

DOES MUSIC AFFECT TECHNOSTRESS?

by

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ABSTRACT

This research investigates technostress and how its effects may be mitigated through the use of music. In general, technostress is a form of stress induced specifically by technology use. We hypothesize in this study that musical preference and the application of background music will impact subjects experiencing technostress. Our ultimate goal is to determine ways technostress can be reduced. Our research method utilized an experiment where 22 students completed a stressful online task while listening to music clips. Each clip contained silence as well as upbeat and relaxing music arranged in random order. The online task was manipulated to induce stress by: showing a ticking hour glass; providing a large red count down timer; telling the students they must get an 80% or higher on a set of questions; and, having too much work to complete under the time constraint. Stress levels were measured using a multi-method approach featuring a galvanic skin sensor, a post-experiment questionnaire, and measures of task accuracy and timeliness. The data was analyzed to determine if the presence of music affected technostress. The results indicated music order was significantly related to stress levels and task accuracy, and appeared to be more important than the music selections. Moreover, user music preference was a strong predictor of both galvanic skin response and accuracy of task completion. Overall, starting the experiment with silence or relaxing music tended to reduce stress levels throughout the experience but did not necessarily increase the accuracy of the task. We provide suggestions for future research to look closer at these factors.

INTRODUCTION

Technostress is the main topic of interest of this research. Technology use is prominent in the workplace and in university settings. Its adoption can increase efficiency and productivity, and provide knowledge workers with more capabilities. With this upside, comes several negatives and many of these downsides have been overlooked. Specifically, technology can induce stress in users due to many factors with issues related to reliability problems and usability incompatibilities (Ayyagari Grover & Purvis 2011). In order to utilize technology properly, any potentially negative effects must not only be examined and isolated, but a solution to overcome those effects should be identified and implemented. This study looks at how music offers the potential to reduce negative technology-related impacts. Discovering ways to reduce stress induced by technology is necessary for students, professors, employees, managers, and many others regularly working with information and communication technologies (ICTs) to help benefit from the advantages of technology without experiencing drawbacks.

There have been many studies that research specific antecedents and implications of technostress (Ayyagari Grover & Purvis 2011). Antecedents often are grouped into three categories: usability, intrusiveness and dynamism. Usability refers to the ICT's usefulness, complexity and reliability. Intrusiveness is the degree to which ICTs enable users to be constantly reachable and the degree of anonymity. Dynamism represents the perception of how rapidly technology changes. Commonly researched themes for stressors in these areas include role ambiguity and work overload. If usability, intrusiveness and dynamism of ICTs work against the user, then they will feel as though they have a lack of information needed to complete the job and the user will perceive that the assigned work exceeds their capability or skill level (Ayyagari Grover & Purvis 2011). By understanding how these factors relate to stress, potential mitigating factors can be identified and this ultimately applied in ways that reduce stress.

Based on past studies, researchers suggest that technostress needs to be addressed and reduced. Although the problems have been identified, not enough solutions have been suggested. The present study looks at music as a possible mitigating factor for technostress. Music has been shown to soothe or distract individuals from physiological

and psychological responses to stress (Getz Marks & Roy 2014). Many factors seem to influence ways music aids individuals experiencing stress including music preferences and type of stress. In most cases, research indicates music has the potential to help (Davis, Gfeller, & Thaut, 1999).

To our knowledge, music has not specifically been applied to technostress. The present study examines if music can act as a relaxer or distractor of stress with particular attention paid to stressors induced by ICTs. Furthermore, this research leads to potential implications in education environments and the workplace. To test how music could reduce technostress, participants were given a track of music with a random combination of upbeat music, relaxing music and silence and asked to complete a timed reading test on a computer intentionally coded with known stressors such as role ambiguity and work overload to induce stress. A galvanic skin sensor and post-test survey were used to measure participants' physiological and psychological responses to stress then used to find correlations music type and order to determine the most effectively methods to reduce technostress.

