noticed that traditional treatment of common visual problems (near-sightedness or myopia in particular) seemed to increase both the rate of progression and the total amount of myopia. At that time, the number of people developing myopia, astigmatism, and other vision conditions was increasing rapidly.

Clinicians noted that the time of onset was beginning to change from juvenile years to the late teens and into the twenties. The data were inconsistent with genetic origin theories. Clinicians saw that vision deterioration is usually associated with periods during which the individual performed near vision tasks for prolonged periods. Other critical factors included: a confined visual target (the page of a book or a VDT screen) and high attentional demand (the material must be understood).

Skeffington, a leading vision theorist who integrated scientific and clinical data, noted that sharp eyesight was just one of many factors in vision. He suggested a more comprehensive model thirty years before modern brain studies confirmed his ideas.

Skeffington proposed that vision is an understanding or perception which emerges from a process which involves focusing, fine ocular motor control (eye aiming and teaming), combining the images of both eyes, comparing visual input with memories of prior experience, and integration of input from all the other senses.

Nearly all people are born with the mechanism for clear distance eyesight, but the precision and efficiency (speed of operation) of vision is determined largely by the level of fine ocular-motor control (visual skill) developed during early visual experiences. Skills for teaming the two eyes (binocular vision) begins to develop beginning at about four months of age.

Behavioral optometrists and others have demonstrated that the nature and quality of early visual experience determines the way each individual adapts to cope with near vision tasks. Virtually no effort (oculomotor control) is required to keep the images of the two eyes aligned on distant objects. Near vision, on the other hand, requires a complex and precise interaction of focusing, aiming and alignment before visual information can be taken in.

A demonstration of the difference in visual skill and effort required for distance versus near vision work is appropriate here. To do this experiment, hold both arms straight out in front of you, then point both index fingers upward. Next, without moving your head, quickly glance back and forth from one finger to the other. Notice the effort and sensations associated with this eye movement.

Complete the experiment by bringing both hands toward you, with forefingers still pointed upward. The distance should be about 8 to 10 inches. Without moving your head, glance again from finger to finger. Note the added effort required this time, and notice any sensations of pulling or straining near the eyes.

Although the sensations are exaggerated, this demonstration provides personal experience of the effort involved in the fine motor control required to focus, aim, and align the eyes.

This is the process that occurs five times per second for a person reading at about 300 words per minute. It is a skill which is learned by trial and error from infancy to about age six.

Why is distance vision so natural? Throughout man’s evolution, distance vision was a key to survival—hunting, evasion of danger, and most other visually-guided tasks were distance vision tasks. Although short periods of near visual effort were also part of living, highly developed distance vision gave the individual a considerable survival advantage.

Within the last 100 years, however, the conditions of life have changed drastically. The industrial, post-industrial, and now the information, ages require that workers do an ever increasing amount of near vision work. The impact of this shift has been profound. The percentage of the population with myopia, for example, has increased from about 12 to 14 percent at the beginning of the century to an estimated 36 percent in the 1980s.

This was most clearly revealed by Young and Baldwin's study of Eskimos at Point Barrow, Alaska. Among the gener-
Myopia is seen as one of several adaptive responses by an individual to the low but persistent levels of stress which is produced by near vision work.

As viewed here, stress is not a psychological feeling. It is a measurable physiological process; a flood of adrenal system chemicals to prepare the body for fight or flight. These changes are linked to increased absenteeism rates of VDT users. Studies repeatedly show that prolonged, low levels of stress trigger many physical and behavioral changes (adaptations) as the individual attempts to cope with the source of stress:

Sperry states that investigation of the neurological and cytological structure of the brain reveals nothing but a mechanism for control of the musculature. Muscles only take orders. If there is a physiological drive...[i.e., pressure from a supervisor to complete the computer task, or a drive to achieve within the VDT user]...and if that drive cannot be satisfied by movement, the person will either a) cease the activity to escape (avoid discomfort induced by it), b) lower the achievement and understanding (reduce the performance and accuracy), c) distort the structure itself (any temporary or permanent changes in vision), or d) ...some combination of these three alternatives.

**RESOLVING OR PREVENTING COMPUTER-RELATED VISION PROBLEMS**

A recent study by the Data Entry Managers Association (DEMA) found that about 73 percent of VDT operators had vision-related complaints. This was up from 69 percent the year before. The lowest level of complaints we have found is in a Bell Laboratories study comparing VDT workers with operators doing the same task, but with paper materials. Bell researchers found that about 52 percent of VDT users had vision-related complaints compared to about 41 percent for the control group working with paper.

