Game Difficulty and Mood Repair

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Abstract

This proposal aims to cement published research on the effect of computer game difficulty on noxious moods by establishing a backing in the The Limited Capacity Model of Motivated Mediated Message Processing (LC4MP). The purpose of this study is to further establish a link between people in noxious mood states and the difficulty of video games. Participants will be chosen randomly to be put through either a boredom/control condition or through a mood manipulation designed to put them into a negatively valenced mood. While the participants are connected to psychophysiological measurement tools, they will play a computer game at a randomly assigned difficulty of either boredom/easy, hard, or flow. The results of the study should show similar results to that of previous research on video games and mood repair, a curvilinear relationship where mood repair increases with difficulty to a point then diminishes once the task is too difficult (Bowman & Tamborini, 2012).

Keywords: limited capacity model of motivated mediated message processing, mood management, mood repair, video games

Game Difficulty and Mood Repair

Introduction

Several studies show that there is a relationship between the difficulty of a computer game and the mood repair of the person playing the game, with results showing there is a curvilinear relationship between the difficulty of the game played and the mood repair of the participant. Bowman and Tamborini's (2012) study showed that when participants were manipulated into a noxious mood state and then played a computer game, their corresponding mood repair would rise alongside the difficulty of the game to a point then diminished with further difficulty; however those results are based on self-reported measures with the participant deciding where they were emotionally on their own using a modified 9 x 9 Affect Grid metric with abstract concepts for boundaries such as "stress," "relaxation," and "boredom," (See Appendix A for Affect Grid). Because self-reported data is limited to the understanding of the measure by the participant, I believe the data gathered in previous studies could be improved upon using psychophysiological measures established within the Limited Capacity Model of Motivated Mediated Message Processing (LC4MP).

Literature Review

In recent publications on the LC4MP (Fisher, Huskey, Keene, & Weber, 2018; Fisher, Keene, Huskey, & Weber, 2018), both *taking stock of the past* and *looking to the future* establish the idea of cognitive load and cognitive overload. Both cognitive load and cognitive overload are based on the idea that cognitive resources exist in a finite pool that is always changing due to the dynamic allocation of those resources in relation to what a person is experiencing at a given time. Complexity of what the person is experiencing can be measured as information introduced per second (ii/sec), and is predicted by the LC4MP to increase secondary task reaction time as ii/sec increases. With higher ii/sec, cognitive overload comes into play. The LC4MP predicts that as available resources near zero, such as when ii/sec increases dramatically, resources are shifted away from the primary task of message processing and focus on the secondary task. For this study, that means that as the complexity of the gameplay increases to a difficulty level the participant cannot keep up with, the secondary task reaction times will become faster as the participant shifts from the main objective of the game to the secondary objective.

The speed of secondary task reaction times will be tracked using a built-in part of the *Asteroid Impact* computer game, which will serve as the basis for the stimulus that participants in the study experience (Huskey, Craighead, Miller, & Weber, 2018). *Asteroid Impact* is a python-based computer game that should feel familiar to the participants because it shares similar goals to many video games over the last few decades. For the main objective the player will use their mouse to navigate their reticle, shaped like a spaceship, around Asteroids that are floating and bouncing around the screen to collect stars; the secondary task for the participant is to press the spacebar key whenever they see a red circle appear on the screen and hear a tone.

Asteroid Impact for this study will consist of three difficulty levels: easy, flow, and hard. In previous studies, game difficulty was used successfully as a conceptualization of varying levels of attentional resources (Bowman & Tamborini, 2012, 2015) as, *task demand*. Participants in this study will be randomly selected to either the easy level of task demand which will be the same level of difficulty as a tutorial for the game, a hard level of task demand which will make the game's primary objective of dodging asteroids nearly impossible to play because the speeds will be at or near maximum velocities, or a third level of task demand that will be referred to as the *Flow condition* which will attune the difficulty of the game to the capability of the participant. The flow condition increases the velocity of the asteroids the participant must dodge incrementally as long as the participant continues to evade the asteroids successfully, and will decrease the velocity of the asteroids incrementally if the participants find themselves unable to avoid collision.

In previous similar studies varying task demand of computer games and measuring mood repair, the difficulty conditions tested included a control, a moderate, and a hard level of task demand (Bowman & Tamborini, 2012, 2015). In this study the moderate level of task demand will be replaced with the flow condition inside *Asteroid Impact* because moderate levels of difficulty in an interactive game will be relative to the participant and could potentially be too-easy for more experienced gamers or too-difficult for those participants with little experience. Previous research shows the flow difficulty inside of *Asteroid Impact*, known as the balanced-difficulty, is capable of entering a participant into a flow state based on the participant's global efficiency score when analyzed through fMRI (Huskey, Wilcox, & Weber, 2018). That same flow difficulty, described as a balance between task difficulty and individual ability, was shown to result in high levels of self-reported intrinsic reward which in turn corresponded to increased task-related attentional engagement (Huskey, Craighead, et al., 2018).

