

Video Game Play and Motivation:
Variation in Appetitive and Aversive Motivational System Activation
as a Function of Virtual Threat Level

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To my wife, Hyewon Ko

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Video Game Play and Motivation:

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as a Function of Virtual Threat Level.

Video games are becoming more and more popular. As a medium, this popularity is bringing more attention to video games from politicians, media researchers and the rest of society. Though the topics of video game research have diversified over the past few years, the majority of studies focus on its users' violent behavior or aggression.

This dissertation investigated the pattern of relative activation in the appetitive and aversive motivational systems during violent video game play as a function of the motivational relevance of the stimuli. This dissertation compared the pattern of physiological responses and secondary task reaction times, as well as self-reported emotional responses to different conditions during video game play.

Based on the Limited Capacity Model of Motivated Mediated Message Processing (LC4MP), proposed by A. Lang (2006), a video game was created to elicit certain patterns of motivational system activation. Both physiological responses and self-reported emotions showed that positive components of the video game successfully activated participants' appetitive motivational system, and negative components

successfully activated the aversive system. These different motivational conditions resulted in the different cognitive processing patterns predicted by LC4MP.

Interestingly, the combination of both components did not simply lead to an increase in responses indicative of simultaneous appetitive and aversive system activation. Instead, each dependent variable tended to reflect one or the other of the motivational system's individual activation.

Also, as predicted by LC4MP, individuals with different motivational traits (positivity offset and negativity bias) showed different motivational system activation patterns, which are linked with their emotional experience during gaming. Individual differences in positivity offset also had the expected effect on video game usage.

The results provide data for motivated cognition in the context of video gaming, and insight for the video game industry on improving user experience.

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CHAPTER 1

Introduction

Overview

This dissertation investigates the pattern of relative activation in the appetitive and aversive motivational systems during violent video game play as a function of motivational relevance of the stimuli. This study compares the pattern of physiological responses and secondary task reaction times, as well as self-reported emotional responses to the different conditions during video game play.

Video games are a very popular form of entertainment today in the United States. Video games, once dominantly played by young boys, are now played more by mature users. A report from Entertainment Software Association [ESA] shows that, currently, more than half of the video game players in the United States are 18 years old or older and that the average age of all users is 30 (ESA, 2005). Nintendo, one of the leaders in the video game industry, is releasing a series of video games for senior citizens in the United States after its success in the Japanese market (Snider, 2006), and other major companies such as Sony Computer Entertainment, Sega, and Bandai are joining this trend (Shannon, 2006).

As a medium, the video game allows users to control a character who is an actor in a story in a virtual world, and the outcome of the game is dependent on the character's actions. This feature makes video games different from other electronic media, such as television or radio, where users can choose what content to hear or see but have no control over what happens in the program.

As they grow in popularity and ubiquity, video games are getting more and more attention from society, politicians and media researchers. Early research on video games, conducted when the medium was in its infancy (1975-1990), focused primarily on the relationship between violence introduced in video games and its effect on users (i.e., violent behavior and aggression). Violence has remained a major topic of video game research to this day. Indeed, changes in the medium itself – as the presentation of violence in video games has evolved – have fueled this continuing interest in violent video games and aggression. Having said that, however, it is also true that topics of video game research have diversified over the past few years, from economic studies of the business models of gaming to examining para-social interaction, and the use of video games in education. Another popular area of research focuses on how to improve the technology used to create video games, but research that pays attention to improving the user’s actual gaming experience, rather than assessing its effects or improving the graphics, is still a rarity. Research by communication researchers focusing on how users process information during game play and how it is related to enjoyment and/or learning is even rarer.

This study will look at a topic that has received little if any previous attention, the ability of video games to activate the appetitive and aversive motivational systems, and the extent to which that activation influences the on-line video games experience.

According to P. J. Lang (P. J. Lang, M. M. Bradley & Cuthbert, 1997b), emotions are organized around two basic motivational systems: the appetitive system and the aversive system. Cacioppo and his colleagues suggest that these two systems are separate, and do not always work reciprocally (Cacioppo & Gardner, 1999).

Based on this view of emotion, this study explored the variation in the activation of the appetitive and aversive motivational systems as a function of threat types in the context of video game play. Participants played a video game which contained three different motivational conditions (or threat types) that were expected to activate the appetitive system and the aversive system in different ways. For each motivational condition, there were segments where secondary task reaction times (STRTs) were measured and segments where acoustic startle reflex (SRs) were recorded. STRTs were used to index available cognitive resources, thought to be an indicator of appetitive activation and SRs were used to index aversive system activation. The relationship between these measures and corresponding concepts will be discussed in detail later in following chapters.

During all segments, physiological responses such as heart rate (HR), skin conductance responses (SCRs), and facial electromyographic (EMG) activity were recorded. These measures are used to index dependent variables that relate to motivated cognition, and will also be discussed more in the following chapter. In addition to STRTs and physiological responses, a questionnaire exploring the participants' self-reported emotions toward the gaming experience (positive emotion, negative emotion, arousal, dominance, presence, and enjoyment) was given after each segment was over.

This dissertation will extend our knowledge about the cognitive and emotional processing of information during video game play, specifically building upon A. Lang's work on motivated cognition (A. Lang, 2006; A. Lang, in press).

Theoretical Importance of the Study

Geiger and Newhagen (1993) stated in their essay that “Understanding how individuals process messages is central to any comprehensive theory of communication” (p. 42). This dissertation attempts to contribute to our knowledge of how individuals process messages by choosing a medium (video game) and conducting an experiment to add to our understanding of how users process information, cognitively and emotionally.

In many video games users control a character (or multiple characters) in the game who is part of the story and their actions dictate the outcome of the story. Some games have players control an airplane to complete a flight as scheduled (e.g., *Microsoft Flight Simulator 2004*) or control the budget and build new buildings for a city in order to attract new citizens, which will and increase tax revenue for the expanding the city (e.g., *Sim City*). No matter what form the games take or how different the stories and goals are, video games have one thing in common – they allow users to control central aspects of the environment and to change the outcome of the story.

As a medium, this feature makes video game stand out among other electronic media. Users of television or radio can only turn the receiver on and off or change the volume and content provider (station). Users of video cassette recorders (VCR) can pause, rewind, and fast forward the content. Laserdisc allowed non-linear video play. This feature allowed publishers to allow users to make choices and alter at least the order in which pieces of the content were viewed to change the flow or even alter the final outcome of the story, and products using this feature were called *interactive movies* (some even referred to them as video games). But the limited storage capacity of the medium and high costs of production kept manufacturers from making titles using this

technology. DVD, the format announced as a successor to the laserdisc in 1996, includes this feature but interactive movies for DVD are not nearly as prevalent as video games played on personal computers or dedicated game consoles.

A. Lang's work on motivated cognition has been built on a large body of research on how people process messages presented via electronic media such as television (A. Lang, 1990; A. Lang, Bolls, Potter, & Kawahara, 1999; A. Lang, Dhillon, & Dong, 1995; Yegiyan, S. D. Bradley, Banerjee, & A. Lang, 2005), radio (Bolls, A. Lang, & Potter, 2001; Potter, 2000; Potter & Callison, 2000), computers (A. Lang, Borse, Wise, & David, 2002; A. Lang, Shin, & Lee, 2005; Schwartz, 2003), and video games (A. Lang, Schneider & Deitz, 1999; Schneider, A. Lang, Shin, & S. D. Bradley, 2004). This work is the empirical foundation for the theoretical framework, the Limited Capacity Model of Motivated Mediated Message Processing, or LC4MP (A. Lang, 2006; A. Lang, in press).

In the studies specifically examining the processing of videogames, A. Lang, Schneider & Deitz (1999) examined the interactive effects of actions required by a videogame (hunt, see, fight, kill), the player's experience with violent video games, and their gender on their physiological and emotional responses during play. Schneider, A. Lang, Shin, & S. D. Bradley (2004) explored how the presence of a story affected users' emotional experiences, motivations, presence, and character identification.

This study attempts to further extend our knowledge of mediated information processing based on LC4MP, using a video game as a medium. This dissertation provides more data and insight for communication researchers including, but not limited to, those who use LC4MP as its theoretical framework by extending our knowledge about how people react to video games, both emotionally and cognitively. More specifically, this

dissertation explores the pattern of motivational system activation and the pattern of cognitive resource allocation under different types of video game play condition as we begin to understand the motivated cognitive processing involved in video game play.

This dissertation also asks whether there is any difference in these patterns between people with different motivational traits (motivational system operation characteristics). When processing information from the media, people whose appetitive system is easily activated, or those who have stronger tendency of approaching novel things in everyday life, may show different patterns of cognitive resource allocation and/or motivational system activation than people whose appetitive systems are not so easily activated. The difference in these patterns may be observed only under certain circumstances – such as when the content of the information is arousing/calm or positive/negative by nature. The same question can be asked for those whose aversive system easily activates compared to those for whose activation is slower.

Practical Importance of the Study

“As researchers better understand the interface where mind meets message; this research will contribute more and more to our ability to understand, explain, and predict the outcomes of mediated messages” (A. Lang, Bradley, Chung, & Lee, 2003, p. 654). This study attempts to better understand the process – not just the outcome – of message processing in the context of video games, and provide knowledge that can be used by researchers as well as media (including, but not limited to, video game) practitioners.

As described above, there are a fairly large number of publications that deal with how to improve video game as a product that emphasize the technical side while research on improving user experience is rare. This study is about user experience and the process

of this experience. For practitioners, the findings of this dissertation are expected to extend the body of knowledge for improving the structural and content features within video games in order to achieve specific real-time goals in the cognitive, emotional, or motivational realm. In other words, this type of research can be used to help the designers, writers, and producers of video games make decisions about the structural aspects of video games in order to maximize specific user outcomes. Those outcomes might include maximizing emotional experience, entertainment value, learning, etc. By understanding the patterns of cognition and motivation elicited by various aspects of the medium, practitioners should be able to create video games that will have a bigger impact. That might include creating increased emotion at the moment of dramatic transition in the storyline, or making embedded commercial information more memorable or persuasive but not annoying.

This dissertation may also help video game producers by providing knowledge about whether different types of emotional content have more or less appeal for different types of users. In particular, whether individual differences in motivational activation might impact the type of games one likes to play. For example, A. Lang and her colleagues found that people of certain motivational characteristics have a stronger tendency to engage in risky behavior such as drug use and tobacco consumption (A. Lang, Shin, & Lee, 2005). Such motivational characteristics may also be linked to preferences for playing video games and/or emotional and physiological responses during game play. This might lead to the development of games for groups with certain motivational types. If motivational system activation characteristics impact games enjoyment, producers

could then target different groups from the early stage of product design right through marketing and advertising.

Better understanding of how information is processed during video game play will also help media researchers to understand how information is processed when people use other forms of new media, or so-called interactive media, such as the World Wide Web, which is also capable of altering the content provided based on input from users.

Finally, the introduction of the startle reflex and secondary task reaction time to video game research will add new tools to the arsenal of media researchers who are trying to better understand mediated messages and mediated message processing.

CHAPTER 2

Review of Literature

Video Game as a Medium

Video games have become a favorite activity for Americans. Sales of video games (computer games and console games combined) in 2004 reached 248 million units, or 7.3 billion dollars (Entertainment Software Association [ESA], 2005). The general population still sees children and adolescents as the primary consumers of video games (Dewitt, 1993). This view is also shared by many of the researchers who have conducted studies focused on children and adolescents (e.g., Gentile, Lynch, Linder, & Walsh, 2004; Mellor, 2001).

There is no question that children play video games a lot. Gentile & Walsh (2002) shows that American children (aged 2-17) play video games for an average of one hour per day. A recent nationally representative survey of 3rd to 12th grade students using 2,032 students conducted by the Kaiser Family Foundation showed that 83% of respondents has one or more video game consoles at home, and 86% have one or more computers at home (Roberts, Foehr & Rideout, 2005). This survey also revealed that 35% of respondents reported playing games with a computer the previous day and 52% played video games with a dedicated console (Roberts et al., 2005).

However, industry research shows that there is also a substantial adult market for video games. The average age of game players in 2004 is 30, with 43% of game players between 18 and 49 years old (ESA, 2005). ESA (2005) also reports that 19% of Americans over the age of 50 played video games in 2004, up from 9% in 1999. This suggests that the consumers of video games cover a much broader age range than

previously thought and this range is likely to continue to expand. The adolescent game players of the 80s are the adult game players of the new century. The video game industry is well aware of these facts and as a result pays close attention to mature game players (Brightman, 2006), as well as to academics (Kangas & Cavén-Pöysä, 2005).

Video games are interesting to media researchers for reasons other than the fast growth of sales. First, video games require physical (or behavioral) responses from users. The only physical action required by, for example, television is using the remote control to turn it on and off and select content and volume, whereas a video game requires behavioral responses in order for the content to proceed. Even the user's physiological responses to television and video games are different in several ways. While there is no difference in energy expended between television viewing and sitting quietly (Ainsworth, Haskell, Leon et al., 1993), studies on video game users have shown significant changes in energy expenditure as well as physiological responses. Ridley and Olds (2001) reported that the magnitude of energy expenditure (EE) is related to the amount of body movement associated with video game play. Segal and Dietz (1991) reported increases in heart rate and oxygen consumption in users of video game. Increase in systolic and diastolic blood pressure is also reported in adults (Gwinup, Haw, & Elias, 1983; Segal & Dietz, 1991) as well as young children (Wang & Perry, 2006).

The second reason is that video games allow users to play an active role in content development. In a video game where violence is the main theme (e.g., first-person shooter games, real-time strategy simulation games), users become perpetrators and/or victims of violence, and their skill at mayhem determines the game's outcome. In a video game where violence is not the main theme, such as adventure games, users

become the main character of the story and get to decide what actions to take, which in turn change the flow of the storyline or even the ultimate outcome of the story (e.g., success/failure to accomplish mission, escape from danger with/without the lover, etc.). When the user stops being active by not responding, the video game ceases to progress (Jansz, 2005).

This is not the case for traditional media – from print to television – which only allow users to be observers of already programmed content. Traditional media cannot change the story, or the amount or type of violence presented in response to the user’s input or response. The feature that allows (or even forces) the user to be actively engaged in content development makes video game an interesting medium for media researchers.¹

Emotion, Motivational Systems, and Coactivation

A large body of work suggests that emotion has two primary dimensions, affective valence and arousal (Mehrabian & Russell, 1974; Osgood, Suci, & Tannenbaum, 1957; Smith & Ellsworth, 1985, 1987). Affective valence is thought to be driven by two primary motivational systems in the brain: the appetitive system and the aversive system (M. M. Bradley, Codispoti, Cuthbert, & P. J. Lang, 2001; Dickinson & Dearing, 1979; Konorski, 1967; P. J. Lang, M. M. Bradley, & Cuthbert, 1997a; Solomon & Corbit, 1974). P. J. Lang and his colleagues argue that the appetitive system is activated in situations to promote survival (e.g., food, mate), and the aversive system is activated in response to threat that threaten physical survival (M. M. Bradley et al., 2001; P. J. Lang, 1995).

In accordance with this view, Cacioppo and his colleagues point out that traditional research that involves affective valence has long treated valence as a single

¹ A number of media researchers call this feature *interactivity*. For discussion, see Jansz (2005).

continuum with positive on one end and negative on the other and that this needs to be changed: Cacioppo argues that since most theories conceptualize the appetitive and aversive motivational systems as separate, the feelings associated with them should also be measured separately (Cacioppo & Bernston, 1994; Cacioppo & Gardner, 1999; Ito, Larsen, Smith, & Cacioppo, 1998). While the two systems often activate reciprocally, they may also activate simultaneously (*coactivation*) or activate in a non-related way (*uncoupled*). These latter forms of activation cannot be captured by a single bipolar scale (Cacioppo & Bernston, 1994; Larsen, McGraw, & Cacioppo, 2001). Positivity offset (PO) and negativity bias (NB) are the two concepts at the center of this theory of motivation. These two concepts are related to the theoretical activation functions associated with the appetitive and the aversive motivational system.

Positivity offset refers to a tendency for the appetitive motivational system to be more active than the aversive motivational system in a neutral environment – “as a consequence of the positivity offset, the motivation to approach is stronger than the motivation to avoid at low levels of evaluative activation (e.g. at distances far from a goal)” (Cacioppo & Gardner, 1999, p. 205). This tendency is what ‘motivates’ animals to explore their surroundings to pursue opportunities, such as for food to consume and mates with whom to reproduce.

The other concept, negativity bias, refers to the tendency of the aversive motivational system to respond quickly, of which Cacioppo and Gardner (1999) argue “the heightened sensitivity to negative information is a robust psychological phenomenon” (p. 206). In a moderately dangerous environment, the activation level of one’s aversive motivational system is higher than the activation level of the appetitive

motivational system because danger is consequential – failure to respond to the danger may result in the organism’s death. Hence, any potentially harmful stimuli need to be responded to quickly. Therefore, the aversive system activates more quickly than the appetitive system.

As Cacioppo and Gardner (1999) argued, this phenomenon is found in a broad range of age groups, from infants and toddlers (Putnam & Stifter, 2002), to college students and senior citizens (Mather & Carstensen, 2003; Mather & Knight, 2006; Mather, Knight, & McCaffrey, 2005). Mather and her colleagues’ work suggests that quick response to negative stimuli do not decline with age, though how the negative information is processed after it is encoded may change as one ages (Mather, Canli, English, Whitfield, Wais, Ochsner, Gabrieli & Carstensen, 2004).

To test this idea, Ito, Cacioppo, and P. J. Lang (1998) had a total of 472 slides rated by participants for their positive valence, negative valence, dominance, and arousal during presentation. These slides were positive, negative, or neutral, and all of them were selected from the International Affective Picture System, which is a database of images standardized for three emotional dimensions: valence, arousal, and dominance. The results not only confirmed the existence of PO and NB in the motivational systems, but also showed that the activation patterns of PO and NB looked the way it had been predicted. That is, at low arousal levels, PO's activation level is higher than NB, but NB has a steeper slope that makes NB go higher than PO as the arousal level rises. In this study, the patterns for PO and NB were created for the group of participants as whole. This has been replicated with emotional words selected from a dataset called the Affective Norms for English Words (Ito, Larsen, Smith, & Cacioppo, 1998).

Cacioppo and his colleagues strongly suggested that individual differences in PO and NB exist (Cacioppo & Bernston, 1999). This argument was tested and supported by Ito and Cacioppo (2005), who explored individual differences in PO and NB and confirmed that these differences exist, and these differences are at least temporally stable.

The Motivation Activation Measure

Inspired by the work that stemmed from Cacioppo and P. J. Lang's work on PO and NB (e.g., Ito, Cacioppo, & P. J. Lang, 1998; Ito, Larsen, Smith, & Cacioppo, 1998), A. Lang suggested that that positivity offset (PO) and negativity bias (NB) might be measured as individual difference variables, which might be related to message processing (A. Lang, Shin, & Lee, 2005). More specifically, it was suggested that though PO and NB are continuous variables, the relative difference of these motivational systems' operational characteristics between individuals (higher PO vs. lower PO, higher NB vs. lower NB) will cause them to process mediated messages differently.

A. Lang and her colleagues started addressing this question, which led them to the development of a measure for PO and NB: "Can ratings of emotions while viewing images be used to develop individual difference measures of positivity offset and negativity bias? (A. Lang, Shin, & Lee, 2005, p. 8)" Ito, Cacioppo, and P. J. Lang (1998) was able to produce the theoretically predicted patterns of appetitive and aversive motivational systems activation based on the responses of participants who viewed selected images based on different valence and arousal levels. Based on the findings by Ito, Cacioppo, and P. J. Lang (1998), A. Lang and her colleagues selected 90 images from a database of standardized images, the International affective picture system (IAPS; P. J. Lang, M. M. Bradley, & Cuthbert, 1997a), half rated positive and half rated negative

on a univariate scale for valence, and varying by arousal ratings (from high to low arousal). Each of these images was rated by all participants on three scales: positivity, negativity, and arousal. Several different estimates of PO and NB were calculated and were compared to see if they correlated with each other, to confirm the idea that estimates of PO and NB can be calculated for different individuals.

In order to begin to validate whether these estimates of PO and NB were indexing an underlying motivational substrate, A. Lang et al. (2005) compared the estimates of individuals' PO and NB against their response to Zuckerman's (1994) sensation seeking scale, and their self-reported substance (alcohol, marijuana, and tobacco) use patterns to find if they correlate with these estimates. The logic here was that sensation seeking is a well-established psychobiological variable that is thought to be biologically grounded in motivational activation. A large body of research shows that the sensation seeking trait correlates with individual differences ranging from the tendency for engaging in exploratory behavior in a novel situation to substance abuse. Since the personality traits reflected in sensation seeking are thought to be at least in part the result of an overactive appetitive system and a perhaps weakly activated aversive system, it was logical to compare the estimates for PO and NB against measurements of sensation seeking as one way to test the validity of the measure. Based on the sensation seeking literature which shows a great deal of empirical support for the conceptualization of "sensation seeking as a function of an overactive appetitive motivational system and weakly active aversive motivational system (A. Lang et al., 2005, p. 1)," A. Lang et al. (2005) predicted and found that individual's estimates for PO were indeed positively correlated with SS, and NB did correlate negatively with sensation seeking. In addition, as predicted by the

substance abuse and addiction literature, PO was positively correlated with substance use and negativity bias was negatively related to substance use. A. Lang et al. (2005) also examined whether the time participants spent looking at the IAPS pictures during the experiment was related to PO and NB. They predicted and found that individuals with high PO would spend more time looking at all stimuli, regardless of content, because of their stronger tendency to approach. Similarly, it was found that individuals with high NB spent less time viewing pictures (especially negative ones) than individuals with low NB, supporting the argument that they have a stronger general tendency to avoid.

The measures for PO and NB developed in A. Lang et al. (2005) were further validated again in a separate study (A. Lang, S. D. Bradley, Sparks, & Lee, submitted) with different participants. Again, the predictions about the relationships among PO, NB, sensation seeking scale and substance use were replicated and the measures were again shown to be reliable. In addition, this study showed that PO and NB accurately predicted physiological indicators of appetitive and aversive system activation. A. Lang et al. (submitted) recorded participants' physiological and behavioral responses (eyeblink startle reflex, corrugator and zygomatic activity, and secondary task reaction time) during presentation of individual images. Eyeblink startle reflex was used as an index for aversive system activation, which is part of a bodily response to possible threat (Graham, 1979). Larger magnitude in the eyeblink startle reflex is interpreted as an indication of greater activation of the aversive motivational system (P. J. Lang, Bradley, & Cuthbert, 1990). In simple terms, corrugator activity is a measure of how much one's frowning muscles are activated, and zygomatic activity is a measure of how much one's cheek muscles are pulling the lips for smiling. Corrugator activity is widely used as an index for

negative emotion, which is related to aversive motivational system activation, and zygomatic activity is used as an index for positive emotion, which is related to appetitive motivational system activation. STRT was used as an index for available cognitive resources for encoding information, which should be related to appetitive system activation according to LC4MP. Shorter STRT (faster response to the secondary task) is an indicator of more cognitive resources available during encoding, and LC4MP predicts that appetitive system activation will allocate more cognitive resources for encoding. Skin conductance response (SCR) was measured as an index of physiological arousal, with more frequent SCRs interpreted as higher physiological arousal. Finally, heart rate (HR) was measured as an index of attention paid to the stimuli, where slower HR suggests more external attention paid, but HR can become fast if one is physiologically aroused.

A. Lang et al. (submitted) reported that individuals higher in NB showed greater eyeblink startle potentiation, and more corrugator activity while viewing negative pictures, which suggests these individuals tend to have greater aversive system activation when viewing negative images than individuals lower in NB. Those higher in NB also showed faster HR and higher SC when viewing images rated moderately arousing and negative, which suggests that they were experiencing higher physiological arousal than low NB participants at a lower level of arousal as would be the case if the aversive system responded earlier.

When viewing positive pictures, individuals higher in PO demonstrated faster STRT, inhibited eyeblink startle potentiation, greater HR deceleration, and greater zygomatic activation than those lower in PO. Faster STRT and greater HR deceleration,

suggests that more attention was paid to the stimuli, resulting in more cognitive resources being available when viewing the images. Inhibited eyeblink startle potentiation and greater zygomatic activation indicate that participants higher in PO were experiencing stronger appetitive system activation when viewing positive pictures. Individuals higher in PO also demonstrated fewer SCRs to all pictures, suggesting that they were less aroused. A. Lang et al. (submitted) showed the underlying biological difference between individuals with varying PO and NB, and further validated MAM as a measure of PO and NB.

MAM, the motivation activation measure consists of 90 images selected from the IAPS database (A. Lang, Wang, & S. D. Bradley, 2004). Images were selected using the emotional response norms published with the system. However, A. Lang and her colleagues found “the original MAM measure that requires subjects to view 90 pictures to be somewhat unwieldy (Wang, S. D. Bradley, & A. Lang, 2004, p.8).” An effort to create a reliable measure of PO and NB that requires shorter survey time led to the development of Mini-MAM, a measure of PO and NB that uses a subset of pictures used in the original MAM.

The first version of Mini-MAM, which used 42 pictures, provided high correlation with the original MAM for estimating PO and NB. The first version of Mini-MAM also fared well with Sensation Seeking and No-Risk Sensation Seeking. However, the PO and NB estimated by Mini MAM failed in predicting substance use, which was another important item used for checking the measure’s validity (Wang et al., 2004). This led to the revision of Mini-MAM. The latest version of Mini-MAM available at the time of this study was Mini-MAM 2.1. This study used Mini-MAM 2.1 to measure

participants' PO and NB to analyze whether the differences in motivational traits affect the way one processes information from the stimulus.

The Limited Capacity Model of Motivated Mediated Message Processing

The Limited Capacity Model of Motivated Mediated Message Processing (LC4MP (A. Lang, 2006; in press) has been built on a large body of research about how people process messages presented via various electronic media.

Like it's predecessor, the Limited Capacity Model of Mediated Message Processing (LC3MP; A. Lang, 2000), LC4MP conceptualizes processing information, or thinking, as a process that requires mental resources (or cognitive resources) of which humans have only a finite and limited supply. LC4MP also inherits an important assumption from LC3MP, that processing messages involves three subprocesses that are continuous and simultaneous: encoding, storage, and retrieval (A. Lang, 2000; 2006; in press). When the message is easy to process, there are plenty of cognitive resources available for all three of these subprocesses. However, when the message is harder to process, these subprocesses compete against each other for resources, and since these resources are limited in supply, it is likely that at least one of the subprocesses suffers from insufficient resources supplied.

LC4MP conceptualizes cognitive resource allocation to these subprocesses as a result of automatic and controlled processes. Automatic processes are biological function of the brain, or, a bottom-up process. An example of a mechanism of automatic resource allocation occurs when the stimulus is novel or motivationally relevant. It is caused by an unconscious response to changes in the environment, or learned signals (e.g., door bell, alarm clock buzzer) which is called the orienting response (OR).

Controlled resource allocation is a top-down process that is dictated by the goals of the organism. It is easy to imagine that a high school student who is preparing for a test processes information from her text book differently than her parent who picks up the book out of simple curiosity. In this example, the student, whose goal is long term memory, is likely to allocate more resources to storage, and the parent, whose goal is more passing the time, is likely to allocate resources to encoding (*what's in this book?*) and perhaps, to retrieval (*what's changed since I was in high school?*). In other words, people are, to some extent, capable of controlling the amount of resources allocated to the subprocesses of information processing in subservience to their goals and interests.

Arguably, one of the most interesting features in A. Lang's work on cognitive processing of mediated messages is automatic resource allocation. The notion of automatic or unconscious processing flies in the face of the common belief that people are in charge of how their brain works (at least, of the cognitive processes), and controlled resource allocation, a top-down process, should always be the case. A. Lang's work has shown not only that there are powerful automatic resource allocation mechanisms functioning during mediated message processing, which is a bottom-up process, but that, ultimately, message processing is the result of the interaction of the top down and the bottom up processes. By definition, people cannot stop automatic processing. On the other hand, by dint of controlled processing they can inhibit or facilitate automatic processes. Further, while controlled processes are strongly related to what is individual about people and about a specific context, automatic processes are more representative of what is the same about all people and the underlying similarities in

environment that elicit automatic processing (speed of onset, luminance, change, and motivational relevance).

A. Lang (1990) explains that cardiac deceleration is an indicator of the OR and therefore, by definition, of automatic resource allocation. Furthermore, she found such a cardiac reaction in response to structural features such as camera changes of television. A. Lang (1990) also reported that both increases in structural features and increases in emotional content lead to higher tonic physiological arousal. During the years since this study was conducted, a large body of research exploring the cognitive processing of mediated messages has been done. Studies using different television content replicated the initial findings and expanded our understanding of how people process messages from television (A. Lang, Bolls, Potter, & Kawahara, 1999; A. Lang, Zhou, Schwartz, Bolls, & Potter, 2000; Zhou, 2004). Potter (2000) took this approach and applied it to audio: like camera changes or motion in television, Potter predicted that structural features in the audio such as voice changes and sound effects would result in more frequent automatic resource allocation, and affect the processing of the message as well. This prediction was supported, increasing the generalizability of LC3MP (and its successor, LC4MP). Examples of research that used A. Lang's theoretical framework on processing of media other than television and radio include advertising in Web pages (A. Lang, Borse, Wise, & David, 2002), educational multimedia (Schwartz, 2003), and advertising in video games (Park, S. D. Bradley, & Kim, 2003).

LC4MP is based on its predecessor, LC3MP, and makes theoretical advances by including the idea of *motivated cognition*. According to LC4MP, motivational relevance of the message (from a medium) to the receiver modulates how the message is processed

(A. Lang, 2006). In other words, the two resource allocation processes – automatic and controlled – are affected in part by how motivationally relevant the message is to the person who is processing it.

LC4MP specifically predicts that activation of the appetitive motivational system will increase the cognitive resources allocated to encoding and storage. LC4MP also predicts that activation of the aversive motivational system will cause allocation of cognitive resources to encoding and storage as well as to retrieval as arousing content increases. These general predictions will be explained using examples of processing motivationally relevant messages from the media.

As stated above, automatic responses, including automatic resource allocation, are biological functions of the brain. More specifically, automatic resource allocation is related to the part of the brain that handles unconscious and automatic responses to stimuli – let us call this the *older part of the brain*. The older part of the brain is the first to process information brought in through our sensory organs. It particularly processes and responds to negative stimuli very fast because it is related to the organism's survival. This older part of the brain evolved from amoebas and is fundamentally responsible for initiating the impulse to approach good and avoid bad stimuli.

None of the electronic media have existed for more than a century. The older part of the brain that has been serving us for millions of years have not evolved to deal with this strange, new thing that took place in the environment. As Reeves and Nass (1996) suggest, the old brain responds to what is presented through media as if it was real. It has no mechanism to deal with not-real. Instead the more evolved parts of the brain learned

that images and sounds from the media are not real – let’s call this the *newer part of the brain* – to make adjustments to the brain’s response accordingly.

When there is a television news report about an ongoing natural disaster (e.g., a tornado hitting a town), the horrible image and sound is processed by the viewers’ older part of the brain first hand. The aversive motivational system gets instantly activated. According to LC4MP (A. Lang, in press), it takes time – though only a few hundred milliseconds – for the newer part of the brain to inhibit the physiological responses of avoidance elicited. However, if the following scene is a car being destroyed by the wind with an accompanying loud noise, the older part of the brain will again respond by activating the automatic response sequences for emergency, until the newer part of the brain again inhibits that response. Given how content for electronic media are created today (i.e., providing emotional content continuously in an effort to keep the audience attending) this pattern is expected to continue while the viewer is watching this news. The point here is that while the newer part of the brain knows that what is presented by media is not real (e.g., television news is based on real events, but since the event is not taking place in the viewer’s living room, it has no immediate consequence), the older part of the brain does not know this and keeps responding to the medium as if the event is taking place in right front of that person. This makes the cycle of reaction by the older brain and inhibition by the newer brain repeated over and over when using electronic media like television.