EXPERIMENTAL BACKGROUND

In the present age, technology is growing at exponential rates. Organizations are innovating and implementing different types of technology to increase efficiencies, lower costs and create strategic alternatives (Tarafdar 2007). However, the positives of technology are so heavily applauded that use continues to grow without the negative affects being fully realized. At the very least, ICT's create negative reactions in individuals and require them to adjust in various ways (Ayyagari Grover & Purvis 2011; Tarafdar 2007). The present study not only recognizes these harmful effects, but also seeks to create a solution to mitigate them.

There are two major research areas that the present study examines and combines. First, how does music affect stress? Music has the power to distract individuals from stressful situations or the perception of pain caused by stress (Davis, Gfeller, & Thaut, 1999), and individuals commonly use music for emotional regulation (Juslin & Sloboda). Since music is already proven to help people cope with stress, the present study looks at

how music could affect a different form of stress, technostress, which is our second major research area. There have been studies on the antecedents and impacts of technostress (Ayyagari Grover & Purvis 2011; Tarafdar 2007), but to our knowledge there are no studies on how to reduce or cope with technostress through the use of music. Technostress is a relatively new research topic. In spite of this, its importance cannot be understated. We believe it is necessary to isolate and decrease the specific impacts of technostress because of the ever-increasing presence of ICT's in business and society (Ayyagari Grover & Purvis 2011).

The present study seeks to develop a connection between research studies of how music reduces stress and technostress. With simple deductive reasoning we suggest that if technostress is a form of stress and has similar impacts on individuals, and if research has shown that music can reduce stress, then music should be considered as a way to reduce stress specifically induced by technology. To our knowledge, no other study has looked into listening to different types of music while using ICT's as a way to prevent or reduce stress that will inevitably be induced by the ICT's. Therefore our research question becomes:

Does music mitigate technostress?

We developed exploratory hypotheses to examine our search question. First, we believed that silence or relaxing music is more likely to mitigate technostress better than upbeat music. We hypothesized that relaxing music would be the most effective because prior studies have shown that classical music reduces blood pressure levels after performing a stressful task (Getz Marks & Roy 2014), and in an effort to reduce the bias of music preference, classical music was generalized to relaxing music. We tested the following hypothesis:

H1. Stress levels as measured by galvanic skin response in those who perform knowledge work in a stressful ICT environment will be reduced by relaxing music.

Although most research on music and stress uses classical music, there could also be impact due to musical preferences. Currently popular music includes pop and hip-hop, which can be generalized into upbeat music. When people listen to music they enjoy, their mood increases, and if their mood increases, impacts of strain will be reduced. Therefore:

H2. Stress levels as measured by galvanic skin response in those who perform knowledge work in a stressful ICT environment will be reduced by upbeat music.

Reducing stress is important, but a primary focus in many business environments is to improve task accuracy and efficiency. Therefore, we examined music can help improve task accuracy. Moreover, we structured the test to determine if music type increased accuracy. Our hypothesis was:

H3a. Accuracy as measured by subject test results performing knowledge work in a stressful ICT environment will be improved by relaxing music.

H3b. Accuracy as measured by subject test results performing knowledge work in a stressful ICT environment will be improved by upbeat music.

RESEARCH METHODOLOGY

Twenty-two Subjects for the experiment were recruited from a senior level Management Information Systems course in Dr. McHaney's class at Kansas State University. Students were able to replace one of their quizzes in this class in exchange for participation. They all listened to a music clip which included periods of silence, upbeat music and relaxing music. These clips were put in 6 different orders and randomly assigned to each participant to ensure no other variables were affecting their overall stress levels.

The online test they completed used a set of reading paragraphs chosen from the twenty-four paragraphs created by Cane et al., (2012). These paragraphs were perfect for our testing purposes because they were extracted from a wide variety of texts including

textbooks, biographical texts and fictional texts and therefore do not require specific knowledge. Moreover, they are easy to understand. After each paragraph there were three multiple choice or true/false questions, which made it possible to use measure task accuracy. The reading task was administered on a computer screen in the context of a custom-designed computer software system. Participants were given a time limit to complete the task.

