EFFECTS OF HEAD-MOUNTED DISPLAY (HMD) USE FOR LAPAROSCOPIC SURGERY: A PILOT STUDY

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Background

In the laparoscopic surgery operating room (OR), the monitor cannot always be positioned at the optimal level for the surgeon[1]. This can lead to surgeon discomfort and can negatively affect performance. The frequent head and eye movement between displays can also increase a surgeon's physical fatigue[2].

With the ability to follow the user's movement and always display the image in front of the user's eyes without blocking the real environment, using augmented reality (AR) head-mounted displays (HMDs) as a replacement of conventional monitors have become a potential solution[3]. However, the effects of extended usage of HMDs on surgical performance and user ergonomics are not clear.

Objective

The goal of this work is to evaluate the influence of using a commonly available interactive AR HMD as a replacement for conventional operating room monitors (both surgical field and patient vitals) for an extended duration, as required for surgery, on physical load, perceived workload, and performance.

Hypothesis: Perceived workload would be higher when using the HMD, and that task performance would be equivalent between conditions.

Methods

Participants: 24 medical students (15 female / 9 male)

Conditions: Monitor+Monitor (M+M), HMD+HMD (HL+HL), and HMD+Monitor (HL + M) (Figure 1)

Primary Task: Interrupted suturing on a simulated bowel in a box trainer for 1 hour (Figure 2)

Secondary Task: Monitoring patient vitals on the display for adverse events



Figure 1. Representative pictures of the participant task view for the M+M and HL+HL conditions. The primary task was interrupted suturing in the box trainer and the secondary task was monitoring patient vitals.

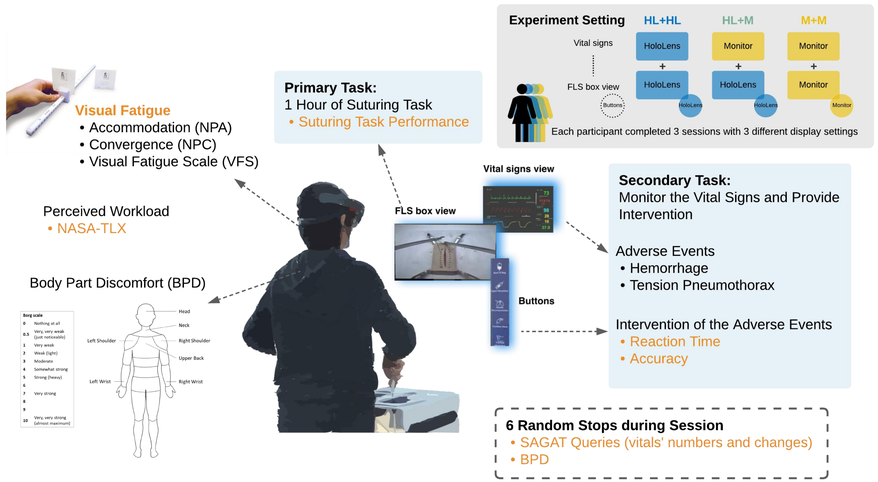


Figure 2. Schematic of the dependent measures collected during the experimental session

Results

- Significant difference between HL+M and M+M settings on suturing task performance (Figure 3)
- Increases in discomfort were primarily reported for the head and neck (Figure 4)
- Similar ratings of visual fatigue increase across conditions after the 1-hour task
- No significant differences in perceived mental demand, physical demand, or frustration (Figure 5)

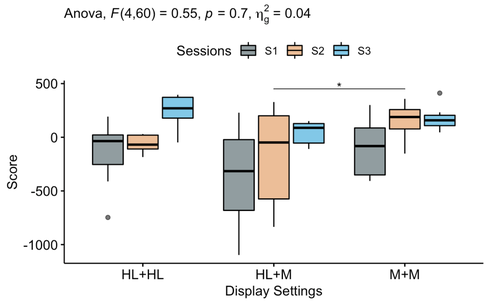


Figure 3. Differences in suturing task performance across sessions and display settings

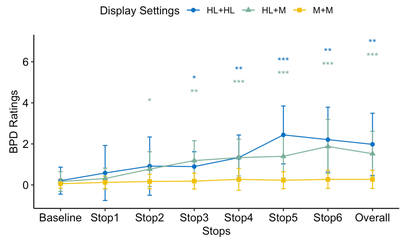


Figure 4. Ratings of head discomfort over the course of the 1-hour session

Results, cont.

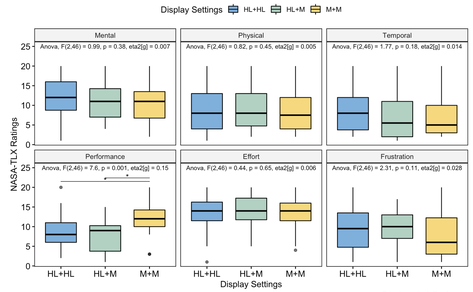


Figure 5. Ratings of perceived workload on the NASA-TLX subscales across display setting

Conclusions

HMD use did not have a negative effect on surgical task performance. It led to elevated discomfort, but equivalent visual fatigue, compared to a traditional display setup. In addition to the influence of a lack of experience with the HMD, these outcomes are attributed to the supported weight of the headset and the limited field of view available within the display. Exploring potential benefits of interactivity may yet yield value in this environment.

References

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