THE EFFECT OF TASK DEMAND ON MOOD REPAIR AND SELECTIVE EXPOSURE TO VIDEO GAMES

By

Nicholas David Bowman

AN ABSTRACT OF A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
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DOCTOR OF PHILOSOPHY

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Dr. Ronald C. Tamborini

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It is argued by entertainment scholars that the potential for video games to intervene in noxious mood states is heightened by the fact that video game play is a more demanding task as compared to consuming other forms of media. According to mood management theory, heightened intervention potential should make video games particularly well-adept at repairing noxious moods. Moreover, according to selective exposure theory, this heightened intervention potential should make video game play more desirable to people experiencing noxious mood states. Although many researchers have made theoretical claims about the unique attributes of video games as compared to more traditional media, both in general and in relation to mood management and selective exposure, these claims have yet to be tested empirically.

To this end, three studies were conducted. Study 1 varied task demand in a video game by experimentally manipulating the amount of control an individual had over a mediated environment and found that (a) increased task demand heightens a video game's intervention potential, (b) heightened intervention potential enhances the video game's ability to relieve boredom and stress, (c) too much task demand has a detrimental effect on mood repair, and (d) the ability of video games to repair negative affect is a function of increased task demand, and not simply increased arousal. Study 2 used behavioral measures of user engagement rather than experimental manipulations of task demand and found that (a) increased involvement with some game controls has a positive

influence on post-game play affect and (b) increased involvement with game controls has a positive influence on affect for bored participants and a negative influence on affect for stressed individuals. Study 3 focused on selective exposure stemming from expectations of a video game's task demand learned from game play, and found that (a) participants in states of boredom and stress preferred moderate levels of expected task demand, and (b) this preference was stronger for stressed participants than for bored participants.

By focusing attention on the role of task demand in these processes, this collection of studies expands previous conceptualization of intervention potential in a manner that aids efforts to understand the uses and effects of interactive media as related to mood regulation. Combined, these studies advance our knowledge of mood management and selective exposure processes related to a specific and increasingly-popular form of interactive media: the video game.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The ability of entertainment media to serve as a regulator of one’s mood state was proposed by Zillmann and Bryant (1985). Their affective-dependent theory of stimulus arrangement – referred to commonly as mood management theory – explains that individuals are motivated to dissipate noxious mood states whenever possible, and will make media choices in line with this motivation. The result of this selective exposure to media fare is mood repair; that is, a marked shift in mood state from noxious to optimal. This process has been tested with a variety of entertainment media, including television and film (Bryant & Zillmann, 1984), music (Knobloch & Zillmann, 2002), and Internet browsing behavior (Mastro, Eastin, & Tamborini, 2003). However, it has not been examined in any great detail with video games.

Entertainment scholars assert that the experience of video game play is unique among other media forms, and that features of technology responsible for this uniqueness afford video games great mood management potential. For example, Grodal (2000) suggests that video game differ significantly from ‘passive’ media such film and television viewing in part because of the increased attention and physical engagement required for the ongoing experience of video game play to continue. In order to play a video game, users have to pay careful attention to the game, make mental maps of game environments, make note of objects and landmarks for future reference, and coordinate visual attention with motor behavior (Grodal, 2000). Unlike more passive media such as film, a video game proceeds only through the player's motivation to continue; this continuation requires a user’s focused attention (Tamborini et al., 2004).

The present investigation begins by asserting that the unique demands placed on users during video game play is in part responsible for the enhanced mood management potential of video games. I maintain that, for individuals in a noxious state, playing video games that place a greater task demand will result in greater mood repair. Moreover, I assert that both (a) users in a noxious state will choose to play video games that offer a high level of task demand and (b) the level of task demand in the games selected by these individuals will predict mood repair.

To my knowledge, prior to this investigation no research has examined with any scientific rigor suggestions that the increased task demand produced by a video game is responsible for their mood management capacity, and that individuals in a noxious state will choose games with greater task demand. The proposed set of studies will examine these assertions in greater detail, specifically looking at how one key dimension of the mood management process – intervention potential – can be used to explain why some media forms might have a greater capacity to influence mood repair than others. More specifically, this paper argues that video games, due to their greater intervention potential, will be more effective in the mood repair process than other media forms such as television when controlling for other mood management-relevant dimensions.

Mood management and selective exposure: An overview

Bryant and Davies (2006) recognize four dimensions mood management that should be considered when examining the role of media use in mood regulation: arousal regulation (via the principle of excitatory homeostasis), behavioral affinity, hedonic valence, and intervention potential. Each is defined and discussed below.

Arousal regulation is understood as the ability for a medium to increase or decrease an individual's felt arousal. With respect to media, it refers to the tendency of individuals to choose media that will help them achieve an optimal level of arousal. Bryant and Zillmann (1984) showed evidence of this concept by experimentally inducing boredom or stress in a group of undergraduate students before affording them an opportunity to watch a series of television programs. Consistent with their predictions, participants in the boredom induction chose to watch exciting programming (e.g., highlights from a football game, an action-adventure show, and a game show) whereas participants in the stress induction chose to watch more relaxing programming (e.g., segments of a travel documentary, orchestra concerts, and a nature program). Recent work by Mastro, Eastin, and Tamborini (2002) replicated these results with Internet search behavior, finding that bored individuals tended to surf the Internet more rapidly than stressed individuals, and interpreting this behavior as consistent with the notion that bored participants engaged in more highly interactive sessions that afforded greater stimulation.

Behavioral affinity refers to similarity between message content and one's current affective state. For example, if an individual was in an aggressive (perhaps even hostile) mood state, a violent boxing match would be understood to have a high level of behavioral affinity, whereas a non-tendentious romantic comedy would have a relatively low level of behavioral affinity. Selective exposure logic would predict that individuals in an aggressive mood would avoid watching the boxing match, preferring the non-tendentious romantic comedy in hopes of dissipating their noxious mood state. Work by Zillmann, Hezel, and Medoff (1980) found support for this claim, reporting that study participants who were provoked prior to viewing television (thus creating negative affective states) avoided watching situational comedies that featured tendentious humor, and action drama programming.

Hedonic valence is understood to be the general pleasurable or unpleasurable tone of a message. One can point to the prototypical Hollywood 'buddy comedy' (e.g., *Turner and Hooch*) as a genre with a generally pleasurable tone, and the blood-soaked 'slasher' film (e.g., *Friday the 13th*) as a genre with a generally unpleasurable tone. Similar examples of pleasurable and unpleasurable tone can be easily thought of in music. The aforementioned work of Knobloch and Zillmann (2002) on music preferences perhaps demonstrates this element most clearly, as participants induced into bad moods – using the same bogus feedback induction as Zillmann et al. (1980) – chose to listen to music rated as 'energetic-joyful' and were more decisive in their music choice. Thus, the tone of a message can be understood to influence media choice based on one's current mood state.

Although the above-listed dimensions are important to understanding the mood management process, the dimension most central to the current series of studies is intervention potential, defined as the medium's ability to capture an aroused individual's attentional resources (Bryant & Davies, 2006). Generally, it is argued that messages with higher intervention potential are more likely to distract an individual from the root cause of their noxious mood state, thus hastening the mood repair process. Prior research examining mood repair has demonstrated that the extent of media exposure's intervention potential is influenced by attributes found in message content (Zillmann, Knobloch, & Yu, 2001; Knobloch, Hastall, Zillmann, & Callison, 2003). The current series of studies differs from research focusing on content attributes, and proposes that the extent of exposure's intervention potential is also influenced by specific attributes of different media forms – in this case, attributes that differ inherently between video games and television.

Intervention potential in different media forms

Both Bryant and Davies (2006) and Grodal (2000) maintain that the highly interactive nature of video games and the user involvement required for the production of its dynamic content demands more of a user's attentional resources than other media forms, such as television or film. If this is true, mood management logic would suggest that this increased demand on a user's attentional resources should results in greater intervention potential. As such, we might expect the user involvement required by video games to increase the medium's ability to intervene in noxious mood states, and therefore aid in the mood repair process. Vorderer (2000) offers a similar claim, arguing that video games demand both cognitive and tactile engagement, and thus increase their intervention potential over other media forms. Likewise, Klimmt and Hartmann (2006) note that video games are specifically designed to demand steady streams of input from the user in order for the game to progress, and therefore should have a higher intervention potential relative to less demanding media, such as television. Beyond simply turning on the television set and selecting a channel, one is hard-pressed to identify another point of entry in which the user has any agency over television content in real-time. Tamborini and Bowman (2010) advance similar logic with regard to the presence enhancing attributes of video game technology. They hold that the vividness and interactivity inherent in video game technology makes playing games an engaging and absorbing experience. Although they focus on how these attributes should increase feelings of presence, these engaging and absorbing attributes make playing video games precisely the type of experience that should have great intervention potential. For example, while traditional narrative media such as television and film require the user only to set the TV tuner on a particular channel or start a VHS or DVD in order to view a complete narrative, video games require near-constant user feedback from one point to the next. The active user involvement required by video games commands a much higher level of engagement than other media. This engagement not only prompts experiences of presence, but also results in a high capacity for the video game to intervene in rumination.

Although the above-mentioned scholars have speculated that attributes of video game technology afford it greater intervention potential than media such as television, neither the claim of video game's inherent superiority to television nor the processes claimed to underlie this superior intervention potential have been empirically demonstrated. To this end, three studies are proposed that aim to demonstrate how one key difference between media forms – task demand – can influence mood repair and selective exposure processes. The first study will vary levels of task demand to examine the effect of task demand on mood repair processes. The second study probes the same question as the first, using measures of actual user engagement during video game play (i.e., the extent to which the respondent physically manipulates the game controls) to predict mood repair process. Finally, the third study examines one's selective exposure to media environments that vary in the amount of task demand on individuals in order to determine if individuals in a noxious state will selectively expose themselves to environments with greater task demand and, subsequent to this, if mood repair resulting from these choices is increased with the selection of media environments higher in task demand.

As a whole, these studies examine a feature of video games thought to distinguish this technology. It attempts to answer questions asking if the requirement for users to actively engage in the production of dynamic media content when playing video games – that is, the heightened level of task demand in video games – significantly increases the intervention potential of this technology as compared to media such as television and film, making them particularly well-suited to serve in a mood management capacity.

STUDY 1

The first study offers a comparison of mood repair under different conditions of task demand created by the requirement for the user to actively engage in the production of the dynamically changing media content. This study examines the claim that video games are superior to television in their mood repair capacity, and that this superior capacity results from the increased task demand created by the need to actively engage in video game play. In this case, intervention potential is corollary to the level of task demand in each video game play condition.

Hypotheses

The logic of this study begins with the assumption that video games have a higher task demand than television (cf. Klimmt & Hartmann, 2006). From this, I propose to examine existing claims that the heightened task demand in video games increases their mood repair capacity, controlling for other mood management-relevant factors. As a result of the intervention potential created by differences in task demand, I predict the following (Figure 1, H1):

> H1: For people in noxious mood states (boredom or stress), an increase in task demand will increase mood repair.

When examining the effect of user-demand produced intervention potential on mood repair, it would be imprudent to ignore the possibility for other recognized dimensions of mood management, such as arousal regulation, to affect mood repair. Though somewhat peripheral to the task demand hypotheses central to this study (H1), the potential influence of physical engagement and arousal regulation should not be overlooked. When experimentally manipulating task demand, there is a natural confound between physical and cognitive resources. Game play that requires more actions should also be expected to increase an individual's felt arousal. As such, arousal is measured and controlled for in tests of H1.[1]

As boredom is a noxious state caused in part by very low levels of arousal, I expect that any increase in felt arousal resulting from the higher levels of physical engagement produced by a game requiring an increased number of actions should produce a more positive effect on mood repair for those in a state of boredom than those in a state of stress. Thus, bored individuals will experience a positive effect on mood repair as a result of the intervention potential produced by heightened task demand as well as a positive effect on mood repair resulting from arousal regulation. Conversely, since stress is a noxious state from elevated levels of arousal, though stressed individuals should experience the same positive effect on mood repair resulting from intervention potential, they should not experience the same a positive effect on mood repair resulting from arousal regulation. Thus, I tender the following hypothesis (Figure 1, H2):

H2: The positive impact of task demand on mood repair will be greater for those in a boredom condition than for those in a stress condition.

Notably, H2 predicts only a main effect for noxious state such that mood repair is greater for bored individuals than it is for stressed individuals. Because the comparatively greater mood repair predicted for those in the boredom condition results from elevated arousal, the degree to which mood repair in the boredom condition surpasses repair in the stress condition should mirror levels of arousal created by the game play conditions. As

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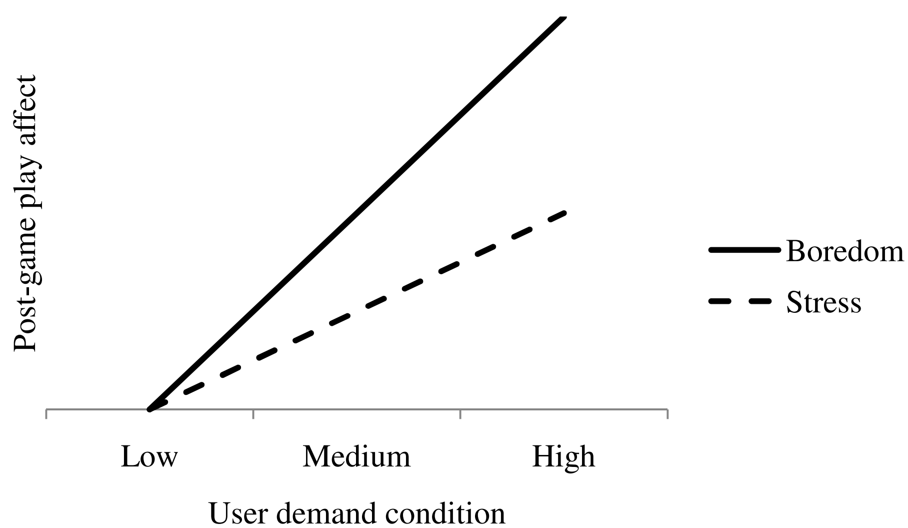
[1] This becomes important specifically when considering the nature of boredom and arousal, the two noxious moods states under investigation in the current study that can also be understood as understimulation (boredom) and overstimulation (stress).

such, because physical activity and its resultant arousal should increase as task demand increases, the extent to which mood repair in boredom conditions exceeds repair in stress conditions should also increase as task demand condition increases. This leads to my third hypothesis (Figure 1, H3):

> H3: For those in a noxious mood state condition (i.e., boredom or stress), there will be a disordinal, nonsymmetrical interaction between mood state and task demand on mood repair. The increased mood repair predicted as task demand condition goes from low to high will be greater for those in the boredom condition than those in the stress condition.

Figure 1. Predicted pattern of mood repair scores for bored versus stressed players as a function of task demand condition.



Finally, there is reason to suspect that the beneficial effect of task demand on mood repair will peak at the point where a game becomes too demanding, and frustration starts to set in (cf. Wolf & Perron, 2003). If this is the case, we might expect extreme levels of task demand to counteract the mood repair process. Yet the point at which task demand becomes noxious and starts to outweigh the mood repair benefits of intervention is difficult to predict, as available research offers no insight on this matter. This makes it is hard to predict where or if this point would be reached in any experimental induction of task demand. As such, I began this study predicting positive linear effects of task demand on mood repair, but I recognize the potential curvilinear influence of task demand on mood repair and its possible effect on all three hypotheses. This potential curvilinear relationship will be examined in data analyses in addition to tests of the predicted linear effects.

METHOD

This study experimentally manipulated the intervention potential of media exposure by way of task demand (i.e., the extent to which the user is required to physically manipulate a video game's controls) and observed subsequent differences in mood repair on respondents placed in noxious states (conditions of boredom versus stress). In a 2 (mood state) x 4 (task demand) between-subjects experimental design, participants were randomly assigned to conditions of boredom or stress, and then asked to play a flight simulator video game programmed to vary (low, low + cognitive task, medium, high) in task demand.

Participants

Participants (N = 172) were recruited from a large, Midwestern university and offered course credit and the chance for a $100 cash prize for participating in the study. The sample contained 79 males and 93 females, with an average age of 21 years, five months, and approximately 81 percent of respondents indicated that they were majoring in communication or a related field (i.e., retailing, advertising, or public relations). Notably, data collection was restricted here to a convenience sample of college students;

however, because the study examines how media exposure impacts mood repair in people experiencing common noxious mood states (in this case, boredom and stress), I have no reason to believe that this population possesses any unique elements that would be expected to have an extraneous effect on the proposed hypotheses. In fact, an argument could be made that college students would a more applicable population than others, as this population represents a substantial portion of the gaming community (Jones, 2003).

