INTERACTIVE AMUSEMENT PARK QUEUES: EXAMINING THE INDIRECT EFFECT OF TASK WORK LOAD ON GUESTS' PERCEPTION OF WAIT DURATION THROUGH TASK IMMERSION

by

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ABSTRACT

With the increasing attendance across amusement and theme parks worldwide, it is not surprising that minimizing the impact of large crowds and long attraction waits on the guests' experience has received much focus by park operators in recent years. Although effective in the short term, attempting to eliminate or reduce wait times by simply increasing capacity cannot be sustained long term. A recent trend in amusement park design is to theme the queue with interactive elements to engage guests and occupy their wait time with the intent of making the wait queue part of the attraction itself.

Much of the research on the topic of waiting in line focuses on improving the customers' experience while waiting by altering the wait queue. Very little research to date empirically tests the impact that queue characteristics have on a customers' perceived wait duration with the research pool void of any applications to an interactive amusement park queue.

This dissertation study tested five hypotheses to determine how playing an interactive math skills game while waiting to ride a virtual roller coaster affected the participants' perceived wait duration. The first hypothesis tested if the participants' perceived wait time decreased as the mental workload of the game increased. The results did not find that this effect of mental workload on perception of time was significant. The second hypothesis tested whether participants who experience higher levels of game immersion estimate perceive wait time to be lower. The results indicated that this effect of game immersion on perceived wait time was significant. The third hypothesis tested whether participants' experience higher levels of game immersion when the perceived mental workload of the math skills game was higher. This effect of mental workload on immersion was found to be significant.

Hypothesis 4 tested whether the participants' perceived wait time was indirectly effected by the mental workload of the math skills through immersion. This indirect effect was found to be significant and the results support complete mediation by immersion because the direct effect was not significant with the indirect effect in the model. Hypothesis tested whether the mediated effect of mental workload on time perception via game immersion was moderated by participants' levels of sensation seeking and extraversion. Individual differences of extraversion and sensation seeking were not found to moderate the indirect effect.

This study demonstrates that research in the area of time perception can be applied to amusement and theme park queue design. Furthermore, it shows the importance of providing guests with an immersive queue experience to positively impact their perception of wait time, the number one complaint of many amusement and theme park visitors. Future research in this field should examine the individual elements of the queue environment to determine the optimal design to increase the level of immersion for park guests.

This dissertation is dedicated to my dad, Houston Glenn Ledbetter. He would often tell me, “Son, one of the most important things a father can do for his family is to take them on vacation.” My father worked hard all of his life to provide for us, but to dedicate time away from work and other distractions to spend with his family was of utmost importance to him. We spent many of those vacations at theme parks, and despite fighting the crowds and standing in long lines, I cherish those moments because we finally had *our* time with Daddy, away from all the work that he had to do to provide for us. Now that you’re gone, I have even more appreciation for your commitment and dedication to make time to spend with us. Oh, what I wouldn’t give to have just one more opportunity to stand in line with you, because our time together seemed to have passed by all too quickly. I love and miss you, Daddy.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BFI	Big Five Inventory
BPS	Boredom Proneness Scale
f	Dutch guilder
GB	Gigabyte
GHz	Gigahertz
IEQ	Immersive Experience Questionnaire
min	Minutes
ms	Milliseconds
MWL	Mental Workload
NASA-TLX	National Aeronautics and Space Administration – Task Load Index
PDJ	Prospective Duration Judgment
s	Seconds
SSS	Sensation Seeking Scale

CHAPTER ONE: INTRODUCTION

Visiting a major theme park can be an exciting endeavor that many people save and plan for, but when the day arrives, it often includes large crowds of people who join together to suffer through large crowds and hours of waiting for rides and attractions. In fact, waiting in long lines is the number one complaint by guests when visiting theme and amusement parks (O'Brien, 2000). In recent years, some parks have tried to alleviate the stress people encounter while waiting by trying to incorporate visual themes and even small interactive elements to occupy guests' time, but do they actually alter guests' perception of time or do they simply make waiting in a queue more tolerable? This dissertation addresses whether the issue is a perception of time issue or a perception of service issue while examining the variables that effect a guest's perception of time while waiting for an amusement park attraction.

Impact of Waiting

In 2013, attendance at the top ten theme park groups worldwide exceeded 377 million (Rubin, 2014). By comparison, the U.S. population at the close of 2013 was just over 371 million (U.S. Census Bureau, 2014). Therefore, it is not surprising that amusement and themed attractions play a major role in the world economy. In fact, this leisure activity of visiting amusement parks and themed attractions is the second largest producer of jobs in the U.S. after healthcare (Rubin, 2014).

With theme park attendance increasing 5.4% in 2013 (Rubin, 2014), the industry is looking to expand its offerings to accommodate the ever growing demand. This can be seen with the construction of new parks worldwide, along with existing properties adding to their current capacity by expanding their parks through new attractions (Bevil, 2015; Bilboa, 2015; Palmeri, 2015; Pedicini, 2015; Rubin, 2014). As with any finite resource, it becomes a precarious formula of adequately matching supply with demand. Everyone has experienced this mismatch of supply and demand - having to wait for service due to a lack of supply of resources. Those resources could be due to limited staff to serve customers, such as in a checkout line at the grocery store, or due to an inadequate supply of finished products, such as waiting for food to be prepared.

In an investor's conference call on February 17, 2011, Tom Staggs, Chairman of Walt Disney Parks and Resorts, reinforced the importance for theme park designers to focus on crowd management by stating that overcrowding "decreases the number of experiences that guests can enjoy, which in turn directly impacts guest satisfaction" (Walt Disney Company, 2011). If overcrowding negatively impacts guests' satisfaction, how can you positively affect guests' satisfaction or at the very least mitigate the negative effect of overcrowding? In one of the most cited articles dedicated to perception of waiting in lines, David Maister (1984) examined the effect of waiting on the consumers' service experience. In this article, he presented the "First Law of Science," where he states that the customer's level of satisfaction is measured by the difference between their perception of the service and their expectation of the service. Interestingly, Maister does not include the actual quality of service in his formula – merely the customer's perception of quality.

A number of studies have been conducted examining the effect that waiting for service has on customers' perception of service quality. Many of these studies examine the relationship between actual wait time and customer satisfaction. Research continues to show that waiting in line negatively impacts a customer's perceived experience.

Bielen and Demoulin (2007) examined the relationship between the four aspects of waiting time - objective, subjective, cognitive, and affective - and customer satisfaction and loyalty. Objective wait time is defined as the actual elapsed time as measured by a timing device such as a stopwatch. Subjective wait time is the customers' perceived wait time. The cognitive wait time is the customers' evaluation that the wait time is acceptable or not. Finally, the affective aspect of wait time includes the customers' emotional response to waiting. In the study, 946 radiological patients were asked questions of their waiting experience which included their perceived wait time, wait time satisfaction, the satisfaction with information provided in case of delay, and satisfaction of the waiting environment (2007). The results indicated that the perceived wait time negatively affected the patients' waiting time satisfaction. Furthermore, the customer satisfaction with information provided regarding a delay and customer satisfaction with the waiting environment positively influenced the patients' waiting time satisfaction. The research also indicated that the patient's wait time satisfaction had a positive effect on the overall service satisfaction. The researchers also examined the service satisfaction and loyalty relationship and found that wait time satisfaction had a moderating effect on this relationship.

While having to wait is generally seen as being nothing more than annoying or frustrating, the psychological impact of waiting for a finite resource can lead to extreme behaviors, referred to as queue rage. In fact, Seabrook (2011) states, "a crowd is most dangerous when density is greatest" (p. 34). Grove, Fisk, and John (2004) state that one of the triggers of queue rage relates to a customer's feeling of not being treated fairly or perception of his or her needs being neglected which is described as social injustice by Larson (1987). Grove et al. (Grove et al., 2004) further state that service organizations should have procedures in place to eliminate or reduce the occurrences of queue rage.

Internet blogger Robert Niles (November 27, 2012) compares retail black Friday events with a typical “rope drop” at a theme park. A “rope drop” is where guests crowd together, waiting for the opening of a theme or amusement park, cordoned off by a rope. At the park opening, the rope is dropped and the guests begin pouring into the empty park. Although Niles describes the procedures that park employees follow to mitigate the risk of queue rage among its guests, he also admits that sometimes there are gaps within these procedures being followed consistently.

Unfortunately, we need to only look at a few examples of what happens when gaps in procedures exist. On the day after Thanksgiving in 2008, shoppers, who had been waiting over 12 hours for entry to a Walmart in Long Island, trampled a store worker to death after rushing through the doors at store opening (Seabrook, 2011). Leading up to the opening of the store, the shoppers had begun pressing against the doors in anticipation of the doors opening for entry. Other examples illustrate tragic outcomes that are on a larger scale. In 1999, 52 people died in Belarus when the crowd pushed its way to an underground train station to avoid an imminent storm (2011). In 1989, 96 people died as a result of being crushed to death by the crowd of fans moving to gain entry into a stadium for a soccer match (2011). Other less dramatic instances include physical altercations between customers and service staff over waiting times (Grove et al., 2004).

Some may note that the aforementioned accounts of queue rage are not related to amusement and theme park settings; however, the potential of queue rage developing at an amusement or theme park is still present. While a disgruntled guest is far from the previously described accounts of “queue rage”, the importance of managing waiting in line is still high as theme park operators look at introducing novel strategies and innovative technologies to manage the demand from theme park visitors.

Queue Design

With evidence indicating that waiting in line has a high impact on guest satisfaction and desires to visit theme parks, theme park operators face the challenge of how to combat this problem of waiting in line for service. Specifically, there are two ways in which to combat the problem of waiting in line – eliminate the wait or change the negative perception of the wait.

Generally speaking, having to wait in a customer service environment is inevitable. Logistically, engineers and managers can create a very efficient system of moving individuals through a service queue, but eliminating a waiting environment altogether would be prohibitively costly. Theoretically, there would need to be enough employees and resources to serve customers as they arrive.

Consider a simple scenario of a ticket window at a movie theater. When one customer arrives to the window, there would need to be at least one employee to serve that customer. If a second customer arrives while the first customer is still being served, a second employee would be needed. At any point in which the ratio of employee to customer falls below 1:1, there is the potential of a customer having to wait for service.

This problem of matching supply and demand is further complicated by seasonality and cyclicality. Continuing with the above scenario of a theater ticket window, consider the variation in the number of customers purchasing tickets at 180, 60, 30, and five minutes prior to show time. No doubt this would require some precision in determining the number of employees needed to serve customers. If the ultimate goal is to eliminate all wait times for customers, management could err on the side of caution by providing the same number of employees needed during the peak times throughout all opening hours. However, this obviously would not be very efficient or cost effective as there would be excess capacity during all times except for the peak times. Alternatively, management could attempt to precisely maintain a 1:1 employee to customer ratio by forecasting the number of customers arriving at the ticket window. Accuracy in forecasting the demand would be imperative, as any miscalculation would result in failure of achieving the goal of eliminating all wait times.

The above scenario is based on the premise that matching supply and demand considers only the employee-to-customer ratio or any other infinite resource. Workforce is considered as much of an infinite resource in this scenario as any other infinite resource, although it can be argued whether any substance is truly infinite (Aristotle, 350 B.C.E.). However, even under the assumption that the supply is theoretically infinite, monetary resources are not infinite, and therefore, any attempt to match infinite demand with infinite supply is cost prohibitive.

Theme park designers have long considered the role of efficiency in their designs of attractions to match supply with demand. In fact, Walt Disney Parks and Resorts lists efficiency as one of their guiding principles called The Four Keys, with the other three being safety, courtesy, and show (*Be our guest : Perfecting the art of customer service*2003). Efficiency of theme park attractions is measured by the number of guests entering the attraction per hour, also called through-put. Through-put is of such great importance, it can sometimes change nearly the entire design of the attraction.

The importance of efficiency in designing theme park attractions is best illustrated in how the storyline and overall design of The Haunted Mansion at Disneyland was altered simply to accommodate the need to increase through-put. Originally designed to be a walkthrough attraction, The Haunted Mansion's original premise was to provide guests with a historical narrative of the mansion's owner while touring the grounds. However, due to the requirement by the park's operations department to build rides that would accommodate thousands of guests per hour, the walkthrough nature of the original concept gave way to the omnimover design, a continuously moving train of ride vehicles. As such, the story of the ride changed from a long narrative to several vignettes comprising each scene (Surrell, 2003).

While the above example illustrates how theme park attraction designers place a high degree of importance on efficiency, the question of eliminating guest wait time still remains. In other words, how do you design an attraction, or any other customer service venue, where a finite resource (attraction capacity) can meet the demand of guests, which more often than not fluctuates?

Some theme and amusement parks have relied upon the use of technology to manage the flow of demand. Accesso Technology Group markets proprietary devices such as the Qbot and Qband, along with mobile device applications, for guests to schedule a reservation for admission to popular attractions.

Disney has a similar product called FastPass+, which is a second generation of FASTPASS® where guests could print out reservation tickets with return times for certain attractions. The FastPass+ operates under the same premise as FASTPASS®, but instead of using printed tickets with return times, guests now use a wristband, which Disney calls MagicBands, with an embedded RFID chip to electronically store the guests' multiple reservations for attractions.

The strategy of the aforementioned devices intends to minimize wait time by minimizing the fluctuations in demand. It should be noted, however, that these technological devices do not increase the capacity of the attractions; it merely attempts to maintain a static level of demand. There still may be another solution to eliminating wait times besides reducing demand or increasing capacity – altering the perception of the waiting experience.

Perception of Waiting Experience

With waiting environments are for the most part inevitable, theme parks have begun to look at ways in which to improve customer waiting experience by essentially changing guest perception of wait times from something negative to something more positive. Many techniques are used throughout the industry, and each is rooted in consumer behavioral research.

