

3.13 Understanding the Impact of User Frustration Intensities on Task Performance Using the OCC Theory of Emotions

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Abstract. Have you ever heard the saying “frustration is written all over your face”? Well this saying is true, but that is not the only place. Frustration is written all over your face . . . and your body. The human body has various means to communicate an emotion without utterance of a single word. The Media Equation says that people interact with computers as if they are human; this includes experiencing frustration. This research measures frustration by monitoring human body-based measures such as heart rate, posture, skin temperature, and respiration. The OCC Theory of Emotions is used to separate frustration into different levels or intensities. The results of this study showed that individual intensities of frustration exist, so that task performance is not degraded. Results from this study can be used by usability testers to model how much frustration is needed before task performance measures start to decrease.

1.0 INTRODUCTION

Interruptions and task-blocking events seem to be common place in human-computer interactions. These task inhibitors contribute to user frustration and are frequent in most users’ interactions with computers. Researchers in human-computer interaction have studied extensively ways to reduce the amount of user frustration experienced by humans; however this emotion continues to occur and varies according to the individual. Since each person is unique, perhaps it is necessary for us to try to understand the relationship between user frustration and its impact on task performance. In this research, the OCC Theory of Emotions is used to separate frustration into its varying amounts, levels, or intensities to understand the unique relationship between each level and user productivity measures.

2.0 BODY

2.1. The Media Equation

The Media Equation theorizes that humans treat new media such as cell phones, tablets, laptops, and video games as if they are interacting with real persons. This display of emotion includes positive and negative emotions. Positive emotions displayed after completing a very important task, signal that activity toward a goal can end and resources can be reallocated for other tasks. However, negative emotions produced after being interrupted from completing a very important task cause an opposite response and motivate users to engage in actions to set things right or prevent unpleasant events from occurring. *User frustration* is one such negative emotion that can occur in human-computer interactions. It is the frustration that occurs when a human is interacting with a computer system. It is experienced by users of any electronic device;

however it is most often associated with desktops, laptops, tablets, and any other portable media.

2.2 Affective Computing

Affective computing is interested in giving computers the ability to interpret human emotions from human body-based measures such as heart rate, skin temperature and respiration measures. User frustration has been measured physiological indicators such as increased heart rate, skin temperature, and respiration. The human body has various ways to communicate user frustration. Some of these ways include increasing the amount of blood pumped to the heart, thereby increasing the temperature of the skin, and increasing the amount of oxygen taken in by the lungs.

Most research in human-computer interaction and affective computing has focused on ways to reduce the amount of user frustration experienced by a human. However, examining the relationship between the amounts of user frustration and task performance measures has not been studied. This paper outlines the use of physiological indicators of frustration, along with the OCC Theory of emotions to model how much user frustration is needed before task performance measures start to decrease. The relationship between user frustration and task performance is also explored in this research. Specifically, the OCC Theory of Emotions was used to separate frustration into various intensities or amounts to understand the individual impact of each level of frustration on task performance measures.

2.3 OCC Theory of Emotions

The OCC Theory was developed in 1988 by Ortony, Clore, and Collins as a cognitive structure to understanding emotions and how they are displayed. Under this theory, there are 22 emotion types and each emotion type has different factors affecting the

intensity of an emotion. Factors that tend to increase emotion intensity often increase the potential for other emotions to occur in that emotion type.

OCC was created for use in artificial intelligence research for emotion synthesis. A key premise in this theory, is emotions have not occurred until they have reached and surpassed a set threshold, Figure 2. Also, once emotions have surpassed this threshold, they are activated and taken on various intensities or amounts as calculated in the original OCC Theory.

Another key premise in OCC Theory is that people perceive the world to be events, agents, and objects and emotion are tightly coupled together. Emotions occur due to consequences of events, actions of agents, or aspects of objects. For instance, a student may have a deadline to submit his/her homework assignment and his/her computer crashes. Initially, the student may feel extreme anger towards his/her computer. However, as the consequences of the event unfold, he/she may begin to feel fear over missing the submission deadline. In the example given, the computer is the agent, the action of the agent is the computer crashing, and failing the homework assignment is the consequence of the computer crashing.

3.0 METHODS

The objective of this work is to try and understand the relationship between the amount of user frustration experienced and task performance. To study this, participants were asked to interact with an application that included system delays of 500 ms while wearing the BioPac BioHarness. Individuals would first experience a control condition that would account for the user's baseline mood and other factors that could affect the test. The actual experiment part of the study included adding the system delays of 500 ms to communications between the mouse and the keyboard.

Measures such as heart rate, skin temperature, posture, and breathing rate were collected from each individual. Productivity measures were calculated as well including: the number of times a subject skipped a task, consecutive number of typos, number of formatting errors, number of uncompleted task, number of times student did not follow directions, etc. These measures were taken during the control and experiment part of the study and then used along with intensities to determine what intensities caused task performance to decrease.