The proposed study would answer the following questions: Is there a relationship between the difficulty of a computer game and the psychophysiological measured mood repair of the person playing? If so, what is the optimal difficulty of a computer game for mood repair of the player?

My first hypothesis is as follows:

The difficulty of a computer game is significantly positively related to the mood repair of the player.

My second hypothesis is as follows:

The mood repair of a participant will be significantly more positive when playing a computer game on a flow difficulty than an easy or hard difficulty.

Methods

Research Participants

Participants will be primarily undergraduate students at a large Texas State University, with the option for anybody over the age of 18 to participate. Participants will be split into six groups evenly using randomization. Three of the groups of participants will be placed in the boredom/control condition and the other three groups in the noxious mood condition. From there, the participant groups will be further split evenly between gameplay difficulties of control, hard, and flow to end up with six evenly distributed randomized groups.

Study Procedures

Before participants arrive, the order of the experiment will be randomized to determine whether the upcoming participant will be tested on the Control, Hard, or Flow difficulty. Participants will begin the experiment by filling out a questionnaire that includes demographic information as well as their experience playing video games. While they are answering this, myself or other lab researchers will connect the participants to the psychophysiological measures including facial EMG sensors, skin conductance sensors, and a heart rate monitor. Once they are done with the questionnaire and are completely hooked up to the Psychophysiological measurements, participants will play through a tutorial of Asteroid Impact on an easy difficulty to familiarize themselves with the gameplay mechanics. Participants will be asked to self-report their current emotional state using the modified version of the Affect Grid. At this point the participants in the control/boring condition will be tasked with threading a large number of metal washers onto a piece of string; while the participants in the noxious mood condition will go through a mood manipulation involving identifying the emotional valence of a series of neutral faces before being told that they are among the worst individuals for human empathy, which should send them into a noxious mood state. (Instead of this empathy manipulation, could use the Seibert & Ellis 25 sentence manipulation) Participants will again be asked to self-report their current emotional state using the modified version of the Affect Grid. Participants will then play through the round of Asteroid Impact that they were randomly assigned for five minutes. At the end of the gaming round, participants will self-report their current emotional state on the modified Affect Grid for the last time. While unhooking the psychophysiological measures, the participants will be debriefed as to the purpose of the study, and the reality behind the negative mood manipulations if they were in those groups.

Instrumentation:

I. Facial electromyography will be used to measure the activation of muscle groups in the participant's face as an indicator of valence.
   A. fEMG sensors will be applied above the participant's left eyebrow to measure the corrugator supercilii.
   B. fEMG sensors will be applied just under the participant's left eye to measure the orbicularis oculi.

C. fEMG sensors will be applied to the participant's left cheek to measure the Zygomaticus.

II. Sensors will be applied to the palm of the participant's left hand, between the base of the thumb and the wrist to measure skin conductance. I will use skin conductance to measure the participant's arousal as they play through the difficulty condition they are assigned.

III. A photoplethysmogram sensor will be attached to the fingertip of the participant's left hand to measure the interbeat-interval of their heart rate. This will be used to measure the participant's resource allocation during the difficulty condition they are assignment.

IV. The modified Affect Grid asks participants to visually map their current mood state. It is a 9 x 9 grid with a positive to negative x-axis and a high to low arousal y-axis. The exact center of the grid is supposed to represent a neutral, everyday feeling. The pre-and-post gameplay results will be used to measure the participants self-reported mood repair.

V. Secondary task reaction times that are embedded into the Asteroid Impact gameplay to measure task demand.

Data Analysis

Because the psychophysiological data will be longitudinal in nature I will use multilevel modeling to determine if there were significant changes in valence in comparison to arousal and resource allocation, as well as use an ANOVA to determine if there was a significant difference in self-reported mood repair of the participants across groups.

Proposed Results

When all of the psychophysiological and self-reported data is collected, cleaned, and analyzed I expect the following results: The interbeat interval of participant's heart rates increased as difficulty increased until the hard difficulty, where it will slow down while remaining higher than the easy difficulty. The secondary task reaction times (STRTs) of participants will slow down as the difficulty increases, and once the primary task of the game becomes too tough (hard difficulty) the STRTs will slow down as the participant is cognitively overloaded and begins to focus on the secondary task. For the control group of participants, skin conductance will increase following a curvilinear pattern with the difficulty of the game; participants in the experiment groups that play the easy and flow conditions will see a decline in skin conductance as they become less aroused and then back up as they succeed with the game. The experiment group with the hard difficulty of the game will experience a sharp decrease in skin conductance due to a mismatched reward to task ratio and defensive processing. Using tonic analysis, the muscle activity of the participant's zygomaticus and orbicularis oculi should increase following a curvilinear pattern as the difficulty of the game increases. The muscle activity of the corrugator supercilii will decrease over the length of the gameplay.