Larson (1987) postulates that waiting can have a positive impact on customer service. To further his point, he provides examples of how several service establishments that have turned the customer's waiting experience positive by changing the environment for the customer. From offering live entertainment and hosting elaborate events in a bank's lobby to displaying news headlines, sports scores, and cartoons, customers no longer dread having to wait, seeing the environment as more engaging than a traditional waiting queue (1987).

Positively changing a customer's waiting experience is a major thesis from Maister's seminal article, *The Psychology of Waiting in Lines* (1984). Maister (1984) states, "We must learn to influence how the customer feels about a given length of waiting time" (p. 1). As such, he proposes eight heuristics to consider when examining the way a customer perceives time passing while waiting (See Table 1).

In his first heuristic, Maister (1984) advises service providers to give customers something to do since customers view occupied time to be shorter than unoccupied time. He also stresses that the activity given to customers should offer a benefit itself and should also be related in some way to the service for which the customer is waiting.

Table 1: Maister's Proposition Concerning the Psychology of Waiting

1. Occupied time feels shorter than unoccupied time.
2. People want to get started.
3. Anxiety makes waits seem longer.
4. Uncertain waits are longer than known, finite waits.
5. Unexplained waits are longer than explained waits.
6. Unfair waits are longer than equitable waits.
7. The more valuable the service, the longer the customer will wait.
8. Solo waits feel longer than group waits.

Applying Maister's principles to the theme park setting, Ledbetter, Mohamed-Ameen, Oglesby, and Boyce (2013) proposes eight guidelines for managing an amusement park guest's perception of time while waiting in line (See Table 2). As with Maister's principles, Ledbetter et. al. included items related to the architectural design of the queue such as layout and physical environment. Supporting Maister's first proposition that occupied time feels shorter than unoccupied time, Ledbetter et al. suggests that a queue should foster engagement. Engaging the guests shifts their attention away from the actual amount of time waiting.

Table 2: Guidelines for Affecting Theme Park Guests' Temporal Processing

1. A queue design needs to foster engagement.
2. The queue environment should maintain the guests' level of interest in the attraction.
3. Queue environments should support positive affect.
4. Comfort should not be overlooked in queues.
5. Visually separate inequitable wait queues.
6. Line layout should facilitate interpersonal interaction.
7. Guests should be adequately informed about the wait duration.
8. Line design should encourage the guests' feeling of consistent progression toward the attraction.

Journalist, Alex Stone (2012), provides a case study that supports one of Maister's principles. He describes how executives at Houston International Airport reduced the number of complaints from customers waiting for their luggage. The first attempt at improving the customers' experience involved increased the number of baggage handlers to reduce the amount of time it took for customers to receive their luggage. Although the average wait time decreased to eight minutes, the complaints from customers continued. The ultimate solution came when the airport moved the arrival gates further from the baggage claim, increasing the amount of time it took for customers to walk to the baggage claim. Complaints were nearly eliminated as a result. The amount of time walking (occupied time) felt shorter than the amount of time waiting at the baggage claim area (unoccupied time).

Chairman of Disney Parks and Resorts, Tom Staggs describes how Disney incorporates specific design elements in their queues, which relate to Maister's (Maister, 1984) and Ledbetter et. al.'s (2013) guidelines. He describes how Disney is aware that guests "don't exactly relish waiting in line," and how the company is changing the guest experience by making the queue line part of the attraction itself. Disney refers to this idea of incorporating the queue into the attraction as "Scene One" (Imagineers (Group), 2010; Walt Disney Company, 2011). As such, Disney has begun to add interactive elements such as games into their queues to occupy the guests' time while they wait in line.

Anecdotally, we have come to believe that "time flies when having fun" and that "a watched pot never boils," but is there scientific proof to these claims? Also, what are the psychological processes that are being altered when our perception of time is being manipulated? This next section provides a historical view to some of the most popular theories surrounding temporal processing and the estimation of time duration.

Perception of Time Theories

Time perception as a psychological construct is not novel (W. James, 1890), with numerous proposed theories regarding the cognitive nature of time perception. According to Block (1990), there are three major aspects of time perception as a psychological construct – succession, temporal perspective, and duration.

Succession refers to the reliance upon temporal order for time judgments. Block (1990) notes that research in succession has been limited to very brief durations such as sensory perceptual processes. Temporal perspective refers to the idea of conceptualizing the distinction of past, present, and future events in relation to one another. Duration refers to the idea that events last for a certain length of time which is marked by certain characteristics used for measuring time. These characteristics serve as clues, which when compared with other clues, help us to estimate the duration length of these events (1990). Duration has received much more research focus compared to the other two aspects and is the theoretical focus of the present dissertation study.

Although Hoagland (1933) first posited the idea of an internal clock used to gauge duration, his approach focused more on a master *chemical* clock. He proposed that changes in the body's chemical processes affected the neural processes of the body, thereby impacting our perception of time duration. However, research has failed to support Hoagland's idea of an internal chemical clock, apart from circadian rhythms which tend to relate more to longer periods of time rather than durations lasting seconds to minutes (Block, 1990).

Despite the lack of evidence supporting Hoagland's view of an internal chemical clock, research during the 1960s provided support to the concept of an internal central clock as a cognitive process to manage time estimation (Church, 1978; Church, 1984; Creelman, 1962; Grondin, 2001a; Grondin, 2001b; Treisman, 1963). One of the components of the central clock model is the pacemaker which emits pulses, the number of which is stored in the component called the accumulator. The number of pulses accumulated during a given time determines one's ability to perceive time duration. If a greater number of pulses are accumulated, the perceived length of time is larger. In an applied setting, a guest's perceived length of wait time depends upon the number of emitted pulses that are accumulated.

One important principle of these central clock models relates to discrepancies between perceived time and actual time. The time estimation error occurs when the accumulation process of the pulses is interrupted (Meck, 1996). When this accumulation process is interrupted, a gap occurs between the time that the interruption begins and the time when the accumulation of pulses resumes, resulting in a lower number of pulses accumulated than the number of pulses transmitted. This discrepancy results in shorter perceived time than actual time.

This idea of an interruption of the accumulation process to create a discrepancy between perceived and actual time relates to the dual task paradigm (Kahneman, 1973). Research has shown that the ability to perform a primary task suffers when a secondary task is performed (Grondin, 2001b). This effect has also been shown in temporal estimation tasks where the introduction of a secondary task negatively affects one's ability to maintain a temporal primary task (Macar, Grondin, & Casini, 1994). When attention to time is distracted, it is perceived that time duration is shorter.

Research has shown that the existence of a stimulus results in an individual underestimating the time duration (Droit-Volet, Meck, & Penney, 2007; Ortega, Lopez, & Church, 2009). In respect to the information-processing model proposed by Gibbon and Church (2014), the stimulus presented to an individual draws attentional resources away from the internal cognitive process of keeping track of time. When an individual's attention is diverted from temporal processing, they tend to judge time as having passed more quickly than reality. Maister's (1984) principle that states unoccupied time feels longer than occupied time correlates to the aforementioned concept that time estimation is an internal cognitive process which can be affected by a secondary task. But does this research hold true under all conditions such as a waiting environment?

Present Study Scope

As indicated above, waiting environments have an impact on patrons' psychological state ranging from seemingly minor dissatisfaction to full rage resulting in catastrophic events. While some may argue that the frequency and severity of these events do not warrant a sense of importance for further research in this area, this reasoning ignores the near miss events that exist. The present dissertation study will indicate that not only do these outcomes alone show the scientific merit for research in this area, but also the potential for future catastrophic events indicate the need for immediate research related to this topic.

Considerable research of waiting in lines and queuing for service has been conducted in the consumer research area. However, much of the focus of this research has been on the customers' level of satisfaction; specifically, how can companies improve the customer experience by changing the customers' waiting experience into a more positive one? While this question has research validity, I believe it lacks the necessary component of a customer's perception of time while waiting. Drawing upon Maister's First Law of Science (1984), I believe that reducing a customer's perception of time (i.e. perceived wait time being shorter than actual wait time), is the significant influence of customer satisfaction.

According to the aforementioned literature (Larson, 1987; Ledbetter et al., 2013; Maister, 1984) it has been theorized that occupying a customer's wait time can change their perception of the length of that wait time. Empirical evidence seems to support this theory (Block, 1990; Gibbon & Church, 2014; Grondin, 2001a; Grondin, 2001b; Kahneman, 1973; Macar et al., 1994; Meck, 1996; Treisman, 1963).

Building off the theoretical underpinnings of a customer's perception of time, companies have begun changing their customers' waiting experience (Larson, 1987). Specifically, amusement and theme parks are now employing technology to apply the theory to the queues for their attractions (Imagineers (Group), 2010; Ledbetter et al., 2013; Surrell, 2003; Walt Disney Company, 2011). As such, the scope of the present study examines mental workload demands and immersion of interactive queue technology that may influence guests' perception of time while waiting for an attraction.

CHAPTER TWO: LITERATURE REVIEW

Although there has been a great deal of research conducted related to waiting environments, much of this research is related to the impact of waiting on perception of customer service, as previously discussed. Furthermore, the research that has been conducted on perception of time while waiting has been limited and has generally focused on non-theme or amusement park environments such as doctor's offices, bank service lines, cinema ticket queues, and telephone on-hold queues. Despite all of the focus and attention that theme park and amusement park designers have given to combating the guests' negative perception of waiting in long lines, research on perception of time in a theme or amusement park queue line is nonexistent. The present study may be the first line of research in this field.

The following literature review will summarize a sampling of the work that has been conducted on perception of time in various field and laboratory settings. Additional reviews will be included on research involving the factors that affect perception of time.

Waiting in a Queue

Antonides, Verhoef, and van Aalst (2002) conducted two experiments involving customers waiting on hold for service. Participants were asked to join a researcher in a mobile field office where they would place a phone call to request a brochure from a financial institution. The participants were told they would receive a monetary reward of ƒ5 (Dutch guilders; approximately $2). After completing the phone call, participants completed a brief questionnaire regarding their wait experience including their perception of wait duration and wait evaluation. These questions involved participants scoring their feelings (i.e., Annoying-Pleasant, Boring-Varied, Unsatisfactory-Satisfactory, Irritating-Not Irritating, Long-Short, Unacceptable-Acceptable) with higher scores indicating an association with the more positive feeling.

Part 2 of the study examined the effect of different types of time fillers (i.e., background music, wait duration information, queue information, and absolute silence) (Antonides et al., 2002). There were two conditions for background music – no music and music from *Titanic* by Celine Dion. Wait duration information consisted of participants hearing a message stating the average wait time. The announced average wait times were higher than actual wait times where announced wait times were 1min, 2min, and 3min for actual wait times of 40*s*, 80*s*, and 120*s* respectively. For the queue information, participants were told at the beginning of the wait that they were the 3^{rd}, 6^{th}, or 9^{th} person in queue corresponding to wait times of 40*s*, 80*s*, and 120*s* respectively (2002).

Results of Part 2 of the study showed a main effect for objective wait time ($p < .01$) where participants' perceived wait time increased with actual wait duration. Secondly, there was a main effect for waiting time fillers ($p < .05$) where music had a positive effect on perceived wait time (i.e., music reduced the perceived wait time). The other fillers had no significant effect on perceived wait time. Furthermore, there were no significant interactions (2002). The results of this study showing that waiting time fillers reduce perceived wait time supports Meister's and Ledbetter's theory that occupied time is perceived to be less than unoccupied time. The present dissertation study aims to apply this theory to interactive queues.

In a study involving customers' perception of time while waiting, Jones and Peppiatt (1996) specifically examined whether time perception significantly differed between occupied versus non-occupied time. The setting for their study consisted of a small counter service fast food restaurant. They conducted their study between 11:30 am and 2:00 pm over a two day period. The amount of time spent waiting in line of the restaurant was measured from the time they entered the store until the time that their transaction began. After the transaction was complete, the researchers then asked each participant, “How long do you think that you were waiting in line?” The dependent variable was the difference between the actual amount of time that the participant waited in line and the amount of time that the participant estimated to have waited in line. There were two different conditions. The occupied time condition consisted of a television set that was placed on the counter within the line versus the non-occupied condition which had none. Additionally, the researchers looked at whether time perception significantly differed between waiting in line alone or with a group.

They found that the discrepancy between perceived and actual wait time was significantly greater when time was occupied than the discrepancy between perceived and actual wait time when time was non-occupied. They also found that the discrepancy between actual and wait time was greater when waiting with a group than the discrepancy between perceived and actual wait time when waiting alone, however, interactions were not reported to have been examined in the study.

There are several shortcomings in this study. Jones and Peppiatt (1996) conducted their experiment using customers in a fast food line. While having ecological validity, this contains many extraneous variables which are unaccounted for. First, the researchers did not control for the customers having devices to keep track of time. Therefore, the participants’ responses could have been biased by this variable. Second, Jones and Peppiatt state that participants may have included the amount of time of the transaction in their estimation of total wait time despite the researchers timing their amount of time waiting in line from the point of entering the restaurant to the moment the transaction began. Last, researchers controlled for having a television for the occupied time condition; however, the level of participant engagement was not considered. This poses a problem of validity, i.e. were the researchers measuring what they intended to measure? Some participants may not have been watching the television while others may have been engaged in other stimuli. By not controlling the environment for various stimuli, one cannot draw conclusions as to which stimulus was affecting the participants' ability to estimate time. This present dissertation study aims to account for these confounding variables by removing time keeping devices from the environment, questioning the participants in such a way that their perception of time is measured directly after the interactive stimulus, and measuring the participants' level of engagement in the interactive stimulus.

In a study conducted by Barlow (2000), Maister's First Law of Science (1984) was empirically tested. Patrons waiting in line at a movie theater ticket counter were asked questions regarding their waiting experience. Four variables were measured – the customers' expected wait time, their actual wait time, their perceived wait time, and their anxiety level. Customers arriving in line were asked what their expected wait time is for the line. As customers received their tickets at the register, they were asked how long they perceived waiting in line. Actual wait time was measured by the researchers. The customers' anxiety level was observed and estimated by the researchers based on the arrival time in proximity to the start time of the movie.