The time limit was the second way to induce stress in participants. The reading task was interrupted periodically by a coded program showing a spinning hourglass and large red countdown timer to induce technostress. Participants were told that they would not receive credit for the quiz unless they got at least an 80% on the reading test, which entailed finishing the task or at least coming close. We tracked not only how accurate the participants answered the questions, but also how much of the reading task each participant completed since it was impossible to finish the entire task.

During the reading test, participants wore the Mindfield eSense Skin Response mobile sensor on two fingers to measure stress levels through skin conductance and hand moisture. Skin conductance is a measurement method based on bioelectrical properties of the skin and was measured in millionth Siemens. This was a way for us to test stress through the participants' biological responses.

The final way we tested stress was through the participant's perception. After the time limit expired, each participant completed a survey to help us gather information about his or her perceived stress level. The survey included a series of questions about stress they've experienced in their recent daily lives. They were also asked if they noticed the music and if it was distracting or enjoyable, what types of music they generally listen to and how often do they listen to music while studying. This survey helped us understand the background of each individual and explain the reasoning behind their other results.

The entire test and data gathering process took 20 minutes per participant. There were two rooms set up, one with the computer and eSensor for participants to actually take the reading test, and the other room had the consent form to sign before the test and the survey about perceived stress after the reading test. In the testing room, participants were hooked up to the mobile sensor and then given 10 minutes to complete the reading

task on the computer. From the program, one of the 6 music orders was selected and played throughout their ten minute reading task. After the ten minutes was complete, their stress levels from the sensor and the accuracy and completeness of the reading task were recorded. After this, they were given their post-test survey, asked not to disclose any information about the reading task program to future participants and were finished with their testing process.

RESULTS

We followed the exact steps laid out in the above Research Methodology section and after statistical analysis on participant galvanic skin response, music preference and test accuracy, we came to several key conclusions.

Hypothesis #1

H1. Stress levels as measured by galvanic skin response in those who perform knowledge work in a stressful ICT environment will be reduced by relaxing music.

Finding #1:

There was no significant difference in the stress levels as measured by galvanic skin response in students who perform knowledge work in a stressful ICT environment when they listened to relaxing music ($p=.99$).

Post Hoc Analysis #1

A post hoc analysis was completed to examine if the order in which music was played in during the exam had an impact on galvanic skin response. Subjects that began the test with silence or relaxing music exhibited lower average stress levels as measured by galvanic skin response throughout the exam than those who began with upbeat music during the exam (significant $F=3.07$, $p<.04$). Table 1 provides the results of the ANOVA for this analysis. Table 2 provides the galvanic scores for the order of the music clips.

Table 1: ANOVA for Music Order versus Galvanic Scores

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	13.75	2.75	3.07	0.04
Error	15	13.42	0.89		
Corrected Total	20	27.18			
R-Square	Coeff Var	Root MSE	GALVSCORES Mean		
0.51	51.7	0.95	1.83		

Table 2: Galvanic Scores by Music Order

Galvanic Level Average	Order of Music Clip
2.9569	UpBeat/Silent/Relax
2.9081	UpBeat/Relax/Silent
1.6849	Silent/Relax/UpBeat
1.2337	Relax/UpBeat/Silent
1.1608	Relax/Silent/UpBeat
0.9445	Silent/UpBeat/Relax

Hypotheses #2

H2. Stress levels as measured by galvanic skin response in those who perform knowledge work in a stressful ICT environment will be reduced by upbeat music.

Finding #2:

There was no significant difference in the stress levels as measured by galvanic skin response in students who perform knowledge work in a stressful ICT environment when they listened to upbeat music ($p=.99$).

Post Hoc Analysis #2a

A post hoc analysis was completed to examine if particular individuals find music stressful and if this impacts their galvanic score. This post hoc analysis was conducted because some subjects seemed to react favorably while others did not. This indicated that a moderating variable due to a general feeling toward music may exist. In their post-test survey subjects indicated whether they found music stressful or not. The results indicate that people who find music stressful had a higher galvanic skin response. Table 3 provides the ANOVA results (Significant at $F=4.86$ $p<.02$).