To determine a proper sample size for this study *a priori*, a meta-analysis of affect regulation research by Augustine and Hemenover (2008) was consulted. This meta-analysis provided an average effect size calculation for pleasant distraction mood repair strategies – such as those specified by mood management research according to Parkinson and Totterdall's (1999) affect regulation strategy taxonomy – as $d = .41$, which corresponds to an effect size f of .19 (effect size f is the proper measure of effect size for analysis of variance (ANOVA) testing such as the analysis performed in this study). However, it should be noted that this effect size measure was calculated from mood management research using what would be classified in the current study as low task demand medium – such as magazine articles, music, and television – which would be expected to have a lesser effect on mood repair than high demand medium such as video games. Although research involving higher demand media is sparse, a secondary analysis of preliminary data from Chen and Raney (2009) using video games as an agent for mood repair provides an average effect size for change in positive and negative mood after game play of $f = .31$; this effect size measure was used to determine the sample size needed for the current study. When comparing eight experimental groups using ANOVA techniques with $\alpha < .05$ one-tailed, a statistical power of $\beta = .80$, and an effect size of $f =$

.31, a minimum of 20 participants were needed per condition (N = 160); after all data was collected, the final sample size of N = 172 was achieved.

Design and Procedure

Upon entering the lab, participants reviewed and signed informed consent forms (Appendices A and B). Once consent was obtained, participants were given a sterilized ear clip to affix to their right ear lobe (a heart rate measurement device) and asked to complete a questionnaire measuring perceived video game skills and demographic characteristics (Appendix C). After the questionnaire was completed and heart rate measures stabilized, participants played or viewed the flight simulator for five minutes to become familiar with the game. Following this session, participants were subjected to either the boredom or stress mood induction. After the induction, participants completed a mood measure (as an induction check) and then played (or viewed) the video game for approximately two to three minutes. During game play, task demand was measured with a distractor task. Once game play was finished, participants completed another set of mood measures (to measure change in mood since induction). Finally, participants completed a questionnaire containing measures of perceived task demand and overall game evaluation before being fully debriefed (Appendix D); the game evaluation measures were part of a separate data collection and thus are not discussed further in this manuscript. The study lasted about one hour in total.

The four levels of task demand (low, low+, medium, high) were created by varying the number of actions required to play the video game. In the low demand condition, game play was set at auto-pilot on to simulate watching a television program (i.e., no actions required). In the medium demand condition, play was set at auto-pilot half on (i.e., some actions required). In the high demand condition, play was set at the auto-pilot off (i.e., full actions required). Finally, concern that participants in the low task demand condition would simply ignore the video game entirely led to the inclusion of a fourth condition labeled low+ task demand, in which a cognitive demand element was added to the low demand condition described above. The logic for the addition of the low+ demand condition was as follows. The goal of the low task demand condition was to simulate the level of demand found in television viewing.[2] If participants exposed to video game play in demonstration mode simply ignored the game, this would not be an accurate corollary to television viewing, which surely contains a cognitive or information processing element (cf. Lang, Bolls, Potter, & Kawahara, 1999). The inclusion of the low+ condition was intended to add such a cognitive processing element to the low demand condition.

Stimuli/Materials

Mood inductions. Consistent with prior research (Bryant & Zillmann, 1984; Mastro et al., 2002), participants were induced into either boredom or stressful affective states. Each induction required participants to perform a particular task for 20 minutes. For the boredom induction, participants were given a large box of metal washers, and asked to thread the washers onto a length of string. For the stress induction, participants were asked to complete a booklet of difficult logic puzzles designed to exceed the talents

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[2] Some might question why a video game set on auto-pilot was used to simulate television viewing in the low task demand condition instead of merely showing similar footage from a television show. Both options were considered but, ultimately, the auto-pilot setting was used for the low-demand condition for two reasons. First, the use of a television viewing condition with unique content would introduce unwanted content differences in the experimental conditions. Second, although it can be argued that playing a game in auto-pilot is not the same as watching television, the level of task demand required to play the game in auto pilot can be equated with the task demand required for viewing television (discussed later in the manuscript). As such, use of the auto-pilot condition allows us to test claims that task demand increases intervention potential of game play over media experience that closely simulate television viewing.

of the participants (Appendix E). Furthermore, participants in the boredom induction were left to their own volition, whereas participants in the stress induction were under constant pressure from an experimenter to perform better. The validity of these inductions – as well as the amount of time allocated to achieve the desired boredom (under-stimulated) or stressful (over-stimulated) states – has been demonstrated in prior research (Bryant & Zillmann, 1984; Mastro et al., 2002).

Video game. The video game played in this study was *Lock-On: Modern Air Combat*, released by Ubisoft in November 2003 and promoted as "an ultra-realistic [combat flight] simulator with faithfully rendered physics, weather, and avionics" (Gametap, 2009, para. 1). The game is played using the Saitek X36F flight stick and X35T throttle in tandem with a standard PC keyboard and mouse, based on how the game's controls are configured. *Lock-On* was particularly well-suited for this study for two reasons: the game has fully programmable flight controls (which allow the experimenter to turn on or off any number of game controls) and variable auto-pilot capability (which allow the experimenter and the user to give varying amounts of game control to the video game itself). In all experimental conditions, participants are asked to pilot the same Russian Su-27 Flanker, a jet fighter built in the late 1970s for the Soviet military by Sukhoi Design Bureau. The jet is known for its agility and ease-of-maneuverability, and variants of the aircraft are still manufactured today.[3] In terms of its use in the study, the Su-27 is offered as a basic training aircraft in the video game for practice on maneuverability and basic flight principles.

[3] Russian Su-27 aircraft were used as recently as the 2008 South Ossetia War (Chang, 2008).

Task demand induction. All participants began playing the flight simulator game at the same starting point, with the aircraft configured for a final approach toward the landing strip. For the low task demand condition, participants played the game with full auto-pilot engaged and all user controls turned off; that is, the game did not require any input from the user in order to progress from flight to landing, akin to television viewing.[4] For the medium task demand condition, participants were in command of the flight controls used to control the speed and direction of the plane (the joystick, throttle, and rudder), while the simulator automatically controlled all other avionics for the participant. These avionics include the landing gears (used to safely land the plane on a landing strip), landing flaps (used to help increase drag to bring the plane to a safe landing speed), airbrakes (used to help bring the plane to a safe ground speed by increasing drag), wheel brakes (used to help slow the speed of the plane once on the landing strip), and drogue chute (a small parachute used to aid in slowing the plane on the ground).[5] For the high task demand condition, participants were in full control of all simulator flight controls with no assistance from the computer. In terms of task demand, the high task demand condition required participants to control both the speed and direction of the aircraft along with all other flight operations. Whereas participants in the medium task demand condition will need only to use the flight controls to land the plane safely, participants in the high task demand condition will need to use both the flight controls and all avionics to land the plane safely. The low+ task demand condition was

[4] As game play in the low task demand condition is set to auto-pilot in order to more closely simulate TV viewing, these participants did not actually "play" the game. For lack of a better word, the word "play" is used throughout this paper to represent exposure in all three conditions.

[5] These avionics were actually be controlled by a remote keyboard in the possession of the primary investigator and hidden from view, although their control appeared automated to the research participant.

simply a replication of the low task demand condition with the addition of a memorization task intended to increase cognitive demand without increasing interaction with the video game. This memorization task required participants to take mental note of all of the avionic settings in the aircraft in preparation for an exam on aircraft landing techniques to be taken at the end of the study; the exam was never actually administered. Notably, all game play sessions were restricted to five minutes. Table 1 lists the different controls made available to the participant in each of the three experimental conditions.

Table 1. Controls available to the user in each task demand condition, at the start of game play.

Low task demand*	Medium task demand	High task demand
Flight controls • [none] Avionics • [none]	Flight controls • Joystick • Throttle • Rudders Avionics • [none]	Flight controls • Joystick • Throttle • Rudders Avionics • Airbrake • Landing flaps • Landing gear • Drogue chute • Wheel brakes

**The low+ task demand condition replicates the controls of the low task demand condition, with the addition of the memorization task.*

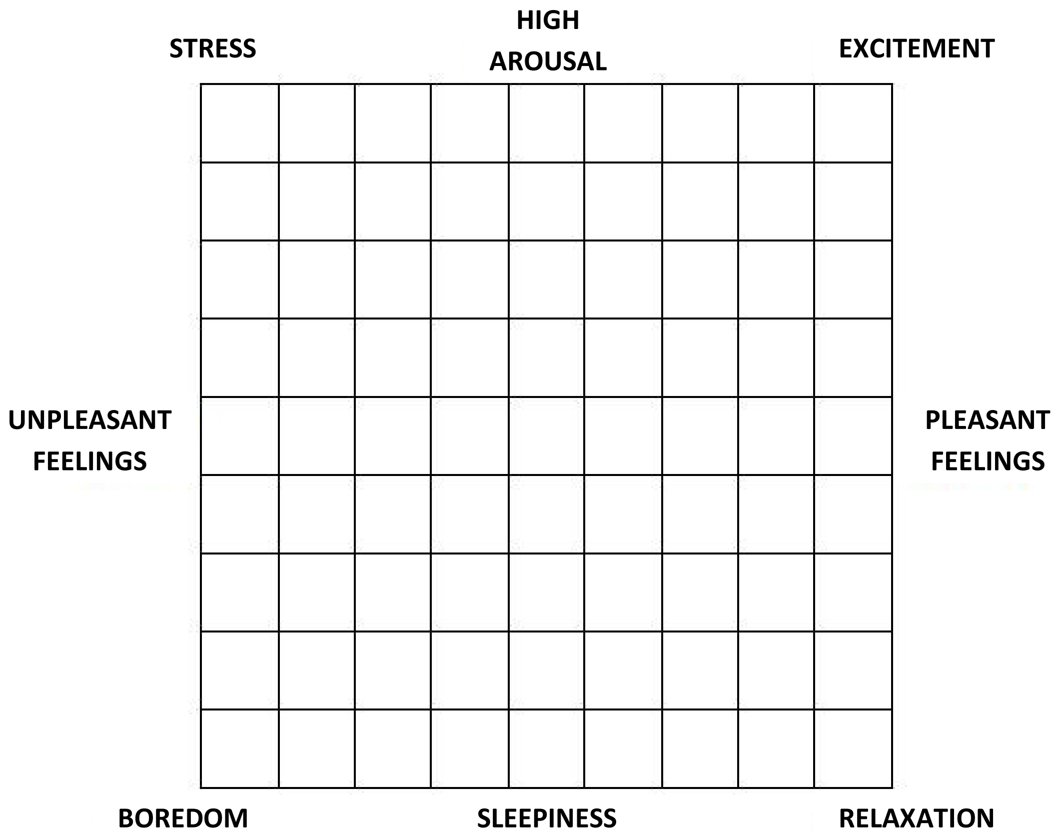
Measures

Distractor task. Task demand was measured using a distractor task consisting of a small black box with a red button and red LED. Participants were asked to press a red button in response to an audio cue (a loud, digitized beep) to activate the LED, and their response time was measured to a precision of 1/100 of a second. Slower reactions were indicative of greater task demand. Similar distractor tasks have been used in research on driver safety (Strayer & Johnston, 2001; Nunes & Recarte, 2002) in which research participants respond to a visual distraction. However, as video game play has been shown to increase one's ability to pay attention to visual distracters (e.g., Green & Bavelier, 2003), participants in the study were asked to respond to an audio cue. The audio cue technique has been used successfully in research on cognitive capacity in response to media messages (e.g., Lang, Bradley, Park, Shin, & Chung, 2006). The audio cue was played eight times during game play, and the reliability of measurement for these reaction time responses was $\alpha = .812$.

Mission feedback. Along with the behavioral measure of task demand, the NASA-Task Load Index (NASA-TLX, Appendix F) was used as a self-report measure of subjective workload assessment. This six-item, 20-point scale is designed for use in measuring workload in human-machine interactions (NASA-TLX, n.d.), and has been used in prior research on flight simulations (c.f. Moroney, Reising, Biers, & Eggemeier, 1993; Rueb, Vidulich, & Hassoun, 1992; Schweingruber, 1999). Sample items from the scale were: "How much mental and perceptual activity was required?" and "How much physical activity was required?" One item from the scale designed to measure perceived performance had a negative effect on scale reliability, and thus was dropped from subsequent analysis. The reliability of the remaining five-item scale was $\alpha = .811$.

Mood repair. Mood repair was measured using a pre-test/post-test administration of an adapted version of the Affect Grid (Russell, Weiss, & Mendelsohn, 1989), see Figure 2. The scale asks participants to visually map their current mood state in the semantic space between positive and negative affect (the x-axis) and high or low arousal (the y-axis) using a 9 x 9 grid, with the square at the center of the grid representing a "neutral, average, everyday feeling" (Russell et al., 1989, pp. 501). My adaptation to this scale deals with a change to the labeling of the bottom-left quadrant of the scale which was originally labeled as “Depression” in prior research. As this label is the conceptual equivalent of boredom in research on mood repair (characterized as a negative affective state in which one is experiencing low levels of arousal), I have re-labeled this quadrant as “Boredom” in the scale provided to participants in my study. The scale has been validated in prior research as a measure of mood and affect (Russell et al., 1989; Killgore, 1998; Swindells, MacLean, Booth, & Meitner, 2007), and the pre-test/post-test implementation of the scale has been established as a valid measure of mood change (e.g., De Petrillo & Winner, 2006; Eich & McCaulay, 2000).

Figure 2. Russell et al. (1989) Affect Grid metric, adapted for use in the current study.



Felt arousal. Although the Affect Grid takes into account measures of self-reported arousal, a subsequent physiological measure of arousal was taken using the Cat-Eye PL-6000, a heart rate monitor that measures in real time the wearer's current pulse rate in beats per minute. Heart rate has been used as an indicator of arousal response to media (e.g., Malmstrom, Opton, & Lazarus, 1965; Snook-Luther, 1990; Riddle, 2004) as it shares a strong positive correlation with skin conductance measures, another indicator of arousal used in media research (e.g., Lang et al, 1999). It has been argued by some (e.g., Freeman et. al, 2008) that arousal-induced increases in heart rate might be obfuscated by attention-induced decreases in heart rate as the heart muscle is involved both sympathetic (i.e., the 'fight or flight' response responsible for increased heart rate as indicative of arousal) and parasympathetic (i.e., the ‘rest and digest’ response responsible for decreased heart rate as indicative of attention) nervous system. However, prior research by Kahana, Gopher, Grunwald, Iani, and Lavie (2004) examining these variables in flight simulators has reported an overall increase in heart rate as a function of both arousal as well as increased work load; the construct of work load in their study is the conceptual equivalent of task demand as defined in the current research. Heart rate was recorded at 10 second intervals for the duration of video game play and the mood manipulation, and the score was converted as a “change from baseline” heart rate measure, with a score of “0” equaling no fluctuation from baseline, positive scores indicating increased heart rate from baseline, and negative scores indicating decreased heart rate from baseline.

Unfortunately, measured arousal via the heart rate monitor did not differ significantly between mood manipulation conditions as would be expected, $t(170) = .026$, *ns*. Average heart rate for bored participants after mood manipulation was $M = .045$ above baseline, $SD = 5.73$, whereas average heart rate for stressed participants was $M = .024$, $SD = 5.08$. Moreover, I found bored participants to actually have a *higher* heart rate than stressed participants, which was opposite of my expectations based on both prior research using the mood inductions as well as data from the self-reported arousal measures. In addition, the heart rate measure had no significant correlation with the self-reported measures of arousal ($r = .019$ with pre-game play arousal, $r = .003$ with post-game play arousal). This data, coupled with previously-mentioned issues regarding the use of heart rate as a valid measure of arousal (e.g., Freeman et. al, 2008), led me to drop the heart rate measures in subsequent data analysis.[6]

Video game skill. Participant's perceived video game skill was assessed using the 10-item, seven-point Likert-scaled Game Playing Skill scale (GaPS; Bracken & Skalski, 2006). Sample items from this scale include: "I am a good video game player" and "I often win when playing video games against other people." The reliability of this 10-item scale was $\alpha = .967$. Sample mean for GaPS was $M = 3.67$, $SD = 1.59$, and an unexpected significant difference was found across task demand conditions, $F(3,168) = 2.706$, $p = .047$, $\eta^2 = .046$. Tukey's honest significant difference (HSD) test reported that participants in the low demand condition ($M = 3.11$, $SD = 1.62$) self-reported a lower level of game skill than participants in the high demand condition ($M = 4.02$, $SD = 1.51$). Thus, video game skill was used as a covariate in all analyses.

