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Systems That Work for Humans

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THE EFFECT OF PRACTICE ON VISUAL CHANGE DETECTION IN COMPUTER DISPLAYS

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People are sometimes unable to detect changes in their field of view, especially when the change coincides with a distraction. This failure to detect visual changes is known as change blindness. Our research on change blindness is motivated by the increasing use of complex digital displays in both military and industrial process control systems. We are interested in the extent to which important changes in displayed information might be missed, and methods to decrease vulnerability to change blindness. The present study examined whether practice detecting specific changes would lead to better change detection performance in general. Participants practiced detecting specific visual changes, such as an icon changing from blue to red, using the flicker paradigm with feedback given after each trial. Practice did lead to improved detection performance for the practiced changes (i.e. the blue to red changes). As performance improved, reaction time declined as well. To assess the generality of this effect, following practice, participants were given a transfer test in which changes that had not occurred during practice were scheduled (e.g., green to yellow changes or icon shape changes). Performance on these novel changes was significantly worse than for the practiced changes and there was no significant difference between the within-category changes (such as green to yellow instead of blue to red), and the between-category novel changes (the shape changes). These results therefore suggest that the improvements observed were specific to the changes practiced. On the other hand, the possibility exists that the procedure used actually taught participants to ignore the features that changed in transfer. During practice, these features were presented, but never changed. If participants learned to ignore these features during practice, that would work to oppose any generalization of heightened visual attention. This and other factors that may have affected performance are discussed.

INTRODUCTION

Mass proliferation of computer-based technology has resulted in the need to examine the interaction between humans and computer systems. The particular area of research discussed in this paper involves the phenomenon of change blindness in computer displays and visual scenes. Imagine, for example, that you are monitoring a computerized radar display as an air traffic controller. You are observing an inbound flight represented on-screen as only a small icon and a number that indicates present altitude. Everything appears normal, but a distraction suddenly pulls your eyes away from the display for a brief moment. When you return your attention to your monitor, would you notice if the icon or altitude of your inbound flight had changed? (Assume no alarm has sounded alerting you to the change.) What if there were 10 or 15 other icons on the screen at the same time?

Recent findings from experiments involving change detection tasks suggest that, under a variety of conditions, changes in visual displays frequently go unnoticed. When the change coincides with a distraction, or even just an eye blink, it becomes even more difficult to detect (O'Regan, Deubal, Clark, & Rensink, 2000). Failure to detect such changes is called change blindness, and it can have serious repercussions if it occurs in the context of military operations, as well as other critical monitoring functions. Although some findings have provided guidance as to the best ways to make changes easier to detect, there is no clear-cut solution to the problem. For example, fixation on the changing object (Grimes, 1996) and attention on the critical display area both serve to increase accuracy in detecting changes (Wolfe, 1999). Hollingworth, Schrock, and Henderson (2001) further investigated fixation by monitoring eye movements. Their results confirmed that participants who were successful at change detection tasks actively fixated on potential change targets. However, fixation in no way guarantees change detection. In addition, even when the object undergoing the change is the focus of attention, change blindness still occurs at a considerable rate (Simons & Levin, 1998). People are also typically unaware of this phenomenon, and overestimate their ability to successfully detect such changes in general (Levin, Momen, Drivdahl, & Simons, 2000).

Change blindness can be induced in various ways. For example, the quick cuts used by film editors can induce change blindness quite easily (Levin & Simons, 1997). Our experiment used a gap-contingent technique known as the *flicker paradigm* (Rensink, O'Regan, & Clark, 1997), where a temporal gap or "mask" is placed between an initial and altered stimulus. Several other approaches exist including blink-contingent and image-relocation techniques, as well as making the change gradually over time. For a more complete review of many of the empirical approaches to change detection, see Rensink (2002). Researchers have devised empirical methods like the *flicker paradigm* to provide a way to simulate distractions such as eye blinking or movements that could draw an observer's attention away from the relevant display area or object. In a standard flicker paradigm study, images are presented in alternating sequence whereby the

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