Similar to Jones and Peppiatt's study (1996), the results of Barlow's (2000) study indicate clear differences between perceived wait times and actual wait times. The researched found that in waits shorter than five minutes, participants were more likely to overestimate the wait time and in waits over five minutes, participants were more likely to be inaccurate in their estimation of wait time. Additionally, Barlow found that a participant's expectation of wait time tended to be overestimated for shorter waits and were increasingly inaccurate with a longer wait. Barlow states that this finding contradicts Jones and Peppiatt's (1996) proposition that a patron's view of queue length acts as an extraneous variable affecting their expected wait time estimation. Although Barlow states that the results indicate higher overestimation of perceived and expected wait times the closer to a movie start time (i.e. higher anxiety), these results were somewhat inconclusive since participants who were late for a movie start time did not give much thought to the researchers' question as to avoid any further delay.

There were several shortcomings of Barlow's (2000) research, many of which were noted by the author. First, as is the challenge with field studies, confounding variables existed, but the researchers did not account for them. For example, the customers' access to a time keeping device such as a clock or watch was not limited. There was no indication that the researchers monitored whether or not customers waiting in line referenced a time keeping device. Second, the variable for anxiety was measured through observation by the researchers estimating the level of anxiety exhibited by the customer. This methodology introduces the problem of inaccurate measurement and bias by the researcher. Third, the measures of expected wait time and perceived wait time were taken from different customers. In other words, customers were either asked what their expected wait time would be, or they were asked what their perceived wait time was, not both. While the author explains that this was intentionally done to address the problem of priming the participants perceived wait time with their expected wait time, it does not allow for a proper comparisons, i.e., were there any individual differences among the participants that could have affected each participant's perception of time? Last, due to the limitations of the methodological design of the study, causal relationships were not statistically examined. As a result, the data presented was limited to descriptive statistics. Utilizing this research, the present dissertation study is intended to show how a guests' perception of time will be lowered when they are distracted with an interactive queue. The present dissertation corrects for the aforementioned weaknesses by controlling for timekeeping devices and by measuring each participants' perception of time through questionnaires instead of researcher observation.

In a field study conducted by Katz, Larson, and Larson (1991), bank customers were asked about their experiences while each was waiting in line to be served. The researchers used two video cameras to film bank customers as they entered the queue and as they left the queue to be served by a bank teller. Approximately one-third of the bank customers were approached after completing their transaction to be asked about their perceived wait times. Later, the recorded video tape was used to record the actual wait time of the customers that were interviewed so that the actual and perceived wait times could be compared. In addition to perceived wait time, customers were asked to rate their wait on three attributes: duration, boredom, and stress. Customers were asked what a reasonable wait would be and also to rate the branch's overall service.

There were three different conditions conducted in separate phases. The first condition was considered the control group where no stimulus was presented to the bank customers in the queue. In the second condition, a large electronic board displayed "up-to-date news and information, interspersed with Bank of Boston ads" (Katz et al., 1991). Condition three consisted of a digital clock positioned at the entrance of the queue that displayed an estimate of the wait duration. Researchers asked participants in the second and third condition whether they had noticed the display board or digital clock, respectively. Those participants that did not notice the stimulus were excluded from the data analysis.

The results of the study consisted of descriptive statistics and correlations (Katz et al., 1991). The researchers did not include any causal analysis. Of the total 277 participants whose data were analyzed, 60% waited less than four minutes, while 3% waited over 12 minutes. The average wait time was 4.2 minutes while the average perceived wait time was 5.1 minutes. When asked about their subjective wait time on a 10-point scale, where 1=short and 10=long, the average participants' score was 3.2 with 85% of the respondents rating the wait as 5 or lower. The researchers indicate that as actual wait times increased, overall customer satisfaction decreased while stress levels increased. Additionally, as actual wait times increased, perceived wait times increased. To compare the differences between the three stimulus conditions, the data was pooled into two groups: waits less than four minutes and waits between four and 12 minutes. There was no effect found for the use of an electronic news board on the perceived wait time although the inclusion of the news board did seem to positively impact the customers' interest level of waiting in line. The researchers did indicate that the use of an electronic clock resulted in lower perceived wait times when compared to the control group. However, this result could be explained by the nature of priming the participants of the actual wait time (1991).

Overall, the study had similar shortcomings to the aforementioned studies (Barlow, 2000; Jones & Peppiatt, 1996). Due to the nature of this being a field study, the researchers did not control for participants having personal time keeping devices which would allow them to check their wait time. Additionally, the participants were questioned about their perceived wait time after having waited in line *and* being served by the bank teller. This could have an impact on the results if the service time changed their perception of wait time. Furthermore, the researchers' conclusions were based solely on descriptive statistics and correlations and did not analyze any causal relationships. This fact limits the interpretation of the results to non-causal relationships without the ability to show the effect of specific variables on the participants' perception of wait time (Katz et al., 1991).

In an attempt to clarify the existing literature related to the effect of music stimulus on perception of wait time, Bailey and Areni (2006) examined the possibility of two distinct processes occurring: diverting attention from the passage of time and creating memory traces that are used by the participant to estimate duration. Two experiments were conducted.

In the first experiment, there were three different manipulations (Bailey & Areni, 2006). The first was whether the participant was engaged in a temporal versus a non-temporal task. The participants in the non-temporal task were asked to list as many brand names of soft drinks as they could remember in order to divert their attention away from keeping track of the passage of time. The temporal task involved the participants behind told they would need to wait in the room since the session was running behind schedule. The second manipulation was whether the atmospheric music was familiar versus unfamiliar. Music familiarity was measured in a pretest consisting of a different group of participants. In the pretest, participants listened to a group of songs, after which they completed a questionnaire where they scored how familiar they were with the song. Out of four different sets of songs according to genre, contemporary dance music was measured to be the familiar whereas traditional country and western music was measured to be the unfamiliar music. The third manipulation was whether the respondents listened to four 3-min songs or six 2-minute songs (2006).

The first experiment by Bailey and Areni (2006) took place in a laboratory setting with the researcher leading a group of participants into a room where the atmospheric music was already playing. The researcher began a timer from the moment the participants entered the room. Participants were instructed to turn off mobile phones and place all personal belongings in a corner of the room. They were allowed to wear watches. The experimenter exited the room after about 30*s*. After 11.5 min, the researcher entered the room and instructed the participants to complete a questionnaire, while discreetly turning off the music. The total time the participants were in the room prior to completing the questionnaire was exactly 12 min.

Results from the first experiment reflect a main effect for task ($p < .0001$) indicating that wait duration estimates are lower for non-temporal tasks compared to a waiting task. Additionally, there was a task X familiarity interaction indicating a shorter estimated duration under the waiting task when familiar music was played versus when unfamiliar music was played. The results of Experiment 2 also indicated a main effect of task ($p <.0001$) where participants engaged in the recall task underestimated the duration of the wait while participants who waited idly overestimated the duration of the wait. Although the cause of this interaction is not exactly determined, the researchers suspect that the shorter, more familiar songs may engage more attentional resources (Bailey & Areni, 2006). These results would indicate that in an amusement park setting, those individuals who are engaged in a task would tend to underestimate wait time when compared to those who are not engaged in a task while waiting.

Secondary Task Characteristics Affecting Time Estimation

Cognitive Load

The results of the previously reviewed research have indicated that there is a relationship between a cognitive task and an individual's perception of time while engaged in the task. However, the above research does not consider the level of mental workload of the cognitive task in this relationship. What level of mental workload is required for a cognitive task to be effective in manipulating an individual's perception of time passing? This question is important for the present dissertation study due to the fact that the level of mental workload of an interactive queue element may determine whether a guest's perception of wait time will be affected.

Within the duration aspect, two paradigms exist – prospective and retrospective judgments (Hicks, Miller, & Kinsbourne, 1976). Prospective time estimation describes the condition where an individual is informed prior to the task that they will be asked to estimate the duration of the task. Conversely, under retrospective time estimation, the individual is not informed prior to the task that they will be asked to estimate the duration of the task. It's important to distinguish between these two paradigms within an attraction queue because amusement park guests understand that they must wait and therefore will intrinsically estimate the duration of their wait time.

Hicks, Miller, and Kinsbourne (1976) conducted a study where participants were given a card sorting task and were asked to estimate the duration of the task. Half of the participants were told in advance that they would be asked to estimate the duration of the task while the other half were not told in advance they would be asked to estimate the duration of the task. The sorting card task consisted of three cognitive levels. The researchers found a negative correlation between the amount of time estimated to have passed and the amount of information processing required while performing a secondary task (i.e. card sorting task) in the prospective group. There was no similar effect on the retrospective group.

The findings by Hicks, et al. are supported by similar studies. In a meta-analysis, Block, Hancock, and Zakay (2010) reviewed 117 experiments examining the effects of cognitive load on time duration judgments, measured as the time duration ratio (subjective duration to objective duration), and the prospective versus retrospective paradigm. Block, et al. limited their meta-analysis to those experiments involving human participants providing duration judgments equal or greater than 3s.

Block, et al. (2010) findings indicate that there was no main effect of cognitive load (high versus low) or paradigm on time duration judgment ratios. However, there was an interaction between cognitive load and paradigm. Participants reported lower prospective judgment ratios under high cognitive load compared to low cognitive load. Conversely, participants reported higher retrospective judgment ratios under high cognitive load compared to low cognitive load. Notably, their results also found that if the participants' judgments came after a delay of many seconds to several minutes, there was no effect of cognitive load. Additionally, stimulus duration and modality did not have a significant moderating effect.

As previously discussed, the trend in amusement and theme park design has been to provide guests with interactive attraction queues to improve their waiting experience. Based on the aforementioned research, it is expected that the guests' perception of wait time can be affected by the level of mental or cognitive workload of the interactive queue experience. Much like in some amusement and theme park attraction queues today, in the present dissertation study, participants will be provided with an interactive game. It is important to note that duration judgment ratio is a measure of accuracy, whereas the scope of this study is on overall time perception. As such the following hypothesis is proposed: H_1: Participants' prospective duration judgment will decrease as the level of mental work load increases.

Goal Motivation

One of the glaring differences between the aforementioned research on the effect of workload on time perception and research involving waiting in line has to do with goal motivation. Research on the effect of workload on time perception simply asks the participant to engage in a task with no competing end goal. As Doob (1971) notes, when an individual is engaged in a negative experience, the participant's goal is to end the experience resulting in an overestimation of the duration of the experience. Conversely, if the task is engaging and enjoyable, then the participant's motivation is to stay engaged in the task. As previously shown, a patron's level of anticipation (i.e. anxiety) has an impact on their perception of time (Barlow, 2000). This indicates that what a person is waiting for plays a part in how they interpret the passage of time. Anecdotally, time passes more slowly when the present experience is viewed as less desirable as the future experience whereas time passes more quickly when the present experience is viewed as more desirable than the future experience.

In a study conducted by Hornik (1984), shoppers waiting in line at one of four retail establishments – two different supermarket locations, one department store, and one bank were asked questions about their waiting experience including their level of enjoyment of the activity they are waiting for, i.e. shopping. Researchers noted the time that these customers arrived in the checkout line and asked a series of questions including the customers' estimated wait time to the nearest minute, enjoyment measures, and the frequency of shopping. Enjoyment measures consisted of the difference between the participant's measure of enjoyment of shopping and their mean measure of enjoyment of five other activities - meal preparation, home repairs, child care, cleaning, and cooking. The results from Hornik's (1984) study indicated a significant effect of enjoyment was on wait time estimation at the $p < .15$ level ($p = .09$). Furthermore, the interaction between the level of enjoyment and the frequency of shopping was found to be significant at the $p < .15$ level ($p = .125$). These findings support the idea that an amusement park guest's enjoyment of the activity (interactive queue) will affect their estimation of the activity (waiting).

In a set of studies conducted by Gable and Poole (2012), the effects of motivational factors and positive versus negative state on time estimation were examined. Part 3 of the study examined whether there is a difference in participants' duration estimation between high approach motivation positive states and high withdrawal motivation negative states. Participants took part in a temporal bisection task where they were asked to estimate the duration of the presentation of a variety of images consisting of high approach motivation positive images and high withdrawal motivation negative images. A 2(picture type) X 7 (duration) ANOVA revealed a significant interaction ($p < .0001$) where participants judged the duration of the high approach motivation positive images as being shorter than the duration of the high withdrawal motivation negative images (Gable & Poole, 2012). The importance of Gable and Poole's (2012) studies is that they provide support to the anecdotal premise that time passes more quickly during positive experiences.

Based on the aforementioned research, it is important to note the distinction between perception of task duration versus perception of wait time as it relates to goal motivation. The goal of the task duration is the task itself whereas the goal of waiting is the experience at the end of the wait. In an attraction queue, the goal is riding the attraction at the end of the wait, at least in the traditional view of attraction queues. However, with the introduction of interactive elements, amusement theme park queues have now become a combination of task duration and attraction waits. This is the premise of interactive attraction queues becoming an extension of the attraction itself. To simulate this in a laboratory setting, the present dissertation uses the goal of riding a virtual roller coaster and while "waiting" to ride the virtual roller coaster, participants will take part in an interactive game.

Task Immersion and Engagement

Considering that goal motivation is a factor in perception of time, the effect of task mental work load on perception of time may not be a direct one – an individual's perception of task experience may determine whether the motivation to continue the task overtakes the motivation to end the task. If the individual is to be more motivated in continuing the task rather than to end the task, the task must be at the least be considered engaging.

Many definitions and theories exist to describe the subjective experiencing while performing a task, with much of the current research focusing on video game engagement, immersion, cognitive absorption, presence, and flow. While a thorough analysis of each of the aforementioned concepts are beyond the scope of this present dissertation study, it is important to note the subtle differences among each of these when determining the appropriate measure to use as an intervening variable within the study.