On the other hand, a video clip depicting a couple having an intimate relationship is expected to be handled by the older part of the brain in a quite different way. Since it is about mating, which is a subject related to an organism’s well-being and passing its genes

to the next generation, the appetitive motivational system is activated. More cognitive resources are expected to be supplied to the encoding process because the brain is now in information-collecting mode. Again, the newer brain knows this isn't real and some inhibition of the response will occur. However, in both cases, the automatic responses are not extinguished. They are only inhibited. Their physiological echoes can still be measured and they still function to modulate the allocation of resources to the various subprocesses of cognitive processing, hence the term motivated cognition.

Media often deliver emotional content. This is especially the case for commercial media whose content is often affected by its ratings. Entertainment media is even more likely to include emotional content compared to content such as news or educational media. Emotionally charged content elicits automatic responses from the brain.

Electronic media tend to elicit such responses from the user's brain by continuously altering the content. Electronic media is also good at including structural features (e.g., camera change, sound effects) to the message it delivers, which also elicit automatic responses. Since automatic responses from the brain include pattern changes in the automatic resource allocation process for information processing, electronic media are capable of having greater influence over the automatic resource allocation than other types of media (e.g., print).

Needless to say, the motivational relevance of a mediated message differs from person to person. One example of this is differences caused by different goals for different individuals. A breaking news story about sudden changes in the international oil market should be more important to a stock holder of an oil company, and even more important to large share holders than to small share holders. Again, in this case,

individuals who have a great interest in the oil market are likely to process information from the news differently than those who have little or no interest. And in this situation, the most important difference between these individuals is probably found in terms of controlled resource allocation. However, if those who are not involved in oil do watch, they will have markedly different automatic allocation responses also.

Another important prediction made by LC4MP is that individuals with different motivational system activation characteristics (i.e., relative differences in PO and NB) will show different levels of modulation in their processing of mediated messages depending on their motivational relevance. Studies that explored this argument include Yegiyani, S. D. Bradley, Banerjee, and A. Lang (2005), which used television messages, and Lee & Park (2006), which used pop-up advertising on the Web.

Yegiyani et al. (2005) used MAM to investigate how individuals with different motivational activation characteristics process emotional television messages. For this study, 210 college students completed the MAM survey and 30 % of the individuals in each extreme group (high PO & high NB, high PO & low NB, low PO & high NB, low PO & low NB) were invited back. Those who were brought back participated in the second experiment, where they were asked to view 26 public service announcements (drug prevention messages) while having their physiological responses recorded. Individuals higher in PO exhibited significantly slower heart rate (indicative of paying more attention to the message), which supported the theoretical prediction that individuals higher in PO would show greater approach tendencies to stimuli and pay greater attention to them. Compared to individuals lower in NB, individuals higher in NB showed: faster heart rate (indicative of greater internal attention and less external

attention), stronger corrugator activation (indicative of greater experience of negative emotion), and larger eyeblink startle responses (indicative of greater activation of the aversive system) to negative PSAs. These findings supported LC4MP, which predicts that when presented with negative stimuli, individuals who are higher in NB would experience greater activation in their aversive system, and direct their cognitive resources to internal processing (e.g., building survival strategy) rather than just stand and observe it carefully.

Lee and Park (2006) applied LC4MP to Internet advertising by using MAM to compare how people with relatively different motivational system activation characteristics react to and process messages from the medium. By applying signal detection analysis to participants' memory of pop-up advertisements, Lee and Park (2006) reported that when compared to participants lower in NB, participants higher in NB exhibited higher sensitivity and a more conservative criterion bias in response to a memory test that involved negative images used in the advertisements. This supported the prediction made by LC4MP that higher activation levels in the aversive system would result in more automatic allocation of cognitive resources to the storage subprocess of information processing (since information about danger needs to be remembered for survival in case the organism is put in the same or similar situation again; A. Lang, in press). When compared to participants lower in PO, participants higher in PO exhibited a more conservative criterion bias in response to the memory test questions on both positive and negative images used in the pop-up advertisement messages. This was consistent with LC4MP, which predicts stronger appetitive system activation will increase automatic allocation of cognitive resources to encoding and storage subprocesses

(A. Lang, in press). It may also be the fact that decisions about positive things need to be accurate – there is no advantage to being fast and wrong (*oops – that WAS a poison mushroom...*) whereas decisions about negative things should be made quickly and there is little risk in jumping out of the way of a car that actually was just a piece of paper blowing in the wind.

Both Yegiyan et al. (2005) and Lee and Park (2006) provide support for various predictions made by the LC4MP, including that individuals with different appetitive and aversive motivational system activation characteristics will exhibit different mediated message processing patterns. However, LC4MP, being a general theory of media processing, makes specific predictions about all media, and those predictions require testing in order for the theory to continue to expand its generality, where applicable, and understand and incorporate variables related to specific media and contents which may change otherwise general predictions. Thus, while we are fairly confident in the LC4MP's predictions about increasing appetitive activation during a television viewing task, we are much less certain about the effects of appetitive activation while playing a videogame, which is a more physically active task where outcomes (positive and negative reinforcers) are directly determined by the game player's own responses.

Emotion, Motivated Cognition, and Video Games

Two studies have applied A. Lang's work on cognitive processing of mediated messages as a theoretical framework and incorporated emotional component to video gaming and its users. The first study, A. Lang, Schneider and Deitz (1999) had participants play *Quake II* (id Software, 1997), a first-person shooter video game that was seen as an extremely violent video game by the standards at the time, and recorded their

physiological responses as well as self-reported emotional responses to the game play. The authors compared physiological data collected during different types of action and found that skin conductance response, used as an index for sympathetic arousal, showed different patterns of activation when participants were engaged in hunting for bad guys compared to fighting them. When participants were hunting, or searching for an opponent, participant's arousal level decreased over the course of repeated hunting sequences. On the other hand, when participants were engaged in fighting, their arousal increased with repetition. Since hunting in this experiment is an information gathering activity, it was likely to result in an increase in participant's appetitive system activation. On the other hand, fighting is an activity that requires both approach (to attack the opponent) and avoidance (stay away from the opponent's attack), it was likely to increase the activation levels of both the participant's appetitive and aversive systems simultaneously. Hence, this result suggests that in the context of a violent video game, engaging in an action that mainly activates the appetitive system gets less arousing as it is repeated, while an action that results in coactivation of the motivational systems gets increasingly arousing with repetition.

A. Lang, Schneider and Deitz (1999) also explored the relationship between experience with playing video games and other dimensions of emotion, where they found that participants who reported experiencing a stronger sense of presence during game play also experienced more physiological arousal. Experience with video games resulted in an increase in self-reported dominance (sense of being in control during game play) and decreases in physiological arousal.

Another video game study conducted by A. Lang and her colleagues (Schneider, A. Lang, Shin, & S. D. Bradley, 2004) compared participants' responses to playing two video games with a story line and two with virtually no story. This study reported that the presence of narrative resulted in users' reporting a greater sense of identification with the characters in a video game, stronger motivation for overcoming opposition, better liking of the video game, stronger sense of presence, more positive emotional response, and higher physiological arousal. Though this study did not specifically test the idea of motivated cognition in LC4MP, the results suggest that video games with a story line result in stronger motivational activation (to accomplish the goal for the game) for its users, which results in users experiencing more positive feelings, higher arousal, greater sense of presence – and, ultimately liking the video game more. In other words, structural features that promote the activation of the player's appetitive system, such as narrative included in video games, are likely to improve their overall gaming experience.

These two studies provide great insight into the processing of mediated information contained in video games. However, they are not specifically designed to explore motivated cognition, which limits the application of their findings in the context of LC4MP.

As discussed previously, users of video games play an active role in content building (i.e., outcome changes depending on the user's performance). This makes video games different from most of the traditional mass media (e.g., television, radio, & print). In this process of content building, video games such as action games, which have the longest history and are seen as a classic genre in video games, are very unique in the way they demand that their users carry out the task of content building. Action games require

users to perform a limited set of actions, such as: shooting projectiles, avoiding an enemy character's attack, or hitting the tennis ball over the net. And these actions need to be repeated throughout the whole period of play until the user successfully achieves the ultimate goal or the user cannot proceed anymore due to poor performance. Repetition of such tasks leads to automation, which leads to a decrease in cognitive load. This is not the case for many other media, such as television and radio. Application of LC4MP to action-type video games to see if media users performing automated task is expected to add to the literature.

Another important goal of this dissertation, which is independent of the characteristics of the medium, is to manipulate the media user's motivational system activation pattern and see how it affects their processing of information and their emotional responses to the media. Schneider, A. Lang, Shin, & S. D. Bradley (2004) showed a strong correlation between motivation (e.g., to overcome obstacles, which is affected more by top-down processes, or controlled in nature), positive emotion, higher arousal, and stronger sense of presence. This opens the door to another question: will the video game user's emotional responses be affected when the video game user's motivational systems, which are mostly controlled by bottom-up processes (or automatic in nature), are manipulated? Previous studies show that emotional content presented from the media activates appetitive and aversive motivational systems and this affects how the information is processed (e.g., A. Lang, S. D. Bradley & Sparks, 2004, Yegiyani et al., 2005). However, previous studies leave room for exploring whether there is any relationship between motivational system activation and other emotional dimensions such as dominance or presence, or user's responses such as liking or enjoyment.

Another significant feature of LC4MP is the set of predictions it makes for individuals with different motivational system activation characteristics. As discussed above, Lee and Park (2006) and Yegiyan et al. (2005) show that people higher in PO are likely to have stronger appetitive system activation, which leads to paying more attention to the message from the media, and people higher in NB are likely to have greater aversive system activation when exposed to negative messages from the media, leading to enhanced storage of the key information and experience of stronger negative emotion. However, whether these different motivational system operation characteristics also have impact on other emotional dimensions (e.g., dominance and presence) or their experience (e.g., enjoyment) remains to be explored. For example, LC4MP predicts that sense of presence will be higher when the response of one's older parts of the brain is larger (A. Lang, 2006) than the inhibitory responses of the new brain, which suggests that greater motivational system activation is linked to presence. This prediction can be tested not only by comparing a participant's reactions under different conditions (i.e., using a within-subjects factor), but also by comparing participants with different PO and NB (i.e., using a between-subjects factor).

To summarize, this study will attempt to use video games to manipulate the activation level of motivational systems, and explore how this affects processing, emotional experience, and game play using LC4MP as a theoretical framework. This study will also attempt to explore how individual differences, indexed by the estimates of PO and NB using Mini-MAM 2.1, may affect how users process information from video games and their emotional experience.

Hypotheses

The following hypotheses are based on LC4MP and the theory of motivational systems introduced in the previous sections. In this experiment, participants played a video game which required the completion of three separate tasks which were designed to create three different motivational conditions. Each condition had two levels of arousing content (calm and arousing).

In the appetitive condition, the goal is to go out and acquire a set of objects which do not pose any threat to the player's character. This condition should activate the appetitive or approach system. This is a "hunt and gather" task, which is not dangerous to the player's character and the task requires approach behavior, and as a result, players' appetitive motivational system should be activated.

In the aversive condition, the goal is avoid, or flight. The player must avoid attacks from hostile objects. Since the player cannot fight back and only can run away from danger, players' aversive motivational system should be activated.

In the coactive condition, the goal is to attack and destroy hostile objects while avoiding attacks from them. This encourages the player to approach and attack (activation of the appetitive motivational system) and to avoid the enemy's attack (activation of the aversive motivational system) at the same time. This should result in both motivational systems being active, or, in *coactivation*.

In the appetitive condition, players are rewarded for a job well done – in this case, hunting and gathering. There are no elements of threat in this condition, which should result in the players experiencing minimal activation of the aversive motivational system. This allows the player to focus their attention exclusively on the primary task of hunting

and gathering without having to worry about the safety of the player's character. From a theoretical stand point, this means that players can allocate processing resources to information intake and approach behavior. Thus, resources will primarily be allocated to encoding.

In the aversive condition, the players' only option is to avoid attacks by computer-controlled characters. This condition discourages players from performing approach behavior and forces players to engage in avoidance behavior. This is expected to activate the players' aversive motivational system and minimize the activation of their appetitive motivational system. Since the players' character is under threat from an external agent, some resources will be allocated to detecting and identify these agents. However, details of the hostiles are not important, thus the majority of resources can be allocated to the task of running away. In lay terms, players will have to divide their cognitive resources to keep their character unharmed. This means the fewer resources will be allocated to information intake and more to internal processes like decision making (which way and where to run), which will result in a different pattern of cognitive resources allocation. Thus, resources will be allocated less to encoding and more to storage and retrieval.

In the coactive condition, players can engage in both approach behavior and avoidance behavior. When players are engaged in approach behavior, they are likely to allocate more processing resources to information intake (e.g., tracking the location of target for hunting). However, the players' character is under threat at the same time, so some resources will still have to be allocated to internal processing (e.g., deciding next move to avoid enemy's attack). Hence, in the coactive condition the allocation of processing resources to information intake (encoding) is likely to be less than during the

appetitive condition but still more than during the aversive condition. And the resource allocation to internal processing (storage and retrieval) is likely to be more than during approach but less than during aversion.

Manipulation for Arousing Content

When people process mediated messages, arousing content leads to arousal on the receiver's side. There are a number of ways to manipulate the arousing content level of the mediated messages. Story (bedtime story vs. horror story), background music (calm vs. upbeat song), visuals (picture of a quiet person vs. yelling person) are examples of what can be manipulated to control the arousing content level.

This study will attempt to manipulate arousing content by manipulating two structural features: the number of objects that appear on screen, and the speed of these objects. In the context of playing video games, more objects means more difficulty, since the player has to capture more targets (appetitive condition), avoid more threatening objects (aversive condition), or fight with more enemies (coactive condition) at any given moment. Increased speed also increases difficulty since it makes it hard to aim and hit targets, and avoid attacks.

And for any task (physical and cognitive), difficulty is known to lead to arousal (physiological and self-reported) on the performer's side (Critchley, Corfield, Chandler, Mathias, & Dolan, 2000; Gellatly & Meyer, 1992; Willemsen, McKeever, & Carroll, 2000). Hence, fewer and slower objects will make the task easy, or, calm (low arousing) content, while more and faster objects will make the task harder and make the content more arousing.

Motivational Activation and External Attention

One factor that affects the speed of the heart beats, or heart rate (HR), is how many cognitive resources are allocated to information intake and how many are allocated to internal processes. Hence, HR deceleration is widely used by experimental psychologists as an index for attentional orienting designed to help sensory intake of relevant stimuli and process that information (Lacey & Lacey, 1970; Obrist, 1976; see Ohman, Hamm, & Hugdahl, 2000 for review). HR deceleration is observed when an individual pays attention to the environment (external attention) in anticipation of relevant future events (Bohlin & Kjellberg, 1979; van der Molen, Somsen, & Jennings, 1996). Ohman, Hamm, and Hugdahl (2000) suggests that HR is faster in a situation of environmental rejection (rejecting information intake for internal processes), and HR is slower in a situation of sensory intake (information intake).

Using HR as an index for information intake, or external attention, has been useful for media researchers as well. It has been successfully used with television(e.g., Grabe, A. Lang, Zhou, & Bolls, 2000; A. Lang, Dhillon, & Dong, 1995; Yegiyan, S. D. Bradley, Banerjee, & A. Lang, 2005), radio (e.g., Bolls, A. Lang, & Potter, 2001; Potter, 2000), computer (e.g., A. Lang, Borse, Wise, & David, 2002; Schwartz, 2003), and video games (e.g., A. Lang, Schneider & Deitz, 1999; Schneider, A. Lang, Shin, & S. D. Bradley, 2004).

As discussed previously, P. J. Lang and his colleagues argue that appetitive motivational system is activated in situations to promote survival, such as seeking for prey or mates. For example, searching for a prey and acquiring it requires careful observation: “Where it is? Is it looking at me or looking away? Can I approach without

being detected?” To analyze the surrounding environment and successfully hunt down the prey, an organism must direct as many cognitive resources as possible to sensory intake.

As suggested in this example, it is believed that activation of the appetitive motivational system should lead to more information intake. Hence, heart rate should be slowest during appetitive activation. Activation of the aversive motivational system should lead to more internal processing – hence the fastest heart rate, and coactivation should be in between. Thus:

H1a: For both levels of arousing content (calm vs. arousing), heart rate, used as an index for external attention or information intake, will be fastest for the aversive condition, slower for the coactive condition, and slowest for the appetitive condition.

Ohman, Hamm, and Hugdahl (2000) also suggests that when a stimulus requiring a sensory discrimination (e.g., friend vs. foe, prey vs. predator) or a fast response (predator is going to jump toward you) is anticipated, heart rate slows down so the cortex gets activated for efficient processing of the expected stimulus and priming of associated responses. The prediction for heart rate deceleration is supported by studies that use mediated messages as stimuli, which find that when other conditions are controlled, stimuli with arousing content tend to result in slower heart rate compared to stimuli with calm content. This was the case for television clips (A. Lang, Bolls, Potter, & Kawahara, 1999), horror films (Carruthers & Taggart, 1973), compelling negative images (A. Lang, Newhagen, & Reeves, 1997), and negative slides (M. M. Bradley, 1994), which suggests arousing content leads to increased attention to the stimulus. This leads to hypotheses H1b and H1c:

H1b: For each condition (appetitive, aversive, coactive), arousing content should elicit slower heart rate than calm content.

H1c: There will be a 2-way interaction between motivational condition and arousing content on HR. While arousing content should elicit slower heart rate than calm content across all three motivational conditions, the difference in heart rate between arousing and calm content will be smallest for the appetitive condition, larger for the coactive condition, and largest for the aversive condition.

Motivational Activation & Arousal

Threat & arousing content are also expected to affect the sympathetic nervous system (SNS) activation. As a result, eccrine sweat gland activity is expected to increase. This is because eccrine sweat glands are solely innervated by the SNS. The eccrine sweat gland activity increases under threat of punishment (Katkin, 1965), and experiments that controlled reward and penalty found that this activity is not affected by reward (e.g., Tranel, 1983).

Skin conductance (SC) measured on the sole of a foot or the palm of a hand indexes activity of the eccrine sweat glands. SC is used as an index of physiological arousal (Cacioppo & Tassinary, 1990; Dawson, Schell, & Filion, 2000; Hopkins & Fletcher, 1994). Moreover, the eccrine sweat glands are innervated exclusively by cholinergic fibers of the SNS, with no parasympathetic input (Beauchaine, 2001). Bradley (2000) argues that the SNS is designed to prepare and instantiate action in general. The action SNS prepares for may be something positive such as sexual activity or adventurous activity, but in many occasions, SNS is found to be activated by negative stimuli – which is interpreted as preparing the organism to get ready for ‘fight or flight.’

Activation level in the SNS also rises as the task one is performing gets more difficult (Clements & Turpin, 1995), which is an indication of stress induced by the task.

There are a number of ways to measure and quantify SC, such as skin conductance level (SCL) and skin conductance response (SCR). The pattern of eccrine sweat gland activity shows rapid fluctuations. Sweat is pumped out at once instead of constantly flowing out over time, and when a person is sweating a lot, the frequency of this pumping action increases as well as the amount of sweat emitted each time. SCR measures the number of fluctuations of this eccrine sweat gland activity.

As discussed above, SCR increases under threat of punishment but not affected by reward (Katkin, 1965; Tranel, 1983). Hence, Hypothesis 2 is proposed:

H2a: The number of skin conductance responses (SCRs), used as an index for physiological arousal, will be smaller for the appetitive condition, and larger for the aversive condition and the coactive condition. There will be no significant difference between the number of SCRs for the aversive condition and the coactive condition.

H2b: For each condition (appetitive, aversive, coactive), arousing content should elicit more SCRs than calm content.

H2c: There will be a 2-way interaction between motivational condition and arousing content on SCR. While arousing content should elicit more SCRs than calm content across all three motivational conditions, the difference in number of SCRs between arousing and calm content will be the smaller for the appetitive condition, and larger for coactive condition and aversive condition. There will be no significant difference in the SCRs between coactive condition and aversive condition.

Motivational Activation and Resources Available at Encoding

Secondary task reaction time (STRT) is a methodology that has its roots in cognitive science (Basil, 1994). This methodology is based on limited capacity models of attention (Neumann, Lipp, & Siddle, 2002), from which some of the basic assumptions (e.g., people are information processors and that information processing requires cognitive resources) of LC4MP are derived.

In the STRT paradigm, study participants engage in two tasks simultaneously – a primary and a secondary task. Participants are instructed to pay close attention to the primary task (e.g., video game play), because the performance of the primary task is very important. Participants are also given a secondary task (e.g., push a button as fast as possible when an audio tone is administered) – this audio tone is called the *secondary task probe*. The time passed from the onset of the audio tone until the participant performs the secondary task is called the STRT.

In their review of the literature using STRT, A. Lang and Basil (1998) defined four pieces of the resource puzzle: *Resources required* (by the task), *Resources allocated* (to the task), *Resources remaining* (in the system during task performance), and *Resources available*. Although there is not an index for *resources allocated* to encoding yet, A. Lang and her colleagues found that secondary task reaction time (STRT) may be used as an index of *resources available* at encoding (A. Lang, Bradley, Park, Shin & Chung, in print), which is useful for studies of media processes and effects; in this study, the concept of *available resources* is defined as resources that are allocated to the task but that are not required in order to perform the task.

LC4MP also suggests that because activation of the motivational systems results in an increase in both resources required by a stimulus and resources allocated to the

stimulus, people tend to have fewer available resources, indexed by STRT, when messages are arousing (Park, Sanders-Jackson, Wilson, & A. Lang, 2005). In addition, LC4MP predicts that more resources are allocated to messages which activate the appetitive system, because information intake is an important dimension of appetitive behavior. LC4MP also predicts that initially more resources will be allocated to encoding negative stimuli by the aversive motivational system to speed up stimulus identification. But that once the stimulus has been identified, fewer resources will be allocated to encoding since resources are needed elsewhere to deal with the threat. LC4MP further argues that at low levels of appetitive or aversive activation – more resources will be allocated to appetitive – compared to aversive stimuli – because of the positivity offset while at moderate levels of activation – more resources may be allocated to negative compared to positive messages due to the negativity bias. Thus at low levels of arousing content – STRTs should be slower for positive compared to negative messages. At moderate levels of arousing content they should be slower for negative compared to positive, and at high levels – they should be slow for positive but very fast (indicative of cognitive overload) for negative.

Cognitive overload during processing of mediated message refers to a state where there is no cognitive resource available. When a subprocess is engaged in a task that requires a lot of resources (e.g., television clip that elicits too many orienting responses) borrows resources from other subprocesses, resulting with poor performance for these other subprocesses (e.g., decrease in audio recognition; Potter, 2000). Park et al. (2005) suggests that when one is experiencing cognitive overload during television viewing, STRT become very fast, which is an indication of “reduction in cognitive effort because

the primary task can no longer be performed well, thus, it is likely some small amount of resources is dedicated to performing the secondary task (p. 5).” Park et al. (2005) reported such an interaction of valence and arousing content on STRT for calm and moderately arousing stimuli.

Each condition in this study is expected to have different levels of difficulty because the tasks are different. The aversive condition task requires participants to avoid approaching objects, which is expected to be the easiest task amongst all three conditions. The appetitive condition requires participants to aim and shoot projectiles in order to capture distant objects, which is expected to require more resources than the aversive task. The coactive condition requires participants to both avoid being shot and to aim and shoot, this is expected to be the hardest task. As the task gets harder, the resources required to do them will increase, leaving fewer resources available.

At the same time, the level of allocated resources should vary as a function of which motivational system is activated. When the appetitive motivational system is more active in the appetitive condition, there should be more resources allocated at both low and high levels of arousing content. When the aversive system is activated there should be more resources allocated to encoding when arousing content is medium, but fewer when it is low or high. In the coactive condition, resources should be allocated to encoding as a function of both systems and there should be the highest allocation of resources regardless of arousing content level.

Because the arousing content manipulation is essentially a difficulty manipulation (more things to gather or more things shooting at you), the resources available in each condition needs to be considered separately for low and high arousing content.

Thus, at low levels of arousing content – there will be the most resources allocated to coactive, followed by appetitive, followed by aversive activation. However, resources required will be greatest for coactive, followed by appetitive, followed by aversive (due to the task difficulty variation). If there is no cognitive overload, then responses should be slowest for coactive, followed by appetitive, followed by aversive.

For high levels of arousing content, more resources will be required to do each task. The already more difficult tasks should overload (which results in very fast STRTs) more quickly than the easier tasks. On the other hand, the aversive task – which is the easiest – will also be the only one which also has a reduction in resources allocated. Thus, the aversive task should show overload first, followed by the coactive, and finally the appetitive task. Thus, it is predicted that STRTs will become very fast (or time out completely because participants do not even hear the secondary task probe) – indicative of overload first for the aversive, followed by the coactive, followed by the appetitive condition.

H3a: For calm content, secondary task reaction times (STRTs), used as an index for resources available for processing information, will be slowest for the coactive condition, faster for the appetitive condition, and fastest for the aversive condition.

H3b: For arousing content, secondary task reaction times (STRTs) will be slowest for the appetitive condition, faster for the coactive condition, and fastest for the aversive condition.

Motivational Activation and Appetitive System Activation

Activation of the appetitive motivational system should lead to positive emotional experience. Experiencing positive stimuli is known to lead to activation in the *orbicularis*

oculi muscle group (Ravaja, 2004; Ravaja, Salminen, Holopainen, Saari, Laarni, & Järvinen, 2004), which is located under the eye (Bradley, Codispoti, Cuthbert et al., 2001). This muscle group draws up the corner of eye characteristic of a smile. It is not under voluntary control, which is different from the muscles that draw up the lip characteristic of a smile (the *zygomaticus major* muscle group).

While a number of studies used the activation of the *zygomaticus major* muscle group as an index for positive emotion, there are two potential issues with its reliability: first is that it is under voluntary control so it can be faked. Second is that lips can be pulled by this muscle group to make different facial expressions for negative emotions, such as disgust or aggression (e.g., screaming ‘ew!’ or growling).

In contrast, the Duchene smile, a smile that shows sincere happiness, has the eyes characteristic of a smile that cannot be faked, which allows the activation of *orbicularis oculi* to be used to differentiate between genuine and forced smiles (Eckman, Davidson, & Friesen, 1990). Based on this reasoning, it is predicted that:

H4: For both levels of arousing content (calm vs. arousing), the electromyographic (EMG) activity of *orbicularis oculi*, used as an index for activation in the appetitive motivational system, will be largest for the appetitive condition, smaller for the coactive condition, and smallest for the aversive condition.

Motivational Activation and Aversive System Activation

Startle reflex (SR) is a bodily response to an abrupt and intense sensory event, which includes various components such as eye blink. Startle reflex is observed in most mammals (Landis & Hunt, 1939). Graham (1979) suggests that startle reflex appears to

be a defensive mechanism to avoid injury (e.g., eye blink) and interrupt the ongoing behavior to respond to possible threat (e.g., full body jerk).

Historical studies revealed that this phenomenon was discovered by a Russian researcher Sechenov (Sechenov, 1863/1965), and was introduced to Western researchers in 1939 with publication of *The Startle Pattern* by Carney Landis and William A. Hunt (Hoffman, 1999). However, it did not get the attention it is receiving by researchers today until Hoffman and his colleagues rediscovered this phenomenon by finding that the magnitude of this reflex in rats varies in response to certain factors (Hoffman & Searle, 1965). The change in magnitude of SR, which is called startle modification, is replicated in humans (Graham, 1975; Hoffman & Ison, 1980).

Vrana, Spence, and P. J. Lang (1988) reported that the startle magnitude can be modified by the emotional state in humans. In this study, a short but loud burst of white noise (50 milliseconds at 95 decibels) was used as an acoustic startle probe. These startle probes were administered while participants were viewing color photographs. A total of 36 photographs which contained either positive, negative, or neutral scenes or objects were shown. The magnitudes of eyeblink startle were largest for negative photographs and smallest for positive ones. And this modification was independent of other measures such as arousal, orienting, and interest in the photographs presented. The authors suggested that “The startle probe is proposed as a broadly useful tool for studying emotion, its development and modification, and for the assessment of pathological anxiety” (Vrana et al., 1988, p.487). Since Vrana et al.(1988) reported the relationship between emotion and startle reflex, the number of studies using this measure in humans has enormously increased (de Jong, 1997).

Activation of the aversive motivational system should lead to both negative emotion expression & facilitation of the eyeblink startle. It is interpreted that larger responses indicate greater activation of the aversive motivational system (P. J. Lang, Bradley, & Cuthbert, 1990). Cuthbert, Schupp, Bradley, McManis, & P. J. Lang (1998) demonstrated that pictures with negative content had larger eyeblink startle reflex than those with positive content.

While negative content is found to facilitate the magnitude of startle reflex (SR), positive content is found to inhibit SR (Bradley, Codispoti, Cuthbert, & P. J. Lang, 2001). Hence, if the appetitive motivational system is more active in the appetitive condition as expected, SR, used as an index for the activation of the aversive motivational system, should be the largest during the aversive condition. SR will be smaller for the coactive condition, which is expected to activate both the appetitive and the aversive motivational system. SR will be the smallest for the appetitive condition, where appetitive motivational system activation should be the largest among three conditions. This leads to hypothesis 5:

H5: For both levels of arousing content (calm vs. arousing), the magnitude of startle reflex(SR), used as an index for activation in the aversive motivational system, will be largest for the aversive condition, smaller for the coactive condition, and smallest for the appetitive condition.

Another index for the activation of the aversive motivational system is the EMG activity in the *corrugator supercilli* muscle group, which is located above the eye brow. Several studies have demonstrated that participants experiencing unpleasant – or aversive – content show greater EMG activity over this muscle group (Bradley, Codispoti,

Cuthbert et al., 2001; P. J. Lang et al., 1993; Larsen et al., 2003). This muscle group is associated with frowning and draws the eye brow down in the characteristic scowl of a frown. This leads to hypothesis 6:

H6: For both levels of arousing content (calm vs. arousing), the EMG activity of *corrugator supercilii*, used as an index for activation in the aversive motivational system, will be smallest for the appetitive condition, larger for the coercive condition, and largest for the aversive condition.

Motivational Activation and Emotional Experience

In the current experiment, after each segment of the stimulus (video game) was over, a questionnaire about the participant's experience during the segment was administered. Three 9-point Likert scales asking how positive, how negative, and how aroused they felt during each segment were provided. A number of studies show that physiologically measured emotional responses (valence and arousal) correlate with corresponding self-report scales. Thus,

H7a: The self report for positive emotion during game play will be largest for appetitive condition, followed by coercive condition, and will be smallest for aversive condition.

H7b: The self report for negative emotion during game play will be largest for aversive condition, followed by coercive condition, and will be smallest for appetitive condition.

H7c: The self report for arousal during game play will be larger for arousing content than calm content.

9-point Likert scales for dominance and presence will be also administered after each segment is over. As discussed previously, in addition to the five self-reported scales described, another 9-point scale on enjoyment (1 = Not enjoyed at all, 9 = Enjoyed very much) during the segment will also be put to the participants.

Dominance has been seen as a basic dimension of emotion among a number of researchers who study dimensional theory of emotions (Russell, 1991; Russell & Mehrabian, 1977; M. M. Bradley & P. J. Lang, 1994). Dominance is a dimension less used than valence or arousal by researchers (Detenber & Simons, 1998; Detenber, Simons & Reiss, 2000). Nevertheless, it is an important dimension that has been overlooked by researchers. Based on their study, Russell and Mehrabian (1977) reported that “only dominance makes it possible to distinguish angry from anxious, alert from surprised, relaxed from protected, and disdainful from impotent (p. 292).” Russell and Mehrabian (1977) also reported that when participants rated emotional words by emotional dimensions, enjoyment did not only include pleasure (positive emotion) and arousal, but also included a feeling of dominance. Since the main purpose of video games is to provide entertainment, dominance is a dimension that deserves more attention.