RESULTS

Induction checks

Mood. The mood inductions used in this study were found to significantly affect arousal and affect levels in the predicted direction.[7] The means are reported in Figure 3. For participants in the boredom condition, the induction produced the expected significant shift in both arousal, $t(109) = 12.0$, $p < .001$, and affect, $t(109) = 11.4$, $p < .001$. For participants in the stress condition, the induction again produced the expected

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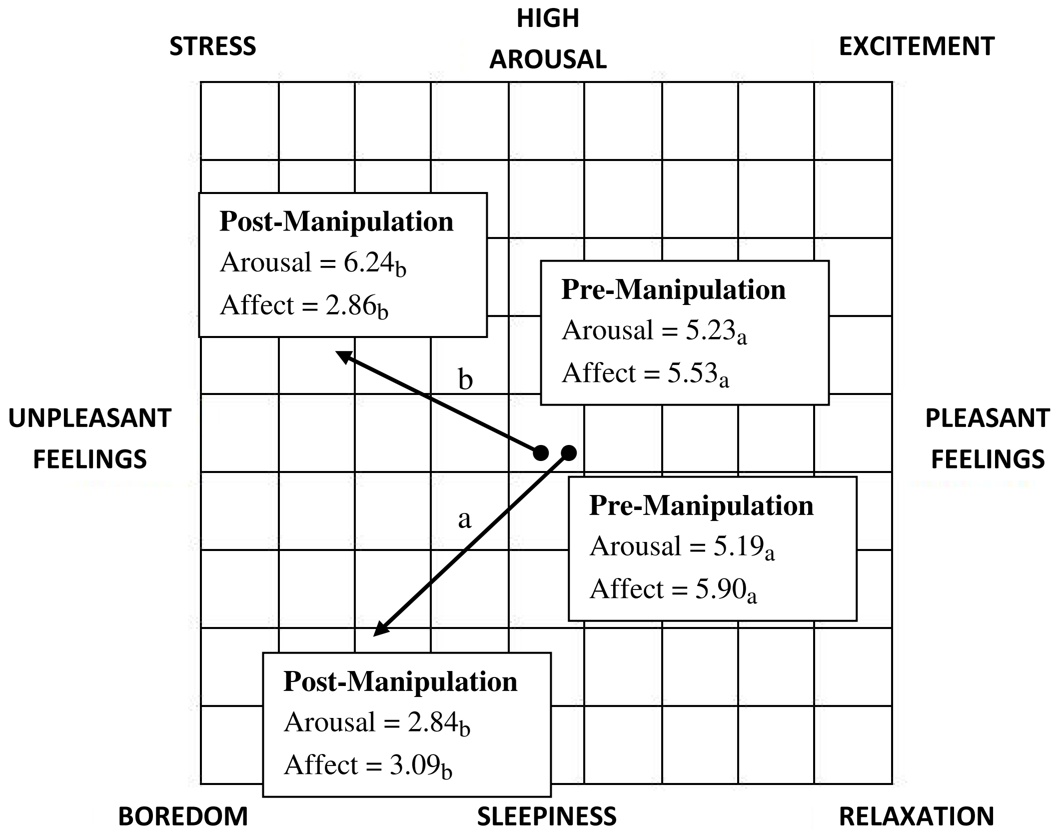
[6] For the sake of completeness, all reported analyses in the study were run using heart rate as a control variable along with the self-reported arousal measure; the variable was not a significant covariate, and the results of these re-analyses did not differ from those reported here. Thus, they are not reported.

[7] There was no significant difference in either pre-induction arousal, $t(221) = -.118$, *ns*, or pre-induction affect, $t(221) = 1.46$, *ns*, between mood conditions.

significant shift in both arousal, $t(112) = -3.88$, $p < .001$, and affect, $t(112) = 12.1$, $p < .001$. Thus, I conclude that my mood manipulations were successful in inducing feelings of boredom and stress in my participants.

Figure 3. Induction check: Arousal and affect means for mood groups, pre- and post-induction.



a = boredom, b = stress
Note: Means with different subscripts differ significantly at p = .05 or greater.

Task demand. An induction check was also performed on the task demand conditions using scores from the distractor task measure. For the distractor task, a univariate analysis of variance (ANOVA) reported a significant difference between task demand condition and response time, $F(3,168) = 20.2$, $p < .001$, $\eta^2 = .27$. As expected, participants in the low task demand condition had the fastest reaction times to the distractor task (M = 1.74 seconds, SD = .41), followed in order by those in the low+ (M =

2.58, *SD* = 1.48), medium (*M* = 2.81, *SD* = 1.69), and high task demand conditions (*M* = 4.48, *SD* = 2.48); this trend followed a linear pattern, $F_{linear}(1,168) = 53.2$, p < .001. Although differing significantly from the low and high task demand conditions, post-hoc analyses using Tukey's HSD test found that reaction times for participants in the low+ and medium task demand conditions did not differ significantly from each other. This suggests that the added cognitive demand from viewing video game footage with a memorization task was not significantly more distracting than playing the video game with a moderate level of control.

Data from the mission feedback scale told a similar story albeit not as pronounced, as participants in the low task demand (*M* = 7.13, *SD* = .533) and low+ task demand (*M* = 7.32, *SD* = .546) conditions evaluated these conditions as less demanding as those participants in the medium task demand (*M* = 10.3, *SD* = .55) and high task demand (*M* = 11.8, *SD* = .493) conditions, $F(3,167) = 19.3$, $p < .001$, $\eta^2 = .26$. In contrast to the self-reported task demand measures, post-hoc analysis using Tukey's HSD showed no significant difference in means between scores in the low and low+ task demand groups, suggesting that perhaps the added cognitive task did not have a perceptible effect on task demand. Notably, these two measures of task demand shared significant correlation ($r = .241$, $p = .001$). These results are used to conclude that the *a priori* task demand conditions indeed differed significantly in the predicted direction. Moreover, as results regarding the relative difference in task demand resulting from the low+ demand condition were not made clear from my induction check, all four task demand conditions were retained in data analysis.

Hypothesis testing

My hypotheses predicted that (H1) increased task demand will result in greater mood repair for those in noxious mood states (H2) mood repair would be greater for bored participants than for stressed participants, and (H3) a significant interaction between mood induction and task demand conditions would exist such that mood repair would be greater for bored participants than for stressed participants. To examine these predictions, an omnibus 2 (mood manipulation) x 4 (task demand condition) ANCOVA was performed with post-game play affect as the dependent variable, and post-game play arousal and perceived video game skill as covariates.[8] ANCOVA results are presented in Table 2, descriptive statistics for mood repair as a function of mood manipulation and task demand condition are presented in Table 3, and resultant pattern of means by mood manipulation and task demand condition are plotted in Figure 4.

Table 2. Results of 2 (mood manipulation) x 4 (task demand) ANCOVA on mood repair.*

	SS	*df*	*MS*	*F*	*p*	η^2
Video game skill	14.9	1	14.9	4.53	.035	.027
Post-game play arousal	7.35	1	7.35	2.23	.137	.014
Task demand	24.6	3	8.20	2.49	.062	.044
Mood manipulation	15.0	1	15.0	4.56	.034	.027
Task demand by mood manipulation	10.6	3	3.52	1.07	.362	.019
Error	533.1	162				

**covariates in this analysis are post-game play arousal and perceived video game skill*

[8] Pre-game play affect was not used as a covariate, as these scores did not differ significantly across task demand conditions, $F(3,162) = 1.95$, $p = .124$ or mood manipulation conditions, $F(1,162) = .128$, $p = .721$.

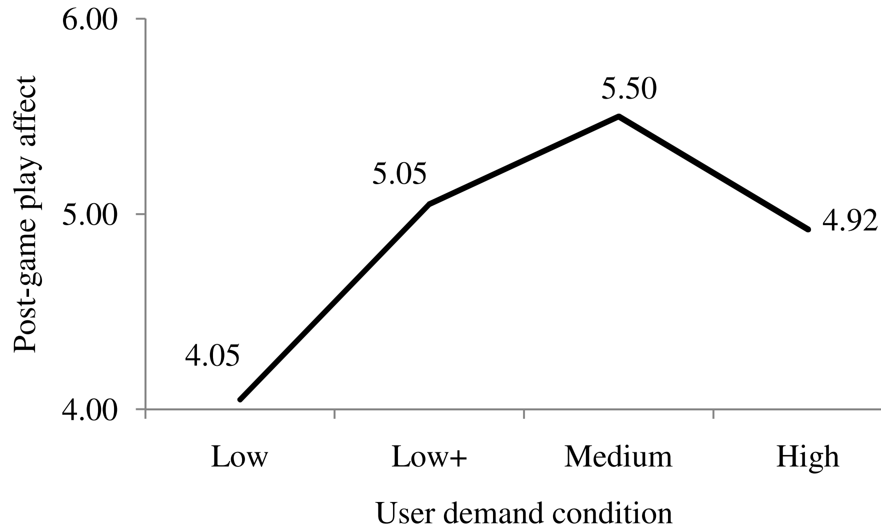
Table 3. Descriptive statistics for mood repair by mood manipulation and task demand condition.

	Task demand condition							
	Low		Low+		Medium		High	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Boredom	4.38_a	1.83	5.40_b	1.39	5.83_c	2.09	5.54_b	1.91
Stress	4.43_a	1.72	4.70_a	1.66	5.20_b	1.91	4.32_a	2.04

Note: Means with different subscripts per row differ at p < .05 level or greater using Tukey's honest significant difference (HSD) post-hoc test.

My first hypothesis predicted that increased task demand will result in greater mood repair for those in noxious mood states. Results from the ANCOVA analysis show that the effect of task demand approaches significance but fails to meet the $p < .05$ criterion, $F(3,162) = 2.49$, $p = .062$, $\eta^2 = .044$, thus suggesting initially that support was not found for H1. However, as suggested earlier, there was reason to suspect that the influence of task demand on mood repair might be nonlinear, as too much task demand might become frustrating and as result offset any positive changes in mood (cf. Wolf & Perron, 2003). In fact, the possibility that video games with very high task demand may be counter-productive to the mood repair is suggested in the present data by inspecting the pattern of mood repair means across conditions of task demand (see Table 3 and Figure 2). Thus, tests were conducted to investigate the potential for a quadratic relationship between task demand and mood repair, and indeed a significant curvilinear relationship was found (k matrix $p_{linear} = .096$, $p_{quadratic} = .035$, $p_{cubic} = .442$). The pattern of means shows that levels of mood repair increased from low ($M = 4.40$, $SD = 1.75$), to low+ ($M = 5.05$, $SD = 1.55$), to moderate levels of task demand ($M = 5.50$, $SD = 2.00$), at which point it peaked and subsequently declined for users in the highest task demand condition (M = 4.92, SD = 1.05).[9] Thus, there is support for H1 to the extent that increased task demand has a significant positive effect on mood repair up to a point before dropping off at the highest level of task demand (see Figure 4).

Figure 4. Observed relationship between task demand condition and subsequent mood repair.

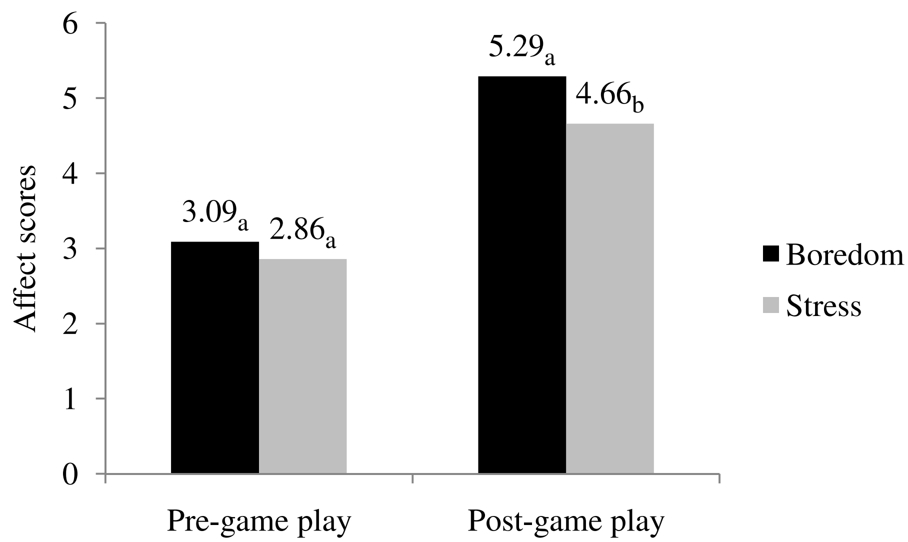


My second hypothesis predicted that mood repair would be greater for bored participants than for stressed participants. The ANCOVA analyses show support for this hypothesis, as a significant difference was found in mood repair between mood manipulation conditions, $F(1,162) = 4.56$, $p = .034$, $\eta^2 = .027$. Although post-game play affect (M = 4.96, SD = 1.88) was significantly greater than pre-game play affect (M = 3.02, SD = 1.65) for all participants, $t(171) = -11.9$, $p < .001$, the increase for bored participants (ΔM = 2.20) was greater than the increase for stress participants (ΔM = 1.80), and these differences were significant from one another, $t(170) = 2.27$, $p = .024$. Overall,

9 In fact, if we remove the high task demand condition from the ANCOVA analysis, the main effect for task demand on mood repair is significant, $F(2,123) = 3.19$, $p = .045$, $\eta^2 = .053$, and linear (k matrix p_{linear} = .013, $p_{quadratic}$ = .864).

mood repair was greater for bored participants than it was for stressed participants when controlling for arousal and video game skill, thus showing support for H2 (also see Figure 5).

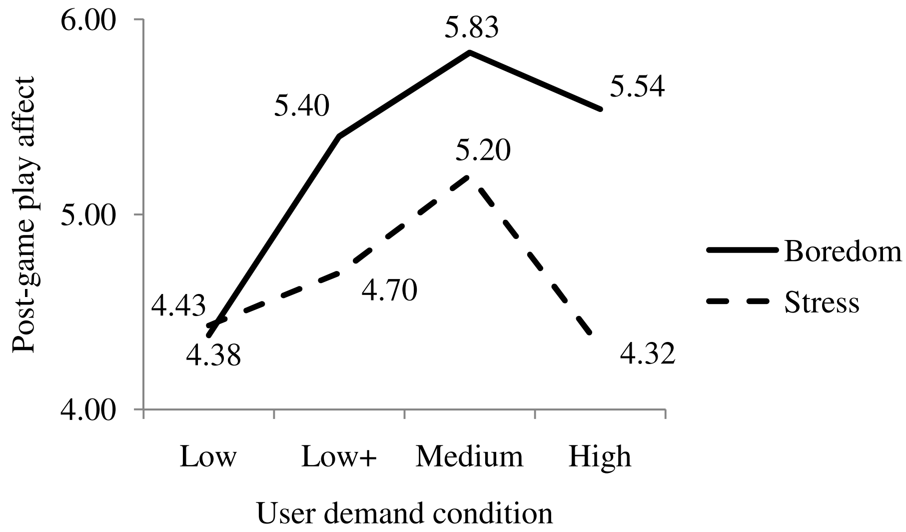
Figure 5. Observed change in post-game play affect across mood manipulation conditions, from baseline.



Note: Means with different subscripts within comparison group differ at p = .05 level or greater.

My third hypothesis predicted that a significant interaction between mood induction and task demand conditions would exist such that the impact of task demand on mood repair would be greater for bored participants than for stressed participants (H3). Results from the ANCOVA analysis showed that the interaction of task demand and mood manipulation was not significant, $F(3,162) = 1.07$, $p = .362$; thus, H3 is not supported.

Figure 6. Observed relationship between mood state and task demand on mood repair.



It should be noted that a significant effect was found for video game skill on mood repair, $F(1,162) = 14.9$, $p = .025$, $\eta^2 = .027$. The partial correlation was calculated between video game skill on mood repair, controlling for arousal, was $r = .177$, $p = .021$. This small-but-significant correlation suggests that individuals with higher self-reported video game skill reported greater mood repair regardless of task demand or mood manipulation.