Table 3: ANOVA for Subjects that Find Music Stressful

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	9.52	4.76	4.86	0.02
Error	18	17.65	0.98		
Corrected Total	20	27.18			
	R-Square	Coeff Var	Root MSE	GALVSCORES Mean	
	0.35	54.1	0.99	1.83	

Post Hoc Analysis #2b

A second post hoc analysis was completed regarding hypothesis 2 to examine if particular individuals who report finding music stressful have higher galvanic scores when upbeat music is played. This post hoc analysis was conducted because some subjects seemed to react negatively during upbeat music. This indicated that a moderating variable due to feelings that music is stressful may have existed. This variable was derived from the post-test survey subjects where subjects indicated whether they found music stressful or not. The results indicate that people who find music stressful and upbeat music was played had a much higher galvanic skin response. Table 4 provides the ANOVA results (significant at $F=5.466$ $p<.014$). So this indicated that during the upbeat

music, people who found music relaxing or are neutral toward music were significantly less stressed than those who find music stressful.

Table 4: ANOVA for Subjects that Find Music Stressful During Upbeat Music

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	10.51019849	5.25509925	5.46	0.0140
Error	18	17.33435958	0.96301998		
Corrected Total	20	27.84455807			

R-Square	Coeff Var	Root MSE	GALVSCORES Mean
0.377460	52.96353	0.981336	1.852852

Hypotheses #3a

H3a. Accuracy as measured by subject test results performing knowledge work in a stressful ICT environment will be improved by relaxing music.

H3b. Accuracy as measured by subject test results performing knowledge work in a stressful ICT environment will be improved by upbeat music.

Finding #3:

Hypotheses 3a and 3b were tested using an ANOVA. The data indicated subjects who reported music stressed them scored significantly higher than subjects that reported music relaxed them. This means that H3b was supported but H3a was not supported. Table 5 provides the ANOVA results reporting these findings (significant at $F=3.61$ $p<.03$). Table 6 indicates that the average correct scores were 77.4% for those that reported music stresses them and between 51.6 and 53.1 for those that felt music relaxes them or are neutral.

Table 5: ANOVA for Percent Correct Versus Feelings about Music Being Stressful

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.33	0.17	3.61	0.03
Error	60	2.77	0.046		
Corrected Total	62	3.11			

R-Square	Coeff Var	Root MSE	Correct Percent Mean
0.11	39.04	0.21	0.55

Table 6: Percent Accuracy by Self-Reported Stress

Percent Correct	Self-Reported Music Stress
77.4	Music Stresses
53.1	Music Neutral
51.6	Music Relaxes

DISCUSSION

The present study was conducted to further understand the effects of technostress on technology users by looking into how it can be reduced, potentially using one or more types of music. Technostress is a negative impact of ICT's that should not be overlooked, and can have major implications for the workplace regarding overall productivity. Its effects may result from work overload, role ambiguity; and other antecedents (Ayyagari Grover & Purvis 2011). Because of these harmful outcomes, this research explores the process of mitigating the effects of technostress through music and therefore increase productivity in the workplace.

Overall, there were a few interesting results that came to the surface that we weren't expecting. First, and most impactful, was that user stress levels as measured by the galvanic skin response sensor depended much more on the order of the music

selections during the reading task then the type of music being played at a certain instance. Specifically, whatever music selection was at the beginning (silence, upbeat music or relaxing music) tended to set the tone for the rest of the reading task even as the music changed. This shows us that users of ICT's should choose wisely what sound environment works best for them as they begin their task since it's the first few minutes that puts people into a focused flow state of work. Understanding these results, we will walk through each hypothesis and discuss how our specific findings proved or disproved our original thoughts.