Aguilar de Arcos et al. (2005), who also used IAPS pictures and had participants from the general population rate their emotions using self-report 9-point scales, reported that when arousal level is controlled (either neutral or arousing), dominance for positive pictures was significantly higher than that for negative pictures. Although it was not statistically significant, negative and arousing pictures were lower in dominance than negative and neutrally arousing pictures. Aguilar de Arcos et al. (2005) also reported that positive and arousing pictures were higher in dominance than positive and neutrally

arousing pictures. The lack of significance for arousal within the same dimension of valence may be a result from having relatively small difference in arousal level of the pictures used. If the arousal levels of the pictures was low and high rather than medium ("neutral") and high ("arousing"), the difference for dominance might have been larger, reaching statistical significance.

In addition to the findings by Aguilar de Arcos et al. (2005), the task required by each motivational condition is also expected to contribute to the participant's sense of dominance. The appetitive condition lets the participant shoot projectiles to collect items, which should give a strong sense of control, which is expected to lead to the highest dominance ratings. The aversive condition puts participants in a situation that they can only avoid harmful objects, and cannot do anything to those objects, which is expected to lead to the lowest ratings for dominance. The coercive condition still has participants avoiding the enemy's attack, but it also allows participants to attack the enemy, which is expected to provide a better sense of control than the aversive condition does, but still less than appetitive condition does. Thus:

H8: When the level of arousing content is controlled, self-reported dominance will be highest for the appetitive condition, followed by coercive condition, and lowest for aversive condition.

Arousal and Emotional Experience

Presence, or spatial presence, is defined as "the sensation of 'being there' in a mediated environment (IJsselsteijn, de Ridder, Freeman, & Avons, 2000, p. 1)," or "the perceptual illusion that a mediated experience is not mediated (Ravaja et al., 2004, p. 340)." Recently, more media researchers are paying attention to this concept, because

they see that “the feeling of presence lies at the center of all mediated experiences (Lee, 2004, p. 27)” – from print to virtual reality. Electronic media which emphasize the interaction with users, such as video games, are thought to be especially effective in eliciting a sense of presence, and ultimately, enjoyment (Green, Brock, & Kaufman, 2004).

A number of studies have explored the relationship between arousal and presence in video game users. A. Lang et al. (1999) has demonstrated that players who were more aroused physiologically also reported to have had a greater sense of presence while playing a violent video game. Schneider et al. (2004) also found that video games that elicited a stronger sense of presence in its users also elicited higher physiological arousal in them. After having all participants play 4 different games that varied in content and in the required set of skills, Ravaja et al. (2004) found that self report for arousal positively correlated with a sense of presence, and for each game, higher difficulty level elicited a stronger sense of presence. Thus:

H9: Arousing content will lead to a greater sense of presence than calm content.

Research on electronic media has shown that arousal is also related to user’s enjoyment. Lombard, Reich, Grabe, Bracken, and Ditton (2000) found that viewing video on larger screen resulted with higher self-reported arousal and higher enjoyment ratings. Ravaja (2004b) explored the effects of motion in television news shown on small screens for hand-held devices, which found that motion was associated with higher self-reported arousal and pleasure.

There are also a number of studies that examined the relationship between arousal and enjoyment with video game users. Schneider et al. (2004) found that video games

that elicit more physiological arousal in participants got higher scores in self-reported positive emotion. Ravaja et al. (2004) also reported that video games that are rated to be more arousing by users were also rated high in the ratings for joy. Thus:

H10: Arousing content will lead to greater sense of enjoyment.

Motivational Activation and MAM

As previously discussed, NB refers to an individual's aversive motivational system activation characteristic as arousal level goes up, and PO refers to the tendency for the appetitive motivational system to be active in a neutral environment (Ito, Larsen, Smith, & Cacioppo, 1998). The Motivation Activation Measure (MAM) is a measure of individual's individual level of motivational activation developed by A. Lang and her colleagues (A. Lang & Lee, 2002; A. Lang, Shin, & Lee, 2005; A. Lang, Wang, & Bradley, 2004). This study used Mini-MAM 2.1 to measure each participant's PO and NB.

When presented with negative stimuli, people higher in NB show larger activation in aversive motivation system than people lower in NB – on the other hand, for all types of stimuli, people higher in PO should show larger activation in appetitive motivation system than people lower in PO (Yegiyan, Bradley, Banerjee, & A. Lang, 2005). Thus,

H11a: During aversive condition, game play participants who are higher in NB will show more activation in the aversive motivation system, indexed by increased corrugator activation, a facilitated startle reflex, and increased self reported negative emotion.

H11b: During all conditions, participants who are higher in PO will show greater activation in the appetitive motivational system, indexed by increased orbicularis oculi, increased self-reported positive emotion, and inhibited startle reflex.

A. Lang and her colleagues have demonstrated that MAM is related to message processing, and risky behavior such as substance usage (A. Lang, Shin & Lee, 2005; A. Lang, Wang, & Bradley, 2004). Although MAM has not been used in a published study to predict media usage yet, A. Lang (2006) has predicted that individuals with high PO are likely to seek out high levels of stimulation (arousing content) and to try out many types of media, including new media. A. Lang (2006) also predicted that individuals with high NB are likely to avoid arousing (particularly arousing and negative) content, and are likely to use traditional media they are used to. This leads to hypotheses 12 and 13:

H12a: Participants who are higher in PO will rate the arousing content of all three motivational conditions more enjoyable than participants who are lower in PO.

H12b: Participants who are lower in NB will rate the arousing content of aversive condition less enjoyable than participants who are lower in NB.

H13a: Participants who are higher in PO will have more experience with video game play than participants who are lower in PO.

H13b: Participants who are lower in NB will have less experience with video game play than participants who are lower in NB.

A. Lang et al. (submitted) has demonstrated that there is an interaction between PO and NB in individual's physiological responses to mediated messages by reporting participants high in both NB and PO showed less startle potentiation when viewing negative pictures than other group of participants (i.e., high NB & low PO, low NB &

high PO, low NB & low PO). This finding suggests that though people with high NB tend to have stronger activation of aversive system when presented with negative stimuli, but those with high PO may show different response from those with low PO because strong activation of the appetitive system can affect their responses. This leads to hypothesis 14:

H14a: Participants who are higher in NB with a higher PO will rate aversive motivational condition more positive than participants who are higher in NB and a lower PO.

H14b: Participants who are higher in NB with a higher PO will show less startle potentiation during aversive motivational condition than participants who are higher in NB with a lower PO.

H14c: Participants who are higher in NB with a higher PO will show larger EMG activity in orbicularis oculi during aversive motivational condition than participants who are higher in NB with a lower PO.

The relationship between individual difference in motivational activation characteristics, arousing content, and subjective experiences in the context of video game play remains unexplored. Hence, research questions 1 and 2 will be explored:

RQ1: Will there be a relationship between motivational conditions in the video game, individual's motivational activation characteristics (PO and NB), and self-reported dominance, presence, and enjoyment?

RQ2: Will there be an interaction among PO and NB and arousing content on self-reported arousal, dominance, presence, and enjoyment?

CHAPTER 3

Methodology

In order to test the above hypotheses, a game was designed and built by the researcher to implement the various gaming conditions in order to elicit the expected motivational states. While playing the game, the physiological responses including heart rate, skin conductance, and facial electromyography (EMG), and secondary task reaction time were recorded. At various times participants reported on their emotional experience during the portion of game they just completed. In addition, individual differences in motivational activation, demographic information, and video game consumption pattern (e.g., hours spent playing video games) were collected.

Design

The overall design for the experiment was a Motivational Condition (3) × Arousing Content (2) × Probe Type (2) × Repetition (5) × Positivity Offset (2) × Negativity Bias (2) mixed design.

Motivational condition, arousing content, probe type, and repetition were within-subjects factors. Positivity offset and negativity bias were between-subjects factors.

Motivational condition represents the three different conditions that are designed to activate the appetitive, aversive or both (coactive) motivational systems of participants. Arousing content had two levels, calm and arousing. Probe type represents acoustic startle probes and acoustic secondary task reaction time (STRT) probes. Repetition represents the five startle probes or the five STRT probes embedded in the different cells

(Motivational Condition x Arousing Content). As a result, there were total of 30 startle probes and 30 STRT probes administered throughout the experiment.

In addition to these startle probes, there were 2 startle probes and 2 STRT probes presented during the practice session, which was the first part of the stimulus presentation, to allow the participants to habituate to the startle probes and practice responding to STRT probes.

The stimulus was a video game custom-built by the researcher using characters from *Star Trek*, a popular television show aired in the United States from 1966 to 1969, which continues to be shown and to be popular 35 years after it was initially broadcast. The game is a typical 2-dimensional vertical shooting game that resembles *Galaga* (Namco, 1981). The design of the video game will be discussed in detail later in this chapter.

Independent Variables

Motivational condition. This experiment attempted to manipulate the pattern of participant's motivational systems activation. There were three patterns this study intended to create: activate the appetitive motivational system, activate the aversive motivational system, and activate both systems.

Literature shows that using certain types of stimuli activates one's motivational systems in certain ways. A number of studies have used still pictures (e.g., Ito, Cacioppo & P. J. Lang, 1998; Ito & Cacioppo, 2005), others have used emotional words (e.g., Ito, Larsen, Smith, & Cacioppo, 1998) and some have used television messages (Yegiyan, S. D. Bradley, Banerjee & A. Lang, 2005) to manipulate motivational system activation.

The stimulus used in this study had three motivational conditions designed to activate subjects' motivation systems in different ways: appetitive condition, aversive condition, and coercive condition. The appetitive condition has no element that threatens the player's character. Under the appetitive condition, the player controls his/her character to gather target objects in a safe environment. This is expected to activate the appetitive motivational system and to have no effect on the aversive motivational system. The aversive condition forces the player's character to avoid hostile objects but will not allow the player to fight back. Since the only action a player can take is avoidance, this condition is expected to primarily activate the aversive motivational system rather than the appetitive motivational system. The last condition, the coercive condition, will allow the player's character and the enemy's characters to fight each other. Since fighting requires both approaching the target (to attack) and avoiding the attack from it, this condition was expected to activate both the appetitive and the aversive motivational systems.

Arousing content. This independent variable had two levels: calm and arousing. Task difficulty, or cognitive demand for a given task is known to correlate with arousal (e.g., Clements & Turpin, 1995; Critchley, Corfield, Chandler, Mathias, & Dolan, 2000; Gellatly & Meyer, 1992; Willemsen, McKeever, & Carroll, 2000). A recent study using a video game as stimulus demonstrated that this is also the case for video gaming by reporting that the more demanding tasks in the video game result in more electrodermal activity, which is commonly used as an index for physiological arousal (Lin, Omata, Hu & Imamiya, 2005).

In order to manipulate the level of arousing content, the difficulty level of the task given was manipulated by varying the number of objects on the screen and their speed across conditions. Calm conditions had three objects moving at slower speed, and arousing conditions had six objects moving at faster speed.

Since there were different types of objects appearing on the screen, the total number of objects appearing on screen was controlled for each type. The maximum number of a certain type of object (enemy ship, enemy torpedo) that can appear on screen was limited, and if an object is removed for any reason (e.g., enemy ship destroyed, torpedo travels across the screen and miss the target), it was replaced so the total number of objects on the screen remains relatively constant most of the time.

Probe Type. There were two different types of probe, startle and STRT, administered during the experiment.

The segments with acoustic startle probes administered the first startle probe 30 seconds after the segment started. The second probe was administered 27 seconds after the first probe. The intervals for third, fourth, and fifth probe were 24 seconds, 26 seconds, and 23 seconds. The decision to administer acoustic startle probes at an average interval of 25 seconds is based on studies that use this measure – for example, the interval between acoustic startle probes for Light and Braff's (2001) study ranged from 24 to 28 seconds, and the interval in Drobles, Miller and Hillman et al. (2001) ranged from 13.5 to 28.5 seconds. David J. Drobles also suggested that “every 20-25 seconds sounds like the right ballpark” (personal communication, August 29, 2005).

In order to be consistent with startle probes, STRT probes during the STRT segments were administered at the exact same intervals as the startle probes during the

startle segments. This also ensured the total length of segments with startle probes and STRT probes was kept the same.

Positivity Offset (PO). This between-subjects factor represents the resting level of activation in a participant's appetitive motivation system. Each participant's estimate for PO was calculated using Mini-MAM (A. Lang et al., 2004). See Figure 3-1. Participants were then divided into two groups – low-PO and high-PO groups – using a median split on their PO estimates.

As shown in Table 3-1, the PO of the participants in this study ranged from -.786 to 5.286. This is slightly narrower than the range of currently available data for Mini-MAM 2.0 ($N = 276$), and even more narrow than the range of accumulated data collected for MAM ($N = 427$). However, considering the small number of participants ($N = 80$) in this study, difference in the range is rather expected. The frequency distribution of PO was a normal curve and is shown in Figure 3-2.

The mean of the participant's PO was 2.346, which was closer to that of MAM data ($M = 2.35$) than that of Mini-MAM 2.0 ($M = 2.21$). The median of the participant's PO was 2.643, which is also closer to that of MAM data ($Median = 2.50$) than that of Mini-MAM 2.0 ($Median = 2.07$). See Table 3-1.

In order to answer questions of whether individual differences in motivational traits affect processing of mediated messages, a median split by PO was done to divide participants to two groups: high PO and low PO groups. A t-test confirmed that high PO and low PO groups had significantly different PO values ($t(78) = -12.666, p < .001$). Another statistical test was conducted to find if these high PO and low PO groups differ in another motivational trait, negativity bias (NB). More discussion about NB will take

place immediately after this section. The t-test revealed that these two groups do not significantly differ in their NB values ($t(78) = -1.095, p = .277$). The mean PO and NB for High and low PO groups are shown in Table 3-2.

Negativity Bias (NB). This between-subjects factor represented the participant's aversive system activation characteristic, or, the speed with which their aversive system activates in the presence of moderately negative stimuli. Like PO, the estimate for each participant's NB was also calculated based on each participant's response to the MAM survey (see Figure 3-1). Responses of high-NB and low-NB groups were compared against each other.

The NB of the participants in this study ranged from .571 to 6.143. See Table 3-1. This is slightly narrower than the range of currently available accumulated data for MAM, and even narrower than the range of accumulated data collected for Mini-MAM 2.0.

The mean of participant's NB was 3.818, which was midway between the MAM data ($M = 4.12$) and the Mini-MAM 2.0 data ($M = 3.64$). The median of participant's NB was 3.929, which, again, is between that of MAM data ($Median = 4.17$) and Mini-MAM 2.0 ($Median = 3.71$). The frequency distribution of NB was a normal curve is shown in Figure 3-2.

To explore whether individual differences in NB affect processing of mediated messages, a median split by NB was done to divide participants to two groups: high NB and low NB groups. A t-test showed that high NB and low NB groups are significantly different in their NB values ($t(78) = -13.132, p < .001$), but not in their PO values ($t(78) = -1.663, p = .100$). The mean PO and NB for High and low NB groups are shown in Table 3-3.

<p>PO = (Average Positivity Ratings of Positive Pictures at Arousal Level 6)</p> <p>- (Average Positivity Ratings of all Pictures at Arousal Level 1)</p> <p>NB = (Average Negativity Ratings of Negative Pictures at Arousal Level 3 and 4)</p> <p>- (Average Negativity Ratings of all Pictures at Arousal Level 1)</p>

Figure 3-1. Formula for calculating PO and NB using MAM and Mini-MAM (A. Lang, Wang, & Bradley, 2004, p. 3)

	MAM	Mini-MAM 2.0	Current Study (Mini-MAM 2.1)
Participants (N)	427	276	80
Positivity Offset			
Mean	2.35	2.21	2.346
Median	2.50	2.07	2.643
Range (Min/Max)	.1/6.77	-2.79/6.07	-.786/5.286
Percentile			
25	1.07	.93	1.21
50	2.50	2.07	2.64
75	3.73	3.50	3.43
Negativity Bias			
Mean	4.12	3.64	3.818
Median	4.17	3.71	3.929
Range (Min/Max)	-.22/6.23	-.86/6.93	.571/6.143
Percentile			
25	3.38	3.00	2.80
50	4.17	3.71	3.93
75	5.00	4.54	4.84

Table 3-1. Comparison of the distribution of participants' PO and NB from this study and other studies using MAM and Mini-MAM 2.0

Estimated Marginal Means of Positivity Offset

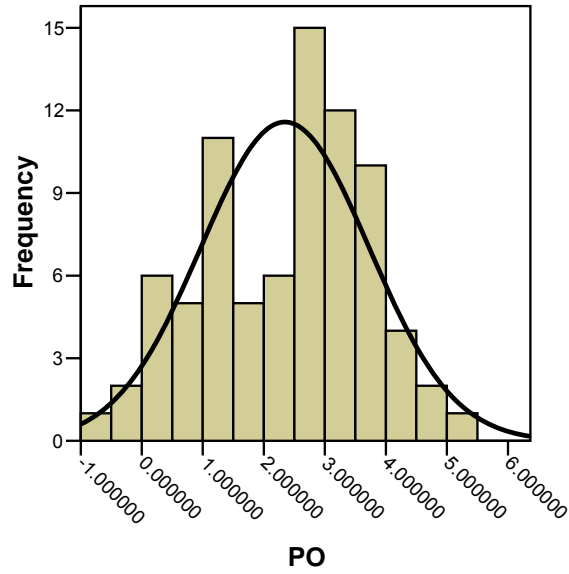


Figure 3-2. Frequency distribution of participants' positivity offset for this study

Estimated Marginal Means of Negativity Bias

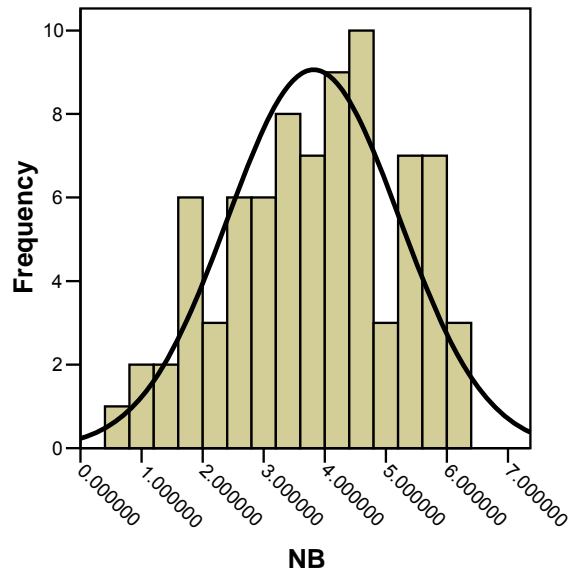


Figure 3-3. Frequency distribution of participants' negativity bias for this study

	Mean PO	SD	Mean NB	SD
Low PO	1.251	.920	3.650	1.562
High PO	3.498	.632	3.995	1.223

Table 3-2. Mean values of PO and NB for Low PO and High PO groups.

	Mean PO	SD	Mean NB	SD
Low NB	2.099	1.161	2.685	.887
High NB	2.606	1.547	5.009	.676

Table 3-3. Mean values of PO and NB for Low NB and High NB groups.

Dependent Variables

Heart rate (HR). A large body of literature shows that when used under proper conditions (e.g., participants not engaging in aerobic activity), variation in participant's heart rate can be used as a reliable index for internal/external attention to the stimulus (see A. Lang, 1994; also see Ohman, Hamm, & Hugdahl, 2000). This study used HR as an index for external attention, or information intake, during stimulus presentation.

The procedure for collecting HR involved abrading participants' skin with a paper towel moistened with rubbing alcohol. After the sites for electrode attachment were cleaned, three Ag-AgCl electrodes (sensor diameter: 8mm, housing diameter: 16 mm, gel cavity: 2 mm deep), manufactured by In Vivo Metric (Healdsburg, California), filled with non-saline conducting gel were attached. Two of these electrodes were placed on the left and right forearms, between the wrist and the elbow. One electrode was placed on the wrist of the non-dominant arm.

All physiological data, except for startle response, were collected for the entire 150 seconds for each segment of the stimulus. Heart rate was stored as milliseconds between beats (inter-beat intervals, or IBI), and then converted into beats per minute and averaged over five second intervals for analysis.

Skin Conductance Response (SCR). Skin conductance is a well-established measure of the sympathetic arousal (citation) and was used as an index for participant's physiological arousal (Schmidt & Walach, 2000; for a review see Dawson, Schell & Filion, 2000). Physiological arousal was measured by scoring the magnitude of SCRs offline. Skin conductance measured on the sole of the foot indexes activity of the eccrine sweat glands, which are directly linked to the sympathetic nervous system, hence used as an index of physiological arousal (Dawson et al., 2000).

The procedure for collecting SCR data involved cleaning participants' skin with a paper towel moistened with distilled water to control hydration, and then attaching two Ag-AgCl electrodes (sensor diameter: 8mm, housing diameter: 16 mm, gel cavity: 2 mm deep), manufactured by In Vivo Metric and filled with an electrically neutral medium as suggested by Dawson et al. (2000). The electrodes were attached to the arch of the participant's foot. The analog signal from the electrodes was sampled at 50 Hz, and then stored to a computer.

Secondary Task Reaction Time (STRT). STRT is used as an index for available cognitive resources of the participant (A. Lang, S. D. Bradley, Park, Shin & Chung, in print). The secondary task given to the participants was to listen for an audio tone and push one of the designated buttons on the game pad with one of their index fingers. To play the game used as the stimulus for this study, participants needed to control their character using only both thumbs, and the game controller was designed to accept input from either index finger in response to the STRT probes.

The STRT probe was a computer-generated 1,000 Hz tone that was 250 milliseconds long. The STRT probe was heard through headphones, through which

participants also heard the sound effects from the game and startle probes during segments that collected startle data.

Based on the recommendation by Crabtree and Antrim (1988), all segments with STRT probes displayed a screen notifying participants to have the participants prepared to respond to the audio probes. Specifically, the following instructions were given:

“During this session, you will hear audio tones ("beep"). When that happens, please respond to it by pressing one of the four buttons that is accessible with your index finger (left or right hand). Those game pad buttons are numbered 5 to 8.

However, keep in mind that your primary task is to carry out your mission! Responding to the audio tone is a secondary task.”

Eyeblink Startle Response (SR). SR was used as an index for aversive system activation of the participant.

Based on the *Guidelines for human startle eyeblink electromyographic studies* published by the Society for Psychophysiological Research (Blumenthal, Cuthbert, Filion, Hackley, Lipp, & Boxtel, 2005), a short and loud burst of white noise (50 milliseconds at 100 decibels) was used as an acoustic startle probe. The startle probe was heard through headphones, through which participants also heard sound effects from the stimulus and STRT probes during segments that collected STRT data.

The procedure for collecting SR data involved cleaning participants' skin right below their left eye, underneath which the *orbicularis oculi* muscle group is located. To ensure the conductivity level was high enough for small electrodes to pick up the EMG

data from the *orbicularis oculi* muscle group, a very small amount of non-saline conducting gel was applied to the skin to keep the moisture level of the skin surface from dropping too low, which would negatively affect the conductivity and collection of EMG data. Then two small Ag-AgCl electrodes (sensor diameter: 4mm, housing diameter: 11 mm, gel cavity: 2 mm deep), manufactured by In Vivo Metric, filled with non-saline conducting gel were attached horizontally under the participant's left eye. The analog signal from the electrodes was sampled at 1,000 Hz, and then stored to a computer.

Before the segment with startle probes started, participants were given the following instructions:

“During this session, you will hear short bursts of white noise ("psst").

Please ignore the noise and concentrate on playing the game.”

Data collection for each SR trial started 50 milliseconds before the acoustic startle probe onset, and continued for 250 milliseconds after the onset. The first 50 milliseconds served as a baseline to calculate the magnitude of the SR.

Facial EMG (Corrugator Supercilii & Orbicularis Oculi).

Facial electromyography (EMG) is a direct measure of the electrical activity that occurs in the facial muscle being measured. Electrical activity varies continuously in muscles even in the absence of contraction. Measurement of the facial EMG activity of the muscle groups that are related to emotional expression is an established index of positive or negative emotions. The three muscle groups that are widely used for this purpose are: the frowning muscles (*corrugator supercilii* muscle group), the smiling muscles that pull the lips (*zygomaticus major* muscle group), and the muscles under the eye lids that activate when one smiles (*orbicularis oculi* muscle group). A number of

studies have used facial EMG as an index of the participant's emotional response to photographs (e.g., P. J. Lang, Greenwald, M. M. Bradley, & Hamm, 1993; 19, 29), audio clips and English words (e.g. Bolls, A. Lang, and Potter 2001; Larsen, Norris, & Cacioppo, 2003), and video clips (e.g., Ravaja, Kallinen, Saari, & Keltikangas-Järvinen, 2004; Yegiyani et al., 2005).

To date, only few studies have measured facial EMG during video game research. Rajava and his colleagues claimed that “[prior to this study,] video game studies have not used psychophysiological measures of emotional valence, such as facial EMG” (Rajava, Saari, Laarni, Kallinen, & et al., 2005, p.3). Recently, Park (2006) and Hazlett (2006) have separately suggested that facial EMG would be a useful measure for tracking emotional responding during video game play.

The EMG of the *corrugator supercilii* muscle group was used as an index of activation in participant's aversive motivational system. The EMG activity of the *corrugator supercilii* muscle group has shown to correspond with negative, or aversive emotion (M. M. Bradley, 2000; M. M. Bradley, Codispoti, Cuthbert et al., 2001).

The procedure for collecting EMG data of the *corrugator supercilii* muscle group involved cleaning participants' skin right above their left eye brow using a cloth alcohol pad. Again, to ensure the conductivity level was high enough for small electrodes to pick up the EMG, a very small amount of non-saline conducting gel was applied to the surface to raise the moisture level of the skin surface. Then two small Ag-AgCl electrodes, identical to those used for collecting SR data, filled with non-saline conducting gel were attached above the target muscle group. The EMG data were sampled at 50 Hz and stored to a computer.

The EMG of the *orbicularis oculi* muscle group was used as an index of the activation in participant's appetitive motivational system. As explained in Chapter 2, EMG of the *orbicularis oculi* muscle group was chosen over *zygomaticus major* muscle group's because the *orbicularis oculi* muscle group is involved in the involuntary drawing up of the corner of the eyes in smiling (the *Duchene smile*), making it a reliable index for positive emotion.

EMG data of the *orbicularis oculi* muscle group were collected using the very same electrodes that collected SR data. The data collection computer was instructed to sample data from the electrodes attached over the *orbicularis oculi* muscle group at two different sampling rates and store them separately. The EMG data of *orbicularis oculi* muscle group were sampled at 50 Hz. EMG during the startle probe time period is not included in the data when examining appetitive system activation because of the eye blink.

Self Report Measures. After each segment of the stimulus was over, participants were asked to rate on a 9-point scale how they felt during the segment for: positive emotion, negative emotion, arousal, dominance, presence, and enjoyment. Following each segment, questions appeared on the screen, which participants used a computer mouse to respond to by clicking on the button that represented his/her emotional reaction during that segment. The format of the questionnaire was consistent across all 5 questions in its layout, identical to the layout used in the computerized MAM instrument. See Appendix B for screen layout and the wording of questions asked for each self-emotion scales.

Stimulus Creation and Design

The stimulus material was a video game with multiple levels (segments), which vary in motivational and arousal conditions. The video game was a traditional 2-dimensional shooting game with vertical orientation. Examples of this type of video game are *Space Invaders* (Taito, 1978), *Galaga* (Namco, 1981), and *Exerion* (Taito, 1982). *Xevious* (Namco, 1982), *1943 – The Battle of Midway* (Capcom, 1987), *Raiden* (Seibu Kaihatsu, 1990), *Air Blade* (Sammy, 1999), *Psyvariar* and *Psyvariar 2: The Will to Fabricate* (Success Corporation, 2000 & 2003) also fall under this category, this game used a computer graphic technique that scrolls the background image to improve and enhance the feeling that the player's character is moving forward.

The video game created for this study used characters from the television show *Star Trek*. In *Star Trek*, the story evolves around main characters who are on board the starship the *U.S.S. Enterprise* (NCC-1701). Participants controlled the actions of the starship in the video game (stimulus). Participants could maneuver their starship to the left or to the right in order to either avoid incoming objects or approach targets. The appetitive condition and the coactive condition allowed participants to have their starship fire projectiles toward targets. Targets in the appetitive condition were dillithium crystals, an imaginary energy source in *Star Trek*. Targets in the coactive condition were *Klingon* battle cruisers, which appear as enemy ships in the same television show.

As shown in Figure 3-4, the main part of the video game (2. *Game Play*) had twelve segments. Each of the three different motivational conditions had four segments each. For each motivational condition, two segments had arousing content and the other two segments had calm content. Among the two segments from the same motivational

condition with arousing/calm content, one included only STRT probes and the other included only startle probes.

To ensure 5 startle probes or STRT probes administered at an average interval of 25 seconds, and other physiology data to be collected for 150 seconds, each segment was set to be played for at least 150 seconds. Total game play time for all 12 segments took minimum of 30 minutes. In addition, participants had to read instructions for playing each segment and respond to questions about their emotional experience during each segment.

Apparatus

The stimulus (video game) was presented on a Gateway computer (Model E-3400) with a 996MHz Pentium 3 central processor unit, 512 MB main memory, ATI Rage Fury Pro video card, and Windows XP Professional with Service Pack 2 (Microsoft, 2004). Display unit was a 17 inch cathode ray tube monitor (Gateway VX720). The screen resolution was set to 1024×768 pixels for the whole procedure.

Two input devices were used for this study. For performing the task (playing game), participants were instructed to use a game pad (Logitech Dual Action Gamepad, Model 963292-0403). For rating their emotions after completing each segment, participants were instructed to use a standard computer mouse.

- 1. Mission Briefing (2 startle probes & 2 STRT probes)
- 2. Game Play
 - 2-1. Appetitive condition (Capture dillithium crystals)
 - 2-1-1. Positive-Calm
 - 2-1-1-a. Positive-Calm with 5 STRT probes
 - 2-1-1-b. Positive-Calm with 5 startle probes
 - 2-1-2. Positive-Arousing
 - 2-1-2-a. Positive-Arousing with 5 STRT probes
 - 2-1-2-b. Positive-Arousing with 5 startle probes
 - 2-2. Aversive condition (Avoid enemy's attack)
 - 2-2a. Negative-Calm
 - 2-2-1-a. Negative-Calm with 5 STRT probes
 - 2-2-1-b. Negative-Calm with 5 startle probes
 - 2-2b. Negative- Arousing
 - 2-2-2-a. Negative-Arousing with 5 STRT probes
 - 2-2-2-b. Negative-Arousing with 5 startle probes
 - 2-3. Coactive Condition (Fight against enemy's space crafts)
 - 2-3a. Coactive-Calm
 - 2-3-1-a. Coactive-Calm with 5 STRT probes
 - 2-3-1-b. Coactive-Calm with 5 startle probes
 - 2-3b. Coactive- Arousing
 - 2-3-2-a. Coactive-Arousing with 5 STRT probes
 - 2-3-2-b. Coactive-Arousing with 5 startle probes
- 3. Return to base

Figure 3-4. The structure of the stimulus (video game)

Participants and Procedure

Participants in this experiment were 80 (44 male, 36 female) students from undergraduate Telecommunications courses at Indiana University, Bloomington, participating for course credit. The average age was 20.99 years old ($SD = 1.69$).

Three participants identified themselves as Asian; one identified himself as Hispanic; three participants identified themselves as black or African American; seventy-two participants identified themselves as white, and one participant identified himself as other. All participants gave informed consent as approved by the Indiana University Human Subjects Committee, study #05-10590. Due to equipment or experimenter error, a few participants were excluded from analysis for some dependent variables. One participant was not included for dependent variables based on facial EMG (i.e., *corrugator supercilli* EMG, *orbicularis oculi* EMG & startle magnitude). Two participants were not included for heart rate analysis. For other dependent variables, all eighty participants' data were used for analysis.