DISCUSSION

Study 1 examined the effects of increased task demand on mood repair for bored and stressed individuals. All participants in the study regardless of task demand condition or mood induction experienced some form of mood repair post-game play, but bored individuals experienced significantly more mood repair than stressed participants. At the same time, task demand increased mood repair up to a point, beyond which too much task demand had a counter-productive effect of mood repair regardless of mood condition. This was evidenced by a significant curvilinear relationship reported for mood repair scores as a function of increased task demand. Finally, there was not a significant interaction between mood manipulation and task demand condition on mood repair. Data from this study show that (a) increasing the amount of control an individual has over a mediated environment – such as increasing the number of control inputs a user has in a video game – significantly increases that medium's intervention potential, (b) this increase in intervention potential results in an enhanced ability for that medium to relieve boredom and stress, (c) too much task demand can have a detrimental effect on mood repair, and (d) the significant ability of video games to repair negative mood states is a function of increased task demand, and not simply increased arousal.

Perhaps the most notable finding in this study is that the effect of task demand on mood repair was observed after controlling for self-reported arousal. That is, I found that the ability of video games to repair negative mood states associated with boredom and stress was a function of increased task demand afforded by the interactive environment, and not simply increased arousal as is commonly suggested in the literature (cf. Bryant & Davies, 2006; Raney, Smith, & Baker, 2006). Of course, this is not to say that the arousal capacity of video games is not an important contributor to their mood management capacity; in fact, for individuals experiencing low levels of arousal, video games might prove to be a most attractive media choice for helping one return to an optimal level of arousal. However, it is important theoretically to demonstrate that intervention potential and arousal regulation are separate constructs that can have differential effects on mood repair, even in situations such as video game play in which it has been previously assumed that both variables are increased as a function of increased control and interactivity. Moreover, binding this added intervention potential to features of interactivity (in this case, control inputs) demonstrates how unique features of video games distinguish user experiences with video games from television and other less interactive media. Not only do these data show that increased task demand contributes to the mood management process, they also show how unique features of video games contribute to task demand.

CONCLUSIONS

Prior literature has suggested that the experience of playing video games is qualitatively different than consuming other forms of media. In terms of mood management and mood repair, it has been proposed that video games – due to their increased task demand – should result in greater mood repair than other forms of media, even when controlling for the effects of arousal and perceived video game skill. By experimentally assigning bored or stressed individuals to various task demand conditions designed to simulate television viewing or video game play, data from this study supports the assertion that greater task demand is related to greater mood repair so long as demand is not too high. Thus, Study 1 provides empirical support for the assertions regarding the nature of video game play and intervention potential as applied to mood management theory.

STUDY 2

Whereas the first study look at mood repair resulting from experimentally-controlled levels of task demand, the second study is designed to predict mood repair resulting from naturally occurring task demand, using measures of user engagement in the production of dynamic media during video game play. Put simply, Study 2 uses measures of the respondent's real-time movements in the video game as an indicator of task demand, and these movement measures are used as a predictor of mood repair.

Hypotheses

The mood repair logic for this study is borrowed in whole from the first study. It is generally expected that users who are more active in the video game environment – that is, those who are more active in the production of dynamic media content vis-à-vis their increased manipulation of the game controls – will experience greater mood repair than those users who are not as active in the video game environment. The first prediction of Study 2:

> H1: For people in noxious mood states (boredom or stress), the extent to which users physically manipulate the game controls will positively predict increased mood repair.

Once again, and as found in Study 1, the natural confound of physical engagement and arousal cannot be ignored. For bored users, mood repair is expected to profit from both the arousal regulation and intervention potential benefits that result from increased task demand, whereas for stressed users, mood repair should profit only from the intervention potential caused by task demand and not by arousal regulation. Because of this confound and based on the data from the first study, I should expect the effect of measured engagement on mood repair to be greater for bored users than for stressed users. Thus, I predict that:

H2: The positive effect of measured engagement on mood repair will be greater for those in a boredom condition than for those in stress condition.

Finally, in a similar fashion to Study 1, I wonder if there is a difference in how participants might engage in a video game if given the added cognitive demand of a memorization task. That is, I wonder if there might there be a difference in measured engagement (and subsequent mood repair) for participants who play the game with or without an added cognitive task. It makes sense that playing a video game under varying levels of cognitive demand might have an influence on how one plays a video game, as media users have a limited capacity to process media content (cf. Lang et al., 1999). Moreover, demonstrating a difference – if any – between a simple game-playing task and a game-playing task in which one is asked to recall something about the event might be another way to get at the question of information processing's effect on mood repair raised in Study 1. As with the prior study, any potential differences in measured engagement and mood repair between the two game play scenarios will be examined in my hypothesis testing.

METHOD

This study used natural measures of user engagement to predict mood repair stemming from video game play. Following a mood induction, participants were video-taped playing a flight simulator video game – the high task demand condition from Study 1 – and their actions coded by two independent coders.

Participants

Participants were recruited in the same manner as Study 1, although participants who took part in Study 1 were excluded from participating in Study 2. Assuming a relatively large effect size $f = .31$ in Study 1 (see above discussion), a power analyses was performed for a multiple regression model with three predictors, $\alpha < .05$, two-tailed, and a statistical power of $\beta = .80$; this analysis provided us with a optimal $n = 40$ for both of my mood manipulation conditions. After data collection a total of N = 100 participants (51 male, 49 female) were used in this study, with $n = 47$ in the boredom manipulation and $n = 49$ in the stress manipulation. Due to errors in video recording discovered during data analysis, four participants were removed from the sample (three from the boredom manipulation, one from the stress manipulation), leaving a final sample size of N = 96. The average age of participants was 21 years, one month, and 69 percent of participants indicated that they were majoring in communication or a related field (i.e., retailing, advertising, or public relations). As with Study 1, I am not concerned with the use of college students as a threat to generalizability (cf. Jones, 2003).

Design and Procedure

The procedure from Study 1 is replicated here in its entirety, with one key difference – rather than randomly assigning participants to one of three conditions of task demand for the game play session, all users played the flight simulator in the high task demand condition from Study 1. The high task demand condition was used in Study 2 so as not to artificially limit the amount of engagement participants could have while playing the study (recall that the other three conditions of task demand in Study 1 – low, low+, and medium – were created by limiting the number of inputs the participant would have control over in the flight simulator). In addition to the high demand condition, just over half of participants (n = 51) were randomly assigned to the play the game with the added cognitive task – the memorization task – from Study 1. To record participant's engagement in the video game, a video camera was used to record the participant's behaviors during game play. The camera was conspicuously mounted to the wall of the laboratory directly above the computer monitor and angled so that it would record only the participant's hands on the game controls (joystick, throttle, and keyboard). All participants consented to being video-taped prior to the start of the study (see Appendix B), and no participants indicated being bothered or distracted by the camera during the experiment.

Stimuli/Materials

Mood inductions. The mood inductions from Study 1 are replicated in Study 2.

Video game. The video game in Study 1 is used again in Study 2, with all auto-pilot features turned off and all game controls fully operational; this is akin to the high task demand condition from the previous study.

Measures

Distractor task. Task demand is measured in Study 2 using the same distractor task measure from Study 1. The reliability of the measurement in this study was $\alpha = .658$.

Mission feedback. The adapted NASA-TLX scale from Study 1 was used in Study 2 (Appendix F). The reliability of the scale in this study was $\alpha = .600$.

Felt arousal. The arousal measure used in Study 2 is identical to the measure from Study 1, although data from this measure was not used in statistical analysis for similar reasons as the prior study.

Measured engagement. The participant's actual manipulation of the video game controls was measured in Study 2 and used in place of the experimentally-induced discrete task demand conditions from Study 1. To measure user input, a digital camcorder with a wide-angle lens was used to record all user controls (joystick, throttle, and keyboard) for the duration of game play. Two independent coders – one male, one female – viewed the footage and coded each participant's use of the controls on a five-point scale. Scale points were: "0" (no visible manipulation of control), "1" (control is being manipulated, but the manipulation is at a minimum), "2" (control is being manipulated in a calm, controlled manner), "3" (control is manipulated in an erratic, hurried manner), and "4" (extreme manipulation of the controller, to the point where the controller itself is actually moved on the desktop). One code was assigned per category to each participant, and the unit of analysis for these codes was one game play session.

Before coding the study footage, both coders were given two sets of 10 sample video recordings of participants playing the video game; this footage was taken from a random set of participants in Study 1. Once an inter-coder reliability greater than $\kappa = .610$ was established on each of the three measures (.610 considered to be the bare minimum standard for claims of 'substantial agreement' among coders by Landis & Koch, 1977), the coders were then asked to view the study footage.[10] Inter-coder reliability was greater than $\kappa = .610$ for all three variables: joystick $\kappa = .827$; throttle $\kappa = .856$; keyboard $\kappa = .961$. Not surprisingly, the three measures of user engagement did not form a uni-dimensonal measure as evidenced by an extremely low reliability, $\alpha = .123$. Although the

[10] Coders spent ~ 45 minutes in training, and the $\kappa = .610$ threshold was exceeded in both trial runs for all three coding categories: joystick ($\kappa_{trial\ 1} = .625$; $\kappa_{trial\ 2} = .875$), throttle ($\kappa_{trial\ 1} = .625$; $\kappa_{trial\ 2} = .750$), and keyboard ($\kappa_{trial\ 1} = .875$; $\kappa_{trial\ 2} = .875$).

joystick and throttle measures shared a small significant correlation with one another (r = .254, p = .012), the keyboard measure was not significantly associated with either the joystick (r = .091, ns) or throttle (r = -.123) measures. Thus, for purposes of data analysis, all three controls were retained in regression analysis so that their effect on mood repair could be examined in tandem with and controlling for one another. The descriptive statistics for all three measures and their correlation matrix are contained in Table 4, with the means in this table representing the average assigned code per game play session for all participants.

Table 4. Descriptive statistics and correlation matrix for measured engagement coding.

	M	*SD*	Joystick	Throttle
Joystick	2.41	.591		
Throttle	1.78	.668	.254*	
Keyboard	1.42	.925	.091	-.123

** = correlation significant at p < .05 or higher.*

Mood repair. The mood measures used in Study 1 are again used in Study 2.

Video game skill. The video game skill measure used in Study 1 was used in Study 2. Notably, there was no significant difference in video game skill between participants in the boredom condition (M = 4.07, SD = 1.54) or the stress condition (M = 3.91, SD = 1.69), $t(98)$ = .466, *ns*.

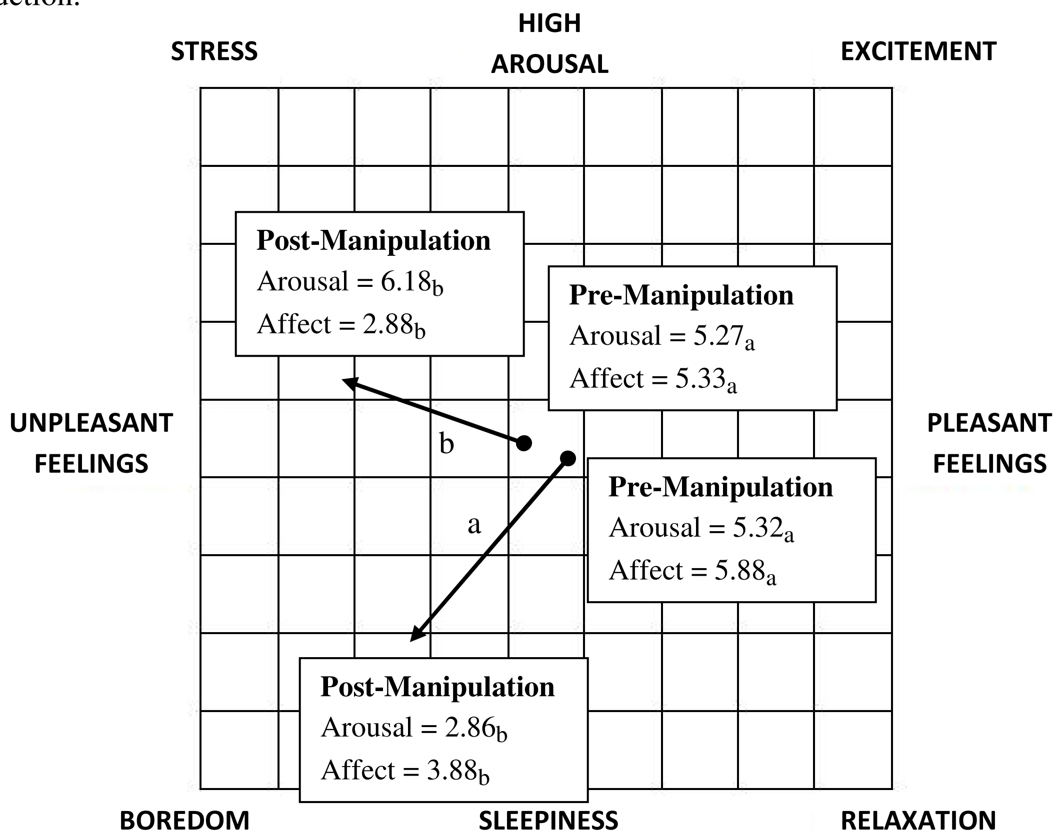
RESULTS

Induction checks

Mood. As in Study 1, the mood manipulations used in this study were found to significantly affect both arousal and affect levels of participants in the predicted direction (see Figure 7). Notably, there was no significant difference in either pre-manipulation arousal, $t(98)$ = .130, *ns*, or pre-manipulation affect, $t(98)$ = 1.43, *ns*, between mood conditions. By condition, the pre-manipulation means were: boredom affect, $M = 5.88$, $SD = 1.70$; boredom arousal, $M = 5.32$, $SD = 1.77$; stressed affect, $M = 5.33$, $SD = 2.06$; stressed arousal, $M = 5.27$, $SD = 2.05$.

For the boredom manipulation, post-manipulation affect ($M = 3.88$, $SD = 1.67$) was significantly lower than pre-manipulation affect, $t(96) = 5.88$, $p < .001$. Similarly, post-manipulation arousal ($M = 2.86$, $SD = 1.53$) was also significantly lower than pre-manipulation arousal, $t(96) = 7.36$, $p < .001$. The boredom manipulation was successful. For the stress manipulation, post-manipulation affect ($M = 2.88$, $SD = 1.63$) was significantly lower than pre-manipulation affect, $t(100) = 6.66$, $p < .001$. Post-manipulation arousal ($M = 6.18$, $SD = 2.26$) was also significantly higher than pre-manipulation arousal, $t(100) = -2.106$, $p = .038$. The stress manipulation was successful. Moreover, post-manipulation affect did not differ significantly between the two conditions, $t(98) = 1.52$, *ns*, indicating that both mood manipulations induced a similarly-valenced noxious mood.

Figure 7. Induction check: Arousal and affect means for mood groups, pre- and post-induction.



a = boredom, b = stress
Note: Means with different subscripts differ significantly at p = .05 or greater.

Task demand. I wondered whether adding a cognitive task to high demand video game play would result in increased task demand in a similar fashion to the added task demand of a cognitive task to the low task demand condition in Study 1. This question was posed in order to examine the relative effect of cognitive tasks in media consumption. Mean comparison did not reveal as significant difference in either the self-reported task demand between conditions, $t(98) = -1.35$, *ns*, or the behavioral measure of task demand, *t*(98) = 1.38, *ns*. Thus, these two task demand groups were collapsed in hypotheses testing.[11]

Hypothesis testing

The first hypothesis of Study 2 predicted a positive relationship between measured engagement and mood repair such that regardless of mood manipulation, participants who were more engaged with the video game (as assessed by independent coders) should experience greater mood repair. This hypothesis was examined by regressing mood repair scores on each of the three measured engagement scores assessed by independent coders to control for the potential influence of post game-play arousal on mood repair, this measure was included as a second step in a hierarchical linear regression model (see Table 5).

Table 5. Summary of regression analysis for the effect of measured engagement and post-game play arousal on mood repair.

	Model 1			Model 2		
Variable	*B*	*SE B*	Β	*B*	*SE B*	β
Joystick				-.210	.359	-.061
Throttle				.023	.314	.008
Keyboard				.460	.223	.209*
Post-game play arousal	-.266	.122	-.216*	-.261	.122	-.211*
Video game skill	.257	.124	.205*	.207	.126	.165
R^2		.091			.134	
F for change in R^2		4.65*			2.78*	

* = *p* < *.05*

The overall regression model was significant, $F(5,90) = 2.78$, $p = .022$. Measures of keyboard engagement were significant positive predictors of mood repair, β = .209, *p*

[11] Upon further reflection, these null findings are not surprising given the limited capacity for individuals to be able to process message content discussed earlier in Study 1 (cf. Lang et al, 2006). Whereas in a low task demand situation the addition of cognitive tasks might be expected to increase demand, in a high task demand situation there is a ceiling effect caused by the already-high resource demands of the video game.

