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OPTIMAL CHARACTERISTICS OF INSERTED GRAPHIC OBJECTS IN STIMULATING CCTV OPERATOR VIGILANCE AND PERFORMANCE

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A thesis submitted to the Faculty of Humanities, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Doctor of Philosophy.

September 2011

DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy at the Faculty of Humanities, University of the Witwatersrand, Johannesburg. It has not been submitted previously for any other degree or examination in any other university.

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SEPTEMBER 2011

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation and thanks to:

- My supervisor, Prof. Andrew Thatcher, who provided guidance, insight and encouragement throughout the process. His speedy responses and feedback are highly appreciated, especially when other priorities called.
- Dr Craig Donald, my husband and source of inspiration for this research, for sharing his area of interest, providing intellectual stimulation, challenging my views and giving ongoing emotional support. In addition, this research would not have been feasible without his technical support in terms of computer equipment, photographic skills, video editing and numerous other forms of assistance.
- Mr Michael Greyling for his statistical advice and assistance.
- Dr Yvonne Broom for support during the initial phases.
- Leaderware cc for the use of SAMAE.
- The organisations, operators and students who took part in the research despite the time commitments involved.
- The models for the photographs – Bafana, Dakalo, Ian, Katherine and Sifiso.
- The research assistants who helped with data collection, in particular Ashleigh, Jennifer, Katherine, Leanne, and Nelson.
- My daughters, Katherine and Heather, who supported the process, graciously made many sacrifices and provided technical support in the form of photographic editing and tips for final formatting. This was truly a family effort.

ABSTRACT

Vigilance is a key process fundamental for sustained performance in many jobs and in particular those requiring continual detection in visually intensive tasks. This research examined operators' overall vigilance performance levels and decrements over time in the context of closed circuit television (CCTV) surveillance. The aims of the research were to develop an intervention to enhance the detection of significant events, and to establish the levels of overall vigilance performance and decrements in a CCTV surveillance task. The intervention consisted of electronically inserting graphic objects (IGOs) or images into the video stream with the intention of assisting operators in detecting actual significant events. IGOs could potentially represent an infinite range of visual stimuli, but it was argued that only particular visual characteristics are likely to enhance the detection of real significant events, rather than merely facilitating the detection of the IGOs themselves. In addition, the characteristics of IGOs are likely to influence the extent to which their relationship to significant events is understood. The research identified a range of characteristics that could be incorporated into IGO design, and focused on salience and semantic distance for the empirical part of the research.

A matched three-group quasi-experimental design involved a sample consisting of 29 specialised CCTV surveillance operators, 13 control room operators doing surveillance, and 31 novices. The task consisted of observing a ninety-minute CCTV video showing general and target behaviour in a video stream of actual work settings. The control group received no IGOs, one treatment group received generic IGOs, and the second treatment group received IGOs with close semantic distances to target behaviours. There were indications that the IGOs had positive effects on alertness and attention sets, but this did not translate into statistically significant improvements in detection rates. Reasons for this included IGO characteristics, the complex and dynamic nature of CCTV displays and significant events, and the dynamic and spatiotemporal properties of the IGOs. Semantic distance was confirmed as an important IGO characteristic.

The research demonstrated a number of critical insights into vigilance dynamics and visual processing and highlighted that there are gaps in the understanding of the attention processes that occur in jobs requiring sustained attention. Only half the target behaviours were detected despite all target behaviours being visible, indicating a concerning underperformance in intensive visual detection tasks involving complex work situations. Responses to vigilance demands were highly individualised, with decrements and surges beginning at different times across individuals. Qualitative analyses of participants' behaviour also found fluctuations in task engagement, suggesting that sustained attention is unstable. Results did not support a steady, linear vigilance decrement for all sub-samples. An increment in detection rates was found for specialised participants after 60 minutes, while novices to surveillance tasks showed a more linear decrement. Work exposure was an important variable that contributed to detection levels and performance fluctuations over time. The research highlights differences between tasks with simple visual stimuli frequently used in vigilance research versus complex real-world tasks in vigilance intensive jobs. Important insights regarding vigilance processes in complex real-world jobs emerged, including the need for active searching processes, visual analysis, high levels of situation awareness and the importance of operator's frame of reference and approach to the detection task. The research has likely implications for other visual imaging technologies such as x-rays, infrared and thermal imaging, and technology using newer millimetre wave and terahertz based imaging common in security, policing, and defence.

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