The author ran the experiment sessions for each subject individually. After providing informed consent, participants were seated in a comfortable chair with leg rest adjusted to keep their feet, to which electrodes were attached, from touching the floor. The experimenter explained about the electrodes and attached them to the participant. After the participant indicated that he or she was ready to begin, the experimenter gave instructions about using the input device (game pad) and initiated the practice session. Once the participant completed the practice session, the experimenter asked whether the participant had any questions and answered them if she or he had any. Then the experimenter told the participant to initiate the stimulus after he left the room.

The physiological data collection was controlled by transistor-transistor-logic (TTL) signals sent out from the stimulus presentation computer's parallel port. Upon receiving this signal, the data collection software either started or ended physiological data collection for that segment. During the practice session, all participants were exposed to 2 startle probes to have them habituate the SR.

The stimulus presentation (including video game play and self report of their emotional responses) lasted for approximately 45 minutes. After the stimulus presentation was over, the experimenter returned and removed all electrodes. Then the experimenter initiated the computer survey software, *MediaLab 2004* (Empirisoft, 2004), where participants completed a series of computerized surveys: MAM 2.1, questionnaire on their video game usage, and demographic questions.

After the video game play is over, participants were thanked and dismissed.

Data Reduction and Analysis

The heart rate data were initially collected as Inter-Beat Interval (IBI) in milliseconds. IBI is the duration between heartbeats, and for this experiment, the interval between R spikes of the QRS complex of electrocardiogram (ECG), which is the result of depolarization of the ventricles (Stern, Ray, & Quigley, 2001). After all data were collected, the IBI data were inspected and converted to beats per minute (BPM) by VPMEVENT 6.9 (Cook, 2003), a computer program designed to edit and reduce aperiodic physiological data such as heart rate. Occurrences of missed beats (equipment not detecting the R spike) or double beats (equipment recording other spikes as the R spike) were corrected: double beats were combined into a single beat, and missed beats were replaced with the average inter beat interval for that period (A. Lang, 1994).

After editing the HR data, data collected for 1.5 seconds after onset of audio probes (i.e., startle and STRT probes) were replaced by data surrounding that period. The first 0.5 second's HR was replaced with the value of the preceding 0.5 second's, and the third 0.5 second's HR was replaced with the value of the following 0.5 second's. The second 0.5 second's HR was replaced with the average of the new values for the first 0.5 second's and the third 0.5 second's HR data. This was an effort made to minimize the influence of audio probes.

Then the HR change score for each data point was obtained by subtracting it from the baseline for that segment. For each segment the baseline used was the average of the last second during the 5-second baseline period immediately preceding each segment.

The HR change score data were averaged over five-second periods for analysis. Physiological data collection for each segment lasted for 150 seconds, resulting in a total of 30 five-second periods per segment.

Skin conductance collected from the subject was passed to a Coulbourn Skin Conductance module, where skin conductance level was sampled and recorded 20 times per second for 150 seconds throughout each segment of stimulus presentation. This data were coded offline using VPMANLOG 7.0 (Cook, 2003), a computer program designed to process analog physiology data (that are converted to digital format) such as skin conductance and EMG data. Spontaneous skin conductance responses (SCRs) greater than .10 microsiemens was scored to obtain the frequency of SCRs per segment.

The EMG data from the *orbicularis oculi* and the corrugator supercilli muscle groups were also sampled at 20 times per second for 150 seconds for each segment. VPMANLOG 7.0 (Cook, 2003) was used to get the average activation level for each half

second during the entire 150 seconds of stimulus presentation for per segment. In an effort to minimize the influence of audio probes (i.e., startle and STRT probes) on facial EMG data, the data collected for 1.5 seconds after onset of these audio probes were replaced by data surrounding that period. The first 0.5 second's EMG datum was replaced with the value of the preceding 0.5 second's, and the third 0.5 second's EMG datum was replaced with the value of the following 0.5 second's. The second 0.5 second's EMG datum was replaced with the average of the new values for the first 0.5 second's and the third 0.5 second's EMG data.

Then each data point was converted to change score by subtracting the baseline value with its value. The mean of facial EMG data collected during the last 0.5 second of the baseline period was used as the baseline value. Use of change score for facial EMG was part of the effort to eliminate effects from individual differences. These change scores were then averaged over five-second periods like the HR data, resulting with total of 30 five-second periods per segment.

For eyeblink startle responses, the physiological response collected to measure the startle reflex (SR), is the EMG data from the *orbicularis oculi* muscle group. These data were collected at a sampling rate of 1,000 Hz, or 1,000 times a second. VPMANLOG 7.0 (Cook, 2003). The size of the SR data was scored offline using an algorithm that converts each trial into a magnitude score using analog-to-digital units (Balaban, Losito, Simons, & Graham, 1986).

Secondary Task Reaction Time (STRT) data, recorded in milliseconds, were analyzed after processing missing data and outliers. Response times beyond the range of 3 times of the interquartile range (IQR) from the 75th percentile were identified as

outliers. A cut-off procedure (truncation) was performed on all outliers, using the largest reaction time value within the range of 3 times of the interquartile range (IQR) from the 75th percentile (for discussion, see Ulrich & Miller, 1994). Treating outliers this way, rather than removing them, is preferable (Stevens, 2002). Missing data was a result of failure to respond to the STRT probe in 3,000 ms. This limit is based on the observation that typical psychology experiments consider reaction times longer than 500 ms to be long (Ratcliff, 1993). For this reason, missing data were seen as extreme outliers over 3,000ms, and replaced by the same value used for the truncation of other outliers.

CHAPTER 4

Results

Hypothesis 1a: Motivational Activation and External Attention

This hypothesis predicts that for both arousing and calm conditions, participants would show the slowest heart rate (HR) during the appetitive condition, followed by the coactive condition, and the fastest HR during the aversive condition.

The statistical test was conducted with a 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) mixed design analysis of variance (ANOVA) on the HR data. The main effect for motivational condition was significant ($F(2,154) = 34.005, p < .001, \text{partial } \eta^2 = .306$). The interaction of motivational condition \times time, as shown in Figure 4-1, was also significant ($F(58,4466) = 5.767, p < .001, \text{partial } \eta^2 = .070$). As expected, participants' HR was in the middle for the coactive condition. However the appetitive and aversive conditions were reversed with participants having the slowest HR during the aversive condition, and the fastest HR during the appetitive condition (see Table 4-1). A perusal of Figure 4-1 shows that the differences between conditions developed in the first 25 seconds and remained stable through the rest of the game playing segment.

Motivational Condition	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	-3.950	.611	-4.279	.825
Aversive	-9.483	.709	-9.778	.654
Coactive	-8.438	.725	-7.346	.797

Table 4-1. Change score of HR for each motivational condition.

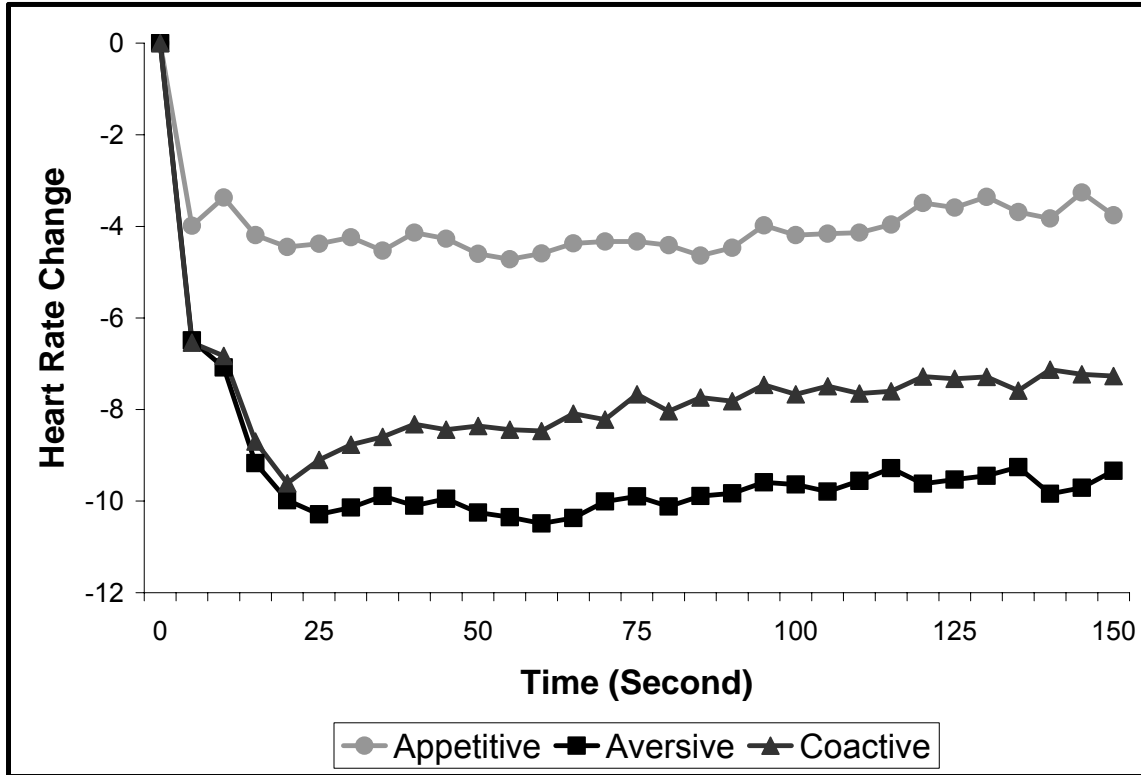


Figure 4-1. Motivational condition x Time on Heart Rate.

Hypothesis 1b: Arousing Content and External Attention

This hypothesis predicts that arousing content should elicit slower heart rate than calm content for all three conditions. The statistical test used a 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) × 30 (Time) mixed design ANOVA which revealed that the main effect of arousing content was not significant ($F < 1$). Thus, arousing content did not significantly alter heart rate deceleration overall.

Hypothesis 1c: Interaction of Motivational Activation × Arousing Content on External Attention

This hypothesis predicts that there would be a 2-way interaction of motivational condition × arousing content, which was not significant ($F(2,154) = 1.119, p = .329$), or a

3-way interaction of motivational condition \times arousing content \times time, which was significant ($F(58,4466) = 1.729, p = .001, \text{partial } \eta^2 = .022$) on HR. This interaction is shown in Figure 4-2. As can be seen in the figure, this interaction is driven by the fact that arousing or calm content seems to matter the most in the coactive condition.

The arousing content \times time interaction was further examined for each motivation condition separately. Thus for each motivational condition, a 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA was conducted on the HR data. These condition-specific main effects of arousing content on HR were not significant though the coactive condition approached significance (appetitive and aversive conditions: both $F < 1$, coactive condition: $F(1,77) = 1.940, p = .168$). The interaction of arousing content \times time on HR was significant for the appetitive condition ($F(29,2233) = 1.908, p = .002, \text{partial } \eta^2 = .024$) and is shown in Figure 4-3, but not for the aversive ($F(29,2233) = 1.091, p = .338$) or coactive conditions ($F(29,2233) = 1.196, p = .217$).

The significant overtime interaction for the appetitive condition seems to be driven by the greater initial deceleration for arousing compared to calm content. The lack of an overtime interaction and the nearly significant main effect of arousing content in the coactive condition suggest that the greater heart rate acceleration for the arousing condition takes place early and is present throughout the session. Despite the marginal significance of the coactive condition, these results suggest that arousing content during coactivation may result in increased heart rate during arousing content which may be indicative of increased arousal more than decreased attention whereas in the appetitive condition, arousing content initially sparks greater deceleration (or attention). In the aversive condition, there is no evidence that arousing content affects attention. Many

things trying to kill you are not significantly more worthy of attention than a single thing trying to kill you.

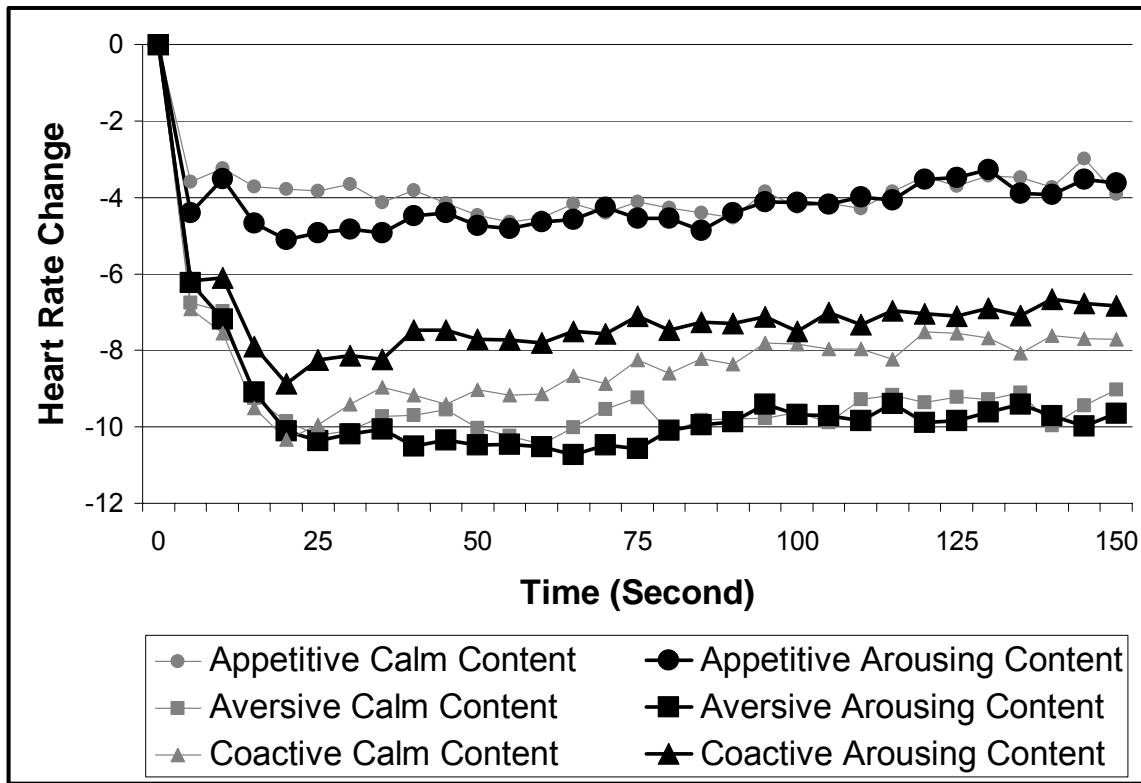


Figure 4-2. Motivational Condition \times Arousing Content \times Time on Heart Rate.

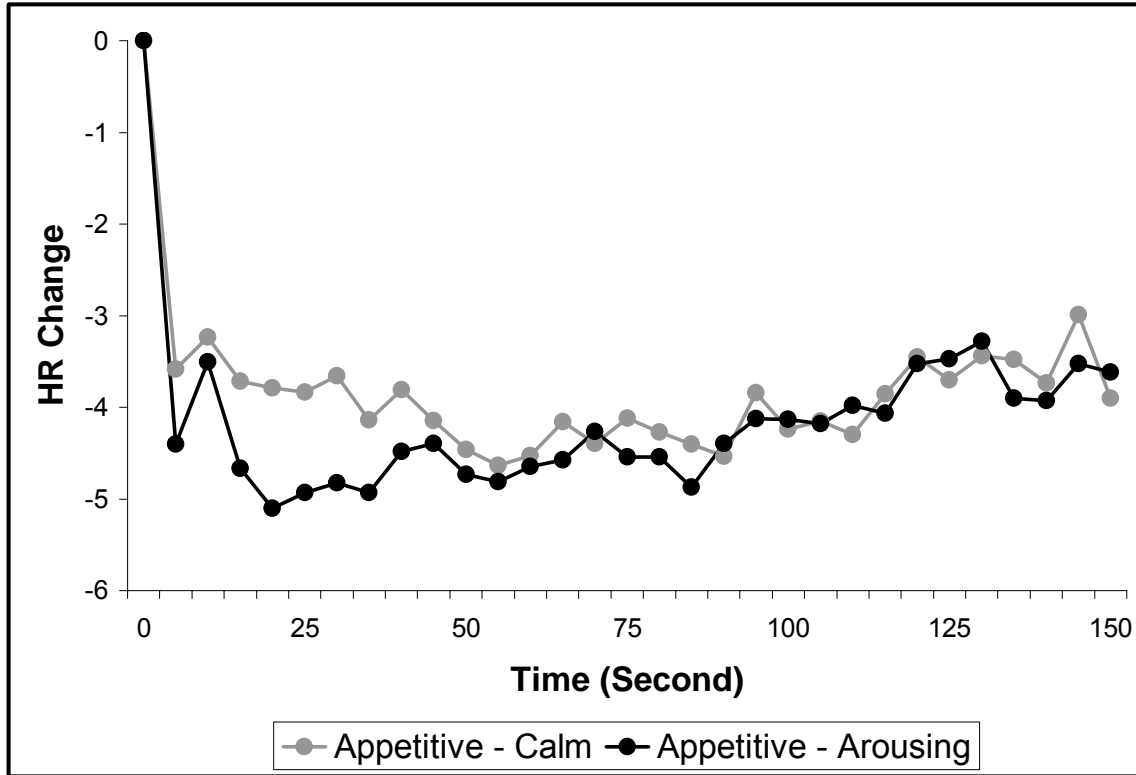


Figure 4-3. HR change over time for calm content and arousing content during appetitive condition.

Hypothesis 2a: Motivational Activation and Physiological Arousal

This hypothesis predicts that the number of skin conductance responses (SCRs) would be smaller for the appetitive condition, and larger for the aversive and the coactive condition, no differences were predicted between the aversive and the coactive condition.

A 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) mixed design ANOVA was run on the SCR data. The main effect for motivational condition was significant ($F(2,158) = 2.947, p = .055, \text{partial } \eta^2 = .036$). As expected, there were the fewest SCRs during the appetitive condition, followed by the coactive and then the aversive condition. See Table 4-2. A post-hoc test using 2 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) mixed design ANOVA was conducted to find

which pair of motivational conditions had significant differences. The difference between appetitive and aversive conditions was significant ($F(1,79) = 6.999, p = .010$, partial $\eta^2 = .081$). The difference between aversive and coactive conditions was also significant ($F(1,79) = 3.899, p = .052$, partial $\eta^2 = .047$). The difference between appetitive and coactive conditions was not significant ($F < 1$).

Motivational Condition	<i>M</i>	<i>SE</i>
Appetitive	7.391	.615
Aversive	8.244	.547
Coactive	7.509	.688

Table 4-2. Number of SCRs for each motivational condition.

Hypothesis 2b: Arousing Content and Physiological Arousal

This hypothesis predicted that the number of SCRs would be larger for all motivational conditions with arousing content compared to those with calm content. The main effect for arousing content approached significance ($F(1,79) = 3.52, p = .064$, partial $\eta^2 = .043$). See Table 4-3. The lack of significance is likely due to the interaction between motivational condition and arousing content, which will be reported below.

Motivational Condition	Calm Content		Arousing Content		Difference (Arousing - Calm)
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	
Appetitive	8.206	.636	6.575	.636	-1.631
Aversive	8.019	.544	8.469	.600	.450
Coactive	7.494	.712	7.525	.706	.031

Table 4-3. Difference in numbers of SCRs between arousing content and calm content for each motivational condition.

Hypothesis 2c: Interaction of Motivational Activation × Arousing Content on Physiological Arousal

This hypothesis predicts that arousing content should elicit more SCRs than calm content across all three motivational conditions, where the difference in number of SCRs between arousing and calm content will be smaller for the appetitive condition, and larger for coactive condition and aversive condition. This is tested by the 2-way interaction of motivational condition and arousing content on SCR.

A 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) ANOVA revealed a significant two way interaction of motivational condition and arousing content ($F(2,158) = 11.385, p < .001, \text{partial } \eta^2 = .126$) and is shown in Figure 4-4. The means are shown in Table 4-3. As expected, there were more SCRs for arousing compared to calm content for the aversive and coactive conditions. However, for the appetitive condition, there were more SCRs for the calm condition. This suggests that during the appetitive condition, the arousing condition was actually less arousing than the calm condition. In retrospect, when faced with this result, it seems likely that this may be a difficulty related effect. Having more dilithium crystals available on screen in the arousing condition may actually have made the task easier rather than harder. This possibility will be explored in detail in the discussion section.

Hypothesis 2c also predicts that there will be no significant difference in the SCRs between coactive condition and aversive condition. 2 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) mixed design ANOVA was conducted to compare the frequency of SCRs in the aversive and coactive conditions. As predicted, the

interaction of motivational condition × arousing content on SCR was not significant ($F < 1$).

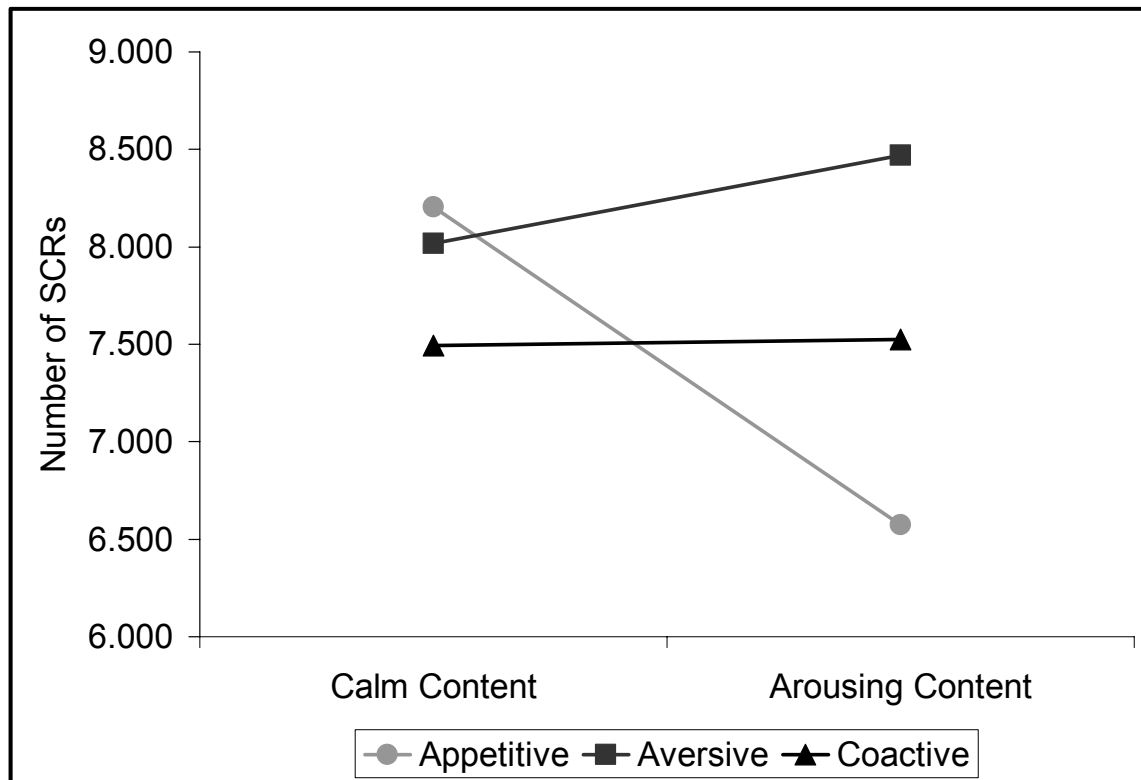


Figure 4-4. Motivational Condition x Arousing Content on SCR

*Hypothesis 3a: Motivational Activation and Cognitive Resources Available Processing
Calm Content*

This hypothesis predicted that for calm content, the length of secondary task reaction times (STRTs) would be longest for the coactive condition, followed by the appetitive condition, and shortest for the aversive condition.

The 3 (Motivational Condition) × 5 (Repeat) mixed design ANOVA was run on the data collected during segments with calm content. The main effect for motivational condition was significant ($F(2,158) = 65.450, p < .001, \text{partial } \eta^2 = .453$). As predicted,

the average length of STRTs was in the order of coactive condition > appetitive condition > aversive condition. See Table 4-4.

Motivational Condition	<i>M</i>	<i>SE</i>
Appetitive	654.283	14.842
Aversive	620.605	21.569
Coactive	803.560	22.125

Table 4-4. Mean STRT for each motivational condition with calm content

Hypothesis 3b: Arousing Content and Cognitive Resources Available Processing

Arousing Content

This hypothesis predicted that for arousing content, STRTs would be longest for the appetitive condition, followed by the coactive condition, and shortest for the aversive condition. Again, the 3 (Motivational Condition) × 5 (Repeat) mixed design ANOVA was run on data collected during segments with arousing content.

The main effect for motivational condition was significant ($F(2,158) = 51.288, p < .001$, partial $\eta^2 = .394$). As expected, mean STRT during the coactive condition was longer than the aversive condition. However, the appetitive condition had fastest STRT. See Table 4-5. The results for both hypothesis 3a and hypothesis 3b should be interpreted in light of the lack of arousal elicited by the appetitive condition’s arousing content, which will be explored in the discussion section.

Motivational Condition	<i>M</i>	<i>SE</i>
Appetitive	638.298	14.594
Aversive	702.640	21.487
Coactive	822.880	24.942

Table 4-5. Mean STRT for each motivational condition with arousing content

Hypothesis 4: Motivational Activation and Appetitive System Activation Indexed by Orbicularis Oculi EMG

This hypothesis predicts that for both levels of arousing content, the electromyographic (EMG) activity of orbicularis oculi will be largest for the appetitive condition, followed by the coactive condition, and smallest for the aversive condition.

The 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) was run on the OO data. The main effect for motivational condition was significant ($F(2,156) = 4.447, p = .013, \text{partial } \eta^2 = .054$). As predicted, the orbicularis oculi activity was higher for appetitive condition ($M = -.170, SE = .036$) than for the coactive condition ($M = -.302, SE = .081$). However, the orbicularis oculi activity was highest during the aversive condition ($M = -.128, SE = .026$), which was not predicted.

The interaction of motivational condition \times time was also significant ($F(58,4524) = 1.754, p < .001, \text{partial } \eta^2 = .022$). As shown in Figure 4-5, the magnitude of orbicularis oculi EMG was largest for the first 50 seconds, as predicted by the hypothesis.

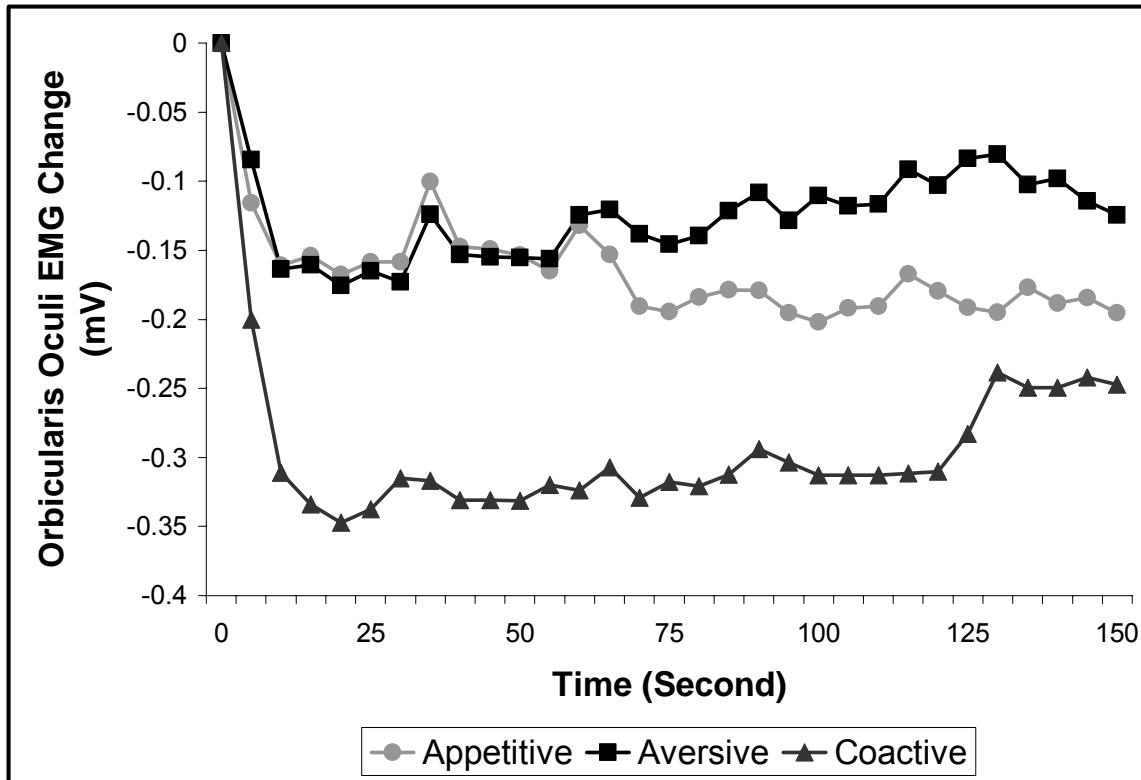


Figure 4-5. Motivational condition x Time on Orbicularis Oculi EMG.

Hypothesis 5: Motivational Activation and Aversive System Activation Indexed by Startle Reflex

This hypothesis predicts that for both levels of arousing content, the magnitude of eyeblink startle reflex (SR) will be largest for the aversive condition, smaller for the coactive condition, and smallest for the appetitive condition.

The 3 (Motivational Condition) × 2 (Arousing Content) ANOVA was run on the startle data, there was a significant main effect for motivational condition ($F(2,152) = 136.445, p < .001, \text{partial } \eta^2 = .642$). As expected, the magnitude of SRs was larger for the aversive condition than the other two motivational conditions. See Table 4-6.

Although the mean SR magnitude was slightly larger for the appetitive condition than the coactive condition, which was not predicted by this hypothesis, a statistical test comparing the SRs from these two conditions with a 2 (Motivational Condition) \times 2 (Arousing Content) ANOVA revealed that the main effect for the motivational condition was not significant ($F(1,76) = 1.750, p = .190$).

Motivational Condition	<i>M</i>	<i>SE</i>
Appetitive	47.269	.379
Aversive	55.890	.384
Coactive	46.509	.342

Table 4-6. Mean t-score of SR for each motivational condition

Hypothesis 6: Motivational Activation and Aversive System Activation Indexed by Corrugator Supercilii EMG

This hypothesis predicts that for both levels of arousing content, the electromyographic (EMG) activity of corrugator supercilii will be largest for the aversive condition, followed by the coactive condition, and the smallest for the appetitive condition.

The 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) ANOVA was run on the corrugator data. The main effect for motivational condition was not significant ($F < 1$).

However, the interaction of motivational condition \times time shown in Figure 4-6 was significant ($F(58,4524) = 2.178, p < .001, \text{partial } \eta^2 = .027$). As predicted, the corrugator activity during coactive condition was higher than appetitive condition, but

aversive condition showed the lowest corrugator activity contrary to the prediction.

Hypothesis 6 was partially supported.