First, going into the study it was hypothesized that a distracting environment will increase the technostress experienced by a user of ICT's. To represent a distracting environment, we used an hour glass symbol, a timer, and task that was impossible to complete. We tested user stress with a galvanic skin device and found that rather than music playing at the moment, it was the tone set for the test that seemed to matter the most. In other words, if the test began with silence then the user showed lower average stress levels throughout the test than if they began with upbeat music. This means although someone might enjoy upbeat music, it does not seem to be helpful during a focused task on the computer and on average, silence was more effective at decreasing user stress levels. Our post hoc analysis following H1 suggests that not only should distractions be minimized, but relaxing music specifically should be used to lower stress levels while using ICT's. Our findings supported this idea because during our reading task, it was shown that those who started the task with relaxing music had lower overall stress throughout the test than those who started with upbeat music.

Next, we hypothesized that the only way upbeat music will decrease stress during the test is if the musical preference of the user aligns with the selection of music. Our testing supported this hypothesis as described in our second finding. Two post hoc analyses were conducted and showed that people who report finding music stressful had a higher galvanic skin response. The second outcome was that people who declared they found music stressful and listened to upbeat music had significantly higher galvanic responses than individuals who found music relaxing or were neutral about it.

Lastly, the study examined accuracy results since the overall objective is not just to decrease stress, but to increase accuracy in so doing. We hypothesized that if the

participant listened to relaxing music then their overall test accuracy would be higher than those who started with upbeat music or silence. However, the converse was true. As reported in finding #3, we found that those who said music stresses them scored higher overall on the reading task than those who do not feel stressed by music. This seems contradictory to common sense and needs further investigation.

Throughout our study overall, we realized how much of an impact user preference of music will have on the effectiveness of different types of music in increasing productivity while working with ICT's. Moreover, we must remember that reducing stress is not the only objective, and it is crucial to realize if the reduction of that stress is actually increasing productivity and efficiency. Starting a task while listening to relaxing music tended to be the most effective, but this was contingent on the user at least somewhat enjoying music since it was not purely subconscious. If music is to be implemented in the school or work place, further study must be done to pin point a more exact way of obtaining a consistent, positive impact.

FUTURE STUDY

There are several areas that we would like to suggest as further study to dive deeper into the idea of music reducing technostress. These essentially fall into two categories: the first being would include looking more closely at the collected data to better understand its nuances and to further determine more variables for future data collection; and second being to take this study in a different direction and see what other solutions may exist.

Suggestions to dive deeper into this study include more specific types of music, more specific tasks and showing only one type of music during a task. First, "upbeat" and "relaxing" music is generalized. It would be helpful in further studies to take into account participant preference and use more specific genres so that we can truly understand the nature and power of user preference. Next, our reading task was also very generalized. It was meant to be a neutral activity so no participant would have an advantage over another with knowledge in a specific field, however if we truly want to know what type of music might increase productivity it should be studied for a more specific field or task to more deeply understand how particular participants would be

affected. Last, as mentioned above, this study turned into an observation of the music order played during the task instead of each individual music type. In the future during a similar study, one track of music should be played per person per testing occasion. Then, one person can be tested multiple times to see the real differences between different types of music.

Our next category of future research suggestions builds off the idea that music might not be the best answer to increase accuracy while working with ICT's. This study's findings indicate music can reduce stress, so if that does not also increase task accuracy in this area, another area of application could be investigated. There are a plethora of situations where the end result is a reduction of stress and music could be extremely beneficial in these situations. Some examples include mental illnesses, athletes before stressful competition, and orators or performers before they take the stage. Likewise, if future studies show music does not increase productivity or accuracy, then we must look further into the idea of what does. Our research has led us to the idea of multitasking and if it is really possible to focus on two things at once. If not, then the real solution to technostress could potentially be to minimize all distractions, including music.

This study sought to break the surface between music and technostress. Although, studying these two subjects is far from over, interesting results were obtained and this stimulates future ideas for research. We hope that future research can work to help us better more details regarding how music affects our brains during certain tasks and how to mitigate the results of technostress ways that increase task accuracy. There are many ways to further research these topics since so many factors come into play but no matter how it is done, more detailed research is advised.

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