= .042, whereas joystick and throttle controls were not (see Table 6). Moreover, the measure of post-game play arousal served as significant negative predictors of mood repair in the full regression model, $\beta = -.211$, $p = .036$, and the correlation between post-game play arousal and keyboard manipulation was not significant, $r = .013$, *ns*, indicating that they served as unique predictors of post-game play affect. Interpreted, greater keyboard engagement increased post-game play affect, whereas greater post-game play arousal decreased post-game play affect; both findings are expected from theory. Thus, when considering measured keyboard manipulation, H1 is supported.[12]

The second hypothesis predicted that the effect of measured engagement on mood repair would be greater for bored participants than for stressed participants. To examine this, separate regression analyses were run for bored and stressed participants, and differences in the magnitude and direction of beta-weights observed in the two analyses were visually examined. Specifically, I looked at the beta-weights for all indicators of user-control based engagement (joystick, throttle, and keyboard) to see if the pattern of engagement's effect on mood repair for bored participants differed from the same pattern observed for stressed participants. The separate regression analyses run for bored and stressed participants used the same predictor and control variables as above. Table 6 reports the results of these analyses.

[12] One alternative explanation for the lack of significance associated with the measured joystick and throttle manipulations could be their relatively low variance. Compared to measured keyboard manipulation, which had a standard deviation on a five-point scale of .925, the measured joystick manipulation had a standard deviation of .591, and measured throttle manipulation had a standard deviation of .668.

Table 6. Regression results for the effect of measured engagement and post-game play arousal on mood repair for bored and stressed participants.

Bored participants						
	Model 1			Model 2		
Variable	*B*	*SE B*	Β	*B*	*SE B*	Β
Joystick				.195	.551	.057
Throttle				.360	.404	.140
Keyboard				.604	.303	.289*
Post-game play arousal	-.187	.186	-.150	-.173	.182	-.139
Video game skill	.143	.191	.113	.109	.193	.086
R^2		.041			.158	
F for change in R^2		.945			1.53	
Stressed participants						
	Model 1			Model 2		
Variable	*B*	*SE B*	Β	*B*	*SE B*	Β
Joystick				-.569	.468	-.172
Throttle				-.833	.514	-.233
Keyboard				.162	.326	.073
Post-game play arousal	-.349	.159	-.298*	-.291	.162	-.249
Video game skill	.336	.162	.283*	.324	.161	.273*
R^2		.154			.257	
F for change in R^2		4.18*			2.98*	

* = $p < .05$

Firstly, it should be noted that running separate regression models for bored and stressed participants substantially lowers the power of both tests, as the sample size for bored participants is $n = 47$ and the sample size for stressed participants is $n = 49$. Thus, while significance tests are presented here, they are presented alongside a discussion of the relative magnitude and direction of the reported beta-weights.

When conducting the regression analyses separately for bored and stressed participants, the omnibus model for bored participants was not significant, $F(4,42) = 1.53$, *ns*, while the model for stressed participants was significant, $F(4,44) = 2.98$, $p = .021$. For bored participants keyboard manipulation was found to be a significant positive predictor of mood repair, $\beta = .289$, $p = .050$, but this finding was not replicated with stress participants, β = .073, *ns*. Perhaps more interesting, the beta-weights for measured joystick and throttle manipulation on mood repair were stronger and negative for stressed participants (β = -.172 for joystick measures, β = -.233 for throttle measures), whereas these same measures were weaker and positive for bored participants (β = .057 for joystick measures, β = .140 for throttle measures). Finally, we see that while video game skill served as a significant positive predictor of post-game play affect for stressed individuals (β = .273), it was not a predictor for bored individuals (β = .086). In addition, the significant negative effect of post-game play arousal on mood repair reported in H1 was not replicated here, although the beta-weights were in the same negative direction for both analyses. In fact, the negative influence of arousal on affect was stronger for stressed participants than for bored participants as represented by a greater negative beta-weight for these participants, which supports the earlier claims regarding the counter-productive effect of task demand on affect for stressed participants. Combined, these data provide evidence to suggest how the influence of measured engagement on mood repair might be expected to differ between bored and stressed individuals. In general, it appears that increased engagement with video game controls enhances post-game play affect for bored individuals whereas it inhibits post-game play affect for stressed individuals; this pattern of results is consistent with for H2.

DISCUSSION

Whereas Study 1 examined mood repair from experimentally-induced levels of task demand, Study 2 examined naturally-occurring engagement in a video game environment as a predictor of mood repair. The results of this second study show that while some measures of user engagement – namely, joystick and throttle control manipulation – were not significant predictors of mood repair (albeit they trended in the predicted positive direction), measures of keyboard manipulation were found to be a strong and significant positive predictor of mood repair. Interestingly, this pattern was only found for bored participants; for stressed participants, evidence suggests that measured user engagement may in fact be a negative predictor of mood repair. Upon further reflection, it is not surprising that the joystick and throttle controls did not have a significant association with mood repair, especially given the nature of the flight simulator control used in this study. In a flight simulator, joystick and throttle controls require very deliberate and smooth operation that likely requires the user to maintain rather than manipulate the position of these devices during game play. Conversely, the keyboard in this particular video game was used to control the many other toggle functions of the aircraft (such as landing gears, airbrakes, and other controls). Thus, the user was required to constantly manipulate the keyboard in order to operate these aircraft functions successfully, akin to a traditional video game controller. These points speak to a limitation of the study that is highlighted later in the paper; nonetheless, this limitation does not preclude the significant results found in support of H1 and H2.

CONCLUSIONS

Study 2 was designed to examine mood repair stemming from measured user engagement in video games. Using behavioral measures of task demand as opposed to random assignment to task demand conditions as was done in Study 1, data from the second study shows that increased involvement with some game controls has a positive influence on post-game play affect. In general, increased engagement of a video game's controls had a positive effect on post-game play affect for bored participants and a negative effect on post-game play affect for stressed individuals. Specifically, increased keyboard engagement (an indicator of greater command of the aircraft) was a significant positive predictor of post-game play affect for bored participants, whereas increased throttle and joystick engagement (whose overuse is indicative of lesser command of the aircraft) was a negative predictor of affect for stressed participants. Perhaps this indicates that bored participants desire more engagement with their video games, while stressed participants desired less engagement. These data show that an individual's mood state can influence the mood repair associated with the physical actions they perform while playing a video game.

STUDY 3

The final study examines the influence of mood state on selective exposure to video games known to vary in task demand, and mood repair resulting from these selections. This study differs from the previous two studies in that its central goal is to demonstrate how the mood of players can be expected to influence their preference for different video games; or, in this case, different configurations of the same video game that vary in their predicted potential for mood repair. This is done to see if individuals in a noxious state will selectively expose themselves to environments with greater task demand and, subsequent to this, if mood repair resulting from these 'naturally-occurring' choices is increased with the selection of media environments higher in task demand.

Hypotheses

From selective exposure theory, and based on data from the previous two studies, it is expected that users experiencing noxious mood states will choose game conditions known to have a higher amount of task demand than those not in a noxious mood. Yet as found in Study 1, data on mood repair suggests a curvilinear pattern in which high levels of task demand (compared to moderate levels) have a detrimental effect on repair. The first study found that mood repair was highest at moderate levels of task demand, decreased slightly at the highest level of task demand, and was significantly lower at the lowest amount of task demand. As such, if selection is driven by anticipated mood repair, we cannot assume that a noxious mood will results in an unlimited desire for added task demand. Since this study replicates the task demand conditions used in the first study, the game choice hypotheses are modeled after the pattern of mood repair means observed in

Study 1. Thus, given conditions in which players are familiar with the task demand levels available in a video game, I offer my first hypothesis:

> H1: If given the choice to play a video game with varying conditions of task demand, a curvilinear choice pattern will be observed in which individuals in a noxious mood state will prefer a game with low task demand *less* than one with moderate task demand, and will prefer a game with moderate task demand *more* than one with high task demand.

Related to this, I am also concerned with how this pattern of task demand choices might differ as a function of the type of noxious mood state an individual is experiencing; in this case, boredom or stress. Logic from Study 1 proposed that bored individuals might benefit more from task demand than stressed individuals, and this claim was supported in the data from that study. Bored individuals benefit not only from the intervention brought on by increased task demand, but may also benefit from game play's ability to heighten arousal. This effect differs for stressed individuals. Although stressed individuals too should benefit from the intervention brought by increased task demand, game play's ability to heighten arousal would not be expected to provide the same added mood-repair benefit it might provide to bored individuals, particularly if task demand is at a high level. For stressed individuals, it was reported in Study 1 that a moderate task demand game led to greater mood repair than either the low or high task demand game, and that little mood repair from the high task demand game was apparent. By contrast, the mood repair primacy of the moderate task demand condition was not apparent for bored individuals. For these respondents, the moderate task demand game again led to greater mood repair than the low demand game, but the repair benefits for the moderate demand condition did not differ significantly from those in the high demand condition.

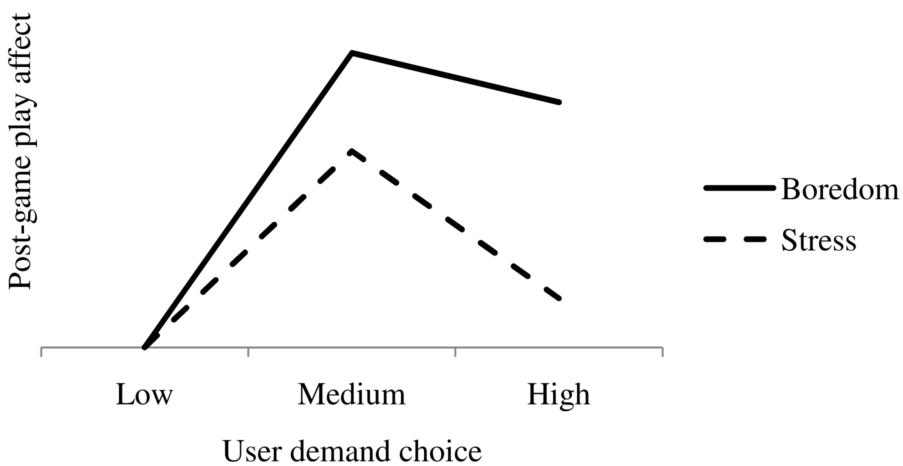
The second hypothesis for Study 3 is based on two previously identified considerations. First, given that the logic for my game-choice hypotheses is based on the understanding that selection is driven by anticipated mood repair, I would expect differences in the game-choice behaviors of bored and stressed individuals to mirror differences between bored and stressed individuals in the amount of mood repair expected from games at different levels of task demand. Second, since the current study replicates the task demand conditions used in Study 1, the game-choice hypotheses are modeled after the pattern of mood repair observed in the prior study. As such, based on the assertion that stressed individuals will anticipate greater mood repair in the moderate task demand condition than the low or high demand conditions and that bored individuals will not mirror this pattern, I predict that stressed individuals will show a greater bias toward moderate task demand as compared to bored individuals.

> H2: Selective exposure patterns will differ significantly between stressed and bored individuals such that stressed participants will show a greater preference for moderate levels of task demand over both low and high task demand, whereas bored participants will not show the same preference for moderate levels of task demand over both low and high task demand.

Although the primary focus of my study is to understand selective exposure patterns stemming from mood states, the current study also examines mood repair resulting from selective exposure. Study 1 presents logic that explains why bored individuals should experience greater mood repair from games with increased task demand than stressed individuals, as both the arousal and intervention potential of increased task demand should benefit bored players, whereas stressed players would benefit only from task demand's intervention potential. Data from the first study supported this logic, as indeed bored individuals experienced significantly greater post-game play affect than stressed individuals (see Results section, Study 1). The third hypothesis is based on an understanding that the goal of selective exposure behaviors is to make media selections in line with motivations to facilitate mood repair. From this, it is expected that the highest levels of mood repair will be experienced by individuals who make video game play selections in line with predicted patterns from H1 (the expectation that moderate levels of task demand will be most preferred) and H2 (the expectation that stressed individuals will show a greater demand for moderate levels of task demand than bored individuals) Moreover, since only bored players should benefit from the arousal potential of increased task demand due to the counter-productive influence of arousal on stressed participants (see earlier discussion in Study 1), bored respondents should experience greater mood repair than stressed respondents making the same choices. Specifically, post-game play affect scores should be highest for bored participants choosing a moderate level of user repair, and lowest for stressed participants choosing a low level of user repair. The final hypothesis for Study 3 (also see Figure 8):

> H3: For those in a noxious mood state condition (i.e., boredom or stress), there will be a disordinal, nonsymmetrical interaction between mood state and task demand on mood repair. The curvilinear relationship between mood state and task demand in which the highest post-game play affect is found at moderate levels of mood repair will be stronger for bored participants than for stressed participants.

Figure 8. Predicted pattern of mood repair scores as a function of task demand condition, split by mood manipulation.



METHOD

Study 3 examines how learned expectations of differential task demand in a video game might influence selective exposure to that game. A 2 (mood manipulation) x 3 (task demand) between-subjects experimental design was employed. Participants played the same flight simulator video game used in the previous two studies at all three levels of task demand before being subjected to a randomly-assigned mood manipulation.

Participants

Participants were recruited in a similar manner to the first two studies, although participants from either Study 1 or Study 2 were excluded from participating in Study 3. Using an effect size measure of $f = .31$ (cf. Chen & Raney, 2009, also see earlier discussion), an expected effect size of $\omega = .40$ (ω is the proper effect size measure for chi-square goodness-of-fit analyses as conducted in the current study) was used to determine *a priori* the sample size for this study. Power analyses using $\omega = .40$ was performed for a chi-square contingency table with three possible choices, $\alpha < .05$, two-tailed, and a statistical power of $\beta = .80$; this analysis provided us with a optimal N = 61; after all data was collected, a final sample size of N = 64 was achieved for this study. This sample contained 39 males and 25 females with an average age of 22 years, five months, and 73 percent of participants self-reported majoring in communication or a related field. As with the first two studies, data collection was restricted here to a convenience sample of college students.

Design and Procedure

Upon entering the lab, participants reviewed and signed the informed consent forms (Appendices A and B). Once consent was obtained, participants were asked to complete a questionnaire measuring perceived video game skills and demographic characteristics (the same survey completed in the first two studies, Appendix C). After completing the questionnaire, participants were given five minutes to learn the controls of the flight simulator game before playing each version of the video game (each of the three task demand conditions) for five minutes. The games were played in the following order of task demand: high, low, and moderate. After reach game play session, participants were asked to complete a perceived task demand measure. Playing all three games prior to the mood manipulation was important, as selective exposure processes are driven by learned expectations regarding the medium's capacity to repair mood that stem from an individual's prior experience with that medium (Atkin, 1985). After playing all three versions of the game, participants were subjected to either the boredom or stress manipulation, and then asked to choose one of the three task demand conditions to play for five minutes. Task demand choice was recorded by the primary researcher, and participants played the game. Once game play was completed, participants were fully debriefed as to the purpose of the study (Appendix D) and entered into the cash drawing. The entire procedure lasted about one hour.

Stimuli/Materials

Mood inductions. The mood inductions from Studies 1 and 2 are replicated in Study 3.

Video game. The same video game used in Studies 1 and 2 is used in Study 3, with the same task demand conditions used in Study 1 implemented here in Study 3.

Measures

Distractor task. The task demand measure used in Study 3 is identical to the measure used in Studies 1 and 2. Note that the distractor task measure was not used in data analysis for this study; rather, the measure was retained in the experimental game play condition to more closely replicate the same game play conditions from the first two studies.

Mission feedback. The NASA-TLX scale from first two studies was used in Study 3 (Appendix F). Average reliability of this scale – with one item removed (see explanation in Study 1) was $\alpha = .72$; the scale was administered four times.

Arousal. The arousal measure used in Study 3 is identical to the measure from Studies 1 and 2, although data from this scale was not used in analysis of Study 3 for reasons explained in Study 1.

Mood repair. The mood measures used in Studies 1 and 2 are used in Study 3.

Selective exposure. To measure participant's preference for a particular task demand setting, the primary investigator recorded which version of the video game (low, medium, or high task demand) participants chose to play.