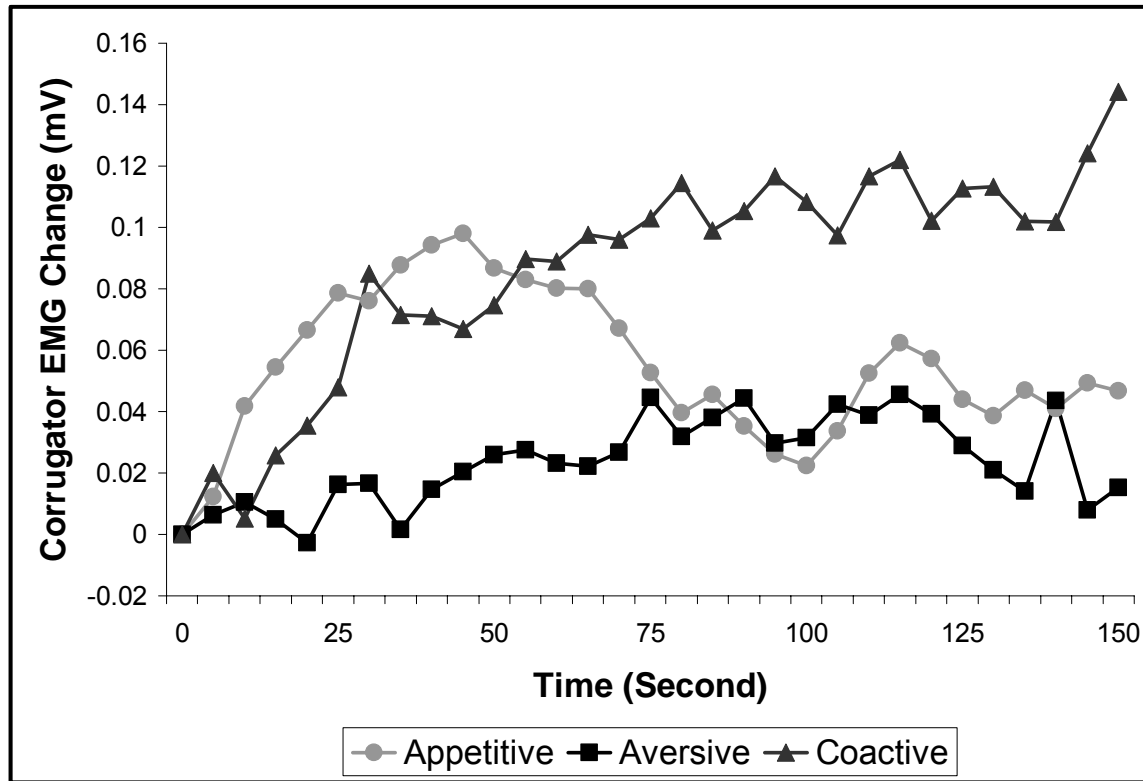


Figure 4-6. Motivational condition x Time on Corrugator Supercilii EMG.

Hypothesis 7a: Motivational Activation and Self-Reported Positive Emotion

This hypothesis predicts that self-reported positive emotion would be largest for appetitive condition, followed by coactive condition, and smallest for aversive condition.

The 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) ANOVA was run on the self reported positive emotion. The main effect for motivational condition was significant ($F(2,158) = 36.367, p < .001, \text{partial } \eta^2 = .315$). The mean for positive emotion ratings was the lowest for aversive condition, followed by appetitive, and then coactive. See Table 4-7.

As expected, the aversive condition had the lowest rating. However, the mean rating for coactive condition was higher than appetitive condition, which was not predicted. A separate statistical test to compare the coactive and appetitive conditions was conducted with a 2 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA. The main effect for motivational condition was significant ($F(1,79) = 3.930, p = .051, \text{partial } \eta^2 = .047$).

Motivational Condition	<i>M</i>	<i>SE</i>
Appetitive	5.825	.156
Aversive	4.831	.193
Coactive	6.141	.169

Table 4-7. Mean ratings of self-reported positive emotion for each motivational condition

Hypothesis 7b: Motivational Activation and Self-Reported Negative Emotion

This hypothesis predicts that self-reported negative emotion will be largest for the aversive condition, followed by the coactive condition, and that it will be smallest for the appetitive condition.

The 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) ANOVA was run on the self reported negative emotion data. The main effect for motivational condition was significant ($F(2,158) = 20.034, p < .001, \text{partial } \eta^2 = .202$). As predicted, the ratings for the participant's negative emotion were highest for aversive condition, followed by coactive condition, and then appetitive condition.

Motivational Condition	<i>M</i>	<i>SE</i>
Appetitive	3.600	.160
Aversive	4.653	.195
Coactive	3.991	.173

Table 4-8. Mean ratings of self-reported negative emotion for each motivational condition

Hypothesis 7c: Motivational Activation and Self-Reported Arousal

This hypothesis predicts that self-reported arousal will be larger for arousing content compared to calm content.

The 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) ANOVA was run on the self reported arousal data. The main effect for arousing content was significant ($F(1,79) = 75.062, p < .001, \text{partial } \eta^2 = .487$). As expected, arousing content ($M = 5.877, SE = .176$) was rated higher in self-reported arousal than calm content ($M = 4.977, SE = .156$).

There was also a significant interaction of motivational condition × arousing content on self-reported arousal ($F(2,158) = 6.271, p = .002, \text{partial } \eta^2 = .074$). For all three conditions, arousing content was rated more arousing than calm content (see Table 9). This is not in line with physiological arousal (SCR data), which elicited less physiological arousal for arousing content than calm content in appetitive condition. This will be further explored in the discussion section.

Motivational Condition	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	4.606	.193	5.494	.205
Aversive	4.106	.204	5.394	.217
Coactive	6.219	.179	6.744	.192

Table 4-9. Mean ratings of self-reported arousal for motivational condition × arousing content

Hypothesis 8: Motivational Activation and Self-Reported Dominance

This hypothesis predicts that when the level of arousing content is controlled, self-reported dominance will be the highest for the appetitive condition, followed by the coactive condition, and lowest for the aversive condition.

The 3 (Motivational Condition) \times 2 (Probe Type) ANOVA was run separately on the calm and the arousing content for the dominance data. The main effect for motivational condition on dominance for both calm content ($F(2,158) = 11.582, p < .001$, partial $\eta^2 = .128$), and arousing content ($F(2,158) = 18.111, p < .001$, partial $\eta^2 = .186$) were significant. As expected, the rating for dominance was highest for appetitive condition, followed by coactive condition, and then aversive condition. See Table 4-10.

Since the mean value for dominance was smaller for arousing content in all motivational conditions, a post-hoc test to further investigate the main effect of arousing content on dominance was conducted using a 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA for each motivational condition. The main effect for arousing content on dominance was significant for the appetitive condition ($F(1,79) = 3.875, p = .053$, partial $\eta^2 = .047$), the aversive condition ($F(1,79) = 7.714, p = .007$, partial $\eta^2 = .089$) and the coactive condition ($F(1,79) = 5.196, p = .025$, partial $\eta^2 = .062$). Thus, players always felt more dominant during calm compared to arousing content.

Motivational Condition	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	6.394	.186	6.063	.162
Aversive	5.331	.249	4.775	.216
Coactive	6.238	.179	5.906	.177

Table 4-10. Mean ratings of self-reported dominance for each motivational condition and level of arousing content

Hypothesis 9: Arousing Content and Sense of Presence

This hypothesis predicts that self-reported sense of presence will be greater for arousing compared to calm content.

The 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) ANOVA was run on the presence data. The main effect for arousing content was significant ($F(1,79) = 27.854, p < .001, \text{partial } \eta^2 = .261$). As expected, people felt stronger sense of presence during arousing ($M = 5.148, SE = .207$) compared to calm content ($M = 4.554, SE = .175$).

The interaction of motivational condition \times arousing content on sense of presence was also significant ($F(2,158) = 5.386, p = .005, \text{partial } \eta^2 = .064$). As shown in Table 4-11, the aversive condition has the largest difference in ratings for presence between calm and arousing contents.

A separate statistical test to explore the difference between calm and arousing conditions within each motivational conditions was conducted using a 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA. The main effect for arousing content on presence was significant for both the appetitive condition ($F(1,79) = 15.906, p < .001, \text{partial } \eta^2 = .168$) and the aversive condition ($F(1,79) = 27.534, p < .001, \text{partial } \eta^2 = .258$), but not significant for coactive condition ($F(1,79) = 2.092, p = .152, \text{partial } \eta^2 = .026$).

Motivational Condition	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	4.194	.193	4.856	.211
Aversive	3.988	.206	4.881	.245
Coactive	5.481	.226	5.706	.236

Table 4-11. Mean ratings of self-reported presence for each motivational condition and level of arousing content

Hypothesis 10: Arousing Content and Enjoyment

This hypothesis predicts that self-reported enjoyment will be greater for arousing content compared to calm content.

The 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) ANOVA was run on the enjoyment measure. The main effect for arousing content was significant ($F(1,79) = 38.771, p < .001, \text{partial } \eta^2 = .329$). As expected, arousing content ($M = 5.635, SE = .159$) was rated higher in enjoyment than calm content ($M = 5.104, SE = .151$). The interaction of motivational condition \times arousing content on self-reported enjoyment was not significant ($F(2,158) = 1.907, p = .152, \text{partial } \eta^2 = .024$). As shown in Table 4-12, aversive condition has the largest improvement in enjoyment when the content was arousing.

A separate statistical test to explore the difference between calm and arousing conditions within each motivational conditions was conducted using a 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA. The main effect for arousing content on enjoyment was significant for appetitive condition ($F(1,79) = 14.163, p < .001, \text{partial } \eta^2 = .152$), aversive condition ($F(1,79) = 17.420, p < .001, \text{partial } \eta^2 = .181$), and coactive condition ($F(1,79) = 7.038, p = .010, \text{partial } \eta^2 = .082$).

Motivational Condition	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	4.956	.193	5.519	.187
Aversive	4.081	.189	4.800	.212
Coactive	6.275	.181	6.588	.171

Table 4-12. Mean ratings of self-reported enjoyment for each motivational condition and level of arousing content

Hypothesis 11a: Negativity Bias and Aversive System Activation

This hypothesis predicts that during the aversive condition, participants who are higher in NB will show increased corrugator activation, facilitated startle reflexes, and increased self reported negative emotion.

For all facial EMG measures and SR, there were total of 79 participants, who were divided to high NB ($n = 39$) and low NB ($n = 40$) groups. The statistical test for corrugator activation was conducted with a 2 (NB) \times 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA. Neither the main effect of NB nor the interaction of NB \times Time on corrugator supercillii EMG were significant (both $F < 1$). The means of corrugator EMG of high and low NB group from each level of arousing content is shown in Table 4-13. The means for the calm condition are in the correct direction.

The statistical test for SR was conducted with a 2 (NB) \times 2 (Arousing Content) mixed design ANOVA. The main effect of NB on the startle data was not significant ($F < 1$). The means of SR are shown in Table 4-14. The means for the arousing condition are in the correct direction.

For all self-report measures, there were total of 80 participants, who were divided to high NB ($n = 39$) and low NB ($n = 41$) groups. The statistical test for self-reported negative emotion was conducted with a 2 (NB) \times 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA. The main effect of NB on self reported negative emotion was not significant ($F < 1$). The means of self-reported negative emotion are shown in Table 4-15 and are not in the correct direction.

Content	Low NB		High NB	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Calm	.087	.043	.103	.044
Arousing	-.022	.093	-.071	.094
Both Contents	.033	.057	.016	.058

Table 4-13. Mean change score of corrugator supercilii EMG for each level of arousing content during aversive condition, by negativity bias

Content	Low NB		High NB	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Calm	58.268	.804	58.056	.814
Arousing	52.896	.694	53.786	.703
Both Contents	55.582	.547	55.921	.554

Table 4-14. Mean t-score of startle magnitude for each level of arousing content by negativity bias

Content	Low NB		High NB	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Calm	4.549	.304	4.436	.312
Arousing	5.000	.312	4.615	.320
Both Contents	4.774	.274	4.526	.281

Table 4-15. Mean ratings of self-reported negative emotion for each level of arousing content by negativity bias

Hypothesis 11b: Positivity Offset and Appetitive System Activation

This hypothesis predicts that during all conditions, participants who are higher in PO will show increased orbicularis oculi EMG activity, higher self-reported positive emotion, and inhibited startle reflex.

For all facial EMG measures, there were total of 79 participants, who were divided to high PO ($n = 39$) and low PO ($n = 40$) groups. The statistical test for orbicularis oculi was conducted with a 2 (PO) \times 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA. Both the main effect of PO and the interaction of PO \times Time on orbicularis oculi EMG were not significant (both $F < 1$). Only the means for the aversive condition are in the correct direction.

For all self-report measures, there were total of 80 participants, who were divided to high PO ($n = 39$) and low PO ($n = 41$) groups. The statistical test for self-reported positive emotion was conducted with a 2 (PO) \times 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA. The main effect of PO on self reported positive emotion ($F(1,78) = 2.031, p = .158$) was not significant though the means are in the correct direction.

SR of high PO and low PO groups were compared through a statistical test using a 2 (PO) \times 3 (Motivational Condition) \times 2 (Arousing Content) mixed design ANOVA. The main effect of PO on SR was not significant ($F < 1$) though the means are in the expected direction for the appetitive and the coactive conditions.

Motivational Condition	Low PO		High PO	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	-.226	.050	-.113	.051
Aversive	-.107	.037	-.149	.037
Coactive	-.343	.114	-.260	.116
All Three Conditions	-.225	.057	-.174	.058

Table 4-16. Mean change score of orbicularis oculi EMG for each motivational condition by positivity offset

Motivational Condition	Low PO		High PO	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	5.695	.219	5.962	.224
Aversive	4.585	.269	5.090	.275
Coactive	5.909	.234	6.385	.240
All Three Conditions	5.396	.204	5.812	.209

Table 4-17. Mean ratings of self-reported positive emotion for each motivational condition by positivity offset

Motivational Condition	Low PO		High PO	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	47.697	.524	46.807	.545
Aversive	55.045	.518	56.803	.538
Coactive	46.879	.473	46.109	.492
All Three Conditions	49.874	.080	49.906	.083

Table 4-18. Mean t-score of startle magnitude for each motivational condition by positivity offset

Hypothesis 12a: Positivity Offset and Arousing Content on Enjoyment

This hypothesis predicts that participants higher in PO would rate the arousing content of all three motivational conditions more enjoyable than participants who are lower in PO.

The 2 (PO) × 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) ANOVA was run on the enjoyment measure. The interaction of PO × arousing content on self reported enjoyment approached significance ($F(1,78) = 3.497, p = .065$, partial $\eta^2 = .043$). As expected, high PO group ($n = 39$) rated arousing content much higher for enjoyment than low PO group ($n = 41$) did. See Table 4-19.

Positivity Offset	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Low PO	5.020	.212	5.398	.220
High PO	5.192	.218	5.885	.225

Table 4-19. Mean ratings of self-reported enjoyment for each level of arousing content, separated by participant's PO.

Hypothesis 12b: Negativity Bias and Arousing Content on Enjoyment

This hypothesis predicts that participants who are higher in NB will rate the arousing content of the aversive condition less enjoyable than participants who are lower in NB.

The statistical test for self-reported enjoyment was conducted with a 2 (NB) × 2 (Arousing Content) × 2 (Probe Type) ANOVA on the enjoyment data. The interaction of NB × arousing content on self reported enjoyment approached significance ($F(1,78) = 3.101, p = .082, \text{partial } \eta^2 = .190$). Though the high NB group rated calm content less enjoyable than the low NB group, the ratings for arousing content were almost the same – in fact, the high NB group’s rating was slightly higher than low NB group’s. See Table 4-20.

Negativity Bias	Calm Content		Arousing Content	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Low NB	4.329	.262	4.756	.298
High NB	3.821	.269	4.846	.305

Table 4-20. Mean ratings of self-reported enjoyment for each level of arousing content during aversive condition, separated by participant’s NB

Hypothesis 13a: Positivity Offset and Video Game Usage

This hypothesis predicts that participants who are higher in PO will play video games more than participants who are lower in PO.

As predicted, participants higher in PO ($n = 39$) reported that they spent more hours playing video games (6.5 hours/week) than participants lower in PO ($n = 41, 2.866$ hours/week). See Table 4-21. A t-test comparing hours spent on video games on a typical week between these two groups was significant ($t(78) = -2.352, p = .021$).

Positivity Offset	<i>M</i>	<i>SD</i>
Low PO	2.866	6.365
High PO	6.500	7.438

Table 4-21. Mean of self-reported hours playing video games on a typical week, by participant’s PO.

Hypothesis 13b: Negativity Bias and Video Game Usage

This hypothesis predicts that participants who are higher in NB will play video game less than participants who are lower in NB. Though the time spent on video games on a typical week was shorter among participants who are higher in NB as expected (see Table 4-22), a t-test revealed that the main effect of NB was not significant ($t(78) = .043, p = .966$).

Negativity Bias	<i>M</i>	<i>SD</i>
Low NB	4.671	6.783
High NB	4.603	7.516

Table 4-22. Mean of self-reported hours playing video games on a typical week, by participant's NB.

Hypothesis 14a: Positivity Offset in High NB Participants on Self-Reported Positive Emotion for Aversive Motivational Condition

This hypothesis predicts that participants who are higher in NB with a higher PO will rate the aversive motivational condition more positive than participants who are higher in NB with a lower PO.

There were total of 39 participants who were categorized as high NB participants. Among them, 23 were from the low PO group, and 16 were from the high PO group. A t-test confirmed that the high PO group's PO was significantly higher than that of low PO group's ($t(37) = -8.448, p < .001$) However, another t-test revealed that high PO group's NB was also significantly lower than that of low PO group's ($t(37) = 2.406, p = .021$). See Table 4-23.

Though the high PO participants did rate the aversive condition higher in enjoyment than the low PO participants as expected (see Table 4-24), the statistical test

for self-reported enjoyment conducted with a 2 (PO) × 2 (Arousing Content) × 2 (Probe Type) mixed design ANOVA revealed that the main effect of PO on self reported positive emotion was not significant ($F < 1$).

Positivity Offset	Mean PO	SD	Mean NB	SD
Low PO	1.121	1.122	5.304	.682
High PO	3.640	.743	4.804	.605

Table 4-23. Mean values of PO and NB for Low PO and High PO participants from the High NB group.

Positivity Offset	M	SE
Low PO	4.625	.366
High PO	4.728	.305

Table 4-24. Self reported positive emotion for aversive condition among high NB participants with high and low PO.

Hypothesis 14b: Positivity Offset in High NB Participants on Startle Reflex for Aversive Motivational Condition

This hypothesis predicts that participants who are higher in NB with a higher PO will show less startle potentiation during the aversive motivational condition than participants who are higher in NB with a lower PO.

The statistical test for SR from the high NB – high PO group ($n = 23$) and the high NB – low PO group ($n = 16$) was conducted with a 2 (PO) × 2 (Arousing Content) ANOVA. The main effect of PO on startle response magnitude only approached significance ($F(1,37) = 2.497, p = .123$). However, given the smaller number of subjects in this analysis ($n = 39$) this should be considered to be suggestive.

Positivity Offset	<i>M</i>	<i>SE</i>
Low PO	55.381	.912
High PO	57.256	.760

Table 4-25. Mean of t-values of startle magnitude during aversive conditions among high NB participants with high and low PO.

Hypothesis 14c: Positivity Offset in High NB Participants on Orbicularis Oculi EMG for Aversive Motivational Condition

This hypothesis predicts that participants who are higher in NB with a higher PO will show larger EMG activity in orbicularis oculi during aversive motivational condition than participants who are higher in NB with a lower PO.

From high NB participants with facial EMG data ($N = 39$). Low PO group ($n = 23$) and high PO group ($n = 16$) were compared using a 2 (PO) \times 2 (Arousing Content) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA. Both the main effect of PO on orbicularis oculi EMG and the interaction of PO \times Time on orbicularis oculi EMG were not significant (both $F < 1$).

Positivity Offset	<i>M</i>	<i>SE</i>
Low PO	-.084	.050
High PO	-.202	.042

Table 4-26. Mean change scores of orbicularis oculi EMG during aversive conditions among high NB participants with high and low PO.

Research Question 1: Positivity Offset, Negativity Bias, and Motivational Conditions on Self-Reported Emotions

This research question asks whether there will be a relationship between motivational conditions in the video game, individual's PO and NB, and self-reported dominance, presence, and enjoyment.

All participants' data of self-reported emotion was available ($N = 80$) for analysis. To compare the difference of high PO ($n = 39$) and low PO ($n = 41$) groups, statistical tests for each self-reported emotion (i.e., dominance, presence, enjoyment) were conducted with a 2 (PO) \times 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) mixed design ANOVA. The difference of high NB ($n = 39$) and low NB ($n = 41$) groups, was tested using a 2 (NB) \times 3 (Motivational Condition) \times 2 (Arousing Content) \times 2 (Probe Type) ANOVA.

The main effect of PO on dominance was significant ($F(1,78) = 5.539, p = .021$, partial $\eta^2 = .066$), with participants with higher PO feeling more dominant than participants with lower PO. The main effect of PO on presence ($F(1,78) = 1.454, p = .232$) and the main effect of PO on enjoyment ($F(1,78) = 1.221, p = .273$) were not significant, though participants with higher PO felt higher in both presence and enjoyment. See Table 4-27.

None of the interaction of PO \times motivational condition on dominance, presence, and enjoyment were significant (all $F < 1$).

The main effect of NB on presence, dominance, and enjoyment were not significant (all $F < 1$). However, the interaction of NB \times motivational condition on dominance ($F(2,156) = 3.235, p = .042$, partial $\eta^2 = .040$), and presence ($F(2,156) = 4.339, p = .015$, partial $\eta^2 = .053$) were significant. Also, the interaction of NB \times motivational condition on enjoyment was approaching significance ($F(2,156) = 2.472, p = .088$, partial $\eta^2 = .031$).

Positivity Offset	Self-Reported Emotion					
	Dominance		Presence		Enjoyment	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Low PO	5.492	.178	4.636	.255	5.209	.208
High PO	6.092	.183	5.077	.262	5.538	.213

Table 4-27. Mean of self-reported emotions by participants with high and low PO

Self-Reported Emotion	Positivity Offset	Appetitive		Aversive		Coactive	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Dominance	Low PO	5.982	.211	4.860	.295	5.634	.217
	High PO	6.487	.216	5.256	.302	6.532	.222
Presence	Low PO	4.384	.258	4.213	.292	5.311	.302
	High PO	4.673	.264	4.667	.299	5.891	.310
Enjoyment	Low PO	5.146	.245	4.238	.253	6.244	.231
	High PO	5.333	.251	4.654	.259	6.628	.237

Table 4-28. Interaction of PO \times motivational condition on self-reported emotions

Negativity Bias	Self-Reported Emotion					
	Dominance		Presence		Enjoyment	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Low NB	5.807	.184	4.858	.258	5.283	.209
High NB	5.761	.189	4.844	.264	5.462	.214

Table 4-29. Mean of self-reported emotions by participants with high and low NB

Self-Reported Emotion	Negativity Bias	Appetitive		Aversive		Coactive	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Dominance	Low NB	6.335	.214	5.274	.294	5.811	.224
	High NB	6.115	.219	4.821	.301	6.346	.230
Presence	Low NB	4.671	.257	4.555	.294	5.348	.303
	High NB	4.372	.264	4.308	.301	5.853	.311
Enjoyment	Low NB	5.085	.244	4.543	.254	6.220	.230
	High NB	5.397	.250	4.333	.261	6.654	.236

Table 4-30. Interaction of NB \times motivational condition on self-reported emotions

The interaction of PO × NB on dominance, presence, and enjoyment, shown in Figure 4-7, was further explored using a 2 (PO) × 2 (NB) × 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) mixed design ANOVA. The number of participants for each sub-group was: High PO – high NB ($n = 23$), high PO – low NB ($n = 16$), low PO – high NB ($n = 16$), and low PO – low NB ($n = 25$). The statistical test revealed that the interaction of PO × NB was not significant on dominance ($F(1,76) = .916, p = .342$), presence ($F(1,76) = 2.141, p = .148$), or enjoyment ($F(1,76) = 1.431, p = .235$).

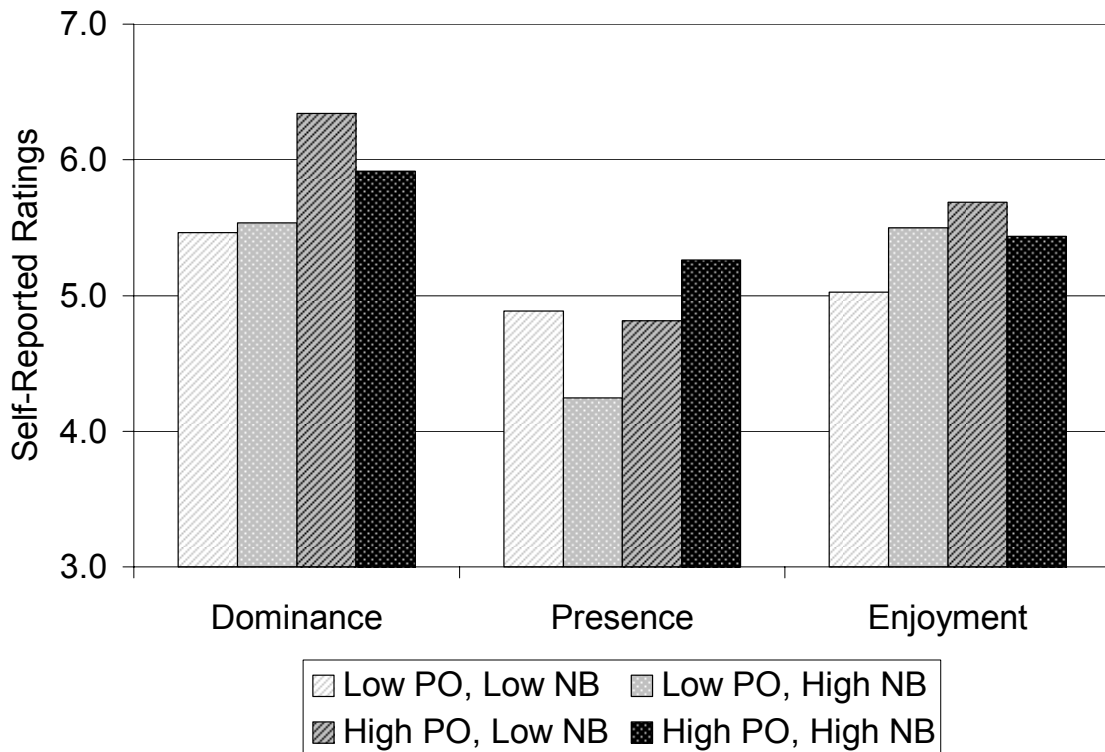


Figure 4-7. Interaction of PO × NB on self-reported emotions

Research Question 2: Interaction of Positivity Offset × Negativity Bias × Arousing Content on Self-Reported Emotions

This research question asks whether there will be a three-way interaction of PO × NB × arousing content on self-reported positive emotion, negative emotion, arousal, dominance, presence, and enjoyment. Again, the number of participants for each subgroup was: High PO – high NB ($n = 23$), high PO – low NB ($n = 16$), low PO – high NB ($n = 16$), and low PO – low NB ($n = 25$).

The statistical test for each self-reported emotion (i.e., arousal, dominance, presence, enjoyment) was conducted with a 2 (PO) × 2 (NB) × 3 (Motivational Condition) × 2 (Arousing Content) × 2 (Probe Type) ANOVA. The 3-way interaction of PO × NB × Arousing Content on all self-reported emotions were not significant (arousal, dominance, presence, and enjoyment: $F < 1$).

Self-Reported Emotion	PO × NB	Calm Content		Arousing Content	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Arousal	Low PO, Low NB	4.960	.284	5.473	.314
	Low PO, High NB	4.927	.354	6.292	.393
	High PO, Low NB	5.104	.354	5.792	.393
	High PO, High NB	4.942	.296	6.087	.328
Dominance	Low PO, Low NB	5.673	.273	5.253	.225
	Low PO, High NB	5.750	.341	5.323	.281
	High PO, Low NB	6.604	.341	6.083	.281
	High PO, High NB	6.065	.284	5.768	.235
Presence	Low PO, Low NB	4.673	.311	5.100	.369
	Low PO, High NB	3.854	.388	4.635	.461
	High PO, Low NB	4.708	.388	4.917	.461
	High PO, High NB	4.804	.324	5.717	.385
Enjoyment	Low PO, Low NB	4.873	.273	5.173	.282
	Low PO, High NB	5.250	.341	5.750	.352
	High PO, Low NB	5.375	.341	6.000	.352
	High PO, High NB	5.065	.285	5.804	.294

Table 4-31. Mean of self-reported emotions by participants by PO × NB

CHAPTER 5

Discussion

The goal of this dissertation was to investigate the pattern of relative activation in the appetitive and aversive motivational systems during video game play as a function of the motivational relevance of the stimuli. There were three general goals for this study:

- To manipulate the player's motivational system activation and arousal levels during video game play in order to elicit theoretically predicted motivated cognitive responses.
- To compare how individuals with different motivational system activation characteristics (i.e., positivity offset and negativity bias) differ in their responses to video game play, and see if the results replicate those found in other studies using different media.
- To extend our knowledge of motivated mediated information processing by exploring the interaction of positivity offset, negativity bias and arousing content on motivational system activation.

In order to achieve the first goal of manipulating the participant's motivational system activation levels and arousal levels during video game play to elicit cognitive and emotional responses predicted by LC4MP, a video game was created with contents designed to elicit different levels of motivation activation. Specifically, segments where the player engaged in hunting and gathering behavior were used to activate the appetitive motivational system. Segments where fleeing from danger was the only possible action were created to elicit aversive activation and segments where both hunting and fleeing were necessary were designed to elicit coactivation. Overall, the game segments

functioned as predicted. Hunting and gathering segments did appear to elicit appetitive activation evidenced by attenuated SRs, increased orbicularis oculi EMG, and increased positive emotional experience. Similarly, fleeing segments appeared to elicit aversive activation as evidenced by potentiated SRs, and greater self-reported negative emotion. And finally, fleeing and fighting segments appeared to elicit activation in both systems as evidenced by attenuated SRs, greatest ratings for self-reported positive emotion, self-reported negative emotion greater than appetitive condition, and greatest corrugator supercillii EMG.

In addition to the motivational activation manipulation, there was also an arousing content manipulation. To make the content more arousing, more items moving faster were present in the arousing compared to the calm conditions. As a result, the arousing conditions were also more difficult. Because of this, based on LC4MP, it was also predicted that more complicated contents would reduce available cognitive resources. This was also supported as evidenced by longer STRT for arousing contents in aversive and coercive conditions.

A general prediction that video game contents that were designed to be more arousing would result in stronger physiological arousal and stronger self-reported emotional responses was generally supported as well. Self reported arousal was higher in all motivational conditions and physiological arousal was higher in the aversive and coercive conditions. Experienced emotion also seemed to be heightened by arousing content as shown by greater ratings for presence and enjoyment after playing arousing content in all three motivational conditions (see Table 4-11 and Table 4-12).

However, the prediction that stronger activation of the appetitive motivational system during video game play would result in more external attention being paid to the video game was not supported. Instead, the aversive and the coercive conditions elicited similar and strong levels of external attention while the appetitive condition elicited the least external attention. A summary of these results with corresponding hypotheses is shown in Table 5-1.

The second goal was to compare how individuals with different motivational system activation characteristics differ in their responses to video game play, and find out if the results replicated previous studies. The first prediction was that participants with higher PO would show higher appetitive motivational system activation during video game play and would play more video games. Overall the pattern of results shown by the data was in line with this prediction (participants with higher PO exhibited attenuated SR and greater activity in orbicularis oculi EMG), though statistical significance was not achieved.

The second prediction was that participants with higher NB would show higher aversive motivational system activation during video game play and use video games less in general. Though the overall pattern of results shown by the data was in line with this prediction, the results failed to achieve statistical significance. A summary of findings on difference in individual's motivational system activation characteristics and their responses with corresponding hypotheses is shown in Table 5-2.

The third goal, to extend our knowledge of mediated information processing by exploring the interaction of motivational traits (PO and NB) and content that affects arousal or motivational system activation, was addressed by asking research questions

(RQ 1 and RQ2) about how PO and NB interact with dominance, presence, and enjoyment without making any specific predictions. Participants with higher PO felt more dominant, stronger presence, and more enjoyment, though only the results for dominance reached statistical significance. NB was also found to have effects on dominance and presence, evidenced by the interaction of NB and motivational condition on these emotions.

