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The effects of a computer malfunction on subsequent task performance

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Although previous research has examined the effects of computer malfunctions on employee frustration, to our knowledge no research has explored computer malfunction's effect on subsequent task performance. It was hypothesised that participants who experience a malfunction would perform worse on a subsequent task than those who experience no malfunction. Participants ($n = 204$) were randomly assigned to experience either a computer malfunction or not during the first task. Participants then completed a subsequent task. The results confirmed that the Malfunction group performed worse than the Control group on both tasks. Implications for workplace performance are discussed.

Keywords: computer malfunction; performance; frustration; technology; digital divide

1. Introduction

Frustration in the workplace is an increasingly more difficult problem to deal with, and as the use of technology increases, the demand for workers to become more proficient with computers rises. According to the US National Telecommunications and Information Administration, 73% of employees who are 16 and older use a computer at work (Lazar *et al*. 2006a). Frustration is a frequent complaint by employees using computers (Heacox and Sorenson 2004). This frustration can be brought upon by a number of reasons, the most common being malfunctions that occur during web browsing, emailing and work processing (Lazar *et al*. 2006a). The average percentage of time wasted on fixing computer issues is about 43.7% (Lazar *et al*. 2006b). Many inexperienced workers find themselves faced with frozen web pages, lost documents and various other malfunctions that are not only frustrating, but debilitating in certain situations. Despite the known effects of malfunctions on emotions, few researchers have examined the effects of malfunctions on performance, particularly the effects of malfunctions on tasks that must be completed after the malfunction. The purpose of our research is to understand how these computer malfunctions can affect people's performance on future tasks performed after the malfunction has occurred.

When employees become frustrated as a result of computer malfunctions, it can affect the entire workplace's productivity (Lazar *et al*. 2006b). Some maladaptive responses to computer malfunctions can be anger, aggression, withdrawal from the goal or goals that are similar, fixation or 'frozenness', negative views about computers in general, and even physical discomfort (Child and Waterhouse 1953; Bessière *et al*. 2004; Lazar *et al*. 2006b; Kweon *et al*. 2008). All of these negative responses can drastically decrease an employee's ability to perform on future tasks. According to Fox and Spector (1999), some behavioural reactions to computer frustration can include negative effects on future job performance, absenteeism, disturbances in organisational climate, and effective work productivity of other employees.

Computer frustration is commonly considered a side-effect of the *digital divide*. The *digital divide* is the phenomenon in which some groups are filled with people who are proficient with computers as well as those who struggle to use them (Bessière *et al*. 2006). Offices that contain a large digital divide between employees may see higher levels of frustration. For example, older employees, who have little to no experience with computers, may feel pressured into working more with new technology in an effort to keep up with the more technically advanced younger generations. The digital divide may also account for many workers' inabilities to cope with computer malfunctions, or understand common troubleshooting procedures if there are inequalities in technical experience within the office. (Darabi *et al*. 2007). For example, workers may feel stressed if there is a

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computer malfunction they cannot fix on their own, or are too embarrassed to seek help from their peers. Experiencing frustration, however, depends on some important mediating variables.

According to Bessière's (2004, 2006) computer frustration model, the level of frustration people experience during computer interaction depends on two types of mediators: dispositional and situational. Dispositional mediators include the level of computer experience, psychological factors such as self efficiency, and mood at the time of the computer malfunction (Lazar *et al*. 2006b). For example, few experiences with computers, coupled with low self-esteem and a bad mood will cause a person to experience frustration from a computer malfunction immediately. The situational mediators include the level of goal commitment, the severity of the malfunction (such as the amount of information that is lost) and pressure to complete the goal (such as a deadline) (Lazar *et al*. 2006a). Situational mediators tend to influence the level of frustration, while the dispositional mediators influence how quickly the frustration escalates throughout other tasks. When a computer malfunction occurs, it includes both of these mediators, the malfunction will cause more severe user frustration, greater loss in time spent trying to fix the problem, and a more negative attitude towards similar subsequent tasks (Fox and Spector 1999, Bessière *et al*. 2004, Lazar *et al*. 2006b).