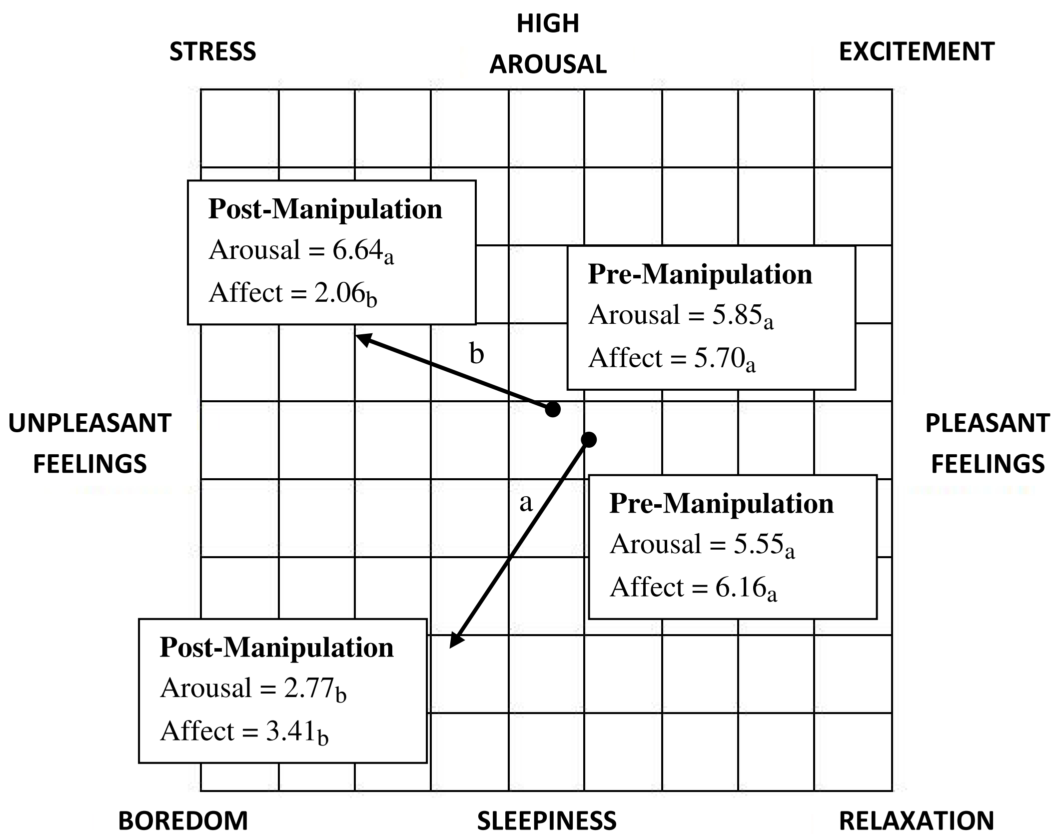
Perceived game skill. The same measure of perceived game skill, and game success used in the first two studies is replicated here in Study 3. Notably, perceived game skill did not differ significantly between bored ($M = 4.22$, $SD = 1.38$) and stressed ($M = 4.46$, $SD = 1.62$) participants, $t(62) = -.639$, *ns*.

RESULTS

Induction check

Mood. The mood manipulations used in this study were found to significantly affect both arousal and affect levels of participants in the predicted direction. Notably, there was no significant difference in either pre-manipulation arousal, $t(62) = .395$, *ns*, or pre-manipulation affect, $t(62) = .625$, *ns*, between mood conditions. For the boredom manipulation, post-manipulation affect was significantly lower than the pre-manipulation affect, $t(30) = 6.92$, $p < .001$, and post-manipulation arousal significantly lower than pre-manipulation arousal, $t(30) = 5.42$, $p < .001$. For the stress manipulation, post-manipulation affect was significantly lower than the pre-manipulation affect, $t(32) = 10.1$, $p < .001$, although post-manipulation arousal did not differ significantly from the pre-manipulation arousal above, $t(32) = -1.80$, $p = .081$. However, post-manipulation affect in the stress condition was significantly lower than post-manipulation affect in the boredom condition, $t(62) = 3.19$, $p = .003$, indicating that the stress mood manipulation induced a more noxious mood state than the boredom mood manipulation. Figure 9 contains a graphical depiction of the mood manipulation induction.

Figure 9. Induction check: Arousal and affect means for mood groups, pre and post induction.



Notes: a = boredom, b = stress, means with different subscripts across pre- and post-manipulation conditions differ significantly at p = .05 or greater.

Task demand. Although not an induction per se, participant's self-reported task demand was measured after each of the three practice sessions with the video game as indicated by their scores on the NASA-TLX. Note that the behavioral distractor task measured was not used during the practice sessions due to concerns that participants might simply learn to do the task better with multiple iterations. A repeated-measures ANOVA reports that indeed a significant difference in perceived task demand was found between the three video game conditions in the predicted direction, $F(2,126) = 265.1$, $p < .001$, $\eta^2 = .808$. Perceptions of task demand were lowest in the low task demand condition (M = 3.72, SD = .389), moderate in the moderate task demand condition (M =

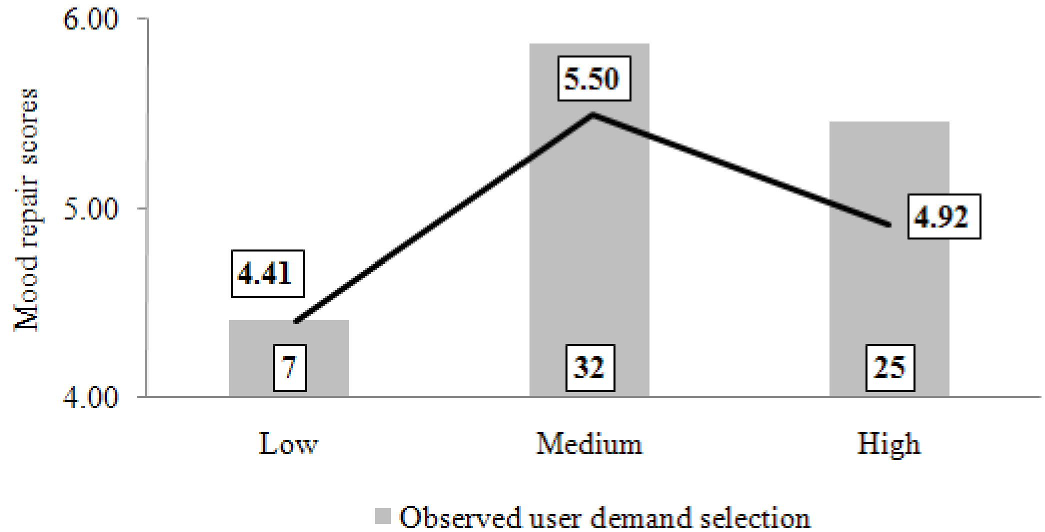
11.5, SD = .389), and highest in the high task demand condition (M = 12.6, SD = .350). Thus, I can conclude the participants did perceive the expected significant difference in task demand between task demand conditions.

Hypothesis testing

Selective exposure. My first hypothesis predicted that, given the choice to play video games known to vary in task demand, a curvilinear choice pattern would be observed among individuals in noxious mood states such that individuals would prefer low amounts of task demand the least, moderate amounts of task demand the most, and high amounts of task demand less so than moderate but more so that low amounts. To examine this, I first conducted a chi-square goodness of fit test to see if the observed pattern of game choice behaviors differed from chance. Then, I examined visually the observed pattern of game choices and compared this to the pattern of post-game play affect scores from Study 1. The chi-square goodness of fit showed that indeed the observed pattern of game choice behaviors differed significantly from chance, χ^2 (2, n = 64) = 15.6, $p < .001$. Visual inspection reveals that the selection of game play with varying levels of task demand appears to follow the predicted curvilinear pattern. Participants chose the low task demand condition the least (7 observed choices), the moderate task demand condition the most (32 observed choices), and the high task demand in the middle (25 observed choices). As the chi-square analysis provides us evidence that the observed game choice behaviors differed significantly from chance, and simple observation of the pattern of game choices follows the expected curvilinear relationship reported in Study 1, I conclude that the findings are consistent with for H1.

Figure 10 shows the post-game affect scores from Study 1 superimposed on the observed task demand selections from the current study.

Figure 10. Observed post-game play affect scores from Study 1 superimposed on observed task demand selections from current study.



The second hypothesis predicted a significant difference in selective exposure patterns between stressed and bored individuals; specifically, that stressed individuals would prefer moderate task demand over high task demand more so than bored individuals. To examine this, a chi-square goodness-of-fit test was conducted to comparing the observed pattern of selected task demand exhibited by bored participants with the observed selection pattern exhibited by stressed participants. This test required us to split the data file into separate groups of n = 31 (bored participants) and n = 33 (stressed participants), see Table 7. As at least one cell had a frequency of less than five, Yate's correction was applied to the final chi-square critical value (Yates, 1934).

Table 7. Observed frequency of task demand choices by mood manipulation.

	Low	Moderate	High	Total *n*
Boredom	6	13	12	31
Stress	1	19	13	33

$\chi^2_{Yates}(1, n = 31) = 18.8, p < .001.$

The result of the test comparing task demand choices for bored and stressed participants revealed that the pattern of choices in each condition varied significantly, $\chi^2_{\text{Yates}}(1, n = 31) = 18.8$, $p < .001$. Although all participants showed aversion to the low task demand condition, stressed participants showed greater preference for moderate task demand than did bored participants, and both stressed and bored participants showed equal preference for high task demand. Thus, I conclude that the findings are consistent with H2. Figure 11 shows a comparison between the observed task demand selection frequencies for bored participants in the current study and post-game play affect scores for bored participants in Study 1. Figure 12 shows the same comparison for stressed participants.

Figure 11. Observed post-game play affect scores for bored participants in Study 1 superimposed on observed task demand selections for bored participants from current study.

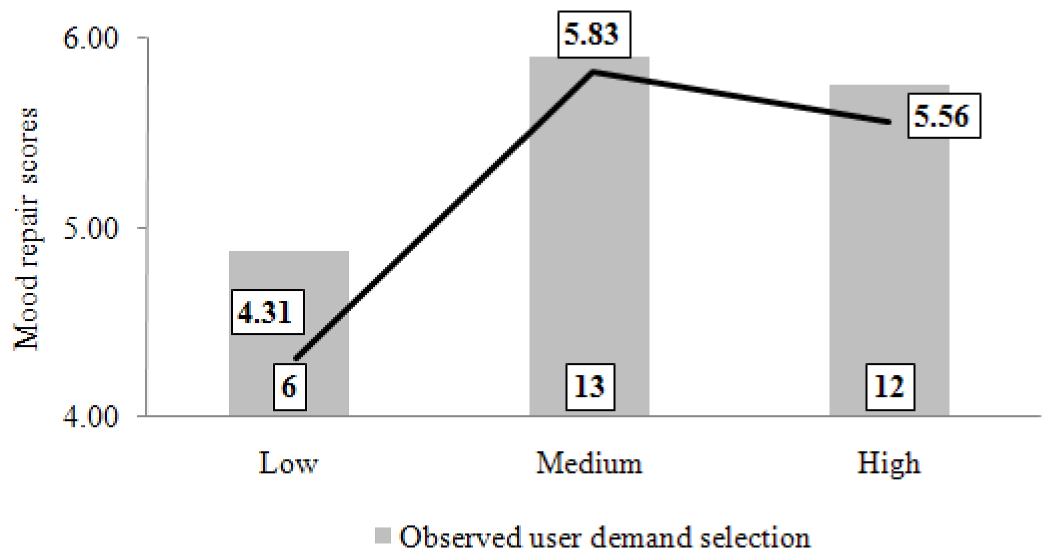
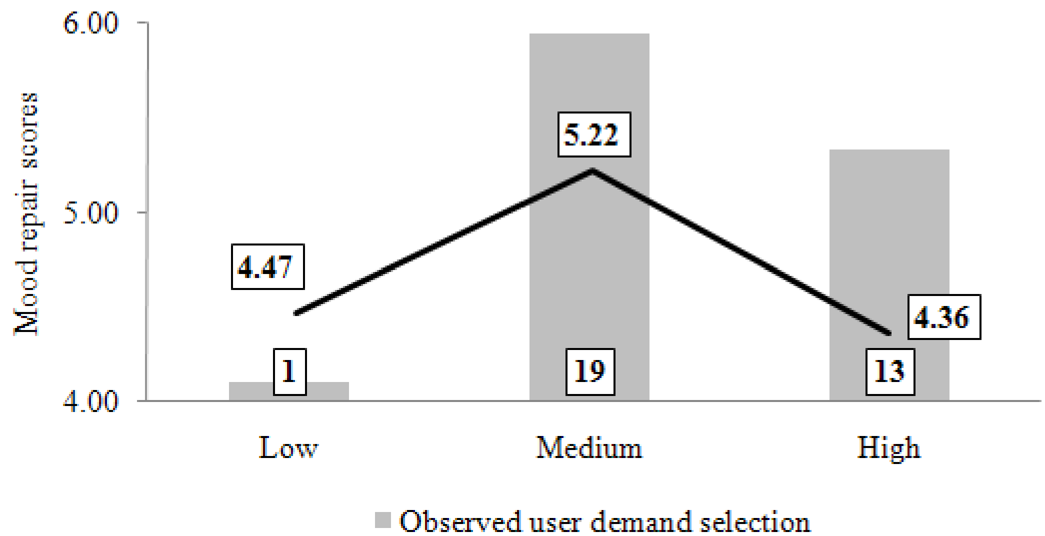


Figure 12. Observed post-game play affect scores for stressed participants in Study 1 superimposed on observed task demand selections for stressed participants from current study.



Mood repair. The final hypothesis made predictions about the combined effect of mood manipulation and task demand choice on post-game play affect. Specifically, this hypothesis predicted that the curvilinear relationship between mood manipulation and task demand in which the highest post-game play affect is found at moderate levels of mood repair will be stronger for bored participants than for stressed participants. This hypothesis was tested using a 2 (mood manipulation) x 3 (task demand) ANCOVA model, with post-game play arousal, pre-game play affect, and perceived video game skill as covariates.[13] Table 8 contains the ANCOVA analysis results, Table 9 contains the descriptive statistics of this analysis, and Figure 13 graphs the descriptives.

Table 8. Results of 2 (mood manipulation) x 3 (task demand) ANCOVA on mood repair.*

	SS	*Df*	*MS*	*F*	*p*	η^2
Video game skill	1.34	1	1.34	.285	.596	.005
Post-game play arousal	.019	1	.019	.004	.949	~.000
Pre-game play affect	11.2	1	11.2	2.38	.129	.041
Task demand choice	2.56	2	1.28	.273	.762	.010
Mood manipulation	3.25	1	3.25	.694	.409	.012
Task demand by mood manipulation	1.34	2	.668	.143	.867	.005
Error	258	55				

**covariates in this analysis are post-game play arousal and perceived video game skill*

[13] Pre-game play affect was used as a covariate because of a significant difference in this measure between bored participants (*M* = 3.41, *SD* = 2.13) and stressed participants (*M* = 2.06, *SD* = 1.14), $t(62) = 3.21$, p = .002 (see *Induction check: Mood* for Study 3).

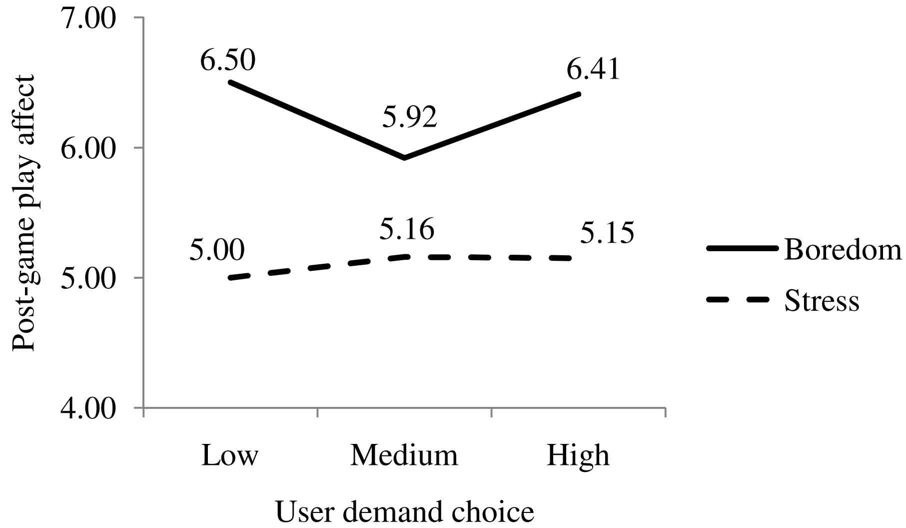
Table 9. Descriptive statistics for mood repair by mood manipulation and task demand condition.