Though there was no significant three-way interaction of PO, NB and arousing content on dominance, presence, or enjoyment, individuals with higher PO and lower NB (sometimes called the risk takers; see A. Lang 2006 for discussion) consistently self reported feeling the most dominant and enjoying the game the most regardless of the arousing content levels. A summary of findings is shown in Table 5-3.

In general, the results of the study support the theoretical predictions made by LC4MP. Motivational condition had strong effects on all dependent variables, though not always in the direction predicted. As expected, appetitive condition led participants to feel more positive and activated their appetitive system (indexed by orbicularis oculi EMG) while the aversive condition led participants to feel more negative and activated their aversive system (indexed by SR). Coactivation did indeed activate both systems but this did not appear, in general, to be an additive effect. Rather, depending on the task, the characteristics of one or the other system (appetitive or aversive) seemed to dominate, depending on which dependent variable was examined. Thus, for HR (attention), orbicularis oculi, and corrugator coactive looked like aversive. For SR and self reported positive emotion coactive looked like appetitive.

H#	DV	Prediction	Supported
H1a	HR	Motivational condition will have effect on cardiac deceleration: appetitive > coactive > aversive	aversive > coactive > appetitive
H1b	HR	Arousing content will have effect on cardiac deceleration: arousing > calm	No
H1c	HR	Motivational condition x arousing content will have effect on cardiac deceleration	Yes
H2a	SCR	Motivational condition will have effect on physiological arousal: coactive & aversive > appetitive	Yes
H2b	SCR	Arousing content will have effect on physiological arousal: arousing > calm	Partially
H2c	SCR	Motivational condition x arousing content will have effect on physiological arousal	Partially
H3a	STRT	Motivational condition will have effect on STRT in calm content: coactive > appetitive > aversive	Yes
H3b	STRT	Motivational condition will have effect on STRT in arousing content: appetitive > coactive > aversive	Partially
H4	Orbicularis Oculi	Motivational condition will have effect on orbicularis oculi activation: appetitive > coactive > aversive	Partially
H5	SR	Motivational condition will have effect on SR magnitude: aversive > coactive > appetitive	Partially
H6	Corrugator Supercilii	Motivational condition will have effect on corrugator activation: aversive > coactive > appetitive	Partially
H7a	Positive Emotion	Motivational condition will have effect on self-reported positive emotion: appetitive > coactive > aversive	Partially
H7b	Negative Emotion	Motivational condition will have effect on self-reported negative emotion: aversive > coactive > appetitive	Yes
H7c	Arousal	Arousing content will have effect on self-reported arousal: arousing > calm	Yes
H8	Dominance	Motivational condition will have effect on self-reported dominance: appetitive > coactive > aversive	Yes
H9	Presence	Arousing content will have effect on self-reported presence: arousing > calm	Yes
H10	Enjoyment	Arousing content will have effect on self-reported enjoyment: arousing > calm	Yes

Table 5-1. Summary of results on players' motivational system activation levels and arousal levels to their cognitive and emotional responses

H#	DV	Prediction	Supported
H11a	Corrugator, SR, Negative Emotion	NB will have effect on aversive system activation during aversive condition. 1. Corrugator activation: High NB > Low NB 2. SR: High NB > Low NB 3. Negative Emotion: High NB > Low NB	1. No 2. No* 3. No
H11b	Orbicularis Oculi, SR, Positive Emotion	PO will have effect on appetitive system activation. 1. Orbicularis oculi activation: High PO > Low PO 2. SR: Low PO > High PO 3. Positive Emotion: High PO > Low PO	1. No* 2. No 3. No*
H12a	Enjoyment	PO x arousing content will have effect on self-reported enjoyment	Yes
H12b	Enjoyment	NB x arousing content will have effect on self-reported enjoyment for aversive condition	No
H13a	Video game usage	PO will have effect on video game usage: High PO > Low PO	Yes
H13b	Video game usage	NB will have effect on video game usage: Low NB > High NB	No*
H14a	Positive Emotion	For individuals with high NB, PO will have effect on self-reported positive emotion: High PO > Low PO	No*
H14b	SR	For individuals with high NB, PO will have effect on SR: Low PO > High PO	No
H14c	Orbicularis Oculi	For individuals with high NB, PO will have effect on orbicularis oculi EMG: High PO > Low PO	No

NOTE: * Results in the predicted direction, though not statistically significant

Table 5-2. Summary of results on individuals with different motivational system activation characteristics and their responses to video game play

Research Question 1

Findings:

High PO group felt more dominant than Low PO group.

Though not statistically significant, High PO group rated higher in presence and enjoyment than Low PO group.

Though not statistically significant, High NB group felt less dominant and less presence than Low NB group.

Research Question 2

Findings:

There was no significant three-way interaction of PO × NB × arousing content on dominance, presence, or enjoyment.

Though not statistically significant, High PO – Low NB group rated higher in dominance and enjoyment than other groups, for both calm and arousing content.

Table 5-3. Summary of results on interaction of motivational traits and content of video game

Arousing Content Manipulation for Appetitive Condition

Many of the unexpected results found in this study involved the arousing content manipulation. Whether this was a problem with the manipulation or with the theory will be discussed in detail below. Other unexpected results tended to involve the coercive condition (as briefly summarized above) where there was little data to guide theorizing. In general, the effects of straight appetitive and straight aversive activation elicited few surprises. The combination of the two was often surprising and when arousing content was considered the surprises were magnified.

This is probably largely due to the confounding of task difficulty and arousing content built into the manipulation. Initially, doubling the number of objects on screen was expected to make the task both more exciting or arousing and somewhat harder for players to perform and this does seem to have been the case for the aversive and coercive conditions. However, for the appetitive condition, this resulting increase in targets, available to be hunted and gathered may have actually made the task less arousing and

easier to perform. The fact that participants always got to play the calm content before the arousing content may have made the arousing content even easier and magnified the differences in physiological arousal.

The self-report data for arousal consistently shows that participants felt more aroused when playing segments with arousing content than those with calm content for all three motivational conditions, matching up with our intuitive initial thought – that more stuff on screen would be more arousing. However, the physiological arousal data, indexed by the number of skin conductance responses (SCRs) only match up with this prediction for the aversive and coactive conditions. However, during the appetitive condition the calm content had more SCRs than the arousing content suggesting that, indeed, having fewer targets made the appetitive condition more arousing and perhaps more difficult.

But this does not explain the results from self-reported arousal, where arousing content (with more objects available to capture) was rated more arousing than calm content. Why would the participants have rated the appetitive condition with arousing content as more arousing than the calm condition when they were physiologically less aroused? One possibility is that the increase in speed at which the targets were moving in the arousing content appetitive condition, increased the sense of being aroused but not the actual arousal. Perhaps because even though the task was easier to perform, their visual field was more complicated due to the increase in the number of objects and their speed of movement. As a result, after the segment was over, participants might have felt more aroused but the task did not require greater activation in the system to be performed well.

During all conditions, participants did show cardiac deceleration, demonstrating that they were paying attention to the video game. The magnitude of heart rate (HR) deceleration was predicted to be in the order of appetitive condition > coactive condition > aversive condition. However, the actual pattern observed was aversive condition > coactive condition > appetitive condition. More precisely, the cardiac deceleration was quite large for the coactive and aversive conditions, and much smaller for the appetitive condition. These results suggest that, as is often seen in other media, negative content more easily compels attention. By definition, both the coactive and aversive conditions posed a threat to the player's character, which activated the player's aversive system (indexed by corrugator activity). And the activation of the aversive system resulted in greater external attention being paid to the media, which is indexed by greater cardiac deceleration. In addition, the actual task being performed – avoiding moving objects – actually required continuous monitoring of the external environment. Hence, even though one might, in the case of a more static threat, expect a reduction in external attention – such a reduction – for this task – might in fact be quite counterproductive.

As reported in the results section, statistical test on each motivational condition using a 2 (Arousing Content) × 2 (Probe Type) × 30 (Time) mixed design ANOVA shows that the 2-way interaction of arousing content × time on HR was statistically significant only for the appetitive condition. As shown above in Figure 4-3, this is due to the difference in HR deceleration during the first 20 seconds. Why did the arousing content that elicited less physiological arousal receive, initially, more external attention? Again, this is consistent with the explanation that visual (but not task) complexity of the message (i.e., number of objects and their speed) was driving some aspects of processing

during appetitive activation. Once the subjects had become accustomed to the more complex screen the greater ease of the task eliminated any difference in attention between the two arousing content conditions.

The STRT data is also consistent with this explanation. As reported in the results section the STRTs were shorter for arousing content ($M = 638.298$, $SE = 14.594$) than calm content ($M = 654.283$, $SE = 14.842$). This difference, tested with a 2 (Arousing Content) \times 5 (Repeat) mixed design ANOVA approached significance ($F(1,79) = 1.982$, $p = .163$, partial $\eta^2 = .024$). Since STRT is indexing available cognitive resources, the faster response time for arousing content suggests that arousing content required fewer resources than the calm content during the appetitive condition. Unfortunately, because there was no STRT probe in the first 25 seconds we cannot retroactively test the prediction that initially the increase in screen visual complexity did require more resources.

Motivational Conditions on Motivated Cognition When Physiological Arousal Level is Controlled

As discussed above, many of the unexpected results involved the arousing content manipulation. As shown in Figure 5-1, physiological arousal, indexed by the number of SCRs is quite different during each motivational condition by arousing content condition.. Of particular interest is that the variance in physiological arousal amongst the motivation conditions was greater for arousing compared to calm (arousing content: $SE = .602$, calm content: $SE = .573$).

In order to explore how motivational conditions affected the participants when arousal is controlled, a series of 3 (Motivational Condition) \times 2 (Probe Type) mixed

design ANOVAs was conducted on the SCR data at each arousing content levels. The results show that calm content from each motivational condition produced the least significant difference in number of SCRs ($F(2,158) = 1.228, p = .296, \text{partial } \eta^2 = .015$). This suggests that during calm content the level of physiological arousal was fairly steady across the motivational conditions. The following analyses were then done to examine the effects of motivational condition when physiological arousal is essentially controlled.

When participants' responses to calm content across the motivational conditions were compared, HR still showed cardiac deceleration for all motivational conditions. Again, the average HR change score shows that the cardiac deceleration was largest for aversive condition ($M = -9.483, SE = .709$), followed by coercive condition ($M = -8.438, SE = .725$), and smallest for appetitive condition ($M = -3.950, SE = .611$). A statistical test using a 3 (Motivational Condition) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA revealed that the main effect for motivational condition was significant ($F(2,154) = 23.284, p < .001, \text{partial } \eta^2 = .232$), as well as the interaction of motivational condition \times time ($F(58,4466) = 3.998, p < .001, \text{partial } \eta^2 = .049$). The effect of motivational condition on HR over time is shown in Figure 5-2.

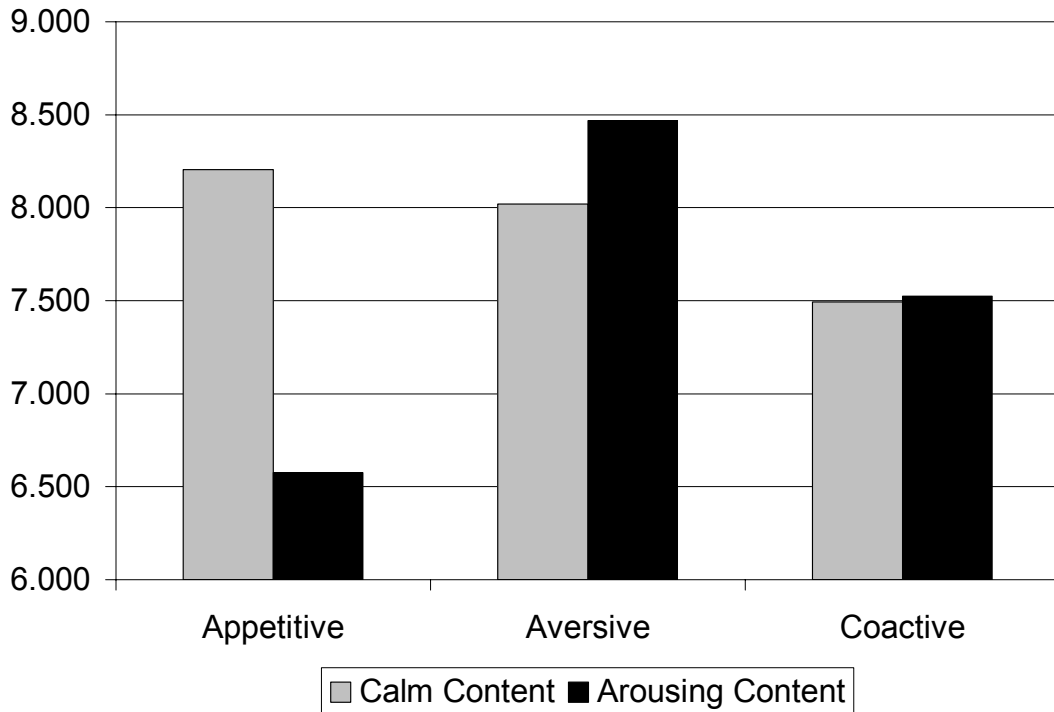


Figure 5-1. Physiological Arousal Elicited by Each Motivational Condition with Differing Arousing Content Levels

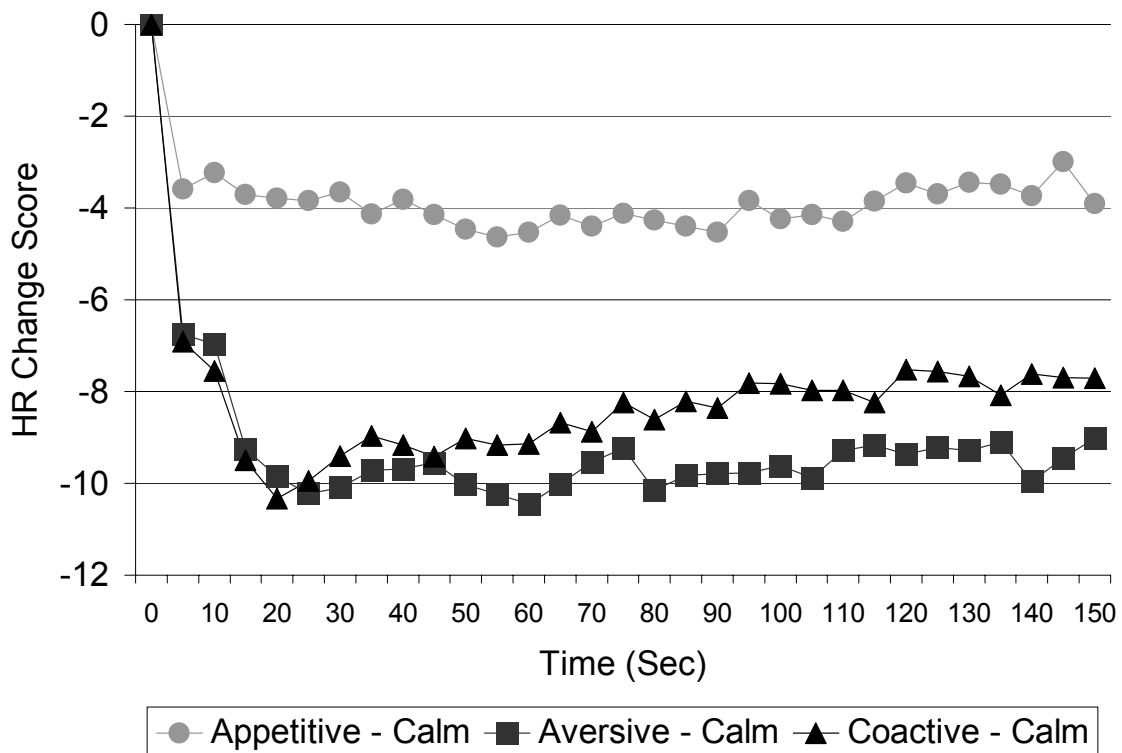


Figure 5-2. Motivational Condition (Calm Content) × Time on Heart Rate

Performing the same analysis on the orbicularis oculi data (calm content only revealed that the main effect for motivational condition was again significant ($F(2,154) = 3.797, p = .025, \text{partial } \eta^2 = .046$), as well as the interaction of motivational condition \times time ($F(58,4524) = 1.616, p = .002, \text{partial } \eta^2 = .020$). The mean change score over the whole 150 seconds shows that orbicularis oculi activity was highest for the aversive condition ($M = -.123, SE = .032$), followed closely by appetitive condition ($M = -.162, SE = .049$), and smallest for coactive condition ($M = -.327, SE = .082$). However, for the first 60 seconds, the orbicularis oculi EMG during appetitive condition was higher than aversive condition, which is in line with the prediction made by hypothesis 4. See Figure 5-3. The difference between appetitive and aversive conditions in orbicularis oculi EMG during the first 60 seconds was not clear in Figure 4-4, which used EMG data averaged over calm and arousing content.

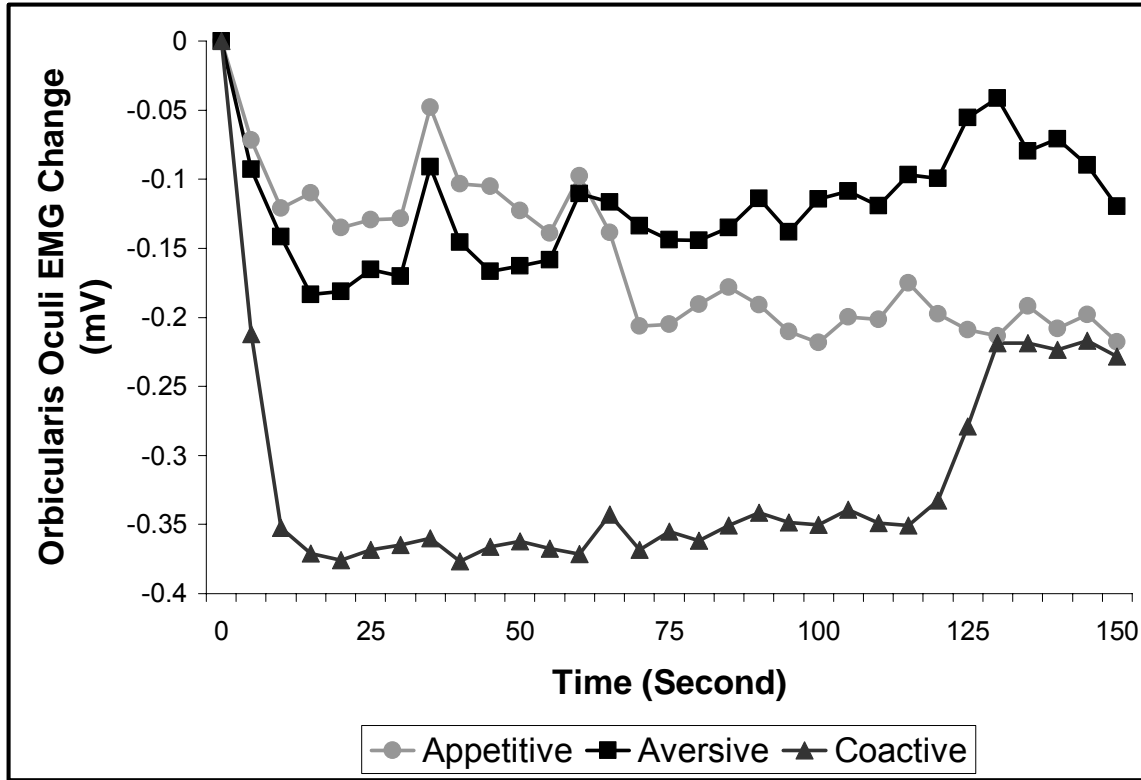


Figure 5-3. Motivational Condition (Calm Content) × Time on Orbicularis Oculi EMG

The same analysis was also run on the corrugator supercilii data for calm content revealing that the main effect for motivational condition was not significant ($F < 1$), but that the interaction of motivational condition × time was significant ($F(58,4524) = 1.344$, $p = .043$, partial $\eta^2 = .017$) and is shown in Figure 5.4. The mean change scores over the whole 150 seconds show that corrugator activity was highest for the aversive condition ($M = .095$, $SE = .030$), followed by coactive condition ($M = .087$, $SE = .048$), and smallest for appetitive condition ($M = .029$, $SE = .045$), as was predicted by hypothesis 6 but not found when the data were averaged across arousing content conditions.

Figure 5-4 shows that corrugator activity increases rapidly for all motivational conditions during the first 25 seconds or so – probably indicative of greater attention

during the initial portion of each segment (furlrowing of the brow with intense concentration). However, once players understand the task, corrugator begins to reflect emotional response – remaining high when there is aversive activation and falling in the appetitive condition where there is no aversive activation.

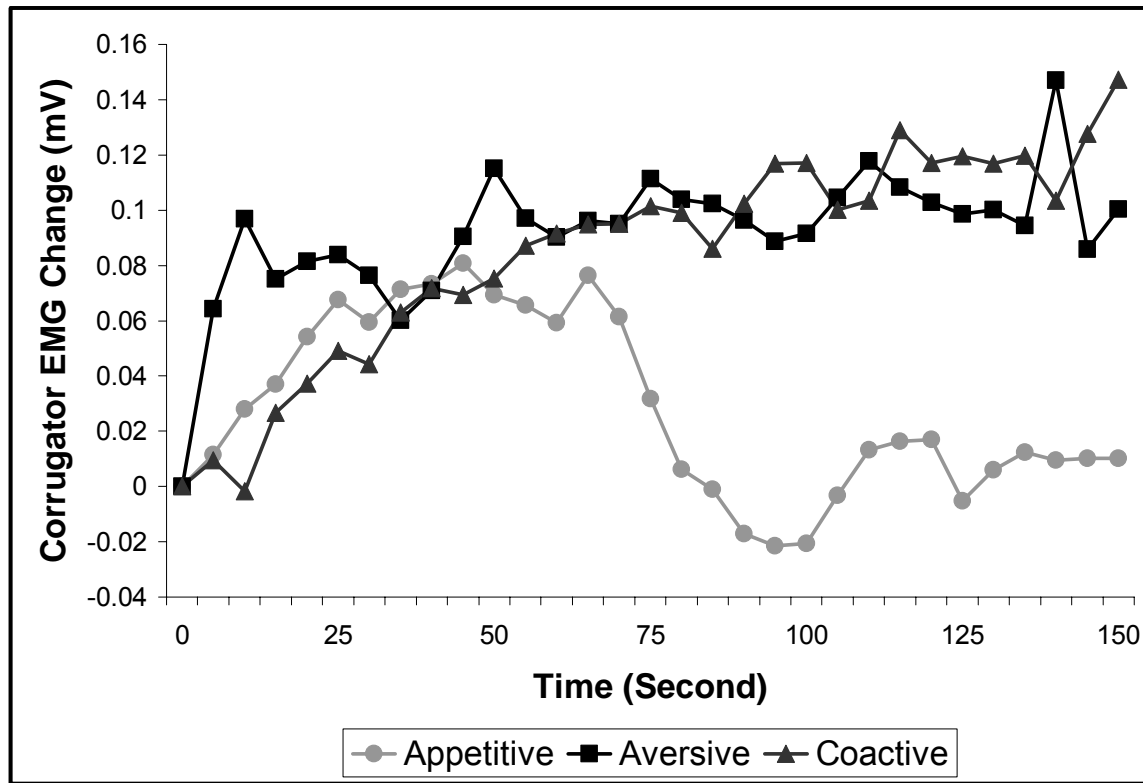


Figure 5-4. Motivational Condition (Calm Content) × Time on Corrugator Supercilii EMG

The same analysis done on the SR data also reveals (as did the initial analysis) the larger startles for the aversive condition ($M = 58.458, SE = .543$) than for the appetitive condition ($M = 48.349, SE = .609$) with the smallest SR during the coactive condition ($M = 46.399, SE = .467$). A statistical test (ANOVA) comparing the SR magnitude from the calm content of three motivational conditions revealed that motivational condition had significant effect on SR ($F(2,152) = 119.944, p < .001, \text{partial } \eta^2 = .612$).

The results of this same analysis on the self-reported positive and negative emotion, and on dominance replicated those found in the initial analysis. Positive emotion was rated high to low in the order of coercive ($M = 6.194, SE = .178$) > appetitive ($M = 5.913, SE = .169$) > aversive ($M = 4.831, SE = .218$). Negative emotion was rated high to low in the order of aversive ($M = 4.494, SE = .216$) > coercive ($M = 3.750, SE = .176$) > appetitive ($M = 3.475, SE = .179$). Dominance was rated high to low in the order of appetitive ($M = 6.394, SE = .186$) > coercive ($M = 6.238, SE = .179$) > aversive ($M = 5.331, SE = .249$).

A 3 (Motivational Condition) \times 2 (Probe Type) ANOVA on self-reported measures showed that the main effect of motivational condition was significant for positive emotions ($F(2,158) = 28.288, p < .001, \text{partial } \eta^2 = .264$), negative emotions ($F(2,158) = 13.501, p < .001, \text{partial } \eta^2 = .146$), and dominance ($F(2,158) = 11.582, p < .001, \text{partial } \eta^2 = .128$).

H#	DV	Prediction	Supported
H1a	HR	Magnitude of cardiac deceleration will be appetitive > coactive > aversive	aversive > coactive > appetitive
H3a	STRT	Cognitive resources available will be coactive > appetitive > aversive	Yes
H4	Orbicularis Oculi	Appetitive system activation will be appetitive > coactive > aversive	Yes
H5	SR	Aversive system activation will be aversive > coactive > appetitive	aversive > appetitive > coactive
H6	Corrugator	Aversive system activation will be aversive > coactive > appetitive	Yes
H7a	Positive Emotion	Positive emotion will be appetitive > coactive > aversive	coactive > appetitive > aversive
H7b	Negative Emotion	Negative emotion will be aversive > coactive > appetitive	Yes
H8	Dominance	Dominance will be rated appetitive > coactive > aversive	Yes

Table 5-4. Summary of hypotheses that involves comparison of motivational conditions retested with physiological arousal level controlled across motivational conditions

One of the surprising findings from this analysis is that the combination of positive components and negative components (i.e., the coactive condition) does not simply lead to increase in responses indicative of appetitive and aversive system activation simultaneously. When used alone, positive components (the hunt and gathering task) of the video game successfully activated player's appetitive system and negative components (the avoidance task) activated player's aversive system. However, when both were used together in this study, the player's responses tended to be more like one or the other of the motivational systems alone – rather than an additive combination of the two systems. As mentioned above, results from the SR were indicative of the appetitive system activation, while results from the orbicularis oculi EMG and corrugator EMG showed are indicative of the aversive system activation. Coactive condition also had the highest ratings for self-reported positive emotion, while ratings for self-reported negative emotion were in the middle of two other conditions.

Initially, coactive condition was expected to activate each motivational systems at a level between appetitive and aversive conditions in general. This prediction was not supported in some dependent variables: coactive condition had the lowest orbicularis oculi activity and the highest ratings for self-reported positive emotion.

One possible explanation for this is that the combination of positive and negative components was enhancing or suppressing individual responses – in this case, enhancement in self-reported (perceived) positive emotion and suppression in orbicularis oculi EMG. The relationship between salt and sweetness might provide insight to this. When used in large quantity, saltiness is associated with aversive activation and sweetness is associated with appetitive activation (O'Doherty, Rolls, Francis, Bowtell, &

McGlone, 2001). However, when small amount of salt is added to a mainly sweet product, it enhances the sweetness (Breslin & Beauchamp, 1997; Hutton, 2002; Ugawa, Konosu, & Kurihara, 1992), which is a phenomenon known by experienced chefs long before it has been studied by scientists. It may be that the combination of positive and negative components leading to enhancement/suppression of motivational activation reflected in individual dependent variables (such as facial EMG) is not limited to taste.

Interaction of Personal Trait × Motivational Conditions on Motivated Cognition When Physiological Arousal Level is Controlled

Predicted differences in appetitive activation as a function of PO and for aversive activation as a function of NB were also tested on the calm content alone. The results of these analyses are summarized in Table 5-5. In general, as with the overall analysis, most of the results did not achieve statistical significance, though they were in the right direction.

H#	DV	Prediction	Supported
H11a	Corrugator, SR, Negative Emotion	NB will have effect on aversive system activation during aversive condition. 1. Corrugator activation: High NB > Low NB 2. SR: High NB > Low NB 3. Negative Emotion: High NB > Low NB	1. No 2. No 3. No
H11b	Orbicularis Oculi, SR, Positive Emotion	PO will have effect on appetitive system activation. 1. Orbicularis oculi activation: High PO > Low PO 2. SR: Low PO > High PO 3. Positive Emotion: High PO > Low PO	1. No 2. Yes 3. No

Table 5-5. Summary of hypotheses that involves comparison of motivational system activation characteristics retested with physiological arousal level controlled across motivational conditions

It was predicted that SR should be smaller for high compared to low PO individuals. The mean t-score value of SR data was lower for high PO group ($M = 50.410$, $SE = .345$) than low PO group ($M = 51.678$, $SE = .331$) as was the main effect of PO on SR ($F(1,75) = 7.042$, $p = .010$, partial $\eta^2 = .086$) when tested by a 2 (PO) \times 3 (Motivational Condition) \times 2 (Probe Type) mixed design ANOVA. The initial analysis, averaging across arousing content levels, did not show a significant effect on SR ($F < 1$), suggesting again the variance in physiological arousal from the arousing content of each motivational condition was a factor that diminished the main effect of PO.

It was also predicted that high compared to low PO individuals would exhibit stronger orbicularis oculi EMG activity. The means for high PO group ($M = -.184$, $SE = .052$) was higher than low PO group ($M = -.223$, $SE = .052$). However, the statistical test using a 2 (PO) \times 3 (Motivational Condition) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA revealed that the main effect of PO and the interaction of PO \times time on orbicularis oculi EMG were both not significant (both $F < 1$).

In addition to physiological responses, it was predicted that high compared to low PO individuals would report greater positive emotion. As in the initial analysis, examination of the calm content alone revealed that the mean ratings for calm content were higher for high PO group ($M = 5.782$, $SE = .221$) than low PO group ($M = 5.516$, $SE = .216$). However, as in the initial analysis, the statistical test using a 2 (PO) \times 3 (Motivational Condition) \times 2 (Probe Type) mixed design ANOVA revealed that the main effect of PO nor the interaction of PO \times motivational condition was not significant (both $F < 1$). See Table 5-6.

Motivational Condition	Low PO		High PO	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Appetitive	5.878	.237	5.949	.243
Aversive	4.659	.305	5.013	.313
Coactive	6.012	.249	6.385	.255

Table 5-6. Mean ratings of self-reported positive emotion for each motivational condition with calm content, by positivity offset group

It was also expected that high compared to low PO individuals would feel more dominant, more present, and report more enjoyment for all three motivational conditions. The analysis on the calm content (Table 5-7) produced results consistent with the initial analysis that included ratings from both levels of arousing content shown in Table 4-27. The main effect of PO on dominance, which was significant in the initial analysis, now approaches significance ($F(1,78) = 3.683, p = .059, \text{partial } \eta^2 = .045$), though the main effects of PO on presence ($F(1,78) = 1.389, p = .242$) and enjoyment were still not significant ($F < 1$).

Emotion	Positivity Offset	Appetitive		Aversive		Coactive	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Dominance	Low PO	6.122	.257	5.244	0.350	5.744	.238
	High PO	6.679	.264	5.423	0.359	6.756	.244
Presence	Low PO	4.098	.270	3.878	0.289	5.085	.311
	High PO	4.295	.277	4.103	0.296	5.897	.319
Enjoyment	Low PO	4.927	.271	4.061	0.265	6.073	.252
	High PO	4.987	.278	4.103	0.272	6.487	.258

Table 5-7. Mean ratings of self-reported emotions for each motivational condition with calm content, by positivity offset groups

Based on the general prediction that high NB individuals would have greater aversive system activation, it was predicted that high compared to low NB individuals would exhibit stronger corrugator supercilii EMG activity. The means from aversive-calm content was higher for high NB group ($M = .103$, $SE = .044$) than low NB group ($M = .087$, $SE = .043$), which is in the predicted direction. However, the statistical test using a 2 (NB) \times 3 (Motivational Condition) \times 2 (Probe Type) \times 30 (Time) mixed design ANOVA revealed that the main effect of NB ($F < 1$) and the interaction of NB \times time ($F(29, 2233) = 1.293$, $p = .136$) on corrugator activity were both not significant.