Computer malfunctions can also affect one's ability to recognise situational cues, and respond to them accordingly. Pilots who experience malfunctions not only perform worse than those who do not, but also perform slower (Beringer and Harris 1999). Other studies examined the effects of stress brought on by similar malfunctions (Tiwari *et al*. 2008), repeated malfunctions (Jones 2008), and troubleshooting abilities after a malfunction (Darabi *et al*. 2007); however, there is a lack of research conducted that directly involves the malfunction's effect on the user's future performance.

Our experiment was conducted to better understand how a computer malfunction affects performance immediately on the task that has malfunctioned, as well as the effect on a subsequent task following the malfunction. This experiment will focus on the aspects of performance on the initial malfunctioned task as well as their performance on the subsequent task to discover how the malfunction directly impacts future performance.

We hypothesise that people who experience a computer malfunction on a task will perform worse on that task than those who do not experience a malfunction. In addition, we hypothesise that those who experience a malfunction will perform worse on a subsequent task than those who do not experience a malfunction.

2. Pilot study

A pilot study was conducted in order to measure the validity of the manipulation's ability to frustrate the participants.

2.1. Method

2.1.1. Participants

A sample of 28 undergraduate students enrolled in psychology courses at Eastern Kentucky University volunteered for the study by signing up online. They were given course credit as an incentive for participating.

2.1.2. Materials and procedure

2.1.2.1. Power point task. Upon arrival to the laboratory, participants were first seated in a room with a computer and a monitor, as well as a piece of paper they could use to mark their answers. Participants were then asked to complete a memory-recall task, which was presented as 60 Power Point slides comprised as 30 pairs of image and question slides. For each image, participants were presented with an image that flashed on the computer screen for 3 s, and they were instructed to memorise as much as possible about the image. The images were of scenery or still-life objects. The image was then immediately followed by a question that pertained to an element in the picture, for which they had 6 s to answer (see Appendix A). For example, and image of a building may appear, and the following question might ask 'how many windows did the building have?' and participants would fill in the answer on their answer sheet. If they did not know the answer, participants could leave the space blank and wait for the next question to appear. The researcher informed the participant that they may not touch the mouse or press any keys during the memory-recall assignment as it would stop or slow down the presentation; the researcher also told the participant that he or she was going to be timed so that they did not try to slow down the presentation. After the researcher finished instructing the participants, he left the room for the duration of the task.

2.1.2.2. Control and malfunction manipulation. Participants were randomly assigned to either the Control group or Malfunction group. In the Control group, participants completed the task as described

above. For all 30 image–question pairs, the image was presented for 3 s, and the question was presented for 6 s. In the Malfunction group, the participants were given the exact same instructions. However, after slide 3 of the memory-recall presentation, the program simulated a computer malfunction in that it only gave the participants 0.5 s rather than 3 s to view the image they were instructed to recall. They were still provided the 6 s to answer the question, but had inadequate time to fully memorise the image. When the researcher returned to the room, he only acknowledged the malfunction if the participant mentioned it, and replied that it was an unfortunate error of the computer and encouraged the participant to continue. The total time for the task was 5 min. Both groups of participants were asked to complete a short survey, describing how they felt during the task, and were then debriefed.

2.1.3. *Emotion survey*

A four-item survey was also given to all participants immediately after they finished the PowerPoint exercise (see Appendix B). The survey asked them to report on a Likert scale how angry, frustrated, pleased, and happy they felt after completing the task ($1 = not\ at\ all$, $5 = very\ much$). These four items were chosen because they represent the types of emotions people would experience after completing a task. The mean of participants' responses on the angry and frustrated items was obtained for the Negative Emotion score ($\alpha = .74$), and the mean of participants' responses on the happy and pleased items was obtained for the Positive Emotion score ($\alpha = .56$).