	Low		Medium		High	
	M	*SD*	*M*	*SD*	*M*	*SD*
Boredom	6.50_a	1.76	5.92_a	1.85	6.41_a	2.39
Stress	5.00	-	5.16_a	2.24	5.15_a	2.27

Note: Means with different subscripts per row differ at p < .05 level or greater using Tukey's HSD post-hoc text.

The ANCOVA model does not support the proposed hypothesis. There is no main effect for mood for mood manipulation on affect scores, $F(1,55) = .694$, *ns*, nor is there a main effect of task demand choice on affect scores, $F(2,55) = .273$, *ns*. For task demand choices, neither a linear or quadratic effect was reported (k matrix $p_{linear} = .635$, $p_{quadratic} = .876$). Although overall the bored participants ($M = 6.23$, $SD = 2.01$) self-reported greater affect than stressed participants ($M = 5.15$, $SD = 2.18$), the effect was not significant – no doubt in part due to a lack of statistical power resulting from small sample sizes ($n = 31$ for bored participants, $n = 33$ for stressed participants). It should be noted that bored participants began with a significantly greater affect score than the stressed participants (see *Induction check: Mood*). In fact, bored participants overall experienced less mood repair than stressed participants (ΔM bored participants = 2.82, ΔM stressed participants = 3.09). Furthermore, for bored participants, post-game play affect was actually lowest in the medium task demand choice; for stressed participants, there is almost no perceptible change in affect scores across task demand conditions. Combined, these data do not provide support for H3. This is surprising given the data from Study 1, but an alternative explanation for these results is presented in the Discussion section below.

Figure 13. Observed relationship between mood state and task demand on mood repair, separated by mood manipulation condition.



DISCUSSION

The third study was aimed at predicting selective exposure to video game settings known to vary in task demand as a result of experimentally-induced noxious mood states. As predicted, participants demonstrated a clear preference for moderate levels of task demand, and this preference was greater for stressed as compared to bored participants. However, the effect of this process on mood repair was not found. These findings are discussed in further detail below

Task demand and selective exposure

The first hypotheses – and perhaps the primary focus of Study 3 – were concerned with the influence of task demand on individual's selective exposure patterns. Based on the pattern of post-game play affect scores from Study 1 it was predicted that participants experiencing noxious mood states would prefer moderate levels of task demand as compared to extremely high or low levels, and that stressed participants would show a more distinct preference for moderate task demand levels than would bored participants.

Indeed, both of these predictions were supported. After being given a set amount of time to develop learned expectations about a video game at three discrete levels of task demand, both stressed and bored participants showed the greatest preference for moderate task demand levels as compared to low or high levels of task demand, and stressed individuals showed a greater bias for moderate task demand than did bored individuals. This data is compelling for two reasons. First, it lends further empirical support to my assertions regarding selective exposure processes in newer forms of interactive media. In this case, the data give us a closer look at how we can understand the intervention potential in terms of the demand a medium places on its user, and how this task demand can be used as a predictor of video game choice related to two orthogonal and commonly-experienced mood states. Second, this research provides empirical evidence for selective exposure assumptions regarding learned expectations that have gone largely untested.

Selective exposure theory as applied to entertainment media is based partly on the dual propositions that (a) previous encounters with media lead to learned expectations related to a medium's ability to satisfy certain needs, and (b) these learned expectations drive media choice. Yet, I know of no research that has experimentally varied learned expectations to examine their influence on this part of the theoretical process. This may be largely due to the fact that most prior selective exposure research has examined forms of traditional entertainment media so ubiquitous that learned expectations are difficult to vary, or assumed to be universal. For example, when conducting selective exposure research on television and film, it makes sense to assume that individuals have well learned expectations about standard offerings well before they enter an experimental setting, making it difficult to manipulate and test learned expectations' influence. At the same time, it is important to note that while the experimental design used in Study 1 is unique form other selective exposure and mood management research in that participants are given an opportunity to practice and experience each of the three experimental video game conditions prior to post-mood manipulation selection, the design did not include a no-practice control group. As such, the different levels of learned expectation against a no-expectation control cannot be measured or compared with the current design. To rectify this potential oversight, future research might consider a Solomon four-group or other related design in replications of this study.

Selective exposure and mood repair

Although the primary focus of Study 3 was to examine the effect of task demand on selective exposure to video games, this study was also concerned with how actual task demand choices would influence subsequent mood repair. It was expected that, regardless of task demand choice, bored participants would experience greater mood repair than stressed participants, and that participants who made task demand choices in line with the selective exposure predictions would experience the greatest mood repair. Neither prediction was supported by the data. Despite earlier research, mood repair was not significantly greater for bored participants, and mood repair was not significantly affected by task demand choices. In fact, bored participants in the study who chose moderate levels of task demand experienced the least amount of mood repair of all participants in the study. Especially in light data from Study 1 in which task demand was found to have a generally positive effect on mood repair, these findings were unexpected and require further investigation. One potential explanation lies in the nature of the mood induction, specifically that the stress induction produced a significantly more noxious mood state than the boredom induction in this study. This difference in the intensity of noxious mood states might have introduced a ceiling effect and, as a result, restricted the ability of bored individuals to improve their mood state. This being said, the post-mood manipulation affect scores from Study 1 (M = 3.06, SD = 1.62) were not significantly different from the post-manipulation affect scores in the current study (M = 3.41, SD = 2.12), $t(43) = -.835$, *ns*, so the ceiling effect argument does not seem to be a likely explanation for the observed data trends. A second potential alternative explanation for the non-support for the mood repair hypotheses is related to the behavioral measure of task demand (the response time task) used during the post-mood manipulation game play session. Although this measure was included to more fully replicate the experimental design of Study 1, it might also have inadvertently worked against mood repair because the unexpected nature of the task, especially given that the task was not performed in any of the three practice game play sessions. It seems likely that the introduction of any task that was not in line with participant's learned expectations associated with game play would have created some amount of dissonance in the minds of those playing the game with the added tasks. Given the potentially disrupting nature of the response time task in relation to video game play, a negative effect on post-game play affect is plausible. Finally, a third alternative explanation for the non-significant effect of task demand choice on mood repair would be that participants were in fact choosing the task demand condition that would create what they considered to be an optimal mood state. In contrast to my expectation that all participants would require moderate levels of task demand in order to reach an optimal mood state, the optimal levels required may have differed across participants. Perhaps the levels of task demand actually selected by individuals were optimal in each case. Given this, no difference in post game play affect scores would be expected across task demand selections. Although the mood manipulations successfully induced similar levels noxious mood in both bored and stressed participants, I do not have data to suggest what individual participants would consider to be an optimal mood; thus, this assumption cannot be tested with these data.

CONCLUSIONS

The first two studies focused exclusively on the role of task demand in the mood repair process using logic from mood management theory. The third study focused specifically on the role of learned expectations regarding a medium's task demand on selective exposure behaviors. Secondary to the selective exposure hypotheses, Study 3 also examined how these 'naturally-occurring' selective exposure behaviors influenced the mood repair process. In line with the post-game play affect scores from Study 1 in which moderate task demand was found to result in the greatest mood repair, in Study 3 participants showed the greatest preference for moderate amounts of task demand; this preference was stronger for stressed participants than for bored participants. Finally, no evidence was provided to support predictions regarding the influence of 'naturally-occurring' task demand choice on resultant mood repair. Thus, although Study 3 provides support for assertions regarding the effect of task demand on selective exposure to varying conditions of task demand in video games, it does not provide evidence that these selections are actually effective in producing the desired mood repair. Nonetheless, evidence in Study 3 demonstrating the role of learned expectations in the selective exposure to video games adds to our understanding of selective exposure processes.

GENERAL DISCUSSION

The presented series of three studies was designed to examine the role of task demand on selective exposure and mood management processes. These studies come at an important impasse in media research. Although ample research exists on video game uses and effects as well as on selective exposure to and mood management in traditional media, no known research to date has combined the two. Many scholars have asserted that video games are distinct from other forms of entertainment medium in that they require near-constant feedback from the user, yet prior to this investigation this claim has not been supported empirically. Study 1 varied the amount of task demand in a video game, and found that increasing task demand results in greater mood repair to a point, at which too much task demand becomes detrimental to the mood repair process; this process was more effective for bored participants than for stressed participants. Study 2 used different behavioral measures of user engagement and found that, in general, increased controller manipulation had a positive influence on mood repair for bored individuals and a negative influence on mood repair for stressed individuals. Study 3 focused on selective exposure stemming from learned expectations following game play, and found an overall preference for moderate levels of task demand; this preference was more pronounced for stressed individuals. Combined, the three studies presented here offer data to establish the role of task demand as a feature of intervention potential relevant to understanding how selective exposure and mood management processes might differ from traditional media (such as television) to more interactive media (such as video games).

Limitations

Although limitations associated with each of the individual studies have been discussed earlier in this manuscript, a few limitations common to the all studies are discussed here. These limitations are related to the relatively short amount of time participants spent playing video games in the studies, concerns with the simulated television viewing condition, and the use of college-aged students. Each of these potential limitations is discussed below.

For each of the three studies presented here, participants were given no more than five minutes to play each version of the video game. Although this length of time seemed to be sufficient enough to demonstrate both mood repair and selective exposure to task demand conditions, the present series of studies does not investigate the potential for an important relationship to exist between time spent playing video games and task demand. For example, is it possible that as an individual spends more time with a video game and become increasingly familiar with the game's controls, the game might become less demanding. In this case, we might expect task demand to be highest upon first exposure with a video game, and reduced with each subsequent exposure (or, task demand may be reduced simply as a function of time spent playing during any one exposure). In terms of mood repair, we might expect the mood repair capacity of a video game to diminish as a function of increase time spent playing the game; in terms of selective exposure, we might expect that exposure to video games over time would create more stable learned expectations regarding a video game's mood repair capacity. At the same time, one might also consider that video games are programmed to be more difficult as the player progresses through the game (cf. Boyan & Bowman, 2007), thus maintaining a heightened level of task demand as play is continued. Nonetheless, future research should consider this relationship with more experimental rigor.

As discussed earlier, the low demand condition used in the current set of studies was designed to simulate television viewing while keeping media content as constant as possible. After weighing several options – including showing training footage of aircraft landings from Boeing and Lockheed-Martin sales videos – the decision was made to have participants in the low task demand conditions watch video game footage in demonstration mode rather than providing them with actual television programming to watch. Showing demonstration footage from the video game was required in order to attribute any observed differences in selective exposure and mood repair to differences in task demand. Controlling media content allows for the dismissal of claims that the observed effects in this set of studies resulted from differences in the hedonic valence and behavioral affinity of media content. At the same time, using the simulated television viewing condition might reduce the generalizability of the reported results. Replications of this study would benefit by incorporating an actual television viewing condition in order to more completely capture nuanced differences between task demand in these media forms.

Finally, the set of studies presented here individually relied on a rather small sampling of college-aged students. Although *a priori* power analyses justified the use of a small sample in each study and the sampling frame represents a significant portion of video game players (Jones, 2003), other populations may differ in their experience with video games, which in turn might affect their selective exposure behaviors.

Future research directions

The studies presented here focus specifically on task demand as it relates to intervention potential. Although the data presented from these studies provides empirical support to bolster the claims of many authors who have argued that some unique quality of video games, usually labeled interactivity, makes the technology well-adept at the mood management process, left unanswered by this research are questions related to other equally-important features of the theory, such as arousal regulation (the ability for a medium to increase or decrease an individual's felt arousal), behavioral affinity (the similarity between message content and one's current affective state) and hedonic valence (the general pleasurable or unpleasurable tone of a message). The studies presented here statistically controlled for self-reported arousal and experimentally controlled for behavioral affinity and hedonic valence by keeping content constant across task demand conditions. Left unaddressed by this research are questions related to how these elements might operate differently in video games or other interactive media as opposed to traditional forms of media. Tangentially related to this point, the presented studies focused on only a single type of video game (a flight simulator game) and only two types of moods (boredom and stress). Additional research is needed to examine the extent to which the findings here will generalize to other types of video games with varying control schemes and levels of task demand, and whether the influence of task demand seen here on boredom and stress will be observed also on other mood states such as sadness (Kim & Oliver, 2007) and hostility and aggression (Bushman & Anderson, 2002; Dill & Dill, 1998; Griffiths, 1999) commonly studied in entertainment research.

CONCLUDING REMARKS

The increasing popularity of video games as a form of media entertainment has pushed scholars to re-conceptualize many of our more traditional theories of media uses and effects. Although many scholars have made theoretical claims about the uniqueness of video games as compared to non-interactive media, few scholars have attempted to both clearly define the essential qualities of video games that make them unique and to show the relevance of this uniqueness. The set of studies presented here define one unique quality of video games over other forms of media – namely, their enhanced task demand – and show how this task demand can influence selective exposure and mood management processes, two long-established theories of media uses and effects. While the data presented here add to a growing body of research attempting to expand the theoretical scope of selective exposure and mood management theory to include interactive entertainment media such as video games, the study also highlights several areas in which future study is necessary. As the video game and interactive media industry continues to grow, so must our understanding the reciprocal processes that govern how mood states can affect game play choices, and how game play choices can in turn affect mood states.

APPENDICES

Appendix A. Consent Form

RESEARCH PARTICPATION CONSENT FORM

Thank you for your interest in this research study, which is designed to look at video game preferences. If you agree to participate in this study, you will be asked to play a set of video games and answer some questions about your opinion of them. This is a research project for the MSU Department of Communication. Your participation in this study will help researchers get a better understanding of how video game opinions are formed.

This study will take no more than one hour to complete. For your participation, you will be offered course credit from your instructors. If you are not a student at Michigan State University eligible to receive credit for this study, you will receive a $10 payment upon completion of the study. Additionally, you will be entered into a drawing for a $100 cash prize (chances in winning are approximately 1 in 300).

You must be 18 years or older to participate. If you do choose to participate in this study, your confidentiality will be protected to the maximum extent allowable by law. Only researchers involved with this study will have access to this information.

Participation in this study is voluntary, and you may quit at any time. Also, you may choose to skip any question(s) you feel uncomfortable answering. We will not collect any personal identification information from you, unless you choose to be in the $100 cash prize drawing. If you choose to be entered into this drawing, we will provide a separate form that will request your full name and MSU e-mail; we will ask you to place this form into a locked ballot box before you leave the laboratory. The only forms that will have your identity (i.e., name) marked are this consent form and the $100 cash prize form, and both will be stored in separate locked file cabinet. There will be no mechanism for us to identify any of your study data as yours.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the Study Coordinator, Nick Bowman, at 562 Com Arts, East Lansing, MI 48824, bowmann5@msu.edu, or (517) 355 - 2170. You may also contact the Primary Investigator, Dr. Ronald Tamborini, at 570 Com Arts, East Lansing, MI 48824, tamborin@msu.edu, or (517) 355 – 0178.

If you have any questions or concerns about your role and rights as a research participant, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University Human Research Protection Programs at (517) 355-2180, Fax (517) 432-4503, or e-mail irb@msu.edu or regular mail at 202 Olds Hall, MSU, East Lansing, MI 48824.

Your signature below indicates your voluntary agreement to participate in this study.

____

Signature | Printed Name | Date

Appendix B. Video recording consent form.

RESEARCH PARTICPATION VIDEO CONSENT FORM

Thank you for your interest in this research study, which is designed to look at video game preferences. If you agree to participate in this study, you will be asked to play a set of video games and answer some questions about your opinion of them. This is a research project for the MSU Department of Communication. Your participation in this study will help researchers get a better understanding of how video game opinions are formed.

As part of this study, we would like your permission to video record your video game playing session. Your face will not be recorded, only your hands while playing the video game. This information will be used to measure your interactions with the video game environment. All recordings will be kept confidential, and will not contain any information that could identify you as a participant in the study.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the Study Coordinator, Nick Bowman, at 562 Com Arts, East Lansing, MI 48824, bowmann5@msu.edu, or (517) 355 - 2170. You may also contact the Primary Investigator, Dr. Ronald Tamborini, at 570 Com Arts, East Lansing, MI 48824, tamborin@msu.edu, or (517) 355 – 0178.

