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A Challenge to Eye-Level, Perpendicular-to-Gaze, Monitor Placement

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1. Introduction

The recommendation that computer monitors be placed at or slightly below eye-level is based in part on the belief that the "normal line of sight," considered to be the resting point of the eyes, is 15° below the horizontal when the head is upright.

A statement to that effect appears first in an engineering handbook published in 1963 (Morgan et al., 1963). No references were provided and a conversation with one of the authors of the chapter (Orlansky, 1994) could not determine a basis for the statement. It was confirmed that it did not result from laboratory or field studies. Eye-level monitor placement has developed as a guideline despite little or no evidence to support it, and despite the discomfort that persists with this placement.

2. Near vision improves with low gaze angles

Lower monitor placement is advantageous from a visual standpoint. Hill and Kroemer (1986) found that the preferred declination of the line of sight for their subjects became lower as the object of view became closer. At 1 m. it averaged -24.5° and at 0.5 m. -33° below the Frankfurt Line in a seated position. Ripple (1952) found that accommodation (focusing at near objects) improved by over 25 percent with a downward gaze angle.

The eyes have a resting point of vergence (RPV), the distance at which the eyes converge when there is no object on which to converge. The RPV averages around 1.12 m. when looking straight ahead and comes in to about 0.87 m. when the gaze angle is lowered 30° (Heuer and Owens, 1989). Viewing objects closer than the RPV has been found to contribute to eye strain; lowering the monitor allows one to work at the same viewing distance, but with reduced effort. As Krimsky (1948) observed, "when looking upwards, the eyes tend to diverge...and when they look down, the effort to converge is much easier." Tyrell and Leibowitz (1990) found that lower gaze angles resulted in reduced headaches and eyestrain. Tsubota and Nakamori (1993) found that lower monitor placement exposed less of the eyeball to the atmosphere and reduced the rate of tear evaporation, thus reducing the risk of Dry Eye Syndrome.

A factor that may affect monitor location is the interaction between glare and monitor tilt. In many offices lowering and tilting the monitor back will result in unacceptable levels of glare. One of the few studies in support of eye-level monitor placement (Grandjean et al., 1983) did not control for glare, which was cited as a strong annoyance factor in that study and most likely contributed to the preferred settings.

With this as the background, we have examined two aspects of monitor positioning: neck posture and the effect of monitor tilt about the horizontal axis.

3. Monitor tilt

In a study of the effects of monitor tilt, Ankrum et al., (1995a) found that a visual phenomenon known as the vertical horopter (Helmholtz, 1866/1925) influences both postural and visual comfort. The horopter is the locus of points in space that appear binocularly fused to the observer.

In daily life, objects in the visual field that are above the point of fixation are almost always farther away than the point of fixation, while objects that are lower are generally closer. This has resulted in a visual system that is better equipped to view objects in a plane that tips away at the top from the viewer. Therefore, a monitor with the top tipped forward should be expected to increase postural and visual discomfort when compared to one which is tipped back.

When we compared postural and visual discomfort at two monitor heights and three monitor tilts (Ankrum et al., 1995a), we found that both the greatest and least increase in neck discomfort occurred with the monitor in a low position: the greatest was with the monitor tipped forward and the least was with the monitor tipped back. This was also the case with reports of "tired eyes." Subjects reported greater increases in upper back discomfort at both the high and low monitor positions when the top of the monitor was tipped forward. Complaints of "I feel tired looking at the screen" followed the same trend, with increased discomfort for the forward monitor tilt at both high and low gaze angles. We also found (Ankrum et al., 1995b) that a monitor tilted toward the user at the top led to decreased viewing distances, a contributor to visual discomfort.

4. Neck posture

An argument given for eye-level monitor placement is that it forces the head to remain erect. While well intentioned, this can limit the options that users have for alternate postures that allow both postural and visual comfort (Ankrum and Nemeth, 1995).

Eye-level visual targets restrict the head and neck to one posture that is both visually and posturally comfortable. When users tire of the head-erect posture, their alternatives are limited. Flexion, while physically comfortable (for short durations), may result in an uncomfortable, upward gaze angle and will not usually be assumed. Extension and forward head posture, while visually acceptable, have been associated with both discomfort and disease (Kumar, 1994; McKinnon, 1994). A downward monitor location allows users to alternate among a wide range of head and neck postures without sacrificing visual comfort (Ankrum and Nemeth, 1995).

Recommendations for an eye-level monitor location assume that a military-style head-erect posture is desirable. Jones et al., (1961) found that for seated subjects, the Frankfurt Plane was -13.64° declined from the horizontal and the head/neck was flexed an average of 22° in the "most comfortable" posture when compared to the posture of "greatest height."

Because previous studies on preferred gaze angles (Hill & Kroemer, 1986; Menzoni, 1992) were done with the head fixed in a position where the Frankfurt Plane was horizontal (an essentially head-upright position), the fact that the preferred head/neck posture is more flexed would indicate an even lower preferred monitor location.

5. Recommendations

Monitor height and tilt are interrelated. From an analysis of existing studies and the capabilities of the visual system, it is suggested that the top of the monitor be located distinctly below the horizontal, with its top farther from the eyes than the bottom. Glare and reflections must be satisfactorily addressed or the benefits will be lost.

6. References

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