OCC Theory was also adapted for the emotion type anger since frustration is not included in the original theory, Figure 1, and assumed the control study without the added frustrating events provided a baseline for the subject's usual behavior. This was also done for task performance measures.

```
if (value > control high)
intensity = value - control high
else if (value < control low)
intensity = control low - value
else intensity = 0;
```

Figure 1. Adaptation of OCC Theory of Emotions.

To understand the relationship between task performance and user frustration, we counted the number intensities where task performance metrics remain unchanged, the number of intensities where task performance decreased, and the number of intensities where task performance increased and compared these measures for each individual in the study.

44 subjects participated in the study, females and 23 males, and two were excluded because their task performance data was missing or incomplete. Bio-signal intensities were calculated for each of the subjects in the study and task performance was used to compute the total number of intensities that decreased, increased, or left task performance unchanged.

```
IF (EMOTION-POTENTIAL) > (EMOTION-THRESHOLD)
THEN
SET (EMOTION-INTENSITY) = (EMOTION-POTENTIAL) -
(EMOTION-THRESHOLD)
ELSE
SET (EMOTION-INTENSITY) = 0;
```

Figure 2. Original OCC Computational Theory of Emotions.

The lab practitioner conducting the study asked informal questions after the study to understand the mood of the user upon finishing. Users were asked to provide their observations about their level of frustration while interacting with the web-page that included system delays. During the study, users were given the option to skip a task and go on to the next tab, if they did not want to complete the task.

This study is in compliance with the George Washington University's Office of Human Subjects Internal Review Board. All applicable documentation

can be found against the IRB number 110732. All human subjects were provided with an approved informed consent form.

4.0 RESULTS

Results from the study showed that on average users were able to complete the task assigned to them without going over the allotted time of 15 minutes. The duration of the study with added delays was faster. This was surprising since the study included system delays that created a barrier to task completion.

The majority of participants did not skip a task. When asked why participants did not skip a task and go on to the next, some subjects said they wanted to follow directions and felt that the task was easy enough without skipping a task. A few users opted to skip a task, but then went on to complete the skipped task before the end of the study. The only participant to skip a task and stay with his decision was the oldest participant, 45 years of age, in the study.

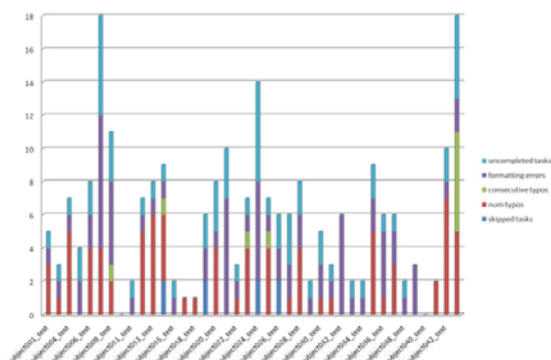


Figure 3. Task performance measures for study with delays.

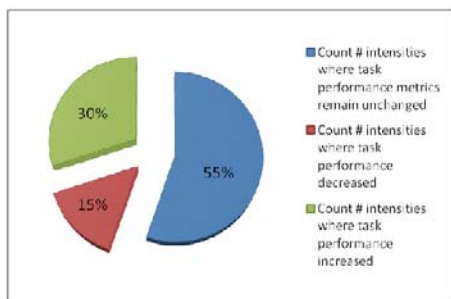


Figure 4. Results for frustration intensities and task performance.

Results from the study showed that users' observations and lab practitioners frustration

observations taken after the experiment were not always congruent with the average intensity calculated by the OCC Theory of Emotions.

5.0 CONCLUSION AND DISCUSSION

Users are more familiar with frustrating incidents than ever before due to the ubiquity of computers. Although developers, testers, and usability engineers have improved the computing interfaces, frustrations still linger. With the everyday use of cell phones, TVs, tablets, mp3 players, etc., users have all become accustomed to certain frustrations. Although frustration occurs as shown in the graphs above, it seems that the normal user, as observed in this study, has adapted themselves to the events. Perhaps, it is necessary to understand and interpret the frustration events and limit their frequency rather than adapting the interface.

From analysis of the graphs above, there seems to exist intensities that allow a user to be productive without affecting task performance. These intensities can better assist usability testers and developers if one can maximize the occurrence of such intensities.

6.0 FUTURE WORK

Future work from this research includes using bio-signal data, task performance measures, and contextual data about what artifacts or widgets a person is interacting with while using an application. Perhaps including contextual information, along with bio-signal and task performance measures could allow developers to gain more insight into what widgets users are encountering the most problems. Also, collecting localized task performance measures along with bio-signal measures taken at longer intervals will help relate these two measures together. These measures, if used during usability testing, could provide a more useful metric in determining how a person really feels about a new application.

An example of this would be in human-in-the-loop usability testing by providing a new user with a system that they have never worked with before. Contextual information such as what widget a person clicked is recorded, along with the number of discrete measurable tasks completed and the time in between each task completed, along with the fly calculations of user frustration intensities. Since each user is different, perhaps if a certain population of the users are experiencing frustration levels

above a certain threshold set by usability engineers, developers could leverage this information to analyze parts of the user interface that is causing the decrease in productivity measures.

7.0 ACKNOWLEDGMENT

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