It was predicted that SRs during the aversive condition should be larger for high compared to low NB individuals during aversive condition. The mean t-score value of SR data from aversive-calm content was slightly lower for high NB individuals ($M = 58.056$, $SD = 5.382$) than low NB individuals ($M = 58.268$, $SD = 4.781$), though a t-test revealed that this difference was not significant ($t(77) = .185$, $p = .853$).

It was also predicted that self-reported negative emotion for aversive-calm content should be higher for high NB individuals compared to low NB individuals. The mean ratings were lower for high NB individuals ($M = 4.436$, $SE = .312$) than low NB individuals ($M = 4.549$, $SE = .304$). As in the initial analysis, the statistical test using a 2 (NB) \times 2 (Probe Type) mixed design ANOVA revealed that the main effect of NB was not significant ($F < 1$).

Analyses of the effects of NB on self reported dominance, presence, and enjoyment during calm content returned all nonsignificant results (all $F < 1$) was as the case in the initial analysis. However, the interaction of NB \times motivational condition on dominance approached significance ($F(2,156) = 2.857$, $p = .060$, partial $\eta^2 = .035$), and

there was a significant interaction on presence ($F(2,156) = 6.048, p = .003$, partial $\eta^2 = .072$), and enjoyment ($F(2,156) = 3.890, p = .022$, partial $\eta^2 = .048$). As shown in table 5-8, during aversive and coercive conditions, those with high NB felt less dominant, less present, and less enjoyment. However, there is no consistent effect of NB during appetitive activation. Thus, effects of NB are only visible during conditions which include aversive activation as would be expected.

A series of statistical tests using a 2 (NB) \times 2 (Probe Type) mixed design ANOVA revealed that the main effect of NB approached significance on presence ($F(1,78) = 3.433, p = .068$, partial $\eta^2 = .042$), but was not significant on dominance ($F(1,78) = 1.440, p = .234$) or enjoyment ($F(1,78) = 1.838, p = .179$).

Testing the effect of NB on aversive and coercive conditions using a 2 (NB) \times 2 (Motivational Condition) \times 2 (Probe Type) mixed design ANOVA yielded a non-significant effect of NB on dominance, presence, and enjoyment (all $F < 1$).

Emotion	Negativity Bias	Appetitive		Aversive		Coactive	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Dominance	Low NB	6.500	.260	5.622	.347	5.988	.248
	High NB	6.282	.267	5.026	.356	6.500	.254
Presence	Low NB	4.463	.267	4.354	.283	5.244	.316
	High NB	3.910	.274	3.603	.290	5.731	.324
Enjoyment	Low NB	4.854	.271	4.329	.262	6.024	.251
	High NB	5.064	.277	3.821	.269	6.538	.257

Table 5-8. Mean ratings of self-reported emotions for each motivational condition with calm content, by negativity bias groups

The interaction of PO and NB on the self reported emotional data was also examined using just the calm content. Interaction of PO \times NB was not significant on positive emotion ($F(1,76) = 1.370, p = .245$), negative emotion ($F < 1$), arousal ($F < 1$),

dominance ($F < 1$), presence ($F(1,76) = 1.666, p = .201$), or enjoyment ($F(1,76) = 1.211, p = .275$).

However, the three-way interaction of PO \times NB \times motivational condition, looking only at calm content, was significant for arousal ($F(2,152) = 3.474, p = .033$, partial $\eta^2 = .044$, Figure 5-7), and approached significance for presence ($F(2,152) = 2.399, p = .094$, partial $\eta^2 = .031$, Figure 5-9) and enjoyment ($F(2,152) = 2.398, p = .094$, partial $\eta^2 = .031$, Figure 5-10) while remaining insignificant for positive and negative emotion, and dominance (all $F < 1$).

A perusal of these interactions demonstrates that despite the spotty record of statistical significance (possibly as a result of the small sample size for between subject effects and the weakness of median split, which is used for PO and NB manipulations), there is reason to have some confidence in the theoretical predictions.

First, examining Figure 5-5, where self reported positive emotion is the dependent variable, we see that during coactive and appetitive conditions, the four PO \times NB groups (from here on called the motivational groups) have little effect on positive emotion, where all groups seem to feel about the same level of positive emotion. However, during aversive activation – when it is all bad – the high PO & low NB group (sometimes called the risk takers) are reporting more positive emotions than the other groups while the low PO & high NB group (sometimes called the risk avoiders; see A. Lang, 2006 for discussion) are reporting the least positive emotion. A post-hoc test comparing these two groups using a 2 (Motivational Groups) \times 2 (Motivational Condition) \times 2 (Probe Type) mixed design ANOVA revealed that the difference in self-reported positive emotions between these two motivational groups approaches significance ($F(1,30) = 3.262, p$

= .081, partial $\eta^2 = .098$). Again, the lack of significance in this analysis seems to be due to insufficient sample size ($N = 32$).

Figure 5-10 shows a similar pattern with no differences in appetitive and coactive but with the risk takers enjoying the aversive condition way more than the other groups. A post-hoc test comparing the risk takers ($n = 16$; $M = 5.656$, $SE = .479$) and others ($n = 64$; $M = 4.625$, $SE = .240$) using a 2 (Risk Takers – Non Risk Takers) \times 2 (Probe Type) mixed design ANOVA revealed that for the self-reported enjoyment during aversive-calm content, the main effect of motivational groups (risk taker vs. non-risk taker) approaches significance ($F(1,78) = 3.701$, $p = .058$, partial $\eta^2 = .045$). The lack of significance is likely to be from the very small sample size of risk takers.

Indeed, in all of these figures, we see the risk taking group (high PO & low NB) during aversive activation feeling the most dominant, the most present, the most positive, the most enjoyment, and the *least* negative emotion as would be expected.

Interestingly, we also see that this same group, the risk takers, reporting the most negative emotion during appetitive and coactive conditions and the least negative emotion during the aversive conditions. This might suggest that this group of people perceived aversive activation as positive and the lack of aversive activation to be negative.

These results show that individual differences in motivational traits have a significant interactive effect with motivational condition for a number of emotional responses and a suggestive pattern of mean responses for the others. Given these results it seems likely that the lack of statistical significance is more likely due to the relatively small number of participants in each sub-group (ranging from 16- 24) and the weakness of the median split manipulation.

Emotion	PO & NB	Appetitive		Aversive		Coactive		All Three Conditions	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Positive Emotion	Low PO, Low NB	5.780	.307	4.760	.388	5.720	.317	5.420	.277
	Low PO, High NB	6.031	.384	4.500	.485	6.469	.396	5.667	.346
	High PO, Low NB	5.906	.384	5.656	.485	6.656	.396	6.073	.346
	High PO, High NB	5.978	.320	4.565	.405	6.196	.330	5.580	.289
Negative Emotion	Low PO, Low NB	3.520	.312	4.760	.392	3.780	.315	4.020	.272
	Low PO, High NB	2.656	.390	4.531	.490	3.250	.394	3.479	.340
	High PO, Low NB	4.063	.390	4.219	.490	4.156	.394	4.146	.340
	High PO, High NB	3.587	.326	4.370	.409	3.783	.329	3.913	.283
Arousal	Low PO, Low NB	5.120	.344	4.180	.364	5.580	.312	4.960	.284
	Low PO, High NB	4.188	.430	3.938	.455	6.656	.390	4.927	.354
	High PO, Low NB	4.406	.430	4.719	.455	6.188	.390	5.104	.354
	High PO, High NB	4.478	.359	3.717	.380	6.630	.325	4.942	.296
Dominance	Low PO, Low NB	6.260	.332	5.260	.445	5.500	.305	5.673	.273
	Low PO, High NB	5.906	.415	5.219	.556	6.125	.382	5.750	.341
	High PO, Low NB	6.875	.415	6.188	.556	6.750	.382	6.604	.341
	High PO, High NB	6.543	.346	4.891	.463	6.761	.318	6.065	.284
Presence	Low PO, Low NB	4.700	.332	4.260	.365	5.060	.402	4.673	.311
	Low PO, High NB	3.156	.415	3.281	.456	5.125	.502	3.854	.388
	High PO, Low NB	4.094	.415	4.500	.456	5.531	.502	4.708	.388
	High PO, High NB	4.435	.346	3.826	.380	6.152	.419	4.804	.324
Enjoyment	Low PO, Low NB	4.900	.351	4.040	.334	5.680	.319	4.873	.273
	Low PO, High NB	4.969	.439	4.094	.418	6.688	.398	5.250	.341
	High PO, Low NB	4.781	.439	4.781	.418	6.563	.398	5.375	.341
	High PO, High NB	5.130	.366	3.630	.348	6.435	.332	5.065	.285

Table 5-9. Mean ratings of self-reported emotions for each motivational condition with calm content, by PO × NB

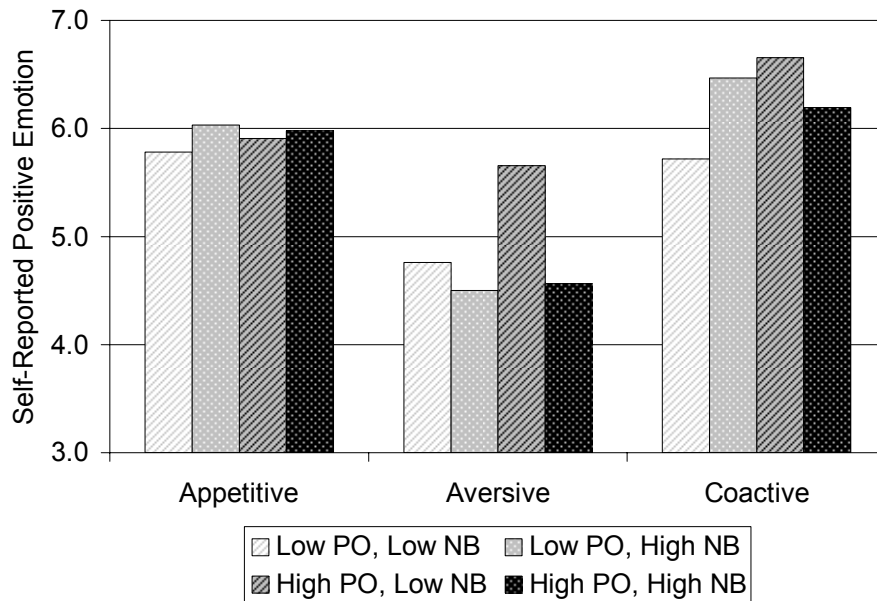


Figure 5-5. Mean ratings of self-reported positive emotions for each motivational condition with calm content, by PO \times NB

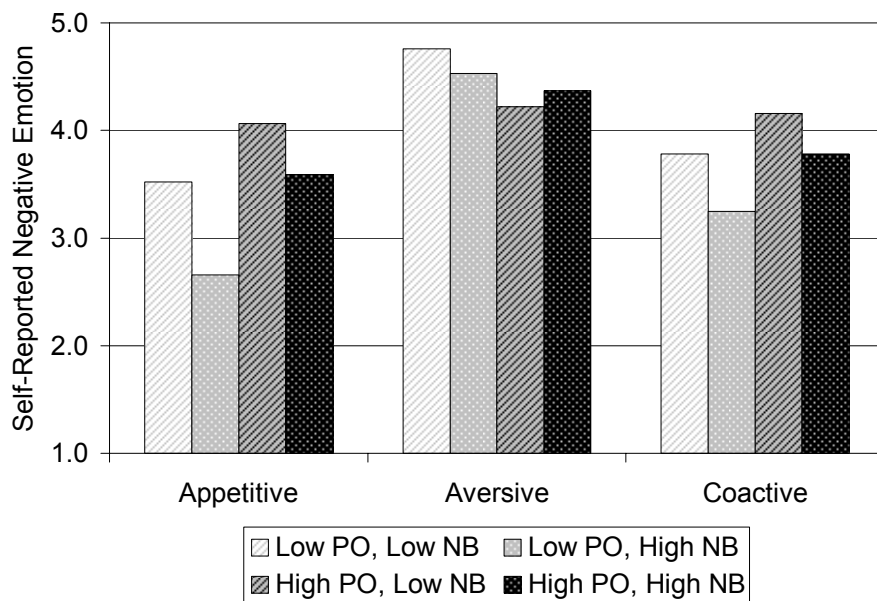


Figure 5-6. Mean ratings of self-reported negative emotions for each motivational condition with calm content, by PO \times NB

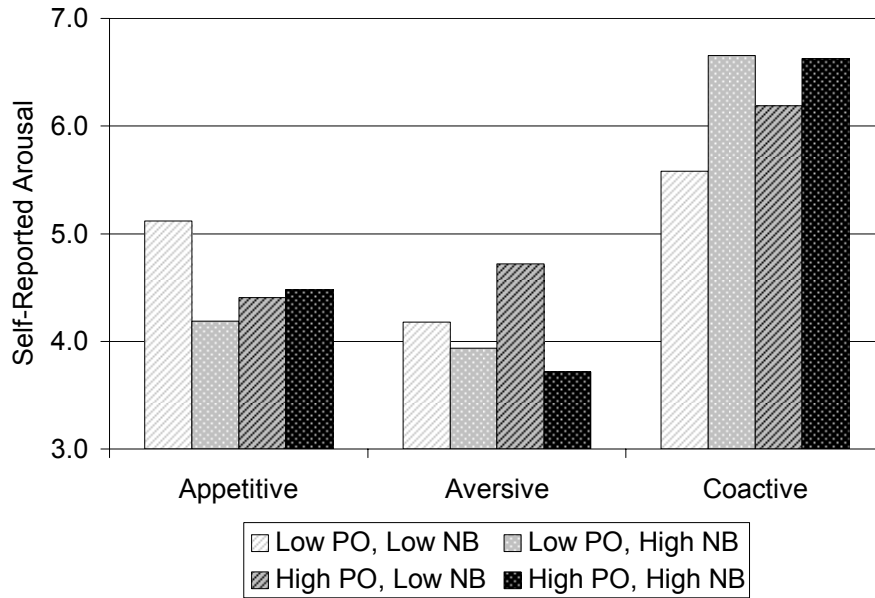


Figure 5-7. Mean ratings of self-reported arousal for each motivational condition with calm content, by PO \times NB

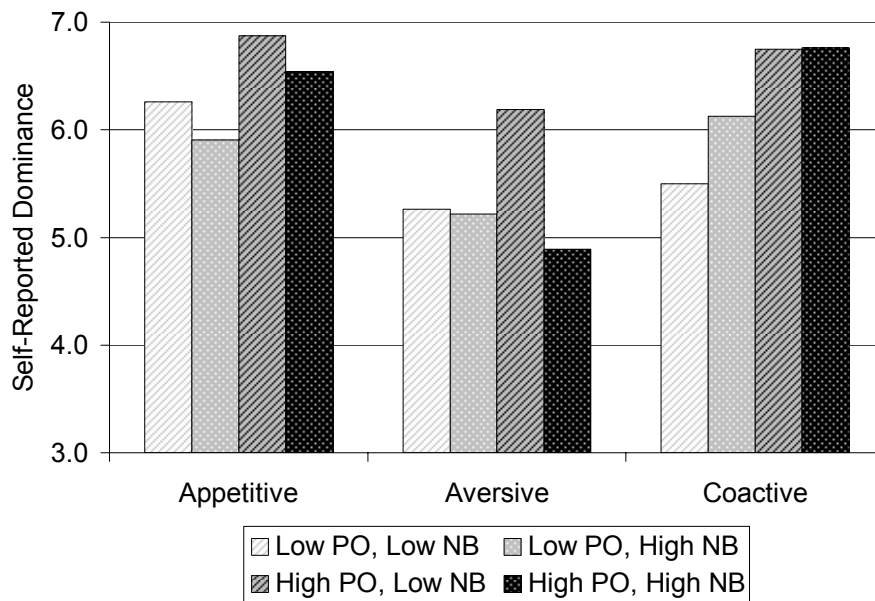


Figure 5-8. Mean ratings of self-reported dominance for each motivational condition with calm content, by PO \times NB

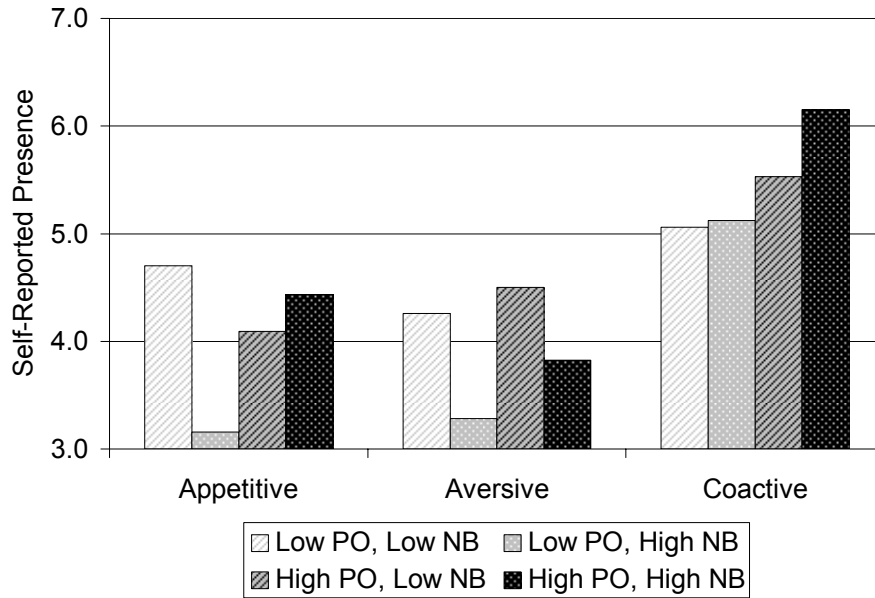


Figure 5-9. Mean ratings of self-reported presence for each motivational condition with calm content, by PO x NB

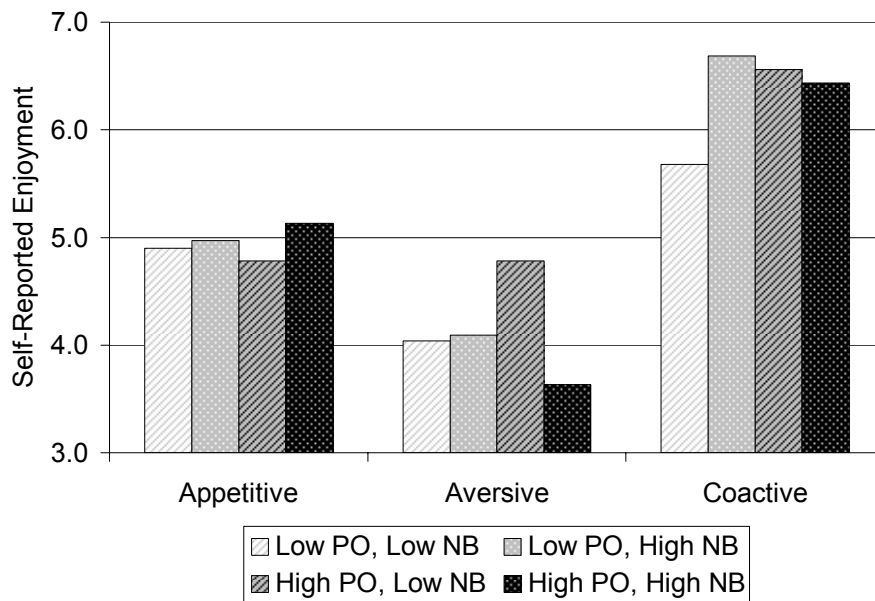


Figure 5-10. Mean ratings of self-reported enjoyment for each motivational condition with calm content, by PO x NB

Limitations of the Current Study

As a laboratory experiment, there were limitations to this study which primarily concern limitations in external validity by not exactly replicating the natural media consumption environment for the participants. Indeed, great effort was made to achieve external validity where possible by designing the stimulus (video game) in a way typical of commercial video games, and using a commercially available control device (game pad) that is used for playing commercial video games. However, participants in this study sat in a chair with electrodes attached to multiple bodyparts, and were instructed to make their best effort to perform the task given by the game. Furthermore, participants were exposed to acoustic startle probes and required to respond to audio tones for measuring secondary task reaction time. Participants were also required to rate their emotional responses to each segment of video game. This does not exactly replicate real world usage of video games that is generally played in a more comfortable environment. Also, the video game used in this study was a classical 2-dimensional vertical shooting game, a genre started by *Space Invaders* (Taito, 1978). Though the quality of the graphics used in the video game in this study was more advanced than *Space Invaders*, the technology used was not as sophisticated as video games commercially available today.

On the other hand, there is no particular reason to suppose that this lack of comfort and normalcy would alter things like motivational activation, attention, or resource allocation. The stimulus used in this study may be crude by today's standard, but it was able to elicit responses to find supported for the theory this study was designed on. Rather, these issues might have had larger effects on the self-reported emotions.

Since the primary goal of this study was to investigate the pattern of motivated cognitive processing of video games, it was necessary to maintain control of the environment and to develop a procedure and use equipment which would allow to track cognitive (secondary task reaction time), physiological (heart rate, skin conductance, orbicularis oculi EMG, corrugator supercilii EMG, startle reflex), and experiential data (self-reported emotion) overtime. These requirements were indeed more important for the questions being asked in this study than replicating “real world” gaming conditions. As a laboratory experiment on motivated cognitive processing of video games, eliciting motivational conditions was more important than maximizing the external validity of this study by replicating naturalistic gaming environment.

For a study that explores the cognitive processing of mediated messages, this study is limited by the study design, which does not incorporate memory tests. Memory tests have been one of the most powerful tools for research in media and cognition, and A. Lang (in press) specifically states that LC4MP uses recognition tests to index encoding, free recall to index retrieval, cued recall to index storage. None of these memory test techniques has been employed for this study. Part of the reason was that by definition, memory tests require materials to memorize in the first place, and the type of video game created for this study (a shooting game, which is a type of action game) was not suitable for delivering items for players to memorize. However, the use of STRT as a measure of available resources gave us insight into at least the level of ongoing resource allocation if not the pattern of allocation across subprocesses.

Another limitation of this study is that the motivational system activation was inferred from measurements of facial EMG and self-reports, rather than directly

measuring the activity of relevant parts of the brain, such as the amygdala (for the role of amygdala and valence, see Breiter, Etcoff, Whalen et al., 1996 and Davidson & Irwin, 1999). However, the cost for using a brain imaging equipment, and the limitations in currently available functional magnetic resonance imaging (fMRI) technology which prohibits conducting experiments with electronic devices (i.e., video game controller) in participant's hands, were major obstacles for directly measuring the brain activity for this particular study.

Finally, this study was most limited by the lack of quality in the arousing content manipulation which led to inconsistently variable levels of arousal across the motivational conditions. Increase in both the number and speed of objects successfully increased both physiological arousal and self-reported arousal for aversive and coercive conditions. However, as discussed above, this manipulation did not increase the physiological arousal in the appetitive condition – possibly because increment of objects decreased the effort required for performing the task (hunt and gathering) on the player's side. For action-type video games, like the one used for this study, perhaps increasing the speed while keeping the number of objects on screen the same may have elicited more physiological arousal and higher self-reported arousal across all three conditions.

Finally, from the perspective of the video game industry, some of the findings of this research are limited to one specific genre of video game – action game. There are other genres of video game that do not require constant input from the player, such as board games or strategy games. When applying scientific theories such as the LC4MP to predict the user's processing of video games, differences in the context based on its genre must be taken to consideration.

Directions for Future Research

Research on emotional responses to video games is still in its infancy and this study was among the first to apply LC4MP as a theoretical frame to explore motivated cognition in video game play. Future research may want to replicate the findings in the context of video games from different genres, as well as in different media.

It was also the first research to attempt to create a coactive state in the user's motivational system activation by combining content features that activate the appetitive system and content features that activate the aversive system. Any future research, whether it is about video games or another medium, will want to attempt to replicate the findings from the coactive condition in this study.

Beyond replication, there are several directions I would like to suggest future research should take. As mentioned earlier, exploring a possible interaction between motivational system activation and arousal by controlling the physiological arousal levels for each motivational condition is one of them. Manipulation of structural features besides the number and speed of objects to find how they will affect motivated cognition is another possible direction. One of the primary tenets of LC4MP is that structure and content interact. The problems with the arousing content manipulation serve as yet another reminder of this fact. Some basic research in this area should be done to try to understand what are the important structural features of videogames and for which dependent variables do they matter? How important is structural features (e.g., number of objects, speed, 2-dimensional vs. 3-dimensional graphics, color, sound effects, background music, vertical vs. horizontal movement, etc.) on motivational activation as well as cognitive resource allocation?

Also, designing a study for video games that incorporates memory testing to index different sub processes of message processing conceptualized by LC4MP is suggested. As discussed above, the type of video game used for this study was not suitable for memory tests, but other genres, such as adventure games (also known as *interactive novels* or *interactive movies*) that rely heavily on storyline, could easily be used to provide content that can be subjected to memory testing.

Exploring whether individuals with different PO and NB process video games, or media in general, differently and if so, how, is another important question future research should address. Research in individual differences and media is likely to help not only the academics but also the media industry, so the industry can serve customers better by creating and delivering better content for its intended users. The lack of statistical significance for many dependent variables from the analyses for the effect of individual differences in motivational trait on motivated cognition and emotional responses was partially due to the insufficient number of participants per each sub-group. However, despite this limitation – many of the predictions were at least partially supported including some related to behavior (how much they play games), emotional responses (how they feel while they are playing), and physiological responses (how much motivational activation is elicited). Future research that attempts to explore the interaction of PO and NB on processing of mediated messages should employ larger numbers of participants and perhaps select participants who are extremely high or low on NB and PO.

Of particular interest, perhaps, is that the risk takers, who are of great interest to people who study public health due to their proclivities to use drugs and engage in other

risky behaviors (like drunk driving, not wearing seatbelts, unprotected sex, etc) really like playing these games – and they really like them when they are negative. Perhaps video games encouraging safe sex and promoting anti-drug messages could be developed to help get public health messages across to these high risk groups.

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Appendix A

Stimulus

Following images are the screen shots from the practice session, and each motivational condition by arousing content.

