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# Unit 2 Inquiry Assignment

**Topic:** Switch-tasking, processing stimulus

**Key concepts to explore:**

- Blood distribution in the brain - by switching between tasks, blood is distributed evenly across the areas of the brain that need it and thus less blood is given to one specific area. Blood contains oxygen, glucose and nutrients necessary for the nerve fibers to work. As a result, because the volume of blood delivered decreases, the less resources the nerve cell has to work with and thus the less efficient the cell becomes (Wells, 2016).
- Reaction time - the time it takes for the sensory nerves to receive stimulus, send it along the appropriate nervous systems and to the appropriate part of the brain, and finally for the brain to perceive that stimulus.
- Switch-tasking versus multitasking - switch-tasking would entail doing different tasks with entirely different outcomes, while multi-tasking would entail doing different tasks related to the same outcome (Bamford, 2019).
- Brain lateralization - how the brain divides itself. For instance, the right eye connects to the left visual field, and vice versa with the left eye (Myers, 2014). Could this possibly affect the time cost of switch-tasking?

**Inquiry question:** How can designers create better, simplistic and easier to understand user interfaces using knowledge of switch-tasking and the way in which humans process information?

There are many bad or rather unnecessarily complex interfaces out in the world, many existing in domains where the operators of such interfaces often have the lives of others in their care. For instance, airplanes, rockets, and nuclear power plants all are examples of complex interfaces. The purpose of this inquiry is not to determine what gauges or buttons can be combined or removed within planes or rockets, but rather to see whether or not the deleterious effects of switch tasking can be minimized in interfaces that demand unusual amounts of information processing.

**Project plan:**

- Research for prior experiments done on switch-tasking looking for how switching between tasks increases the amount of time it takes to complete said tasks versus when said tasks are completed individually.
- Create a game to exemplify the effects of switch-tasking. A game using a computer mouse will be played, followed by a keyboard game. The scores will be taken. Then, they will be played at the same time with the

mouse-based game on the right side of the screen and the keyboard game on the left side, and the scores will be taken. Then, the games will switch sides, and the score will be taken again.

**Biases:** With regards to the game, it is entirely possible that brain lateralization has no part to play in the effects of switch-tasking, and thus there might not be any difference when switching the side the games are displayed on. It is also possible that given the fact we have learned about switch-tasking before, evidence contrary to the claim may get passed by and that our game will not provide the results we are looking for.

**Research:**

- In a study published in 1995, researchers conducted an experiment where participants had to classify as even or odd, or as a consonant or vowel. The researchers conducted five experiments in total and in each experiment, the participants on the first trial would only be required to perform one of the two aforementioned tasks. Then, on the second trial they would be required to task-switch; in other words, they were given both numbers and letters. The researchers found that the response time when given the stimulus had increased to up to 0.6s. They also in a trial allowed the participants to mentally prepare for 1.2s, but yet still there was a significant reaction time cost to the stimulus (Rogers & Monsell, 1995).
- An experiment done in 1999 found that participants named the number that appeared on the screen faster in their first language than in their second language when the language they were supposed to use was repeated. In other words, if the background flashed red that would indicate to the participant to name the number that appeared on the screen in their first language whereas if the background flashed green, they would use their second language. When a number appeared on the same color background twice, the researchers found that the participant's primary language was quicker than their secondary language. However, interestingly enough, the researchers found that it takes longer for a participant to switch from their second language to their first than the other way around (Meuter & Allport, 1999); this can be seen at every instance a switch occurred.
- In a study published in 2001, researchers conducted four experiments in which young adults were required to switch between solving math problems and categorizing geometric objects as some of their tasks (Rubinstein, Meyer, & Evans, 2001). It was found that every time the young adults switched tasks and particularly as the tasks became more complex, the participants lost

time. It was also found that the time lost was greater when these participants had to do tasks that were unfamiliar to them (Rubinstein et al., 2001).

- In a 2014 study, from a group of basketball players, reaction time to a visual cue and auditory cue were measured. The researchers found that participants reacted quicker to the auditory cue than the visual cue (Ghuntla, Gokhale, Mehta, & Shah, 2014).
- The results from our time switching task in class showed that the average time across 21 samples had nearly tripled to quadrupled when students were required to switch between counting and saying the alphabet (Bamford, 2019).