Cognitive absorption, according to Agarwal and Karahana (2000), is characterized by five dimensions: temporal disassociation, focused immersion, heightened enjoyment, control, and curiosity. An important note of cognitive absorption is that it focuses on an individual trait of attitude toward technology instead of the individual's experience while engaging in a specific technology. According to Jennett et al. (2008) this is an important distinction since an individual may have a different experience with a specific technology than what their individual trait would predict.

Presence is another popular term to describe one's view of technology. A key component to virtual reality (Baños et al., 2004), presence as it relates to technology is the perceptual illusion of being present in the virtual environment without a feeling of the real world. In other words, it is the ability to transfer presence from the real world to a simulated world. Presence stems from the term telepresence where the user develops a sense of being present in a different location through interaction with the system's interface (Coelho, Tichon, Hine, Wallis, & Riva, 2006). Like presence, telepresence occurs when the user's sensation of being present in a different location overcomes the user's sensation of being present in their physical location. Furthermore, the user no longer is aware that they are interacting in a simulated environment.

Through extensive qualitative research examining the intrinsic motivation to undertake challenging tasks, Csikszentmihalyi (1990; 2000) coined the term "flow" to describe the rewarding, enjoyable, optimal state of being absorbed in a task. According to Csikszentmihalyi (Csikszentmihalyi, 1990), the idea of flow can be applied to many types of tasks beyond gaming and is characterized as a challenging activity that requires skill and has clear goals with immediate feedback. Additionally, it must require the ability to concentrate on the task with a loss of consciousness of one's self. The individual should have a perceived sense of control over their actions with a state of effortless involvement. Lastly, the individual should experience transformation of time.

Brown and Cairns (2004) uses the term immersion to describe the subjective level of involvement in a game. Immersion is seen as a continuum where the first level is engagement. In order for a user to experience immersion, they must first choose to engage in the task by investing their effort, time, and attention. Once engagement has occurred, then the user may choose to become engrossed in the game. In this second stage of immersion, the user becomes emotionally invested in the game to the point that they lose their awareness of their surroundings and of themselves. The third stage is total immersion or presence according to Brown and Cairns (2004). In this stage, the user can become totally immersed that they are cut off from the real world and the game is the only thing impacting the user's thoughts and feelings. Brockmyer et al. (2009) state that immersion is experienced by most regular video game players.

Now that each of these concepts are defined, it is necessary to identify which is the most appropriate for the present dissertation study with the necessary elements being temporal dissociation and the individual's experience with the cognitive task itself. While including elements of temporal disassociation, cognitive absorption is not considered the appropriate variable due to its primary focus on the individual's personality trait versus the experience with the cognitive task. Likewise, presence is not considered for this study. Although it may be achieved by the cognitive task of this study, presence is not required, and temporal disassociation can be achieved without necessarily achieving presence. Therefore the concept of immersion as described by Jennett et al. (2008) is considered the most appropriate intervening variable for the present study.

Considering that temporal dissociation or the idea of being cut off from the real world is a common attribute among several of the aforementioned definitions, it is reasonable to assume that in order for a guest's perception of wait time in an attraction queue to be altered, the guest must be immersed within the queue. This leads to the following hypothesis:

> H_2: Participants' prospective duration judgment will decrease as the level of immersion increases.

Ijsselsteijn, Kort, Poels, Jurgelionis, and Bellotti (2007) note that there is a similarity between Brown and Cairn's (2004) description of immersion and the concept of flow, with both concepts sharing the ideas of focused attention, diminished sense of self, and losing track of time. It is this idea of focused attention being a precursor to immersion and higher mental work load tasks requiring focused attention that leads to the following hypothesis:

> H_3: Participants' level of immersion will increase as the level of mental work load increases.

Building off of Hypothesis 1 that states that the cognitive load of a task affects an individual's perception of time while waiting, it is further hypothesized that there is an indirect effect of the task where the effect of the cognitive load of a task passes through an individual's level of immersion in the task. This leads to the following hypothesis based on this indirect effect:

> H_4: There is an indirect effect of mental workload on prospective duration judgment where the effect of mental work load is mediated by level of immersion in the cognitive task.

Individual Differences Affecting Time Estimation

If the indirect effect of mental workload on perception of wait time is mediated by level of immersion, does this indirect relationship apply to all individuals equally? For example, if the level of immersion of an interactive attraction queue affects guests' perception of wait time, and the level of immersion is affected by the level of mental workload of the interactive element, are the magnitude of these effects the same for all guests? The answer to this question is important to amusement and theme park designers so that they can configure the interactive queue elements to the target audience of the attraction itself. Imagine if the characteristics of an interactive game within an amusement park queue were to change based on the individual playing.

This idea may not be so farfetched considering this type of scenario has already been employed in amusement and theme parks. Since its opening in 1990, the E. T. Adventure® attraction at Universal Studios Orlando® park has employed a personalized good-bye message to guests. Beginning in March, 2016, Walt Disney Parks and Resorts added a personalized feature to the *it's a small world* attraction at Walt Disney World® in Orlando, Florida. Similar to the E. T. Adventure® attraction, an electronic screen now displays a good-bye message at the end of the ride, personalized with each guest as their boat passes by using the technology of their MyMagic+ wristbands worn by guests of the park. This technology could be used to provide guests with interactive queue elements individualized based on each guest's personality and preferences. This next section examines the possible moderating effect of sensation seeking, boredom susceptibility, and extraversion on the level of immersion.

Sensation Seeking and Boredom Susceptibility

John Watt (1991) conducted a study examining the effect of boredom proneness on time estimation. In this study, 100 undergraduate students were asked to perform one of two versions of a number-circling task, each consisting of 12 minutes in duration. The “simple” version consisted of participants being instructed to circle all the 1s, 5s, and 7s within a range of numbers. In the “complex” version, the participants were instructed to circle all the 3s, every other 4, and each 6 that preceded a 7. Upon completion of this task, the participants were given a modified version of the Boredom Proneness Scale (Farmer & Sundberg, 1986). Along with indicating their subjective perception of passage of time during the task on a 7-point Likert scale (i.e., 1 = fast, 4 = normal, 7 = slow). The participants were also asked to estimate the amount of time passed, in minutes and seconds, during the number-counting task.

Results of the two-way analysis of variance (ANOVA) indicated a main effect for boredom proneness where highly boredom prone individuals reported higher subjective perception of time passage on the Likert scale. However, there was not a significant difference in the estimated amount of time passing between those scoring higher on the Boredom Proneness Scale and those scoring lower on the scale. Furthermore, the task complexity did not have an effect on either the subjective perception of time or the estimated amount of time passage of the task. Lastly, no interactions were indicated.

There are several significant items to note with Watt’s study (1991). First, the researcher indicated that the participants were not informed of the duration of the number-circling task. Additionally, the researcher did not measure the participants’ perceived difficulty or level of engagement of the number-circling task. Lastly, and perhaps most significant, the order in which the researcher administered the questionnaires may be significant. Watt's states that after completing the number-circling task, "participants completed the Boredom Proneness Scale, indicated their perception of passage of time during the number-circling task and recorded the number of minutes and seconds believed to have been spent during the number-circling task." Asking the participants to estimate the duration of time after subjecting them to the Boredom Proneness Scale, may have affected their responses. To account for these issues, in the present dissertation study, the participants' subjective level of mental workload will be measured. Also, the participants' subjective and objective wait time estimates will occur immediately after completing the task.

In a study conducted by Danckert and Allman (2005), subjective perception of temporal durations and temporal allocation of attention were studied as to whether either play a role in a participant's perceived boredom. A total of 476 participants (244 females) were administered the Boredom Proneness Scale (BPS). Of the total group, 20 male and 20 female participants were recruited to take part in the study and were subsequently categorized into two groups – those who scored high on the BPS (i.e., greater than 1 SD above the lager group mean) and those who scored low on the BPS (i.e., less than 1 SD below the larger group mean).

Of significance to the theory of the relationship between boredom proneness and temporal estimation, a simple temporal estimation task was conducted (Danckert & Allman, 2005). In the temporal estimation task, participants were asked to estimate the duration of an illusory motion stimulus. Each participant completed a total of 30 trials varying in duration between 2s and 60s. Although no significant main effect was reported, the researchers indicated a trend towards those with lower BPS scores underestimating durations with those scoring high on the BPS overestimating durations.

Extraversion

Although some research suggests introverts and extraverts differ in time estimation, this research has been inconsistent and difficult to clarify (Doob, 1971). Despite these inconsistencies however, it is still worthwhile to explore the impact of extraversion on time estimation. Much of the research conducted on extraversion and time estimation thus far has been limited to shorter duration of less than 60s intervals. Furthermore, there has been no research to date that has explored this possible relationship applied to an amusement park attraction queue setting.

Eysenck (1959) theorizes that extraversion plays a role in time perception, where extraverts are expected to have a greater tendency for negative time errors (overestimation of time duration). In his study of 60 individuals (30 extraverted neurotics, 30 introverted neurotics), Eysenck presented all participants with a stimulus for 5, 10, 15, and 20 second durations, after which the participants were asked to replicate the stimulus duration. His results indicated a significant difference between the replication duration of a stimulus of 5 and 10 seconds by the introverts and extraverts. Extraverts tended to match stimulus duration with a shorter actual duration than the introverts. In other words, extraverts seemed to believe their replication of a stimulus was longer than it actually was. There was not a significant difference between the extravert and introvert responses for durations of 15 and 20 seconds. He postulates that because extraverts generate more inhibition and dissipate it less quickly, they tend to overestimate the duration of the second exposure to the stimulus (Doob, 1971, p. 225; Eysenck, 1959).

In a study of 20 introverted and 20 extraverted males, participants were presented with a light that was illuminated for a duration of time and were asked to replicate the duration by illuminating the light with a switch (Lynn, 1961). The participants were subjected to 10 trials each of the aforementioned procedure. The results indicated that for the first 7 trials, there was no significant difference between the extraverted and introverted participants' responses. Only during trials 8, 9, and 10 was there a significant difference between the responses of the extraverted and introverted individuals. Although these results do not contradict Eysenck's theory, they certainly do not confirm it either.

In a similar study, 62 participants were presented with an audible stimulus and were asked to provide three types of duration estimation responses (Du Preez, 1964). First, participants were asked to estimate the duration of the auditory response through a linear movement by sliding a handle for the duration matching the initial auditory stimulus. Additionally, the participants were asked to verbally estimate the duration of the stimulus. Finally, 39 of the participants were asked to replicate the duration of the stimulus by depressing a button where the duration of button press indicates the estimated duration of the stimulus. The results of this study do not support Eysenck's theory with there being no significant relationship between extraversion and verbal estimation or replication by button depression. Notably, there was a significant positive relationship between linear movement estimation of the stimulus and extraversion, which contradicts Eysenck's theory (1959).

Lomranz (1983) conducted a study examining the effects of task complexity and personality on time estimation. Participants were presented with two slides in sequence and told to examine each one closely as they would be asked questions regarding the images on the slides.

These slides varied in complexity, on a 5 point scale, based on the number of angles of the shapes displayed on the slide. The first slide presented was always a 3 on the complexity scale with the second slide presented varying in complexity trials. After being presented with these slides, the participants were asked to compare the duration of the second slide presentation with the duration of the first slide presentation and respond accordingly on a 5-point scale where 1 = much less time and 5 = much more time. Although the results of the study found a significant positive relationship between task complexity and time duration estimate, there was no significant difference in duration estimates between extraverts and introverts. However, Lomranz (1983) indicates that the lack of consistency between the results and Eysneck's theory may be due to methodology and that further research is needed.

Similarly to the study by Du Preez (1964), Rammsayer (1997) conducted a study of time duration estimation using the reproduction of an audible stimulus. Thirty-four participants were presented with an auditory stimulus of 5, 15, and 40 seconds in duration. After each stimulus presentation, participants were presented with a second presentation of the stimulus and asked to press a button at the point the duration of the second stimulus matched the first stimulus. The results did not indicate a significant relationship between extraversion and time estimation, but the trend in the data did indicate a tendency of extraverts to overestimate time duration and make less accurate duration estimates compared to introverts.

Based on the above evidence that suggests sensation seeking characteristics and extraversion plays a part in time estimation tasks, the present study examined if the effects of these two variables can be applied to an amusement park attraction queue setting. Specifically, if there is an indirect effect of the workload of an interactive queue on the perception of wait time mediated by immersion of the interactive queue, do sensation seeking and extraversion moderate this indirect effect? As such, the present dissertation study proposes the following hypothesis (Figure 1):

H_5: There will be a moderated mediation relationship where the relationship between the prospective duration judgment and mental work load will be mediated by level of immersion in the cognitive task and that this mediation will be moderated by the participant's levels of extraversion and sensation seeking.