2.2. *Pilot results and discussion*

Two independent *t*-tests were performed in which the condition was the independent variable, and the Negative and Positive Emotion scores were the dependent variables (Figure 1). The students in the Malfunction Group had significantly higher scores on Negative Emotions ($M = 2.00$, $SD = 0.73$) than did those in the Control Group ($M = 1.58$, $SD = 0.57$), $t(25) = -1.66$, $p_{one\text{-}tailed} = .05$. There was no significant difference in Positive Emotion scores between the Malfunction Group ($M = 2.11$, $SD = 0.71$) and the Control Group ($M = 2.27$, $SD = 0.44$), $t(25) = 0.71$, *ns*. In other words, the malfunction only increased the participants' anger and frustration, and had no effect on the participants' positive emotions. In light of the results from the pilot study, it was found that the computer malfunction did indeed illicit frustration and anger in the participants.

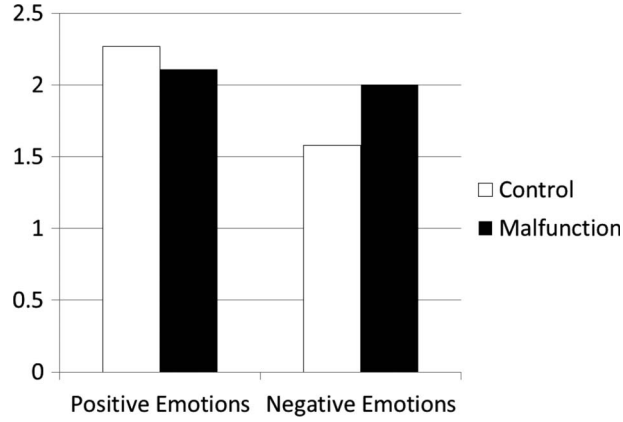

Figure 1. Mean differences between control and malfunction group on emotions (pilot study).

3. Method

3.1. *Participants*

Undergraduate students ($n = 204$) who were enrolled in psychology courses at Eastern Kentucky University volunteered for the study by signing up for it online. Thirteen of the participants who either claimed to speak English as a Second Language (ESL) or were suspected of having less than distinguished English speaking ability were dropped from the study due to the involvement of an anagram task. Any participant that was not finished with the first task after the allotted time was excluded from analyses due to their inability to understand and follow directions. This resulted in a final sample of 194. The participants received course credit for participating. It was made known to the participants that if they felt any discomfort at anytime, then they could leave the study with no penalty.

3.2. *Materials and procedure*

Participants signed up for the study online. Informed consent was obtained from all participants in the study. Participants were randomly assigned to either the Control or Malfunction group, which involved the same procedure as was described in the Pilot Study. The participants were then given an option to do one of two tasks: either decipher a list of 10 anagrams or answer 10 fill-in-the-blank questions that pertained to a PowerPoint presentation on famous psychologists. The anagrams were considered to be a more difficult and time consuming task, and were also very different from the original task. The PowerPoint questions were very simple and could easily be found throughout the presentation, but were very similar to the initial malfunctioned task. The experimenter once again left the room in both the Malfunction and

Control conditions, and returned after the allotted time of 10 min. If a participant mentioned the malfunction, the researcher was instructed to reply that it was an unfortunate computer malfunction, and to encourage the participant to continue with the experiment. The participants were given a debriefing form to clear up any deception, and were informed of the college psychologist's contact information in case they felt lingering frustration from the experiment.

3.2.1. *Performance scoring*

Task 1 Performance was scored according to the number correct out of 30. Task 2 Performance was scored according to the number correct out of 10. However, due to the different nature and number of the questions on each task, the performance scores were all standardised into Z scores.

4. Results

It was predicted that participants who experienced the computer malfunction would perform significantly worse than those who did not on the initial as well as the subsequent tasks. To test this hypothesis, two independent t-tests were performed in which the condition was the independent variable, and Task 1 Performance and Task 2 Performance were the dependent variables (Figure 2). The students in the Malfunction Group performed significantly worse on Task 1 ($M = -0.27$, $SD = 0.80$) than did those in the Control Group ($M = 0.49$, $SD = 0.75$), $t(162) = 6.27$, $p_{one\text{-}tailed} < .01$, $d = 0.98$. The Malfunction Group subsequently performed significantly worse on Task 2 ($M = -0.08$, $SD = 0.68$) than did those in the Control Group ($M_{=} 0.10$, $SD = 0.71$), $t(162) = 1.63$, $p_{one\text{-}tailed} < .05$, $d = 0.26$. In other words, participants who experienced the malfunction during Task 1 not only performed poorly on that task, but also performed worse on the subsequent task, than those who did not experience the malfunction.

