Investigating the Location of an Interruption Recovery Tool for Supervisory-Level Command and Control Missions

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Mission Command and Control (C2) operations rooms are information-heavy and cognitively-taxing on the human supervisors (i.e., mission commanders). Mission supervisors are required to process and integrate information from multiple sources including mission displays carrying mission-critical information. In these environments, supervisors are prone to multiple interruptions that require them to disconnect from their primary mission task to attend to a secondary task (e.g., phone calls, meetings, briefings, etc.). After the completion of the secondary task the interruptee needs to re-orient to the primary task, identify the changes in the environment, and sometimes make quick decisions to address the situation. Owing to the dynamic nature of such environments, constant vigilance is required to restrict potential loss of important information required for decision making.

Interruption Recovery Assistant (IRA) tools used on secondary displays have shown promise in aiding the resumption process in these situations (Scott et al., 2006). Providing a visual interactive timeline of events has shown the potential to reduce the interruption recovery time as well as improve the decision accuracy after an interruption (Sasangohar et al., 2014). However, in the presence of constant, competing stimuli, using a secondary display to access information needed for decision-at-hand may make the human supervisor susceptible to cognitive failures such as change blindness, cognitive tunneling, and loss of situational awareness.

A controlled lab study was conducted in a simulated command and control environment to evaluate the effects of location of an interruption recovery tool (primary mission displays vs. a secondary display) on resumption performance after participants were interrupted. The dependent variables used were interruption recovery time (operationalized as the time it took participants to make a decision after completing a secondary task) and decision accuracy. A 2x2 repeated measures design was used with location (integrated into the primary displays vs. secondary display) and decision difficulty (simple vs. complex) as independent variables. The level of decision difficulty (i.e., type of decision subjects faced when they returned from an interruption) was either simple (only one possible decision for the scenario) or complex (multiple possible solutions but only one optimal decision).

An Unmanned Aerial Vehicle (UAV) supervisory control was used to represent a scenario in which 3 operators controlled multiple UAVs to ensure the safe passage of a convoy through a hostile region. The testbed consisted of three 42-inch wall-mounted Smartboard interactive plasma displays which served as primary displays to provide a variety of mission-related information to the mission commander (Figure 1). The Map Display contained the geospatial map of the mission's areas of interest along with a threat summary and strike schedule timeline with information about known and potential threats to the safety of the convoy. The Mission Status Display (MSD) provided an overview of the current and expected operator performances along with other mission status updates. The Remote Assistance Display (RAD) allowed the mission commander to request status updates from the operators and to help them identify targets. A mobile 12.1-inch Wacom Cintiq tablet display was provided for the mission commander to input command decisions into the system. A Dell Optiplex GX500 server computer, located just outside the experimental room, was used to drive the simulated task environment.

Fourteen computer-literate Reserve Officers' Training Corps (ROTC) students (9 Male, 5 Female) at a large research institution were recruited to participate in this study and were compensated. Subjects were asked to assume the role of UAV team's mission commander. Following an hour of training and two practice trials, they went through two experimental trials; each taking approximately 20-25 minutes and were interrupted twice during each trial. The interruption task was performed in a room adjacent to the primary task room.

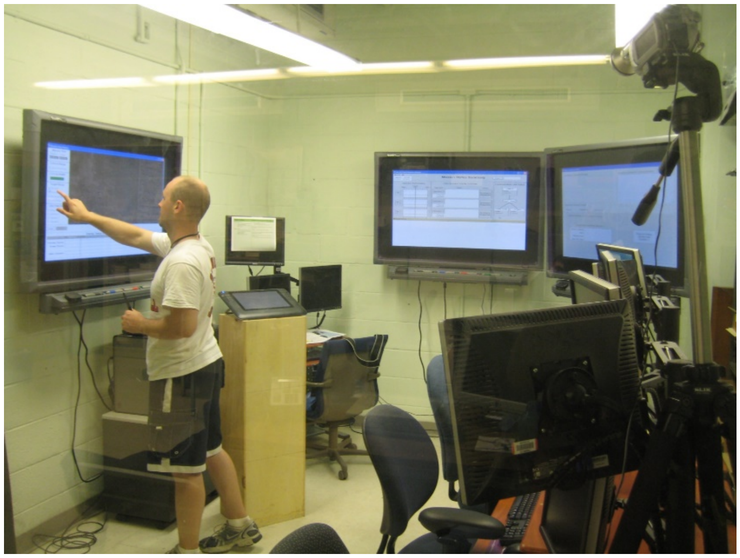

Figure 1: Testbed with the primary displays

An analysis of the data collected showed that the interaction effect between display location and the decision difficulty on recovery time was significant, ($F(1,52) = 10.94$, $p < 0.01$). Simple decisions were significantly longer only during the integrated condition compared to complex decisions. It took more time (about 19 seconds) for the participants to make simple decisions compared to complex ones. Although, the effect of the display location on decision accuracy was not significant (X^2 (1, N = 56) = 0.4242, $p = 0.51$), decision difficulty had a significant effect (X^2 (1, N = 56) = 6.7879, $p < 0.01$. While future work with larger sample size and more realistic scenarios is warranted, these findings may indicate that providing similar decision-support tools on the main mission displays could facilitate interruption recovery specially for complex decisions.

REFERENCES

Sasangohar, F., Scott, S. D., & Cummings, M. L. (2014). Supervisory-level interruption recovery in time-critical control tasks. Applied Ergonomics, 45(4), pp. 1148-1156.

Scott, S. D., Mercier, S., Cummings, M., & Wang, E. (2006). Assisting interruption recovery in supervisory control of multiple UAVs. Paper presented at the Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 50(5), pp. 699-703.