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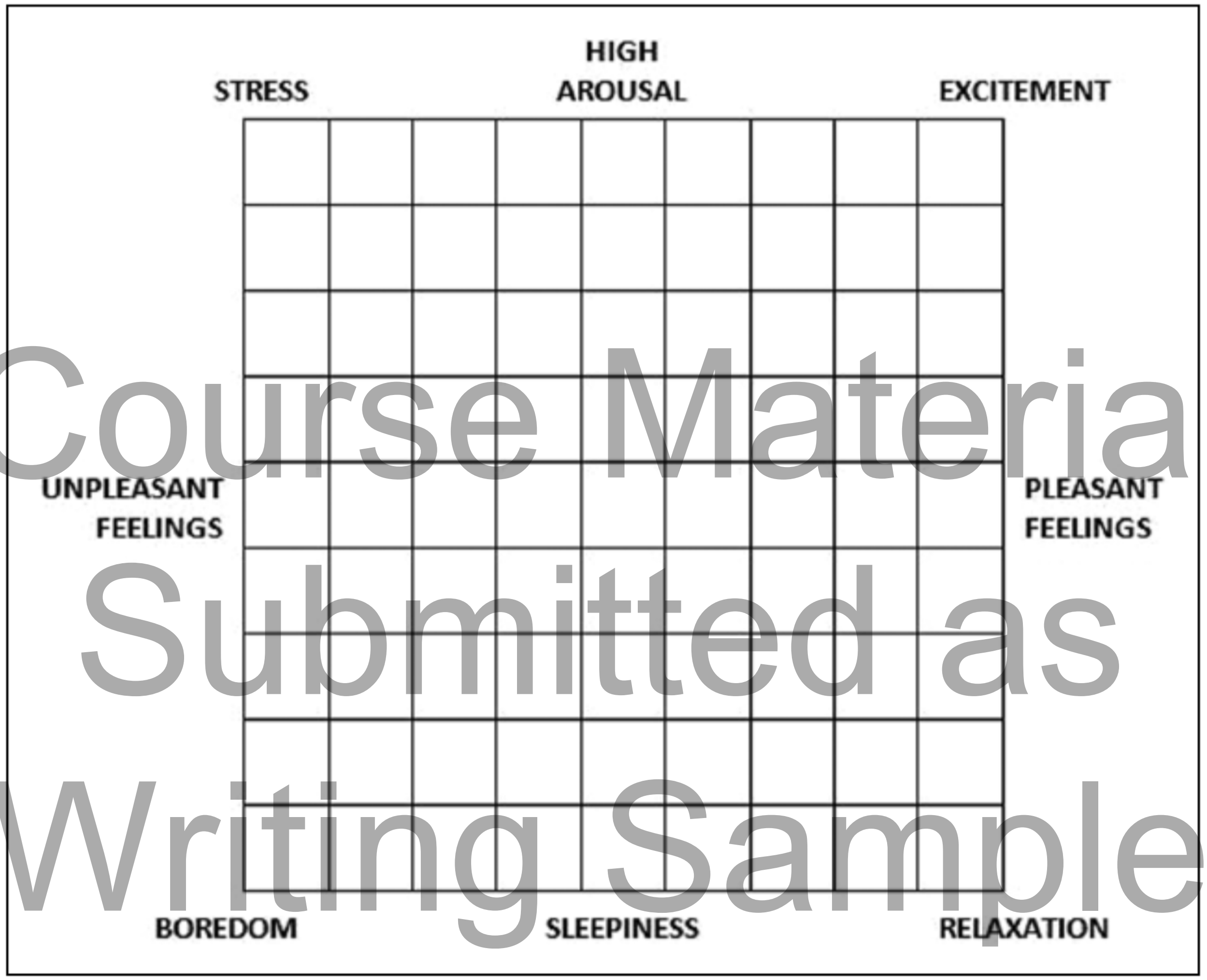
Appendix A

This is the Affect Grid metric used to measure the mood repair of participants in previous studies (Bowman & Tamborini 2012, 2015).



Appendix B

Asteroid Impact Stimulus

Asteroid Impact is an open-source video game stimulus available at the following URL:

https://github.com/medianeuroscience/asteroid_impact

Asteroid Impact is written in Python and can be fully modified to suit the needs of any research.

The tutorial for Asteroid Impact is three rounds:

1) When a red circle appears and a tone sounds through the headphones, hit the spacebar.
2) Use your mouse cursor to fly the spaceship around the screen to collect coins while avoiding the asteroids.
3) Using what was learned in rounds 1 & 2, use the mouse to collect all the coins you can while avoiding asteroids, and hit the spacebar whenever the red circle pings.

The difficulties are as follows:

I. <u>Control/Boring difficulty</u> is the full dodging/collecting/pinging gameplay, but the asteroids are set to a crawling pace which makes the task seem almost annoyingly easy.

II. <u>Flow</u> is a difficulty with the full dodging/collecting/pinging gameplay where the speed of the asteroids increases incrementally whenever the participant succeeds in collecting the full number of coins (11) while avoiding the asteroids. If the participant collides with an asteroid, the speed of the asteroid slows down incrementally.

III. <u>Hard</u> is a difficulty with the full dodging/collecting/pinging gameplay where the speed of the asteroids is set to the maximum possible. This makes the participant's chance of success in collecting coins shrink dramatically.