5. Discussion

The results of the current study showed that computer malfunction resulted in decreased performance of the current task and the immediate task afterwards. Not only did the participants miss more questions during the slideshow as a result of the malfunction, they missed more questions on the subsequent task as well. The results of the pilot study indicated that, when the participants experienced the computer malfunction, their level of anger and frustration was higher than those who did not experience a malfunction, potentially leading them to make more errors as a result. In conjunction with the present study, the results overall found a relationship between participants who experienced the malfunction and an overall decrease in subsequent performance, compared to those participants who did not receive the malfunction (in which their performance and emotional response stayed the same). Overall, these findings suggest that when the participants experienced the malfunction, they became more frustrated, and as a result, the frustration caused debilitating effects on their subsequent performances.

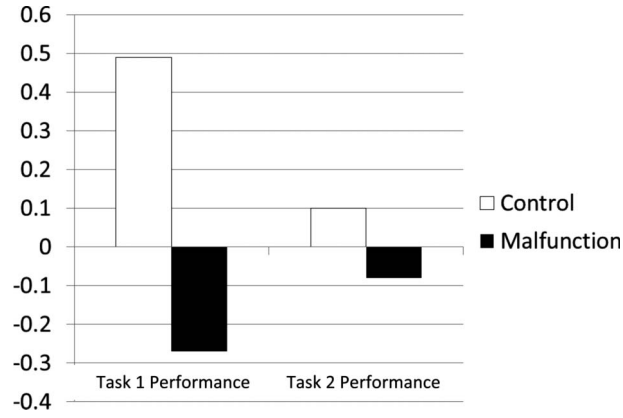

Figure 2. Standardised score differences between control and malfunction group on performance.

5.1. *Implications*

In research on computer malfunctions and user frustration, it is common to find results on how malfunctions effect time wasted on fixing the issues, employees' negative moods and subsequent task choice (Fox and Spector 1999; Bessière *et al*. 2004; Lazar *et al*. 2006a). However, our experiment focused on subsequent task performance directly, rather than the various components that effect performance indirectly. These findings add to the previous research on how computer frustration affects employees' performances not only on the initial task, but on future tasks. Rather than observing how the participants felt during the malfunction, and whether they felt they were able to adjust to it and potentially fix the problem, the participants in this experiment were not given the opportunity to adapt to the malfunctioned task, so they could not attempt to fix the issues. Because the malfunction was part of a timed exercise, it made the participants unable to waste time trying to fix the issue, causing the participants to get frustrated more quickly without any means to alleviate their frustration. This sort of exercise has never, to our knowledge, been observed in experiments relating to computer

frustration. In summary, the results of this experiment are the first to show the extent to which computer malfunctions affect subsequent task performance.

Our findings build upon previous studies by Bessière *et al.* (2006) and Lazar *et al.* (2006a), in that both studies focused on the impact of user frustration in relation to frustration levels and subsequent result of time lost during troubleshoot. Our experiment focused instead on the practical implications of user frustration, such that individuals who experience these types of malfunctions may be more prone to making mistakes on future tasks. This can greatly impact businesses in that a simple computer malfunction would not only waste time, energy, and resources, but also impact later tasks. In organisations such as tax companies, or insurance bureaus, even minor mistakes may be worth thousands of dollars. This may be even more important for organisations like the Department of Defense, in which computer malfunctions may frustrate and distract intelligence or code-breakers, causing them to make future mistakes in their reports, and may lead to even more problems in the future.

It is especially important for businesses that rely heavily on the use of computers to invest in some form of training on how to troubleshoot or to hire more staff to assist in technological errors. While there are several steps to avoid workplace frustration as a result of computer malfunctions (Lazar *et al.* 2006b), our experiment suggests that businesses should not just focus on alleviating worker frustration, but rather get to the heart of the matter and find the fastest possible solutions for the malfunction itself. Even better, they could implement ways of preventing the malfunctions before they even occur. For example, business managers might consider having all of the computers set up to receive automatic updates outside of office hours. They may also consider limiting the use of the employees' hard drive access in order to keep employees from accessing settings that could cause problems in the future.