These data suggest that although environmental factors play a role in vision changes and complaints, even the installation of extensive ergonomic improvements will not resolve what are in reality the visual limitations of individual operators.

Behavioral optometrists use two major tools to deal with visual limitations and problems: lenses and visual performance enhancement training (visual training, or VT).

**VISUAL TRAINING TO DEVELOP VISUAL SKILLS**

As with any learned process, performance can be improved. Visual training, frequently mislabeled “eye exercise,” is a programmed series of activities that provides visual feedback to the person in training about how well he or she is focusing and aiming.

Training helps the person overcome one of the most subtle but significant effects of visual stress, called “lag” by eye doctors. In simple terms, it means that a person is focusing at one distance, but aiming the eyes at another. This disagreement means the person must (1) see either an unsharp single image, (2) suppress the images of one eye to avoid seeing double, or (3) attempt to match focusing with aiming by increasing effort—which increases the visual stress, which in turn increases the lag.

Each of these responses diverts attention from understanding what is being read to struggling to overcome the deficient visual skill, thus reducing user performance speed and accuracy. Visual stress increases and a vicious cycle ensues.

Visual training disrupts the habitual ocular-motor (focusing and aiming) patterns of individuals with poor visual skills. The activities of training provide feedback which enables the person to develop more accurate and precise motor control patterns and to reduce the effort required. Reduced effort diminishes the visual stress reaction.

In terms of behavior, the individual is able to perform visual work more quickly and accurately. This produces an increase in on-the-job performance.

Symptomatic relief of headaches; eyestrain; intermittent blurred eyesight; and certain neck, back, and shoulder discomforts usually begins within the first few weeks of training.

Unfortunately only 3,000 optometrists and a few hundred ophthalmologists perform VT. If all VDT users with deficient vision skills sought help, there would not be enough skilled training specialists to provide it. In-plant group training may be one way to resolve this dilemma. Alternatively, “train the trainer” program supervised by a behavioral optometrist but with visual training conducted by company staff may be viable.

**LENSES, A TOOL FOR THE JOB**

There are two major approaches to prescribing lenses. “Correct the refractive error” (CRE) is the most common. It assumes that the findings of an examination (refraction) show the amount of lens power needed to return the patient to maximum distance acuity (sharpness). Emmetropia, the norm, is commonly written as 20/20 eyesight. Although some CRE-oriented doctors also test for eye teaming and sharpness of near vision, the theory behind CRE does not provide for the effects of stress.

CRE often ignores nearpoint vision needs. In myopia, for example, CRE lenses clear distance but may also recreate the visual conditions which were present when myopia began. A Southern California College of Optometry study compared 100 records in both a CRE and a behavioral practice. Over a ten year span, CRE records showed an average myopic increase of nearly 3.50 diopters. Behavioral records showed less than 1.00 diopter of increase.

The behavioral model focuses on how a person’s visual system responds to nearpoint tasks. Distance compensation lenses may be prescribed, but lenses for near vision tasks are always offered, sometimes as bifocals. VDT users often receive a separate (single vision) pair of spectacles specifically for computer work.
Behavioral nearpoint lenses prescriptions are based on a complex, precise formula which takes into account the way the individual responds to visual stress (case type). Individuals with poor visual skills are extremely sensitive to small differences in lens power and will often reject (find it impossible to wear) lenses just .25 to .50 diopter stronger than the most helpful lens.

Considerable research has been done over the years on the stress-relieving qualities of nearpoint lenses, including studies which show that behaviorally prescribed lenses produce positive improvements in posture and work performance. Behaviorally prescribed nearpoint lenses often closely match the dioptric measure of an individual’s lag. This suggests that the lens works by helping with the task of bringing the point of focus and convergence into agreement. This eliminates the lag, which seems to be a primary source of visually-induced stress.

CONCLUSION

The National Academy of Science study of VDT-related problems suggests that although the computer itself does not cause vision problems, workers with previously-existing vision problems are likely to experience difficulties. In the United States, about 54 percent of all people wear lenses to compensate for vision problems. Another 10 to 12 percent of people would benefit from, but do not wear, lenses. Thus, at least two-thirds of people have previously-existing vision problems.

One response to visual stress is to avoid visual work. But as more and more jobs become computer-centered, avoidance may not be possible. These people are unlikely to stay on the job for long and may be a source of rapid employee turnover. For those employees already experiencing any of a variety of computer-related vision problems, behavioral optometry offers some practical solutions.

REFERENCES

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