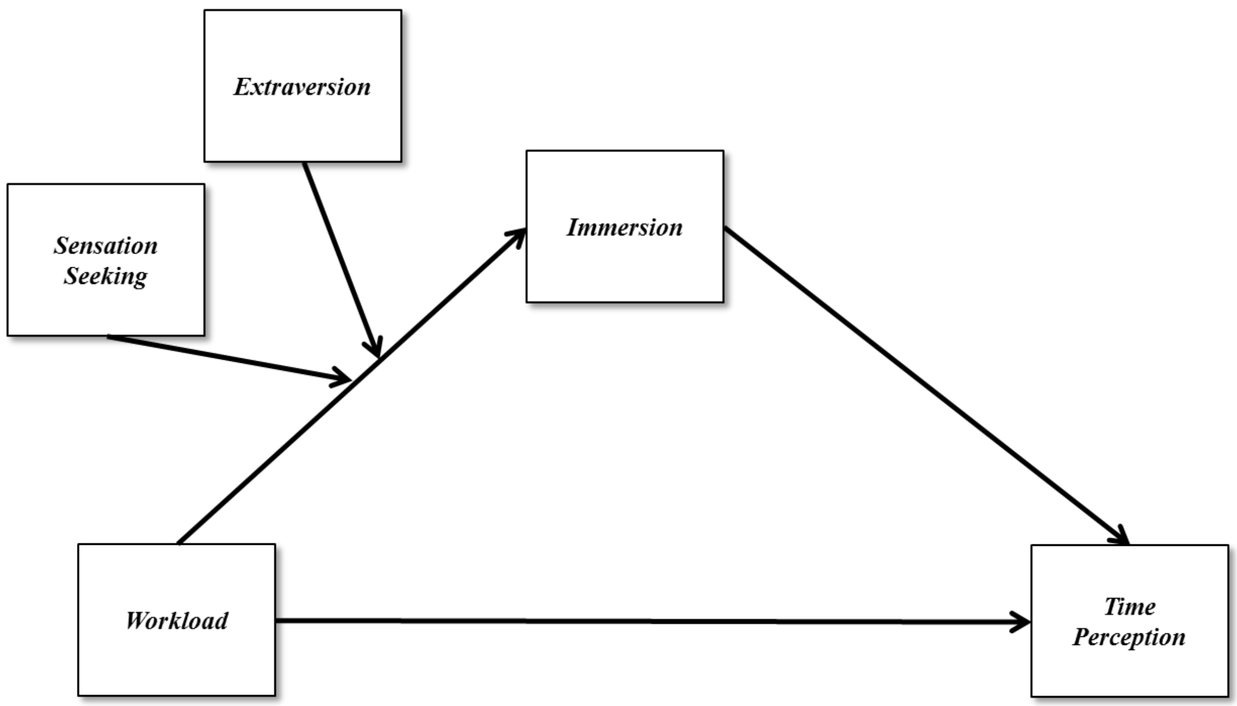


Figure 1: Conceptual model for present study

Synopsis

A common perception of theme and amusement parks is crowded rides and attractions. To combat this, parks have looked into ways of managing the capacity of their attractions to minimize the queue wait time – a common complaint among park guests and a strong predictor of guest satisfaction. Although altering the capacity of an attraction may be effective in the short term, it is a temporary solution as park attendance grows. Alternatively, recent trends in the industry have led to some parks altering the guests' perception of the attraction queues. Specifically, parks have begun introducing interactive elements in queues to change the guests' view of waiting in line.

Evidence presented above shows that providing guests with an activity while waiting in line may alter their perception of time – i.e. guests will perceive the time as passing more quickly while performing an activity while waiting. However, empirical research conducted to determine what elements of the activity are effective in altering a guests' perception of time while waiting has been very limited.

As previously discussed, research indicates that perception of time is affected by cognitive workload (Block et al., 2010; Hicks et al., 1976), which leads to Hypothesis 1. However, this relationship may not be direct. Research indicates that the secondary task also must be engaging and immersive (Agarwal & Karahanna, 2000; IJsselsteijn et al., 2007; Jennett et al., 2008) represented by Hypotheses 2, 3, and 4. Individual factors may moderate this indirect relationship between mental workload and perception a time through the level of immersion of a secondary task. The aforementioned research indicates that a person's sensation seeking tendencies (Danckert & Allman, 2005; Watt, 1991) along with extraversion (Eysenck, 1959;

Rammsayer, 1997) moderate the relationship between mental workload and immersion as indicated in Hypothesis 5 (See Table 3 for a summary of hypotheses).

The present study examined the effect of certain parameters on a guests' perception of time while waiting in line for an amusement park attraction. The goal is to build upon the existing heuristics (Ledbetter et al., 2013; Maister, 1984) and provide empirical evidence for the inclusion of these parameters in theme park design.

Table 3: Hypothesis Summary

Variable		Hypothesis	Supporting Research
Mental Work Load	**Hypothesis 1**	Participants' prospective duration judgment will decrease as the level of mental work load increases.	(Block et al., 2010; Hicks et al., 1976)
Immersion	**Hypothesis 2**	Participants' prospective duration judgment will decrease as the level of immersion increases.	(Agarwal & Karahanna, 2000; IJsselsteijn et al., 2007; Jennett et al., 2008)
	Hypothesis 3	Participants' level of immersion will increase as the level of mental work load increases.	
	Hypothesis 4	There is an indirect effect of mental workload on prospective duration judgment where the effect of mental work load is mediated by level of immersion in the cognitive task.	
Sensation Seeking and Extraversion	**Hypothesis 5**	There will be a moderated mediation relationship where the relationship between the prospective duration judgment and mental work load will be mediated by level of immersion in the cognitive task and that this mediation will be moderated by the participant's levels of extraversion and sensation seeking.	(Danckert & Allman, 2005; Watt, 1991)

CHAPTER THREE: METHODOLOGY

There have been two pilot studies conducted to date. The purpose and scope of the first pilot was to determine the level of difficulty for the math skills game to be used in the succeeding studies. The purpose and scope of the second pilot was to conduct the present dissertation study on a smaller scale and to identify any shortcomings that may need to be addressed prior to proposing the dissertation experiment. The methodology for the dissertation experiment is based on the methodology of the second pilot.

Materials

NASA-Task Load Index

To measure the level of mental work load, the NASA-Task Load Index (TLX) was administered to the participants. The NASA-TLX is the most commonly used mental workload assessment (Stanton, Salmon, Walker, Baber, & Jenkins, 2005). The NASA-TLX is a survey that measures six subjective dimensions: mental demands, physical demands, temporal demands, individual performance, effort, and frustration. The NASA-TLX consists of two evaluation methods. First, there are single, subjective magnitude measures on a 100-point scale (i.e., 1- low, 100, high) for each of the six dimensions. Secondly there are 15 pairwise comparisons of the six scales used to weight the magnitude measures. Only the single, subjective magnitude score of mental demand is used for the current study.

Sensation Seeking Scale – Form V

To measure the level of sensation seeking, the Sensation Seeking Scale-V was administered to participants. The Sensation Seeking Scale was first introduced by Zuckerman, Kolin, Price, and Zoob (1964) and was later revised to include four dimensions - experience seeking, boredom susceptibility, thrill and adventure seeking, and dis-inhibition (Zuckerman, Eysenck, & Eysenck, 1978). Currently in its fifth revision - the SSS-V (Zuckerman, 1994) consists of 10 forced-choice items in each of the four aforementioned dimensions.

Big Five Inventory - Extraversion

To measure introversion/extraversion, the extraversion subscale of the Big Five Inventory (BFI) was administered. The BFI is widely-used, consisting of 44 self-reported items of relatively short phrases, making it preferable for the present research due to its brevity. Each of the 44 questions is measured on a 5-point Likert scale (1 – disagree strongly, 3 – neither agree nor disagree, 5 – agree strongly). The BFI has a robust coefficient alpha reliability for all measures (0.83) and with the extraversion subscale (0.88) (John & Srivastava, 1999).

Immersive Experience Questionnaire

To measure the immersion of the cognitive task, the Immersive Experience Questionnaire (IEQ) was administered (Jennett et al., 2008). Consisting of 31 questions measured on a 7-point Likert scale (1 – not at all/very little/very poor/definitely no, 7 very much so/a lot/very well/definitely yes), the IEQ measures an individual's immersive experience while playing a video game across five immersion factors: cognitive involvement, real world disassociation, emotional involvement, challenge, and control. The questionnaire also includes a single, 10 point

Likert-type question of immersion (1 – not at all immersed, 10 – very immersed) in order to check the reliability of the questionnaire results.

Apparatus

Qualtrics

All the questionnaires were administered through Qualtrics, which is an online data collection platform with the ability to create surveys that can be completed online via a desktop computer or mobile device.

Math Skills (Waiting) Game

While participants waited, they played a math skills game called Quiz Dungeon. This game was chosen for its immersive qualities as well as its ability to manipulate the difficulty level. The game also provided continuous game play for periods of time of 12 minutes which was important for the study. Quiz Dungeon is a role playing game where a player assumes the part of a blue knight and explores the dungeons of castle. Throughout the journey, players encounter other knights and slime monsters that they must battle while locating treasure chests containing gold that can be used for upgrading weapons and armor (Figure 2).

Figure 2: Quiz Dungeon gameplay screenshot

To successfully battle other knights and slime monsters and to open treasure chests, the player must solve math problems within an allotted time (Figure 3). If the player does not answer the math problem correctly in the allotted time, the player's health meter is decreased. If the player's health meter is fully exhausted, the player must restart the current level. The game can be programmed to present different types of math problems with numbers of any range. There were three difficulty levels created for this study as follows: low difficulty – addition problems of numbers ranging from 1-10; medium difficulty – multiplication problems of numbers ranging from 1-15; high difficulty – addition and subtraction problems of double digit numbers.

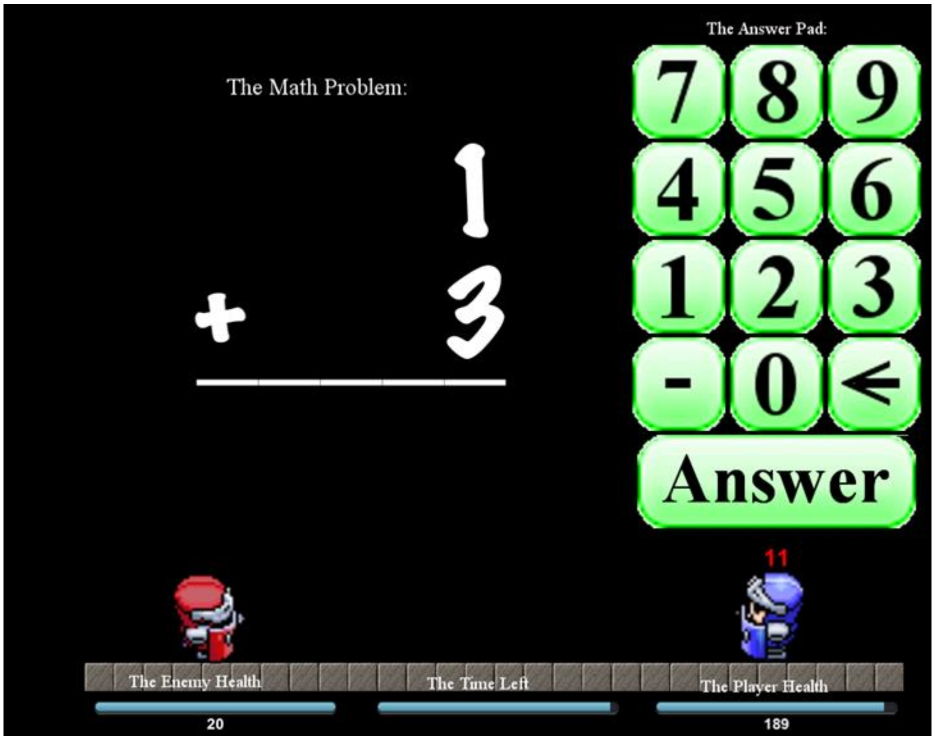


Figure 3: Quiz Dungeon math problem challenge screenshot

An Apple iPad mini (1st Generation) was used to present the math skills game and the Qualtrics surveys during the laboratory phase of the studies. The iPad mini is a tablet computer with a 7.9-inch (diagonal) LED-backlit Multi-Touch display with 1024-by-768 resolution at 163 pixels per inch. The iPad mini uses a Dual-core A5 processor and has Wi-Fi capabilities for internet connectivity. The math skills game of each iPad mini was programmed to correspond to one of the three game difficulty conditions. The back of each iPad mini was numbered 1-6 to correspond to the station number and corresponding game difficulty level.

In order to maintain a consistent wireless network for the iPad tablets, an AT&T Unite Express™ mobile hotspot was used. The mobile hotspot provided internet access to each of the iPad tablets in order for participants to complete the online Qualtrics surveys.

Participants wore ECOOPRO Lightweight Portable Stereo Headphones for two main purposes. First, the gameplay included sound effects which helped to improve the level of immersion of the game. Secondly, the headphones were used to block out noise while playing the game. This allowed the participants to remain focused on the game play while mitigating any distracting noises within the laboratory. The headphones were connected to the iPad mini's 3.5-mm stereo headphone minijack.

To time the duration of gameplay, six Mark 1 economy stopwatches with 1/100 second precision were used. The back of each stopwatch was numbered 1-6 to correspond to the station number for which the stopwatch was used.

Theme Park Experience

The theme park experience for which the participants waited is a roller coaster virtual reality simulation ride. A 360° video simulation of a roller coaster called Valravn™ which will open in Cedar Point in 2016. The roller coaster ride simulates a lifelike roller coaster and participants viewed the virtual roller coaster using the Oculus Rift.

The experiment used the Development Kit 2 version of the Oculus Rift. This Oculus Rift DK2 is a head mounted, virtual reality system having a high definition (960 X 180) viewing screen per eye. The Oculus Rift also features positional tracking through the use of an infrared camera allowing for a participant to turn their head in the virtual environment.

A gaming desktop PC was used to operate the roller coaster simulation software and the Oculus Rift headset. The specifications of the PC include the Windows 10 operating system, Intel I5 Skylake quad core processor operating at 3.5Ghz and 32Gb RAM, and an Nvidia GeForce GTX 980 4GB GDDR5 PCI Express 3.0 graphics card. This gaming computer used met all of the manufacturer's required specifications to operate the Oculus Rift DK2.

IBM SPSS Statistics 22 was used to perform the data analysis. To specifically test for moderated mediation, the PROCESS add-on for SPSS written and developed by Hayes (Hayes, 2012; Preacher & Hayes, 2004; Preacher, Rucker, & Hayes, 2007) was used to perform various mediation and moderation model analysis.

Pilot Study 1

Participants

For pilot study 1, participants consisted of 27 undergraduate students (18 female, 9 male) from the University of Central Florida. The participants were recruited through the University's web-based human subject pool management software system (SONA). Participants were not monetarily compensated but did receive course credits for their participation.

Study Environment

The study was conducted in a laboratory setting in the Psychology building at the University of Central Florida. The lab was set up with three iPad stations with each station corresponding to one of the three math skills game difficulty levels. The iPad at each station was mounted on a table with a TaoTronics fully adjustable, gooseneck iPad stand with a c-clamp base attachment (Figure 4).