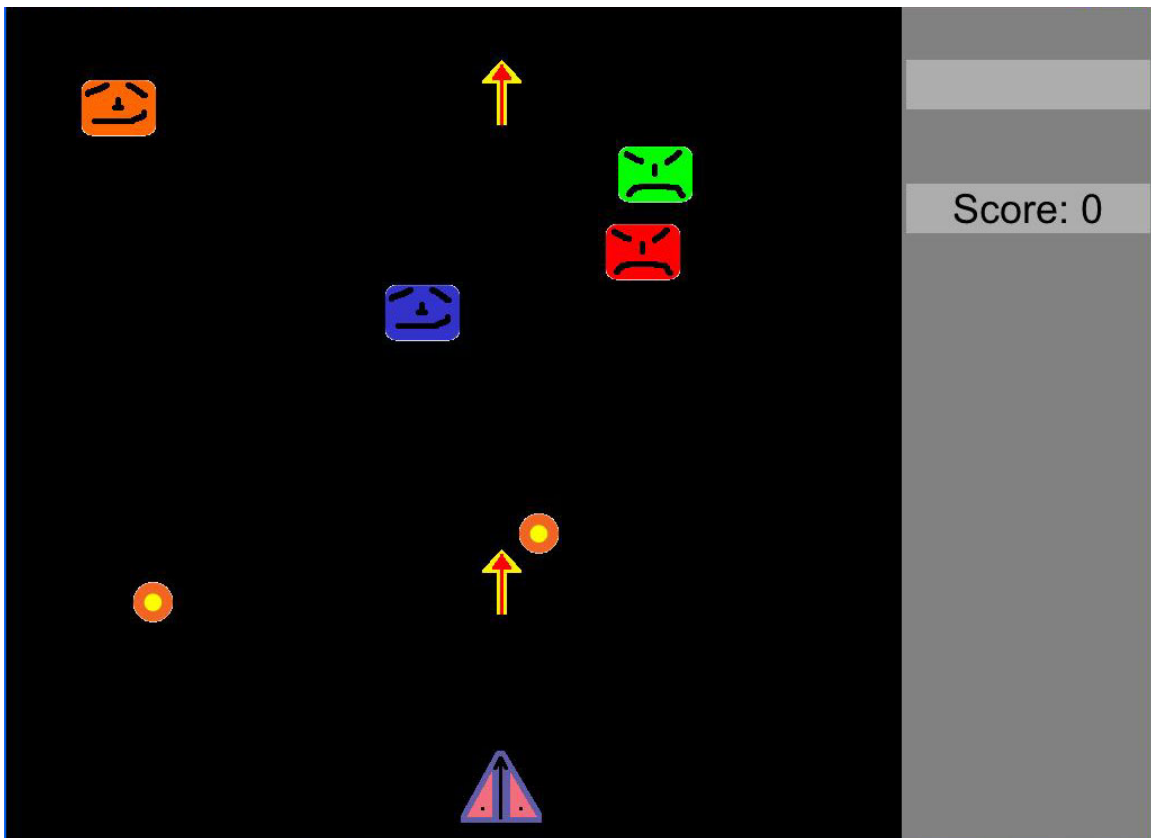


Figure A-1. Practice Session

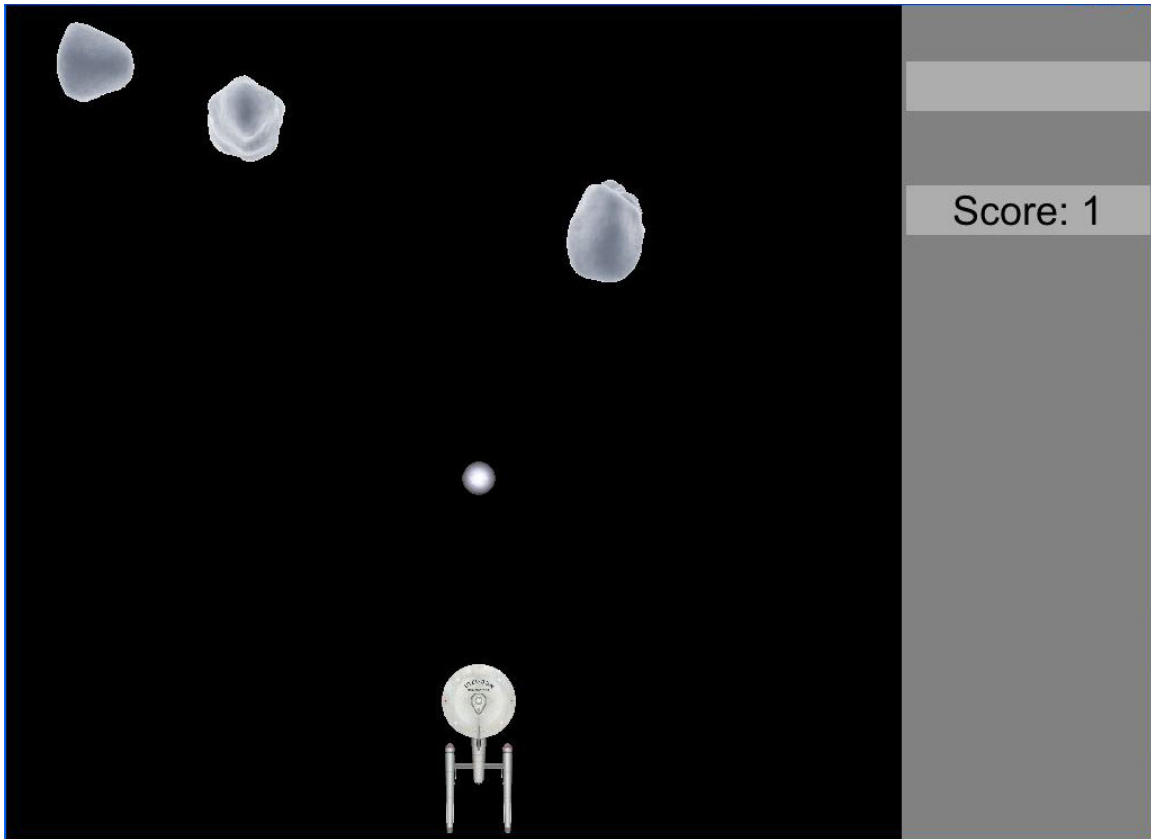


Figure A-2. Appetitive – Calm Content

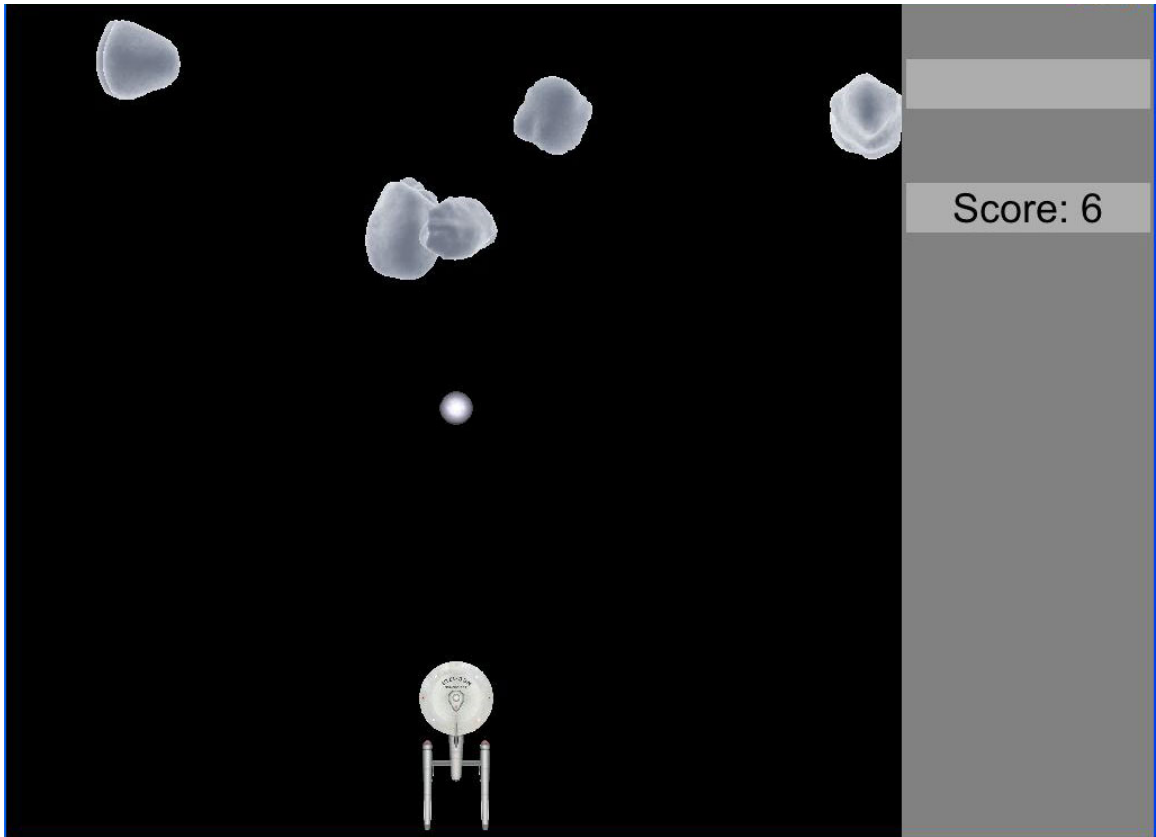


Figure A-3. Appetitive – Arousing Content

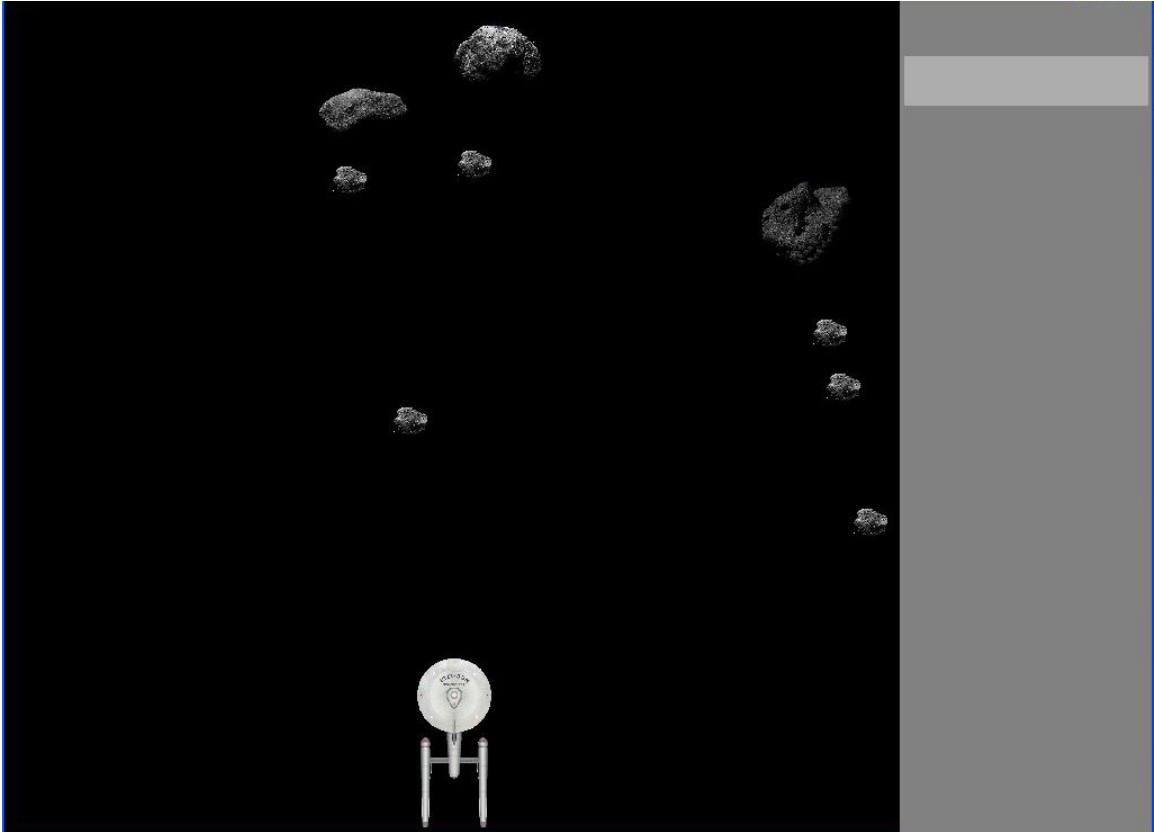


Figure A-4. Aversive – Calm Content

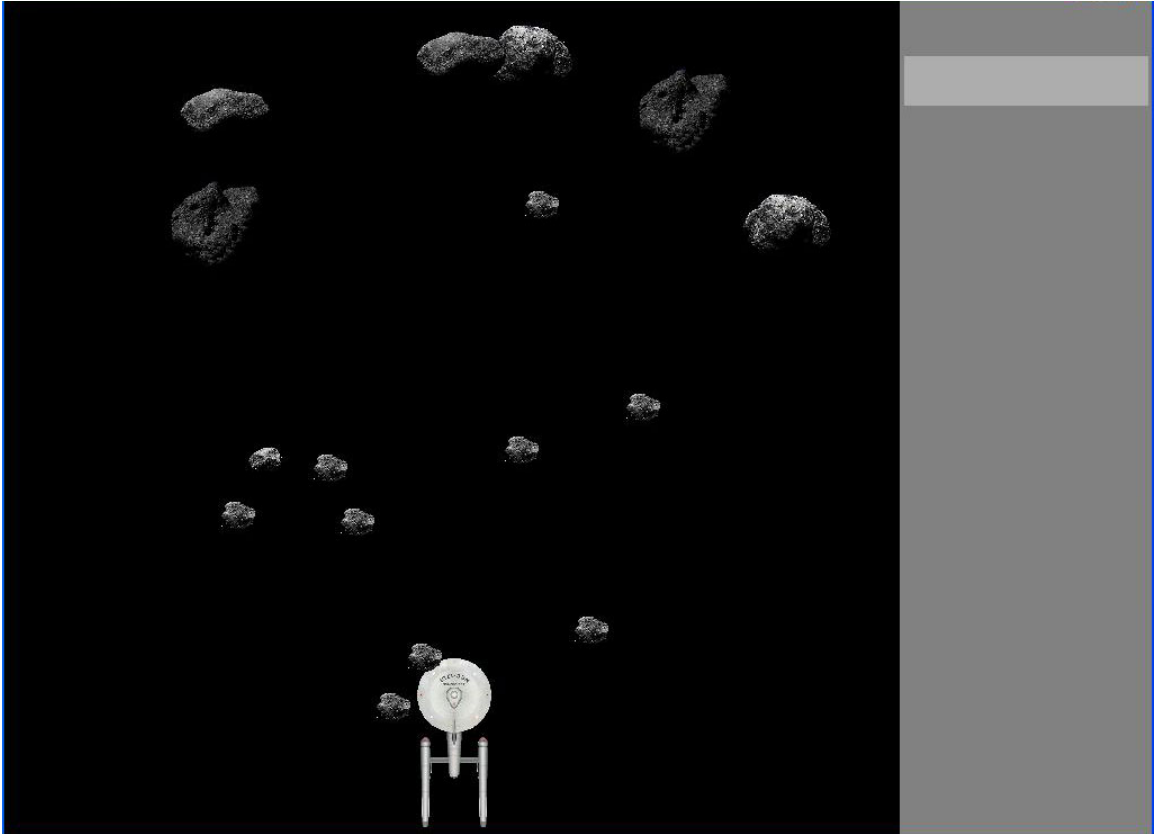


Figure A-5. Aversive – Arousing Content

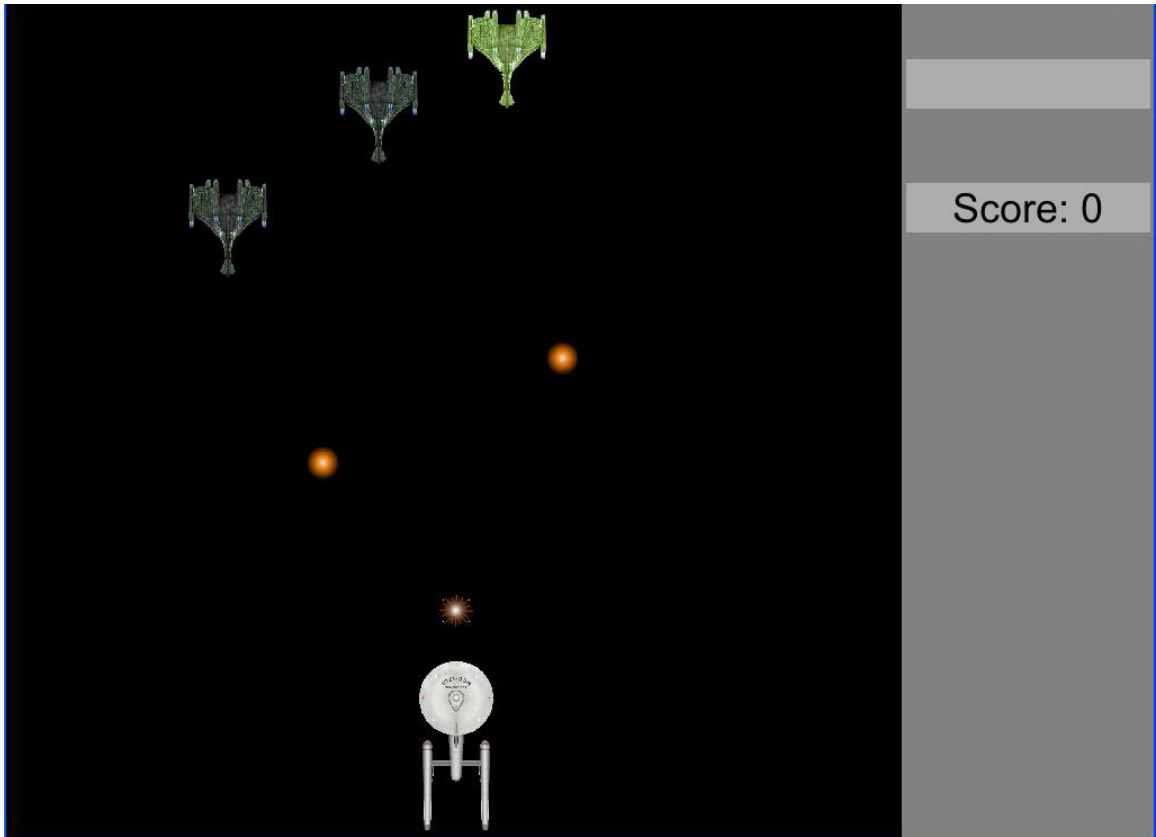


Figure A-6. Coactive – Calm Content

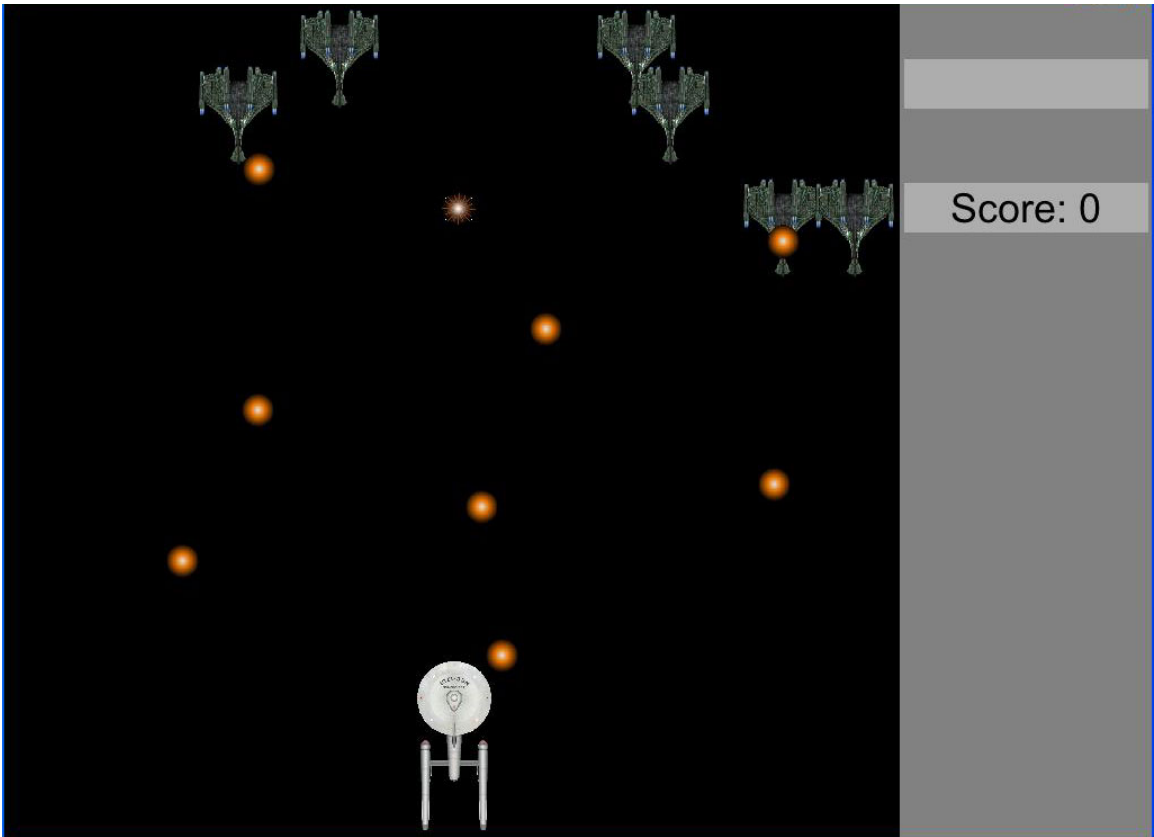


Figure A-7. Coactive – Arousing Content

Appendix B

Self Reported Measures

Following images are the screen shots from the survey on self-reported emotions.

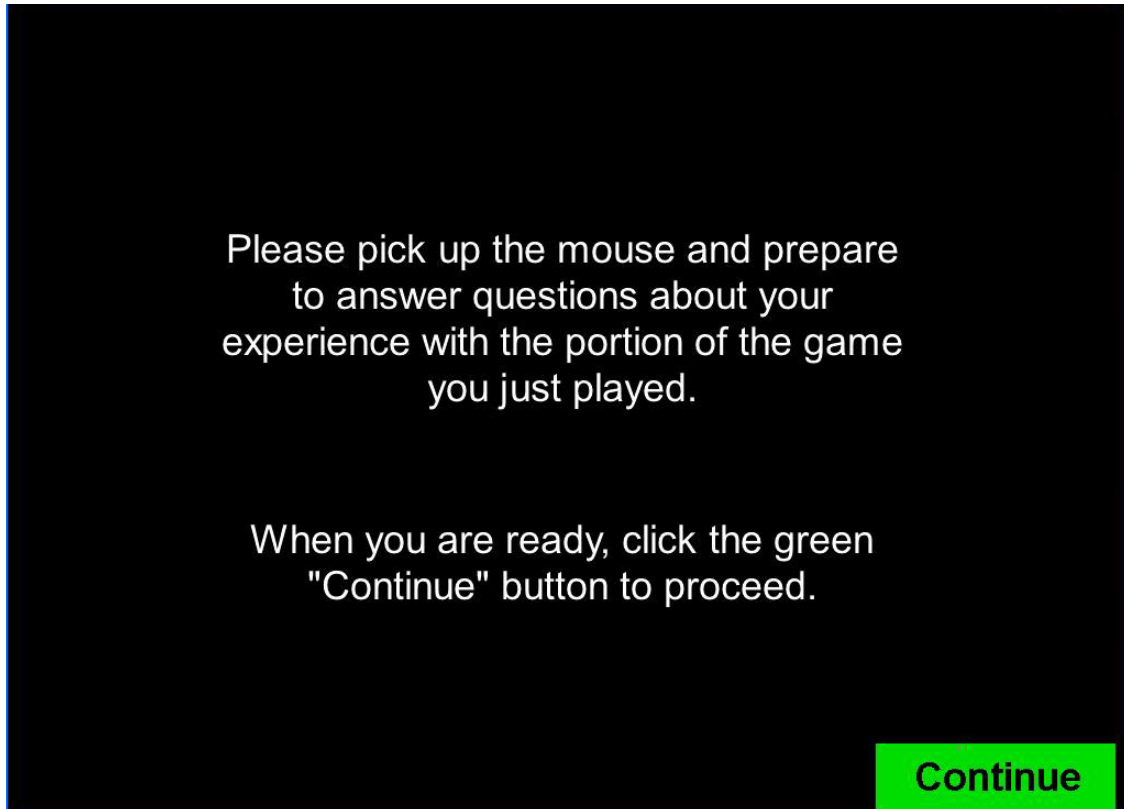


Figure B-1. Instructions for rating self-reported emotions

Please rate how positive this portion of game made you feel

Extremely positive, happy, pleased

Moderately positive

Not at all positive, not at all happy, not at all pleased

Figure B-2. Screen for rating self-reported positive emotion

Please rate how negative
this portion of game made you feel

Extremely negative, unhappy, annoyed

Moderately negative

Not at all negative, not at all unhappy, not at all annoyed

Figure B-3. Screen for rating self-reported negative emotion

Please rate how arousing this portion of game made you feel

Extremely aroused, excited, awake

Moderately aroused

Not at all aroused, not at all excited, not at all awake

Figure B-4. Screen for rating self-reported arousal

Please rate how enjoyable
this portion of game made you feel

Extremely enjoyable, fun

Moderately enjoyable

Not at all enjoyable, not at all fun

Figure B-5. Screen for rating self-reported enjoyment

Please rate how *dominant*
this portion of game made you feel

Extremely in control, extremely dominant

Moderately in control, moderately dominant

Not at all in control, not at all dominant

Figure B-6. Screen for rating self-reported dominance

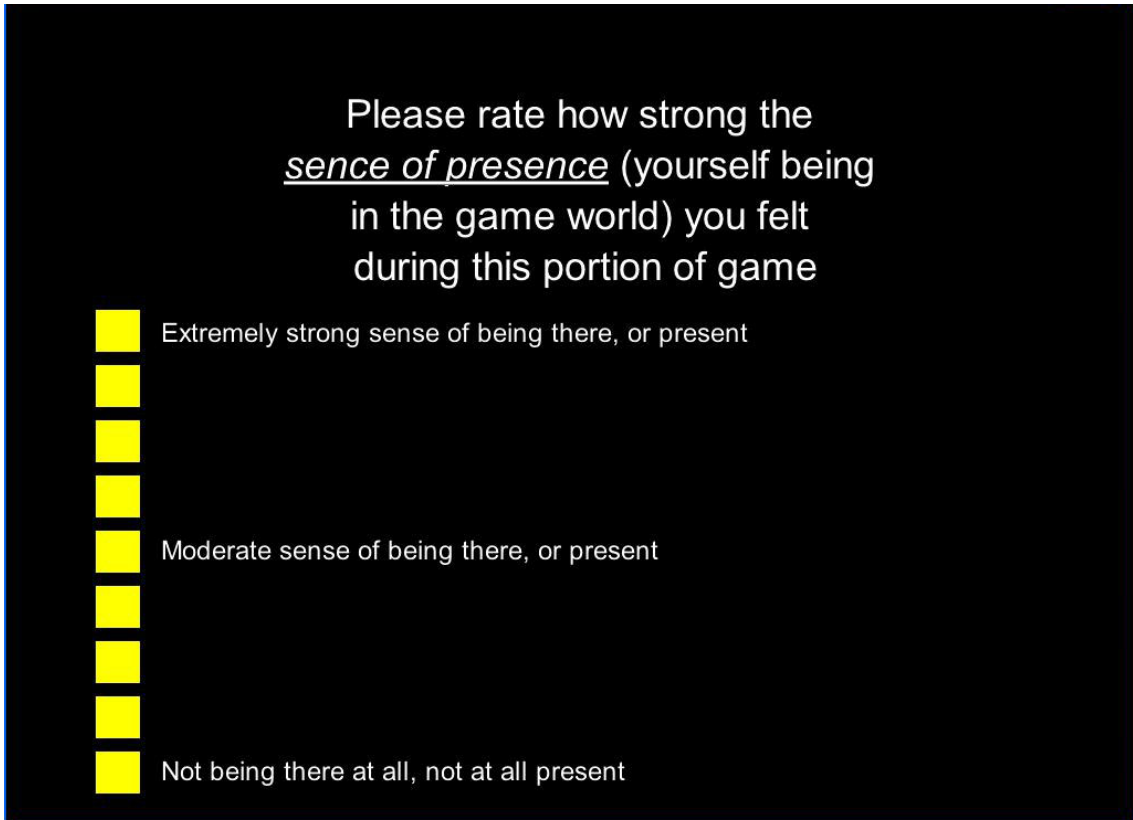


Figure B-7. Screen rating self-reported presence

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B.S. in Computer Science
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Honors

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Republic of Korea. (2001 – 2006)

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Top 10% Paper. International Conference on Politics and Information Systems: Technologies and Applications, 2004.

Journal article

- Park, B. (in press). Striking the Match: PC-Bang, the Key Player that Sparked the Amazing Digital Revolution in Korea. *Journal of Systemics, Cybernetics and Informatics*.
- Park, B., & Gillespie, T. (2003). "PC-bang" Brought a "big-bang": The Unique Aspect of the Korean Internet Industry. *The Journal of Education, Community, and Values*, 3(8). Available: <http://bcis.pacificu.edu/journal/2003/08/park.php>
- Fox, J. R., & Park, B. (2006). The "I" of Embedded Reporting. *Journal of Broadcast and Electronic Media*, 50(1), 36-51.
- Lang, A., Bradley, S. D., Park, B., Shin, M., & Chung, Y. (in press). Parsing the Resource Pie: Using STRTs to measure attention to Mediated Messages. *Media Psychology*.

Books

- Park, B. (1993). *RPG Mandeuilghi* (How to Design a Role Playing Game). Seoul, Korea: Information Age.
- Park, B., & Lee, B. (1992). *Ani-Sedae* (Animation Generation). Seoul, Korea: Dasun Publication.

Manuscripts under review by academic journals

- Park, B., & Bradley, S. D. (Submitted). Aliens and advertisements: Cognitive message processing in an interactive video game environment. Manuscript submitted to *Journal of Interactive Advertising*.
- Fox, J. R., Park, B., & Lang, A. (Submitted). When Available Resources Become Negative Resources: The Effects of Cognitive Overload on Memory Sensitivity and Criterion Bias. Manuscript revised and resubmitted to *Communication Research*.
- Lang, A., Park, B., Sanders-Jackson, A. N., & Wilson, B. D. (Submitted). Separating emotional and cognitive load: How Valence, Arousing Content, Structural Complexity and Information Density affect the availability of cognitive resources. Manuscript revised and resubmitted to *Media Psychology*.

Conference papers

Fox, J. R., Park, B., & Lang, A. (2006, June). *Complicated Emotional Messages Produce Liberal Bias: Effects of Valence and Complexity on Sensitivity and Criterion*. Paper presented to the Information Systems division of the International Communication Association, Dresden, Germany.

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Lang, A., Derryberry, D. Z., Sparks, J. V., Park, B., Kurita, S., Shyu, S. A., & Potter, R. F. (2006, June). *The Effects of Audio and Video Information Density on Available Resources and Encoding*. Paper presented to the Information Systems division of the International Communication Association, Dresden, Germany.

Lee, S., & Park, B. (2006, June). *Effects of Motivational Activation on Processing Positive and Negative Content in Pop-Up Advertisements*. Paper presented to the Information Systems division of the International Communication Association, Dresden, Germany.

Lee, S., Park, B., & Potter, R. F. (2006, June). *The Impact of Structural Complexity and Information Density on Attitudes Toward Radio PSAs*. Paper presented to the Information Systems division of the International Communication Association, Dresden, Germany.

Park, B. (2004, October). *Cultivating the Youth: Propaganda Against Nazis at the Subliminal Level Using Animated Features*. Paper presented at the Society for Animation Studies International Conference, Urbana-Champaign, IL.

Park, B. (2004, July). *It's not the Internet – it's the Broadband that Makes Online Journalism Truly Interactive*. Paper presented at the International Conference on Politics and Information Systems: Technologies and Applications, Orlando, FL.

Park, B. (2004, July). *Striking the Match: PC-Bang, the Key Player that Sparked the Amazing Digital Revolution in Korea*. Paper presented at the International Conference on Politics and Information Systems: Technologies and Applications, Orlando, FL.

Park, B. (2004, February). *PC-bang, the unique and important factor that contributed to online entertainment services in Korea*. Paper presented at the Midwinter Conference of the Association for Education in Journalism and Mass Communication at New Brunswick, NJ.

- Park, B. (2001, March). *How to Market in Korea: Small Country, Big Market for PC Games*. Paper presented at the Game Developers Conference 2001, San Jose, CA.
- Park, B., Bradley, S. D., & Kim, O. (2003, May). *This Galactic War Has Been Brought to You by These Fine Sponsors: Cognitive Message Processing in an Interactive Video Game Environment*. Paper presented to the Information Systems division of the International Communication Association, San Diego, CA.
- Park, B., & Gillespie, T. (2003, June). *PC-Bang: A New Internet-Based Business Model that Brought Such a Big-Bang to the Korean Market and People*. Paper presented to the Asian Studies on the Pacific Coast, Honolulu, HI.
- Park, B., Sanders-Jackson, A. N., Wilson, B. D., & Lang, A. (2005, May). *Separating Speed From Load: Understanding How Pacing and Information Contribute to Variation in STRTs*. Paper presented to the Information Systems division of the International Communication Association, New York, NY.
- Fox, J. R., & Park, B. (2004, August). *The "I" of Embedded Reporting*. Paper presented at the Association for Education in Journalism and Mass Communication, Toronto, Canada.
- Fox, J. R., & Park, B. (2004, February). *Just Adding Graphics Does Not Make Them Remember Better: How Sensitivity of Memory Is Affected by the Complexity of the News Story and the Use of Graphics*. Paper presented at the Midwinter Conference of the Association for Education in Journalism and Mass Communication at New Brunswick, NJ.
- Fox, J. R., Park, B., & Lang, A. (2006, June). *Complicated Emotional Messages Produce Liberal Bias: Effects of Valence and Complexity on Sensitivity and Criterion*. Paper accepted for presentation to the Information Systems division of the International Communication Association, Dresden, Germany.
- Fox, J. R., Park, B., & Lang, A. (2006, June). *When Available Resources Become Negative Resources: Effects of Cognitive Overload on Memory Sensitivity and Criterion*. Paper accepted for presentation to the Information Systems division of the International Communication Association, Dresden, Germany.
- Fox, J. R., Park, B., Grabe, M. E., & Lee, S. (2005, May). *Stay Tuned: Effects of Tabloid TV News Content and Structural Features on Viewer Processing, Memory, and Channel Changing Behavior in Young Adults*. Paper presented to the Information Systems division of the International Communication Association, New York, NY.
- Haverhals, L., Bradley, S. D., Park, B., & Lang, A. (2003, May). *An Empirical Examination of the Secondary Task Reaction Times: Testing What They Really*

- Measure*. Paper presented to the Information Systems division of the International Communication Association, San Diego, CA.
- Lang, A., Bradley, S. D., Park, B., Shin, M., & Chung, Y. (2004, August). *Parsing the Resource Pie: Using STRTs to Measure Attention to Mediated Messages*. Paper presented at the Association for Education in Journalism and Mass Communication, Toronto, Canada.
- Lang, A., Derryberry, D., Sparks, J. V., Park, B., Kurita, S., Shyu, S., & Potter, R. F. (2006, June). *The effects of audio and video information density on available resources and encoding*. Paper accepted for presentation to the Information Systems division of the International Communication Association, Dresden, Germany.
- Lee, S., & Park, B. (2006, June). *Effects of Motivational Activation on Processing Positive and Negative Content in Pop-up Advertisements*. Paper accepted for presentation to the Information Systems division of the International Communication Association, Dresden, Germany.
- Lee, S., & Park, B. (2006, June). *The Impact of Structural Complexity and Information Density on Attitudes toward Radio PSAs*. Paper accepted for presentation to the Information Systems division of the International Communication Association, Dresden, Germany.
- Lee, S., Park, B., & Fox, J. R. (2005, May). *Web Advertising and Pop-Up Ads*. Paper presented to the Information Systems division of the International Communication Association, New York, NY.

Poster session presentations

- Park, B. (2006, March). *You deny, but you're lovin' it: Using psychophysiology for product evaluation*. Poster session presented to the Game Developers Conference, San Jose, CA.
- Park, B. (2006, March). *Online Gaming Business in the Asian Market: Understanding the new business model*. Poster session presented to the Game Developers Conference, San Jose, CA.

Manuscripts in preparation

- Park, B. (in preparation). Virtual violence and real-life emotions: Violent video game playing as a function of motivational systems.

Park, B. (in preparation). Making a tool we borrowed work: Using secondary task reaction time (STRT) for communication science.

Lee, S., & Park, B. (in preparation). Who dies matters: Cognitive and emotional response to empathetic death portrayed on screen, measured by psychophysiological responds.

Invited lectures

June, 1994 *How to build plans for designing good video games.* Presentation for the Center of Information & Culture, Seoul, Korea.

June, 1999 *Why Korean children are so obsessed to Japanese Cartoons.* Presentation for the Young Men's Christian Association – Korea, Seoul, Korea.

University and Teaching Positions

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