In education settings, when students are expected to complete the majority of their work on a computer, and sometimes even turn in assignments online, there are more opportunities for things to go wrong. According to Lazar *et al.* (2006b), students who experienced computer malfunctions became more severely frustrated as the importance of the assignment that they were working on increased. In this case, students completing such tests as the GRE, ACT, and graduate level comprehensive exams, are more likely to be devastated by a computer malfunction that prevents the completion of these tests. In the event that the test may be re-taken, according to our results, the student may perform much worse the second time through than before the malfunction offered. As such, it is important to consider these consequences when utilising new technology and evaluating what problems may arise, and how people will react to them in return.

5.2. *Limitations and future research*

There are three main limitations to the findings of this study that should be rectified for future research. The first limitation was that the malfunction was not obvious enough to some of the participants, and they did not realise that when the slides began to move very quickly, that it was not supposed to happen. The malfunction was designed to be subtle, but in doing so, it may have also become unrecognisable and thus was not what most people would consider a computer malfunction. In utilising a subtle malfunction, it is possible that some participants did not feel as affected by the malfunction as others. Although the subtle malfunction was useful in making the task much harder to complete, the participants' performances on subsequent tasks when they were unable to finish the first task could have produced stronger results.

For future studies, it is advised to use a more severe and typical malfunction (e.g. a computer freeze, program crash, or shut down), which would be more recognisable and troubling to the participants, to compare the severity of the decrease in performance with the findings of this experiment. In utilising a computer malfunction that is obvious, it will elicit clearer cases of frustration, rather than cause confusion. Also, by creating a condition in which the malfunction is so severe that the task could not be completed (e.g. the computer shuts down), future researchers can determine what the effect of malfunction severity is on the participants' subsequent performance on future tasks.

The second limitation of this study pertained to a lack of pretest assessing the participants' prior knowledge of computers. The study was designed to be very simplistic in that the participants were not asked to do any technical tasks other than advance through a PowerPoint. However, it would have been more beneficial to take note of how computer proficiency impacted the participants' degree of frustration, and in turn, their lower in performance on the future task.

For future studies, it would be beneficial for researchers to take into account the participants' level of computer proficiency. This is even more crucial if future researchers look at how participants' react to more advanced computer malfunctions, as they would need to know whether their frustration is caused by the malfunction itself, or their frustration in not understanding or even comprehending the situation due to their lack of proficiency. It would also be important to

assess computer proficiency if looking at how the malfunction affects participants' performance on future computer-based tasks such as typing reports, electronic filing or navigating a web browser.

The third limitation of the study was that we did not evaluate the participants' mood prior to the first task, and prior to the second task in order to determine whether the frustration they felt was already present before the malfunction, or brought on by the malfunction. We utilised the results of the Pilot Study mentioned earlier to determine whether the malfunction actually causes frustration, but because the survey was only four items, it may not have been an accurate assessment.

For future studies, it is advised that a more comprehensive study assessing the participants' mood and level of frustration be provided before and after the malfunction. This would give researchers a better understanding of the degree of frustration of the participant in relation to how they felt immediately before the malfunction and immediately after. The survey would also show the relationship between levels of participants' moods and their future performance, indicating whether or not the malfunction is as effective when participants are feeling negative emotions as opposed to more positive emotions.

6. Conclusion

The current experiment has answered the question on how computer malfunctions affect performance, namely that it lowers performance on the malfunctioned task as well as future tasks. In a business environment where individuals tend to focus on the bottom line, these findings pose a problem with no solution. However, by creating a more knowledgeable staff that is equipped with the skills and abilities to handle malfunctions, overcoming frustration and any other emotion brought on can be made easier and more efficient for the employees (Lazar *et al*. 2006a). By focusing more of their resources on fixing the problems before they arise, and educating their employees on constructive ways of dealing with computer malfunctions, many businesses can look forward to more productive employees and better business revenue.