Figure 4: Pilot Study1 iPad station layout

Procedure

The participants were recruited through the University's web-based human subject pool management software system (SONA). Pilot study 1 was conducted in a controlled lab at the Psychology building at the University of Central Florida. The experiment was conducted in blocks of 2 participants – with each participant scheduled to arrive every 5 minutes. The first participant in each block was scheduled to arrive 30min after the scheduled arrival of the first participant in the previous block. This schedule provided the simulation of arriving at a queue so that there were participants already waiting upon the arrival of an additional participant.

Upon arrival, participants were checked in and the researcher verified the participants SONA ID number. A spreadsheet was used to keep track of the participant number and the iPad station number. The participant numbers on the spreadsheet were numerically ordered where the participant number corresponded to order in which the participants arrived. The three station numbers were ordered by a random number generator in Microsoft Excel. Once the order of the three station numbers was randomized, the same sequence was repeated for the remaining participants. Participants were then provided with a copy of the informed consent and the game instructions. See the Appendix for the informed consent and game instructions that were provided to the participants.

After the participant had sufficient time to review the informed consent and game instructions, the research assistant escorted the participant into the lab. Participants were required to place all personal items including mobile phones and watches in the corner of the lab. Participants were instructed to stand in front of the one of the three iPad stations corresponding to the station number recorded on the spreadsheet. The research assistant aided the participant in donning the headphones and then opened and started the Quiz Dungeon game. Once the game began, the research assistant started the stopwatch timer.

Participants played the math skills game for a predetermined duration of approximately 11min and 42*s*, after which the research assistant approached the participant, stopped the participant from playing the game while simultaneously stopping the stopwatch. It should be noted that the 11min and 42*s* duration was chosen as an arbitrary time frame in order to avoid participants from correctly “guessing” the duration of the game. The research assistant then opened the online survey in Qualtrics and recorded the participant number and station number on the first page of the Qualtrics survey. The participant was then instructed to continue the online survey based on their experience of playing the video game. The research assistant then recorded the actual duration of gameplay measured by the stopwatch onto the spreadsheet on the row corresponding to the participant number.

The first section of the survey asked participants questions regarding their perceived duration of gameplay. They were asked to estimate the length of time they had waited in the computer lab while playing the game (i.e., “Please estimate in minutes and seconds the amount of time that has passed playing the game while you waited to ride the virtual roller coaster”). As in the study by Watt (1991), participants were also asked to indicate their subjective perception of passage of time during the task on a 7-point Likert scale (i.e., 1 = very slowly, 4 = normal, 7 = very fast). The second portion of the survey consisted of the NASA-TLX to provide feedback on the level of mental workload of the math skills game. In the third section of the survey, participants completed the IEQ to provide feedback on their level of immersion while playing the game. The fourth section of the survey consisted of demographic questions and questions related to the participant’s gaming experience. At the end of the survey, the participants were instructed to retrieve their personal items and exit the lab.

A one-way analysis of variance (ANOVA) was conducted to compare weighted mental workload scores on the NASA-TLX among the three different game difficulty levels. Leven’s test for homogeneity of variance indicated unequal variances ($F = 4.07$, $p = .03$); therefore, the Brown-Forsythe test was used and indicated a significant main effect for game difficulty level,

$F(2, 17.86) = 4.95$, $p = .02$, $\eta 2 = .305$. Post-hoc comparisons using the Tukey HSD test indicated that mean MWL score for the low difficulty level ($M = 6.45$, $SD = 4.44$) is significantly different from mean MWL score for the medium difficulty level ($M = 16.04$, $SD = 9.63$), $p = .038$. Additionally, the Tukey HSD test indicates that mean MWL score for the low difficulty level ($M = 6.45$, $SD = 4.44$) is significantly different from mean MWL score for the high difficulty level ($M = 17.35$, $SD = 9.22$), $p = .021$. However there was no significant difference between the mean MWL scores for the medium and high difficulty levels, $p = .938$. Therefore, the difficulty levels of the game were found to be appropriate for the purpose of pilot study 2.

Pilot Study 2

Participants

Participants consisted of 42 undergraduate students (26 female, 16 male) from the University of Central Florida. The participants were recruited through the University's web-based human subject pool management software system (SONA). Participants were not monetarily compensated but did receive course credits for their participation.

Study Environment

The environment for pilot study 2 matched the environment of pilot study 1 with three exceptions. First, the number of iPad stations was increased from three to six to accommodate additional participants (Figure 5). Secondly, study 2 included a virtual roller coaster ride on the Oculus Rift. The Oculus Rift was positioned on the opposite side of the lab from the iPad stations (Figure 6). Lastly, participants completed part of the surveys online prior to coming into the lab.

Figure 5: Pilot study 2 iPad station layout

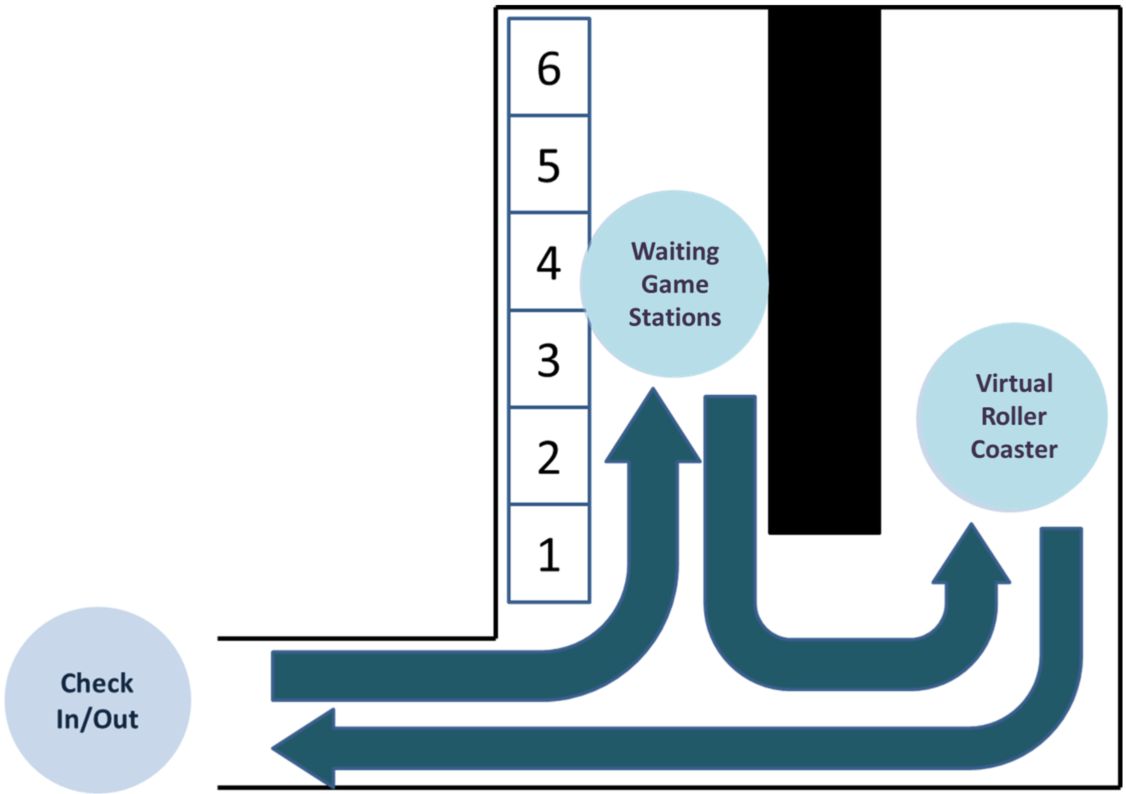


Figure 6: Pilot study 2 laboratory layout

Procedure

This study was conducted in three phases (Figure 7). The first phase consisted of the participants completing an online questionnaire prior to participating in the lab portion of the study. The second phase of the study consisted of the participants waiting to participate in the virtual reality roller coaster experience. During this time participants played the math skills game and completed an additional questionnaire. The third phase consisted of the participants participating in the virtual reality roller coaster experience (Figure 8).

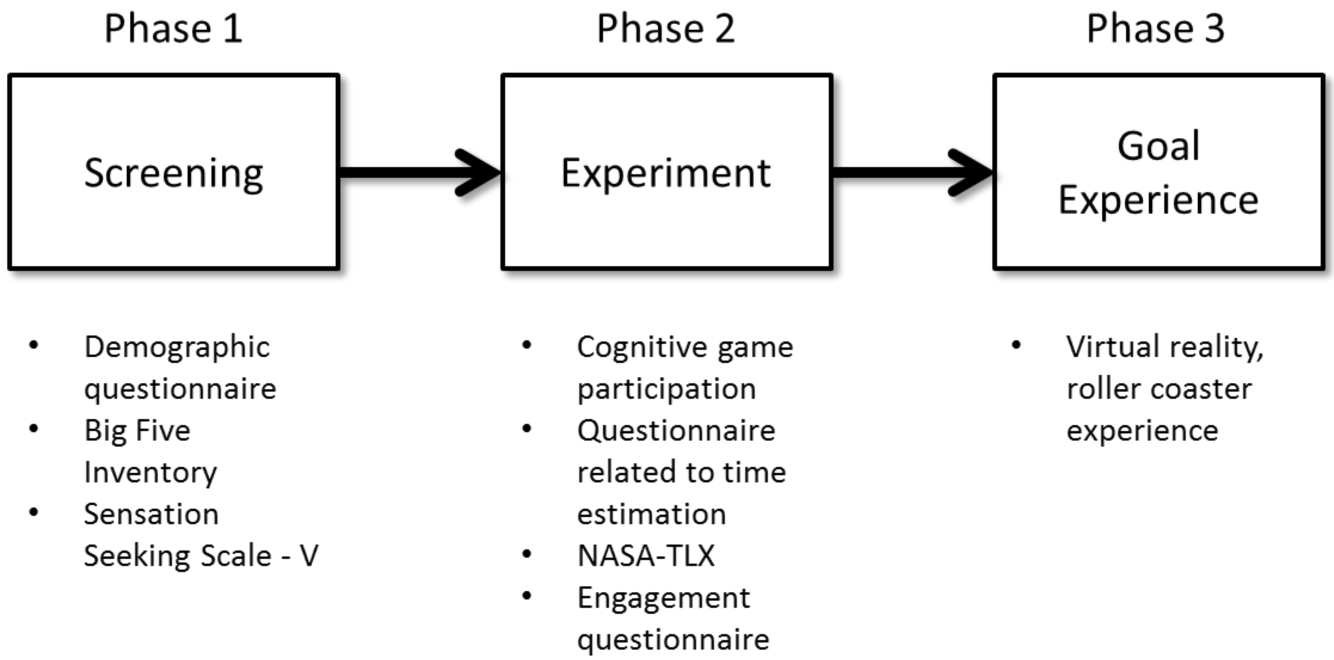


Figure 7: Experiment process flowchart

Figure 8: Oculus station featuring the virtual roller coaster

Phase 1

The participants were recruited through the University's web-based human subject pool management software system (SONA). Participants were told at the time of recruitment that the study involves performance related to theme park attractions. At the time of registration on the SONA system, participants were provided a hyperlink to Qualtrics to complete the Sensation Seeking Scale – V and the Big Five Inventory in addition to a general demographic and gaming experience questions. The aforementioned surveys and questionnaires were administered online prior to the participant participating in the laboratory setting in order to save time and avoid affecting the participants' time estimation.

Phase 2

Phase 2 was conducted in a controlled lab at the Psychology building at the University of Central Florida. The experiment was conducted in blocks of 6 participants – with each participant scheduled to arrive every 5 minutes. The first participant in each block was scheduled to arrive 50min after the scheduled arrival of the first participant in the previous block. This schedule provided the simulation of arriving at a queue so that there were participants already waiting upon the arrival of an additional participant.

Upon arrival, participants were checked in and the researcher verified the participants SONA ID number in the SONA system. A spreadsheet was used to keep track of the participant's SONA ID number, participant number, and the iPad station number. The participant numbers on the spreadsheet was numerically ordered where the participant number corresponded to order in which the participants arrived. The station number was randomly ordered prior to the beginning of the study. The station numbers were ordered by a random number generator in Microsoft Excel for the first block of six participants. Once the order of the first six station numbers was randomized, the same sequence was repeated for each subsequent participant blocks. The research assistant recorded the SONA ID number on the next line of the spreadsheet and wrote down on an index card the SONA ID, participant number, and the station number corresponding to these numbers from the spreadsheet. Tracking the SONA ID, participant number, and station number ensured that the data collected from each participant in the first phase of the study would be accurately matched with the data collected in the second phase of the study. Participants were required to place all personal items into a storage bin including mobile phones and watches. Participants were then provided with a copy of the informed consent and the game instructions. See the Appendix for the informed consent and game instructions that were provided to the participants.

After the participant had sufficient time to review the informed consent and game instructions, a second research assistant escorted the participant into the lab to stand in front of the one of the six iPad stations corresponding to the station number recorded on the index card. The research assistant aided the participant in donning the headphones and then opened and started the Quiz Dungeon game. Once the game began, the participant started the stopwatch timer. The participant then placed the index card and stopwatch into a bin with six compartments with each compartment corresponding to the station number.

Participants played the math skills game for a predetermined duration of approximately 11min and 42*s*, after which a third research assistant retrieved the index card and stop watch from the compartment corresponding to the station number, approached the participant, stopped the participant from playing the game while simultaneously stopping the stopwatch. The research assistant then opened the online survey in Qualtrics and recorded the participant number, SONA ID, and station number from the index card on the first page of the Qualtrics survey. This matched the data collected from the surveys in the first phase with the data collected during the second phase. The participant was then instructed to continue the online survey based on their experience of waiting for the roller coaster ride.

