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The Effect of Conventional Screens vs. Head-Mounted Displays on Alarm Monitoring Strategies

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Head-mounted displays (HMDs) have been tested in a variety of environments due to their unique ability to provide wearers with continuous hands-free information. In hospitals, HMDs could be used to give physicians access to patient related data and alarms, even in situations where this is usually not possible. However, physicians cannot watch a HMD uninterruptedly over a long period of time. Therefore the HMD image could be positioned in the peripheral field of vision, where physicians could check it occasionally to maintain awareness of their patients' health status.

Unfortunately, previous research has shown that visual stimulus changes are harder to detect in the peripheral field of vision (Wolfe, O'Neill, & Bennett, 1998). Pascale et al. (2015) showed that this effect is even stronger on a HMD compared to a conventional screen.

We investigated whether participants cope with the more difficult task of detecting stimulus changes on a HMD by adapting their monitoring strategies. We suspected that participants would rely more on endogenously driven monitoring strategies (Folk, Remington, & Johnston, 1992) if using the HMD and more on exogenously driven monitoring strategies if using the conventional screen. Endogenous viewing strategies imply that users check the screen deliberately whereas exogenous strategies imply that users rely on salient stimuli on the screen to 'automatically' capture their attention.

In our study, university students monitored simulated hospital patients in three conditions: (1) patient monitoring with HMD (2) patient monitoring with conventional screen (3) patient monitoring with conventional screen+flash.

In the conventional screen+flash condition, the screen lit up brightly for a very brief period to indicate a new alarm and was intended to result in an exogenously driven monitoring strategy. While they monitored, participants performed an additional tracking task that was displayed on a tablet computer in front of them. If participants observed a change in the vital signs they reported it verbally to the experimenter.

As expected, in the HMD condition participants detected vital sign changes more slowly and they performed worse in the visual tracking task than in the other conditions. In the HMD condition, participants also checked the screen most frequently and for the longest period of time.

We showed that the HMD resulted in an endogenously driven monitoring strategy. Contrary to what we expected, the conventional screen also resulted in an endogenously driven monitoring strategy. Only in the screen+flash condition did participants rely on a more exogenously driven monitoring strategy. In addition, although the endogenously driven strategies were subjectively more demanding, they resulted in a more slowly detection of vital signs than the exogenously driven strategies.

It is unlikely that physicians will have time and mental resources to monitor a HMD in a clinical environment as frequently as in this experiment. Important patient safety related data might be missed. In conclusion, when designing information for HMDs, designers need to consider endogenously driven monitoring strategies and prevent the user from missing important data by attracting attention effectively with salient stimuli when required.

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