**Synthesis:**

The game provided should exemplify and further support the evidence found in the 1995, 1999 and 2001 studies along with the results in our time-switching activity done in class. The vision and hearing test should also support the 2014 study in the sense that a human can react quicker to an auditory cue than a visual one. Bear in mind, the hearing test could not be completed due to the requirement of special user permissions. That said, the vision test presented has slight flaws with regards to the fact that the measuring of an individual's reaction time also includes reflex time or better thought of as the time it takes for one to move the mouse in the right position.

In addition, while no extensive research or experimentation has been done, the dual games can lend a bit more insight into the specifics of switch tasking and whether or not brain lateralization plays a role in the time costs associated with task switching. Furthermore, a common theme throughout each of the studies done has been how switch tasking affects time-taken, but it would have also been interesting to see if switch-tasking affected performance unrelated to time. For instance, if given unlimited amounts of time, would switch-tasking affect the pure quality of the task being done. Another common theme across each study was that the complexity of the task was a factor in time loss, and so was unfamiliarity. In the 1995 study, participants who had time to mentally prepare still experienced time loss due to switch tasking but at a lesser degree, and in the 2001 study, participants loss more time as the tasks became more complex. Moreover, the 1999 study lends insight into the idea that the time cost is derived from the switching of the current task and not the task being switched to. In essence, the complexity of the task a person switches to does not matter as much as the complexity of the task a person switched from. This idea could have also been tested by the game, if we had set up the dual games to be alternating rather than simultaneous.

Lastly, as the 2014 study supports; auditory cues may be the way forward in attempting to minimize the complexity of complex interfaces. What is particularly interesting about the 2014 study is that basketball players are trained in reacting to primarily visual cues and not auditory ones as basketball is primarily a visual game. Yet still, their reaction times support the idea that humans can hear faster than they think. That said, the results may not be replicated when auditory cues are projected at longer distances because then light will reach the human eye faster than sound. However, for interfaces in close proximity, auditory cues may be an interesting feature.

With regards to biases in research, it is entirely possible that personal points of views affected the research collection. Specifically, the critical analysis of the shortcomings of each study was not investigated; thus, it is probable that confirmation bias played a role in the research. Further, we created the game before doing any research; thus, while the evidence does end up supporting what we were trying to do with the game, the order of the processes is evidence of confirmation bias.

**Evaluation:**

The implications of the findings are that humans who want to be efficient should not resort to switching between doing two tasks simultaneously, but rather to focus on one and then on the other. A simple way to put it is: If task A takes 10 seconds, and task B takes 10 seconds, then in total it would take 20 seconds to complete both one after the other. Switch-tasking would not subtract from this total value, but rather would add to it. If one were to switch between the two tasks, there would be a time cost factor added to that 20 seconds that would likely make the total amount of time taken to be more than 20 seconds. In the case of the game, performance measured by score will likely decrease for an individual if they played two games at the same time versus just one.

With respect to the inquiry question, it is possible that the interfaces in planes, rockets, and nuclear power plants to name a few could be simplified and made more efficient whilst maintaining all the necessary information by simply presenting one set of information at a time. For instance, instead of having a pilot monitor 10 gauges, there could be one screen that shows one or two primary metrics of information and the other eight metrics only appear when they matter. The theory behind this strategy is that a pilot does not need to frequently attend to each gauge which takes time. If a pilot were to change in altitude, then that altitude gauge would appear, but if they were flying more or less at the same level then there is no need for that gauge to be present. Evidently, technology and artificial intelligence would be needed to accomplish such an interface, but it is likely that such an interface would be much more efficient. That said, one could argue that the different controls on a plane are an example of multi-tasking and not switch-tasking in the sense that the controls all lead to the same outcome. However, even if that were the case, it is possible that the interface could still be improved with the aforementioned theory and thus leaves further questions to be asked. That aside, it is highly likely that interfaces can be improved by incorporating more auditory cues.

For future inquiries, doing more in-depth research including analyzing the shortcomings of said research would be helpful. This analysis would also help to reduce any confirmation bias that may be occurring throughout our research. In addition, exploring topics that we have little to no previous knowledge of, would also aid to minimize any confirmation bias. Moreover, after exploring this topic, the more interesting and less researched idea would have been to explore if switch tasking affects quality independent of time. In other words, if switch tasking not only negatively affects efficiency but effectiveness also.

**Conclusions:**

The research found supports the possibility that complex user interfaces can be simplified and its efficiency improved, whilst still providing the same amount of information through the reliance on single-tasking rather than switch-tasking or multitasking. In fact, the SpaceX dragon control panel has to some degree accomplished this feat, but it is not clear whether or not they took into account the idea of switch-tasking.

References

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