The first section of the survey asked participants questions regarding their perceived duration of gameplay. They were asked to estimate the length of time they had waited in the computer lab while playing the game (i.e., “Please estimate in minutes and seconds the amount of time that has passed playing the game while you waited to ride the virtual roller coaster”). As in the study by Watt (1991), participants were also asked to indicate their subjective perception of passage of time during the task on a 7-point Likert scale (i.e., 1 = slow, 4 = normal, 7 = fast). In the second portion of the survey, participants were asked to indicate their level of excitement to ride the virtual roller coaster on a 7-point Likert scale (1 = Not excited at all, 7 = Very excited). Based on the research of Gable and Poole (2012), Barlow (2000), and Hornik (1984), this question was included in the survey to record the level of excitement and interest the participant has in the goal of riding the virtual roller coaster. The third portion of the survey consisted of the NASA-TLX to provide feedback on the level of mental workload of the math skills game. In the fourth section of the survey, participants completed the IEQ to provide feedback on their level of immersion while playing the game.

After stopping the participant from playing the game and after beginning the survey, the research assistant then recorded the actual duration of gameplay measured by the stopwatch onto the spreadsheet on the row corresponding to the participant number, SONA ID number, and station number. After the participant completed the online survey, they were instructed to proceed to the next area to ride the virtual roller coaster.

Phase 3

Phase three consisted of the participants experiencing the virtual reality roller coaster. Participants were instructed to proceed to the final portion of the study where the research assistant instructed them to sit in a chair, aided them in donning the Oculus Rift headset and headphones, and started the roller coaster simulation video. After riding the virtual roller coaster, the participants were instructed to complete additional questions based on the virtual roller coaster experience.

Full Dissertation Study

Participants

Participants consisted of 173 undergraduate students (115 female, 58 male) from the University of Central Florida. The participants were recruited through the University's web-based human subject pool management software system (SONA). Participants were not monetarily compensated but did receive course credits for their participation.

Procedure

The procedure of the full dissertation study matched that of pilot study 2 with two exceptions. After the third phase of riding the virtual roller coaster, participants were instructed to answer additional questions related to their experience. First, participants were asked to rate on a 7-point Likert scale (i.e., 1 = not at all worth the wait, 7 = extremely worth the wait) how much they felt the virtual roller coaster ride was worth the wait. Additionally, participants were asked how often they visited amusement or theme parks and whether they have an annual pass to an amusement or theme park. Along with the supplementary questions above, the full dissertation study differed from pilot study 2 in that an additional difficulty level of the math skills game – addition and subtraction of numbers 100 through 999. This additional difficulty level was added to provide further variance in the participants' mental workload responses.

CHAPTER FOUR: RESULTS

Statistical Design

As previously stated, the purpose of this study is to examine the relationship between the cognitive load of a secondary task and an individual's perception of time while waiting for an amusement park-type ride. Furthermore, the study will also examine the effect that level of immersion in a secondary task and the individual differences, specifically sensation seeking and extraversion, have on the aforementioned cognitive load-perception of time relationship. It is hypothesized that sensation seeking and extraversion will moderate the indirect effect of cognitive load of a task on perception of time through immersion of task. In order to test the five hypotheses, various statistical approaches will be used.

As Baron and Kenny (1986) point out, the terms moderation and mediation should not be confused or used interchangeably. In a simple causal relationship, the predictor variable *X* affects the *Y* outcome variable. This relationship is considered a total effect relationship (Baron & Kenny, 1986; Hayes, 2009; L. R. James & Brett, 1984). In some instances, however, the predictor variable may have an indirect effect on the outcome variable. In this instance, it is said that the effect of *X* on *Y* is *mediated* by a variable, meaning that the *X* variable affects the *Y* variable through a mediating variable *Med* (Figure 9). This effect can be partial where the relationship between *X* and *Y* is reduced when controlling for *Med*, or complete mediation where there is no relationship between *X* and *Y* when controlling for *Med* (L. R. James & Brett, 1984; Kenny, 2014).

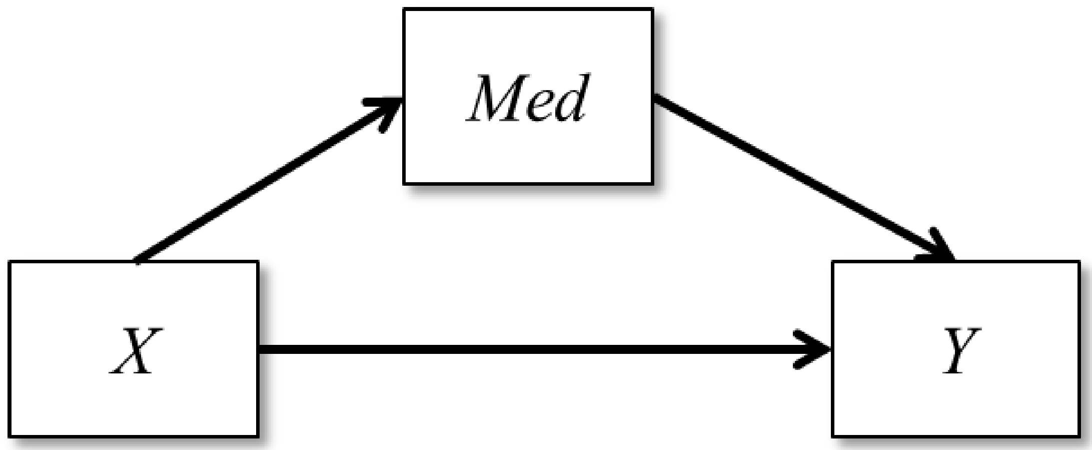


Figure 9: Mediation

Moderation occurs when the strength or direction of the relationship between X and Y, is affected by a third variable (Baron & Kenny, 1986). Simply stated, moderation is the interaction of the predictor variable and another variable (covariate or moderator) on the outcome variable (Kenny, 2014). As shown on Figure 10, the moderator merely affects the relationship between *X* and *Y*, whereas in mediation, the effect of *X* on *Y* pass through the mediator.

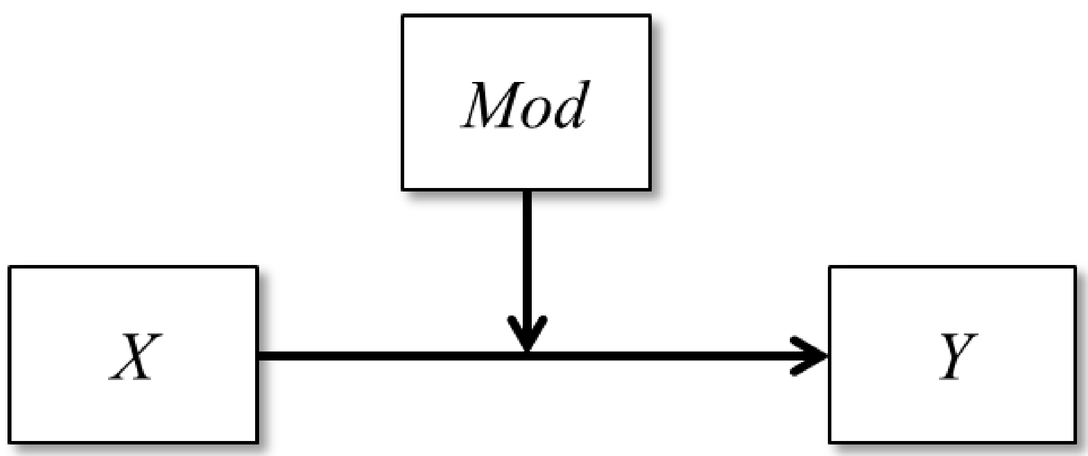
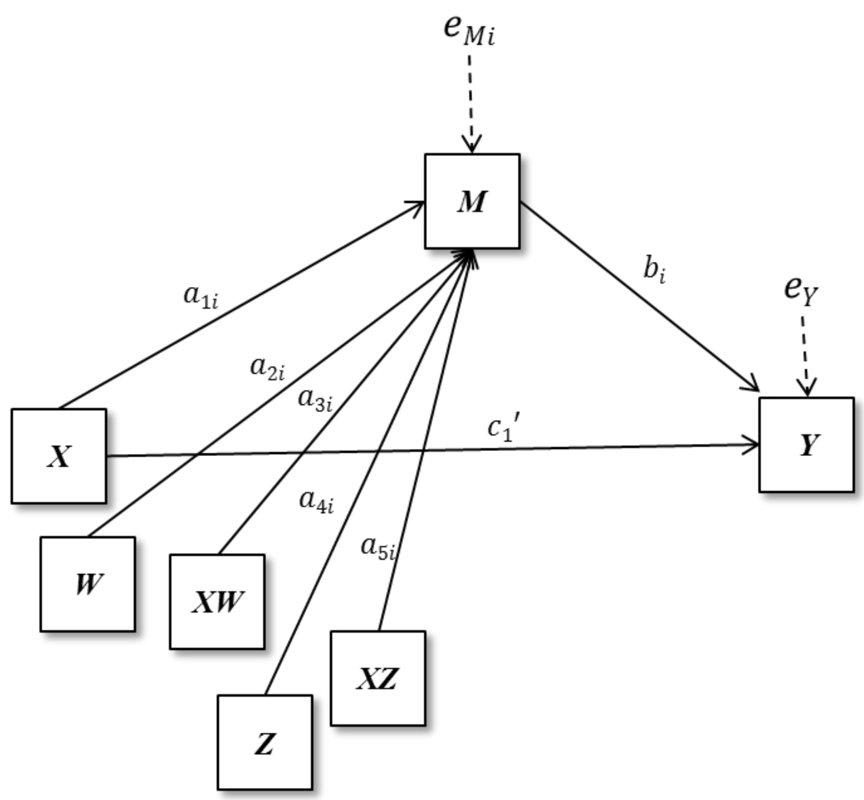


Figure 10: Moderation

The present study hypothesizes what is traditionally called a moderating mediation relationship. This type of relationship is a combination of the two aforementioned models where the mediating effect is moderated. Hayes and Preacher (2013) call this type of relationship conditional indirect effect or conditional process model where the mediating relationship, termed process model, is contingent upon other variables. In the present study, the outcome variable is time perception and the predictor variable is mental workload. It is hypothesized that level of immersion is the mediator which is moderated by the sensation seeking and by the level of extraversion. See Figure 1 for a graphical representation of the present model.

The conceptual model can also be expressed with the statistical model shown in Figure 11. In this statistical model, the predictor variable of mental workload is represented with the variable X and the outcome variable of wait time perception is represented with Y.



$$M = i_1 + a_1X + a_2W + a_3XW + a_4Z + a_5XZ + e_M$$
$$Y = i_2 + c'X + b_1M + e_Y$$

Figure 11: Statistical model

In traditional regression analysis, the direct effect of *Y* regressed on *X* were tested. However, for the present study, it was the indirect effect of *X* on *Y* through a mediating variable M that will be measured. Additionally, the moderating effects of Extraversion (*W*) and Sensation Seeking (*Z*) on this mediated relationship are examined. As shown in Figure 11, the regression equations for this model can be expressed as:

$$M = i_1 + a_1X + a_2W + a_3XW + a_4Z + a_5XZ + e_M$$

$$Y = i_2 + c'X + \boldsymbol{b_1M} + e_Y$$

According to Preacher, Rucker, and Hayes (2007), the indirect effect is the product of the effect of *X* on *M* and the effect of *M* on *Y* controlling for *X*. Due to the introductions of mediators *W* and *Z*, it should be noted that the effect of *X* on *M* is a function of and dependent on *W* and *Z*. Therefore, the effect of *M* on *Y* is also dependent upon *W* and *Z*. Based on this statement, the two equations can be further simplified into one equation through the following adjustments:

Isolate the expressions that are a function of *X* to find the effect of *X* on *M*:

$$M = i_1 + (a_1X + a_3XW + a_5XZ) + a_2W + a_4Z + e_M$$

$$M = i_1 + (\boldsymbol{a_1} + \boldsymbol{a_3W} + \boldsymbol{a_5Z})\boldsymbol{X} + a_2W + a_4Z + e_M$$

Since $\boldsymbol{b_1}$ measures the effect of *M* on *Y*, this can be multiplied by the effect of *X* on *M* to obtain the single expression measuring the indirect effect as a function of *W* and *Z*.

$$Y = i_2 + c'X + \boldsymbol{b_1M} + e_Y$$

$$\omega = (\boldsymbol{a_1} + \boldsymbol{a_3W} + \boldsymbol{a_5Z})\boldsymbol{b_1}$$

$$\omega = \boldsymbol{a_1b_1} + (\boldsymbol{a_3b_1})\boldsymbol{W} + (\boldsymbol{a_5b_1})\boldsymbol{Z}$$

Full Study Results

The procedure of the full study differed very little from that of pilot study 2. The only significant difference between the two was the inclusion of supplementary questions related to the participants' measure of worthiness of waiting for the virtual roller coaster, the participants' amusement park visitation frequency, and the participants' ownership of an annual pass to an amusement or theme park. None of these questions impacted the hypotheses. As such, the data from pilot study 2 and the full study was combined to test all of the hypotheses. For full descriptive statistics of each of the variables used, see Table 4.

Table 4: Variable Descriptive Statistics

				Pearson Correlation					
Variable	α^a	Mean	SD	MWL	IEQ	Extra	SSS-V	Obj-PDJ	Sub-PDJ
MWL	N/A	56.08	25.56		.147*	-.020	-.126	.075	.034
IEQ	0.910	133.74	30.67	.147*		-.053	-.061	-.153*	.582**
Extra	0.871	25.79	6.17	-.020	-.053		.357**	.084	-.019
SSS-V	0.806	17.71	6.39	-.126	-.061	.357**		-.023	-.048
Obj-PDJ	N/A	782.56[b]	304.07[b]	.075	-.153*	.084	-.023		-.029
Sub-PDJ	N/A	4.76	1.403	.034	.582**	-.019	-.048	-.029	

Variables: MWL=NASA-TLX Mental Work Load Raw Score, IEQ=Immersion Experience Questionnaire, Extra=BFI Extraversion Subscale, SSS-V=Sensation Seeking Scale Form V, Obj-PDJ=Objective Prospective Duration Judgment, Sub-PDJ=Subjective Prospective Duration Judgment

[a]Cronbach's alpha

* Correlation is significant at the 0.05 level (two-tailed).