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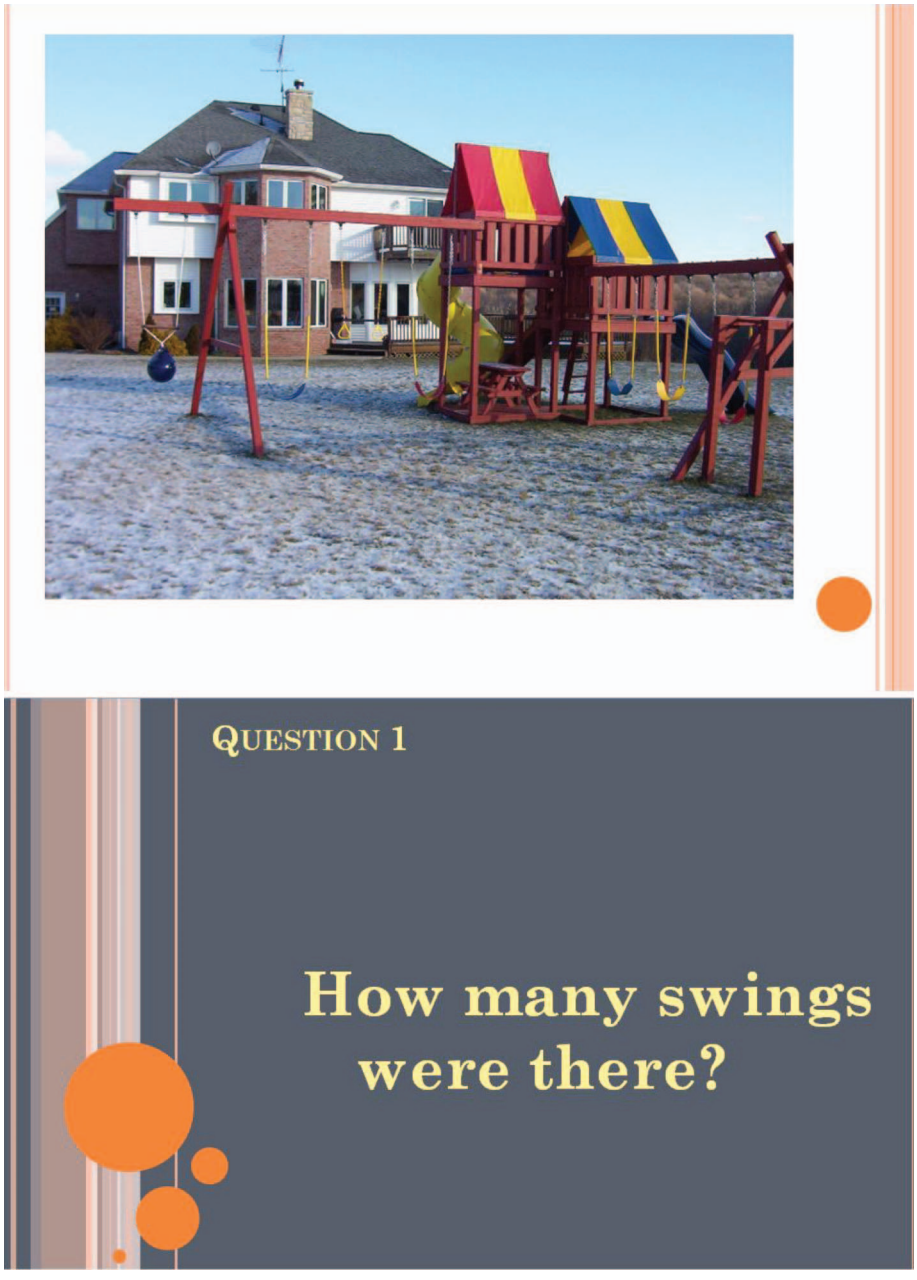
Appendix A

Sample of image-recall task



Appendix B

4-item Emotion Survey
Emotional/Physiological Survey
Please answer the following questions as truthfully as possible by using the scale:

1 – Not at all	2 – Not Really	3 – Not Sure	4 – A Little	5 – Very Much
During this task:				
1. How angry were you?				
1	2	3	4	5
2. How frustrated were you?				
1	2	3	4	5
3. How pleased were you?				
1	2	3	4	5
4. How happy were you?				
1	2	3	4	5

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