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Your signature below indicates your voluntary agreement to allow us to use the video recorded footage.

____

Signature   Printed Name   Date

Appendix C. Pre-test questionnaire.

Background Information

Please answer the following questions about yourself:

What is your gender (circle one)? MALE FEMALE

What is your age (years, months)? _____, _____

What is your major? ____________________

What is your year in school (Frosh, Soph., Junior, Senior, Grad. School)? ____________

Below are statements about your ability to play video games. Please answer using the scale provided below:

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

_____ I often win when playing videogames against other people.

_____ I often win when playing videogames against the computer.

_____ I am a good video game player.

_____ I think about different video game strategies.

_____ I can easily figure out how to play new games.

_____ I have no problem handling the multiple buttons on currently popular game controllers.

_____ I can play games with complicated control systems well.

_____ I have good video game playing skills.

_____ I am a better video game player than most of my friends.

_____ I can finish video games quickly.

Appendix D. Study debriefing form.

RESEARCH PARTICIPANT DEBRIEFING FORM

Thanks again for participating in our experiment. This study was designed to examine how video games can be used to alter mood states. We had you perform either a boring or stressful task for 20 minutes. After you performed this task, we had you play a video game that differed in the amount of demand it required of the user to be played. We predicted that higher levels of task demand would be better at repairing mood. Data from this study helps further our understanding of how video games can affect mood.

Now that you have been debriefed as to the nature of our experiment, we ask that you please do not discuss the details of the study until further notice. This is important because if people are aware of the hypotheses in our study, they may accidentally or purposefully manipulate their answers to survey questions. Be assured that all participants in this study will be debriefed in a similar manner as you have been.

If you have concerns or questions about this study, please contact the Study Coordinator, Nick Bowman, at 562 Com Arts, East Lansing, MI 48824, bowmann5@msu.edu, or (517) 432-3311. You may also contact the Primary Investigator, Dr. Ronald Tamborini, at 570 Com Arts, East Lansing, MI 48824, tamborin@msu.edu, or (517) 355-0178.

If you have any questions or concerns about your role and rights as a research participant, or would like to register a complaint about this particular study, you may contact, anonymously if you wish, the Director of MSU's Human Research Protection Program, Dr. Peter Vasilenko, at (517) 355-2180, Fax (517) 432-4503, or e-mail irb@msu.edu or regular mail at 202 Olds Hall, MSU, East Lansing, MI 48824.

You make take this form with you for your records. Thanks again!

Appendix E. Questions from stress manipulation.

Intelligence Test

Below you will find sample questions taken from a variety of basic intelligence tests. The questions represent a range of different knowledge bases. All of the questions use information learned in a standard K-12 education, but college students tend to score slightly higher than the general population.

Answer each question in the space provided; you may use the front and back of each sheet of paper in your answer. For each question, be sure to show your work/proof of the problem. Once you have moved to a new problem, please do not go back to a previous one.

NOTE: Please provide an answer each question. If you cannot provide a complete answer for each question, we might not be able to use your data in this study.

1. The Fly and the Bicycle

Mike and Sally were 10 km apart. They rode their bicycles at a constant 10 km/hr toward each other. As they started off, a fly took off from one bicycle and flew to the other bicycle at 20 km/hr, then it flew back to the other bicycle. The fly continued to fly back and forth between the two bicycles until the bicycles collided, crushing the fly in between. How far did the fly travel?

2. Throwing Dice

Jack is playing a dice game. He rolls five dice, and a computer calculates his score using a particular scoring method. Jack's last three rolls (and the scores resulting from those rolls) are as follows:

Die 1	**Die 2**	**Die 3**	**Die 4**	**Die 5**	**Score**
5	4	6	3	5	**10**
1	3	3	4	2	**4**
1	6	2	6	4	**0**

What method is being used to score the dice?

3. Eight Loaves of Bread

Three travelers are sitting around a fire, and are about to eat a meal. One of them has five small loaves of bread, and the second has three small loaves of bread. The third has no food, but has eight coins. He offers to pay for some bread. They agree to share the eight loaves equally among the three travelers, and the third traveler will pay eight coins for his share of the eight loaves. All loaves were the same size. The second traveler (who had three loaves) suggests that he be paid three coins, and that the first traveler be paid five coins. The first traveler says that he should get more than five coins. Is he right? How should the money be divided up?

4. Magic number?

What is the smallest number that would meet all of the following criteria?

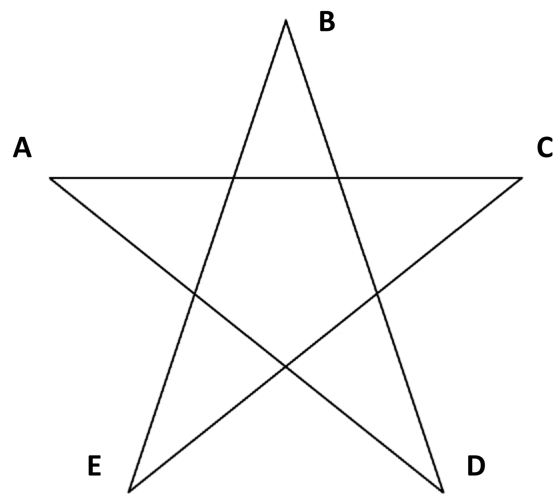
1. If divided by 2, the remainder is 1.
2. If divided by 3, the remainder is 2.
3. If divided by 4, the remainder is 3.
4. If divided by 5, the remainder is 4.
5. If divided by 6, the remainder is 5.
6. If divided by 7, the remainder is 6.
7. If divided by 8, the remainder is 7.
8. If divided by 9, the remainder is 8.
9. If divided by 10, the remainder is 9.

5. The Missing Dollar

Three people are eating at a restaurant. The waiter gives them the bill, which totals up to $30. The three people decide to share the expense equally, rather than figure out how much each really owes. The waiter gives the bill and the $30 to the manager, who sees that they have been overcharged; the real amount should be $25. He gives the waiter five $1 bills to return to the customers, with the restaurant's apologies. But, the waiter is a dishonest man. He puts $2 in his pocket, and returns $3 to the customers. Now, each of the three customers has paid $9, for a total of $27. Add the $2 that the waiter has stolen, and you get $29. But, the original bill was $30. What happened to the missing dollar?

6. Seeing Stars

Typical "stars" are drawn in connected, but not repeated, line segments. For example, a 5-point star is drawn as such - line segments AC, CE, EB, BD, DA. The segments must always alternate a constant number of points (in the above case, skipping 1 point in between). Example:



Given that there is only 1 way to draw a 5-point star, and that there is no way to draw a 6-point star (in continuous lines, that is), and there are 2 ways to draw a 7-point star, how many different ways are there to draw a 1000-point star?

7. **Bowling Playoffs**

Four bowling teams (named A, B, C, and D) will be participating in a round robin (every team plays every other team once, no team is eliminated) playoff. A playoff is called a roll-off in bowling. Each team will play three games. For each game, two teams will bowl each other on lanes 3 and 4, while the other two teams bowl each other on lanes 5 and 6. One of the organizers draws up a complete schedule, showing which teams play which teams, and who bowls on which alley:

	Lanes 3 and 4	**Lanes 5 and 6**
Game #1	A vs. B	C vs. D
Game #2	A vs. C	B vs. D
Game #3	A vs. D	B vs. C

The coach of one team then complains that one of the teams (team A) will get to bowl on the same pair of lanes all three games. In general, repeatedly bowling on the same pair of lanes should be an advantage. Using only the two pairs of lanes mentioned, can you suggest a schedule which will have no team bowling on the same pair of lanes for all three games?

8. The New ABCs

During the first day of a college algebra class, a professor writes the following equation on the board:

$$ABCD \times E = DCBA$$

There is only one solution.

He further mentions that each letter represents a different digit, and none of the digits is zero. The professor mentions that "anyone with a basic understanding of high school mathematics should be able to solve this problem," implying that there are no tricks to the solution. Solve the equation.

9. The County Fair

Four children (including the Anders child) entered paintings in the local County Fair. Based on the information provided below, determine who painted what, and what ribbon each won (1st=blue, 2nd=white, 3rd=red, 4th=yellow):

1. Bill's painting was not the still life.
2. The four paintings were (in some order) Cindy's, the Clark child's, the still life, and the one that took 2nd place.
3. The Brown child's painting finished ahead of Alice's, which finished ahead of the abstract painting.
4. The portrait finished ahead of Doug's painting (which was not the abstract).
5. Bill's painting finished just ahead of the landscape, which finished just ahead of the Davis child's painting.

10. Archimedes' Cattle

The sun god had a herd of cattle consisting of bulls and cows, one part of which was white, a second black, a third spotted, and a fourth brown. Among the bulls, the number of white ones was one half plus one third the number of the black greater than the brown; the number of the black, one quarter plus one fifth the number of the spotted greater than the brown; the number of the spotted, one sixth and one seventh the number of the white greater than the brown. Among the cows, the number of white ones was one third plus one quarter of the total black cattle; the number of the black, one quarter plus one fifth the total of the spotted cattle; the number of spotted, one fifth plus one sixth the total of the brown cattle; the number of the brown, one sixth plus one seventh the total of the white cattle. What was the color composition of the herd?

11. Fries with that?

For lunch Friday, the five employees on duty at Gert's Gas & Go sent out to Big Bill's Burgers & Fries for lunch, with each ordering a different hamburger and a different kind of fries from the restaurant; no two spent the same amount of money on the meal. Given the menu items and prices below and the clues that follow, can you solve this difficult Logic Problem by finding how much each employee spent on lunch, his or her job at Gert's Gas & Go, and the hamburger and fries he or she ordered?

The Works Burger	*2.85*	*Big Fries*	*1.95*
Carolina PitBurger	*2.75*	*Gravy Fries*	*1.75*
Tucson TacoBurger	*2.45*	*Curly Fries*	*1.65*
Double CheeseBurger	*2.25*	*Cheese Fries*	*1.35*
Whaler FishBurger	*1.95*	*Cajun Fries*	*1.25*

1. Tom's meal cost $1.20 more than the car wash operator's lunch, which was more expensive than Sharon's.
2. Wayne spent $1.20 more on his combo than the cashier did.
3. The mechanic's hamburger cost 50¢ more than Russ's hamburger cost.
4. The Gas & Go stock clerk, who isn't Vicky, didn't have the Curly Fries.
5. The store manager isn't the one who ordered the Big Fries.

12. Time to burn

There are two lengths of rope. Each one can burn in exactly one hour. They are not necessarily of the same length or width as each other. They also are not of uniform width (may be wider in middle than on the end), thus burning half of the rope is not necessarily 1/2 hour. By burning the ropes, how do you measure exactly 45 minutes worth of time?

13. Cereal

There is a free gift in my breakfast cereal. The manufacturers say that the gift comes in four different colors, and encourage one to collect all four (thus eating lots of cereal). Assuming there is an equal chance of getting any one of the colors, what is the expected number of boxes I must consume to get all four?

14. The Amoebae

A jar begins with one amoeba. Every minute, every amoeba turns into 0, 1, 2, or 3 amoebae with a probability of 25% for each of the following: dies, does nothing, splits into 2, or splits into 3. What is the probability that the entire amoeba population eventually dies out?

15. Pirates

Five pirates have come across a treasure of 1000 gold coins. According to The Pirate Code, the pirate of highest rank must make a suggestion on how to divide the money; if the majority agrees to his suggestion, then it is to be followed by all the pirates. However, if the suggestion does not get a majority approval then the suggesting pirate is thrown overboard, after which time the remaining pirate of highest rank then makes a suggestion under the same rules. This process repeats, if necessary, until only the pirate of lowest rank is left, in which case he would get everything. Any pirate may make suggestions, and rank does not guarantee getting more coins than anybody else.

Assume that all pirates are infinitely greedy, infinitely logical, and infinitely bloodthirsty, and that each pirate knows this to be true of every other pirate.

The highest priority of each pirate is to get as much money for themselves as possible. The second highest priority is to throw overboard the other pirates. A pirate will vote to throw another one over even if they have no monetary gain by doing so, and even if it would cost them their own life, but would not if throwing them over would cost even 1 coin. How should the first pirate suggest dividing the money to maximize his coins and save his own life?

16. Bill & George

George is driving 100 ft/sec toward an intersection. He looks to his right, and sees Bill, driving 30 ft/sec toward the same intersection. George foolishly slams on his brakes. If he had kept going 100 ft/sec, he would have been through the intersection long before Bill got there. At the instant that he slams on his brakes, the center of George's car is 125 ft from the intersection, and the center of Bill's car is 150 ft from the intersection. George's brakes give his car an acceleration of -30 ft/sec/sec. Bill never changes his speed. Each car is 13 ft long and 7 ft wide.

Will there be a collision?

17. Coins

We have two identical coins. And we roll the one on the left halfway around the other coin, so it rotates without slipping against the other coin, so that it ends up on the right of the other coin. It has rolled over a length of only half its circumference, and yet it has made one complete rotation. If it started right side up, then it ended right side up. Does that make sense?

18. More Coins

In Rengefall, copper coins are minted with the portrait of the Queen on one side and the portrait of the King on the other side.

One day, a half-crazed executioner gives the captured Talin one chance to avoid execution. The executioner brings Talin into an unlit room. He tells Talin that scattered on the table in front of him are one hundred copper coins of which twenty have the Queen side facing up while the rest have the King side facing up. If Talin can separate the coins into two piles, each with the same number of Queens facing up, he will release Talin. One other constraint is that Talin must accomplish this task in 5 minutes. If Talin fails, he will be beheaded.

It is impossible for Talin to see which side the coins are facing up in the darkness, and the contours of the portraits are too similar to decipher by touch. Nevertheless, Talin managed to separate the coins into two piles with the same number of Queens facing up in the time allotted.

How did he accomplish this?

19. The Red Hat Club

Suppose there are 4 people, two of which are wearing red hats, and two of which are wearing blue hats. One person is behind a wall, and the other three are standing in a uniform line, only able to see the person directly in front of them. Which person knows exactly which color hat he's wearing, and why?

20. Power Shift

At Widgett, Inc., the pecking order of executives under CEO Norm Bates is easily determined: each senior executive has an office on a different floor 5th-9th of company headquarters, below the CEO's 10th floor spaces; and the closer to the 10th floor an executive works, the more in favor he or she is. Last week, the offices of the five senior executives, including the VP for Marketing, were swapped, signaling a power shift at the company. Given the data below, can you determine who was on each floor before the move and who is there now: each executive's full name (one first name is Richard, one surname Dubois) and his or her position at Widgett, Inc.?

1. Three of the five senior executives saw their power diminish as they moved down in the building, one dropping three floors; the two who gained power moved up three and two floors.
2. Feldman didn't occupy the 7th floor office before the power shift.
3. The Chief Information Officer moved up in the building to the suite vacated by Blocker.
4. The VP for sales moved into the Chief Financial Officer's old spaces.
5. Hazlett was moved down one floor in the shakeup, with Linda taking over Hazlett's office.
6. Alice got Grayson's former suite, while Grayson moved into the office vacated by the VP for Human Resources. Both Alice and Grayson have seen their power diminish as they are assigned to lower floors than before.
7. Michael left a pen set behind as a gift for Larry, who moved into Michael's old office.
8. The executive who had the 9th floor office before the power shift didn't end up on the 8th floor afterwards.

Appendix F. NASA-TLX (Task Load Index).

Mission Feedback

We would now like to ask you about the landing mission you just completed. Think about the many aspects of the landing mission – including the physical and mental demands – and answer the questions below.

Please read each of the questions below. Answer each question by marking an "X" in the appropriate scale box.

<u>Mental Demand</u>: How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc)? Was the mission easy or demanding, simple or complex, exacting or forgiving?

Low |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_| High

<u>Physical Demand</u>: How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the mission easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Low |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_| High

<u>Temporal Demand</u>: How much time pressure did you feel due to the rate or pace at which the mission occurred? Was the pace slow and leisurely or rapid and frantic?

Low |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_| High

<u>Performance</u>: How successful do you think you were in accomplishing the goals of the mission? How satisfied were you with your performance in accomplishing these goals?

Low |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_| High

<u>Effort</u>: How hard did you have to work (mentally and physically) to accomplish your level of performance?

Low |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_| High

<u>Frustration</u>: How discouraged, stressed, irritated, and annoyed versus gratified, relaxed, content, and complacent did you feel during your mission?

Low |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_| High

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