Human Supervisory Control: A Cognitive Perspective

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Introduction

Skill-based tasks in supervisory control systems often require the human operator to allocate attention to, for example, plan what to do next, monitor the system, or intervene when required to make adjustments (National Academy of Sciences, 1983).

In this pilot study, we attempted to reproduce the supervisory control phenomenon in a simple simulated task environment. The basic supervisory control effect was replicated; namely, over checking the least prioritised item while under checking the most prioritised item.

Results from the current study provide empirical against which future computational cognitive models will be compared.

Method

19 undergraduate students from Rensselaer Polytechnic Institute participated in the experiment.

Six levels of reset frequency were manipulated in each of three blocks. Each block lasted 640 sec.

On each block, subjects monitored six progress bars. Each bar filled from left-to-right at a different speed. For maximum performance, subjects were told to reset each bar when it reached the centre. Hence, for the ideal subject, the different fill speeds would translate into an optimal frequency of 4, 8, 16, 32, 64, or 128 resets per block for each of the different progress bars.

The bars were arranged in a 2 columns □ 3 rows format. Each was covered by a black window. To check on a bar, subjects moved the mouse to and clicked on the black window to uncover the bar. Once uncovered, the bar could be reset by another mouse click.

In addition to the primary task, subjects were also required to perform a concurrent secondary arithmetic task and were asked to be as accurate as possible in both tasks.

The experiment started with a practice block (Block 0) that lasted for 150 s. Blocks 1, 2 and 3 each lasted for 640 s each.

Results

Fig. 1 shows the average number of checks across subjects for each frequency. The difference in percentage ((Actual – Optimal) / Optimal) between the actual number of checks and optimal number of checks are 930%, 426%, 246%, 119%, 50% and –9% for the frequency 4, 8, 16, 32, 64 and 128 respectively.

Significant main effects were obtained for both frequency ($F_{(5, 90)} = 154.791$, $p < 0.001$) and block ($F_{(2, 36)} = 17.693$, $p < 0.001$). Interaction between frequency and block was also found significant ($F_{(10, 180)} = 3.383$, $p < 0.001$).

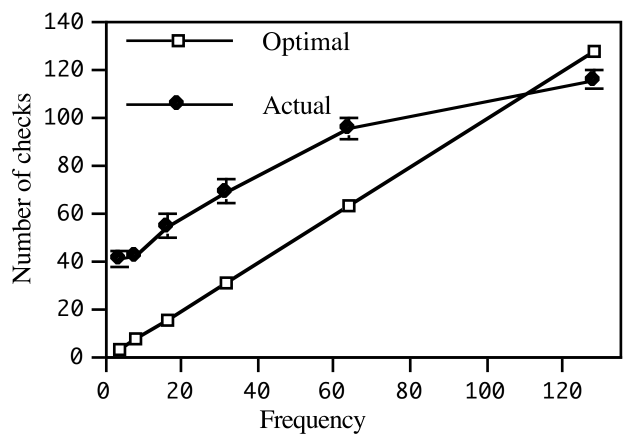

Fig. 1 Average number of checks across subjects and blocks for each bar frequency

Discussion

This study replicated the basic supervisory control effect; namely, subjects did not perform optimally in relation to the bar frequency but attended more than optimal to the slowest bar and less than optimal to the fastest bar. The interaction suggests that, across blocks, subjects did not change their rate of checking for the slowest frequencies (4 and 8), but increased the rate of checks for the higher frequencies (16, 32, 64, and 128).

Our efforts are now focused on building ACT-R computational cognitive models to account for these phenomena. In particular, we have started looking into ACT-R's credit assignment to productions as our preliminary investigation into the cognitive processes involved.

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References

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