** Correlation is significant at the 0.01 level (two-tailed).

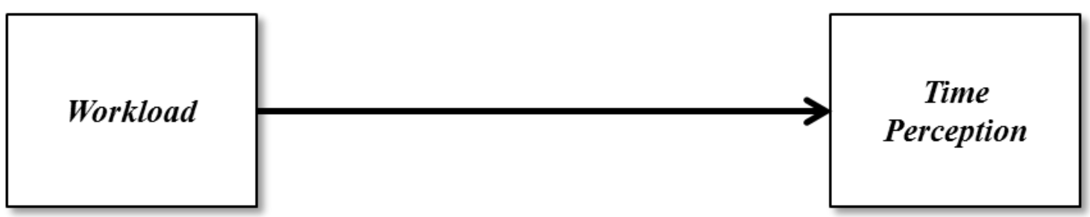
[b]Expressed in seconds

There were three measures of wait duration taken during this study – prospective duration judgment, subjective duration judgment, and prospective duration judgment ratio. As previously stated in the procedure, the target wait duration for each participant was 702s (11min and 42s). The mean actual wait duration reported by participants was 11min and 786.81s (*SD* = 20.45), varying between 621.78s to 13min and 787.25s. First, participants were asked to objectively estimate the duration of wait while playing the math skills game, referred to as the prospective duration judgment. The mean prospective duration judgment as reported by participants was 782.56s (*SD* = 304.07), ranging from 264s to 1959s. This indicates that on average participants overestimated the wait duration. In addition to prospective duration judgment, participants were also asked to subjectively estimate how quickly time had passed on a 7-point Likert scale (i.e., 1 = very slowly, 4 = normal, 7 = very fast). Participants' mean rating was 4.76 (*SD* = 1.40). Lastly, the prospective duration judgment ratio was calculated where the participants' prospective duration judgment was divided by the actual duration of the wait.

The measure that is used as the dependent variable to test the hypotheses is the prospective duration judgment for two significant reasons. Participants were not informed in advance how long they would be waiting, and as such, their expected wait duration was not standardized. Unlike, the subjective measure of duration which can depend on expectations of the wait duration, the prospective duration judgment provides a standard scale in absolute terms of minutes and seconds. Although DJR is frequently used as a dependent variable in empirical examinations of perceived wait time, conceptually, it is closer to a measure of perceptual accuracy (i.e., the closer the ratio is to one, the more accurate one's sense of time is) rather than actual perceived wait time, which is the focus of the current study. Although I focus on the prospective duration judgment as the dependent variable in the current study because it most closely represents one's judgment of wait time, I also report results with prospective duration judgment ratio as the dependent variable and with subjective duration judgment as the dependent variable.

Hypothesis 1

To test hypothesis 1, simple regression analysis was used, where the prospective duration judgment was the dependent variable regressed on the predictor variable of the MWL raw score from the NASA-TLX. The regression equation and conceptual model for this hypothesis is shown in Figure 12. The results of the regression analysis indicated no significant effect of workload on the prospective duration judgment, standardized $\beta = .075$, $R^2 = .006$, $F(1, 213) = 1.200$, $p = .274$ (See Table 5and Table 6).



$$Y_{Time\ Perception} = i + c'X_{Workload} + e$$

Figure 12: Hypothesis 1 simple linear regression statistical and conceptual models

Table 5: Prospective Duration Judgment Regressed on Mental Workload– Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	110884.824	1	110884.824	1.200	.274
Residual	19675289.95	213	92372.253		
Total	19786174.77	214			

Predictors: (Constant), NASA-TLX Mental Work Load Raw Score

Table 6: Prospective Duration Judgment Regressed on Mental Workload – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	732.614(50.084)		14.628	.000
Workload (*X*)	.891(.813)	.075	1.096	.274

Dependent Variable: Prospective Duration Judgment

To analyze participants' subjective perception of time, simple regression analysis was used, where the subjective measure as reported on the Likert scale was the dependent variable regressed on the predictor variable of the MWL raw score from the NASA-TLX. The results of the regression analysis indicated no significant effect of workload on the participants' subjective duration judgment, standardized β = .034, R^2 = .001, F(1, 213) = .247, p = .620 (See Table 7 and Table 8).

Table 7: Subjective Duration Judgment Regressed on Mental Workload – Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	.489	1	.489	.247	.620
Residual	420.935	213	1.976		
Total	421.423	214			

Predictors: (Constant), NASA-TLX Mental Work Load Raw Score

Table 8: Subjective Duration Judgment Regressed on Mental Workload – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	4.653(.232)		20.087	.000
Workload (*X*)	.002(.004)	.034	.497	.620

Dependent Variable: Subjective Duration Judgment

As indicated by Block, et al. (2010), duration estimation accuracy is also affected by mental workload. As such, additional analysis was conducted where the prospective duration judgment ratio was the dependent variable regressed on the predictor variable of the MWL raw score from the NASA-TLX. In order to meet the assumption of normality, the DJR measures were transformed using a ¾ root transformation. The results of the regression analysis indicated no significant effect of workload on the prospective duration judgment ratio, standardized β = .065, R^2 = .004, F(1, 213) = .891, p = .346 (See Table 9 and Table 10).

Table 9: Prospective Duration Judgment Ratio Regressed on Mental Workload – Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	.350	1	.350	.891	.346
Residual	83.552	213	.392		
Total	83.902	214			
Predictors: (Constant), NASA-TLX Mental Work Load Raw Score					

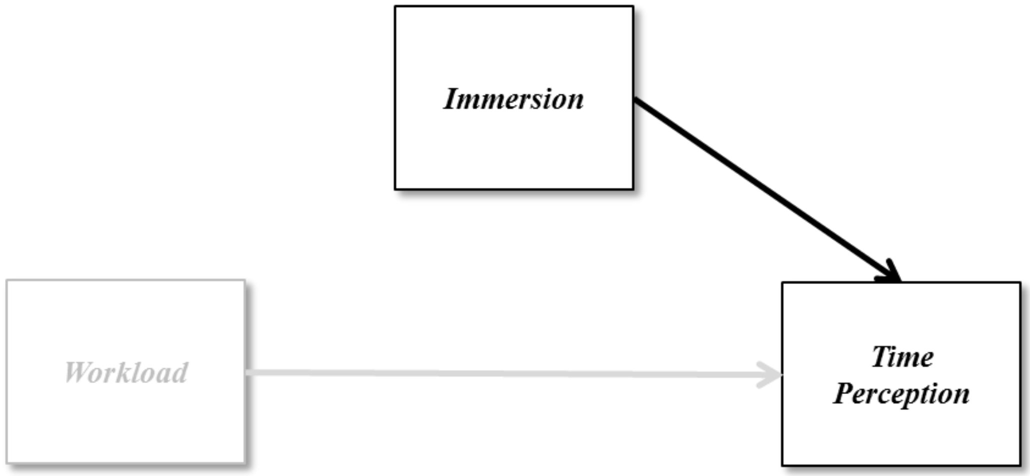
Table 10: Prospective Duration Judgment Ratio Regressed on Mental Workload – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	1.094(.103)		10.595	.000
Workload (*X*)	.002(.002)	.065	.944	.346

Dependent Variable: Duration Judgment Ratio

Hypothesis 2

To test hypothesis 2, simple regression analysis was used, where the prospective duration judgment was the dependent variable regressed on the predictor variable of the IEQ total score. The regression equation and conceptual model for this hypothesis is shown in Figure 13. The results of the regression analysis indicated a significant effect of immersion on the prospective duration judgment, standardized $\beta = -.153$, $R^2 = .023$, $F(1, 213) = 5.072$, $p = .025$ (See Table 11 and Table 12).



$$Y_{Time\ Perception} = i + b_1 M_{Immersion} + e$$

Figure 13: Hypothesis 2 simple linear regression statistical and conceptual models

Table 11: Prospective Duration Judgment Regressed on IEQ – Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	460203.147	1	460203.147	5.072	.025
Residual	19325971.63	213	90732.261		
Total	19786174.77	214			

Predictors: (Constant), IEQ Total Score

Table 12: Prospective Duration Judgment Regressed on IEQ – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	984.758(92.098)		10.693	.000
IEQ Score (*M*)	-1.512(.671)	-.153	-2.252	.025

Dependent Variable: Duration Judgment

To analyze participants' subjective perception of time, simple regression analysis was used, where the subjective measure as reported on the Likert scale was the dependent variable regressed on the predictor variable of the IEQ total score. The results of the regression analysis indicated a significant effect of immersion on the subjective duration judgment, standardized β = .582, R^2 = .338, F(1, 213) = 108.879, p < .0001 (See Table 13 and Table 14).

Table 13: Subjective Duration Judgment Regressed on IEQ – Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	142.551	1	142.551	108.879	.000
Residual	278.872	213	1.309		
Total	421.423	214			

Predictors: (Constant), IEQ Total Score

Table 14: Subjective Duration Judgment Regressed on IEQ – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	1.200(.350)		3.429	.001
IEQ Score (*M*)	.027(.003)	.582	10.435	.000

Dependent Variable: Subjective Duration Judgment

Additional analysis conducted where the prospective duration judgment ratio was the dependent variable regressed on the predictor variable of the IEQ total score. The results of the regression analysis indicated a significant effect of immersion on the prospective duration judgment ratio, standardized β = -.153, R^2 = .024, F(1, 213) = 5.126, p = .025 (See Table 15 and Table 16).

Table 15: Prospective Duration Judgment Ratio Regressed on IEQ – Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.972	1	1.972	5.126	.025
Residual	81.930	213	.385		
Total	83.902	214			

Predictors: (Constant), IEQ Total Score

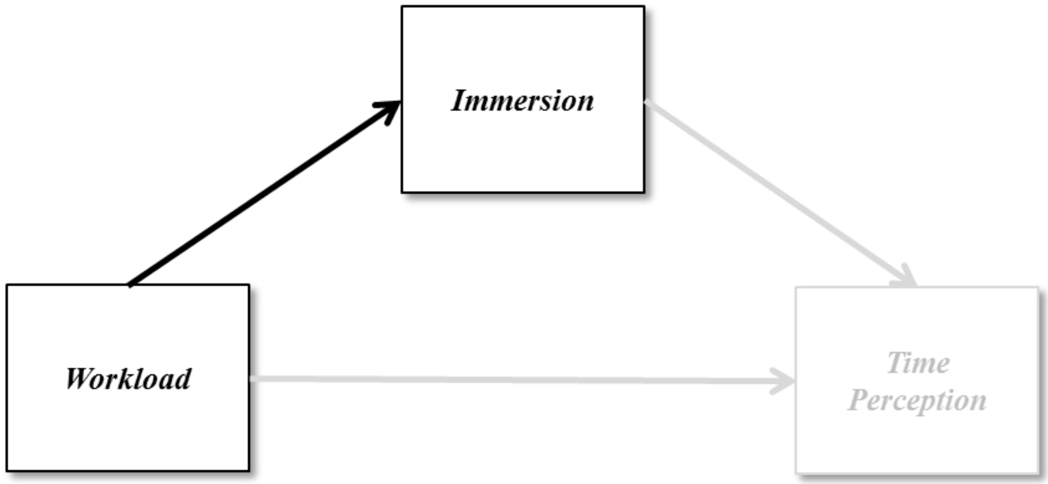
Table 16: Prospective Duration Judgment Ratio Regressed on IEQ – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	1.601(.190)		8.441	.000
IEQ Score (*M*)	-.003(.001)	-.153	-2.264	.025

Dependent Variable: Duration Judgment Ratio

Hypothesis 3

To test hypothesis 3, simple regression analysis was used, where the IEQ was the dependent variable regressed on the predictor variable of the MWL raw score from the NASA-TLX. The regression equation and conceptual model for this hypothesis is shown in Figure 14. The results of the regression analysis indicated a significant main effect of mental workload on immersion, standardized $\beta = .147$, $R^2 = .022$, $F(1, 213) = 4.685$, $p = .032$ (See Table 17 and Table 18).



$$M_{Immersion} = i + a_1 X_{Workload} + e_M$$

Figure 14: Hypothesis 3 simple linear regression statistical and conceptual models

Table 17: IEQ Regressed on Mental Workload – Model Summary

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	4333.494	1	4333.494	4.685	.032
Residual	197013.920	213	924.948		
Total	201347.414	214			

Predictors: (Constant), NASA-TLX Mental Work Load Raw Score

Table 18: IEQ Regressed on Mental Workload – Coefficients with Standard Errors in Parentheses

	Unstandardized Coefficients	Standardized Coefficients	*t*	Sig.
(Constant)	123.864(5.012)		24.715	.000
MWL	.176(.081)	.147	2.165	.032

Dependent Variable: IEQ Total Score

Hypothesis 4

Hypothesis 4 states that the relationship between prospective duration judgment and mental work load will be mediated by level of immersion in the cognitive task. To test hypothesis 4, conditional process modeling will be used where in the first regression equation, IEQ is the dependent variable regressed on the predictor variable of the MWL raw score from the NASA-TLX, and in the second regression equation, the prospective duration judgment is the dependent variable regressed on the predictor variables of the IEQ total score and the MWL raw score from the NASA-TLX. The regression equation and conceptual model for this hypothesis is shown in Figure 15. Holding MWL constant, participants reporting higher levels of game immersion report a lower prospective duration judgment, unstandardized $b_1 = -1.6567$, 95% CI = -2.9910 to -0.3223, $p = 0.0152$ (See Table 19). The direct effect was found to be not significant, unstandardized $c = 1.1830$, 95% CI = -0.4217 to 2.7878, $p = 0.1477$. However, the 95% bootstrap confidence interval for the index of mediation is -0.8584 to -0.0260, unstandardized $\omega = -0.2933$, indicating an indirect effect of workload on prospective duration judgment via immersion that is significantly different from zero. These results support complete mediation because the direct effect is not significant with the indirect effect in the model.

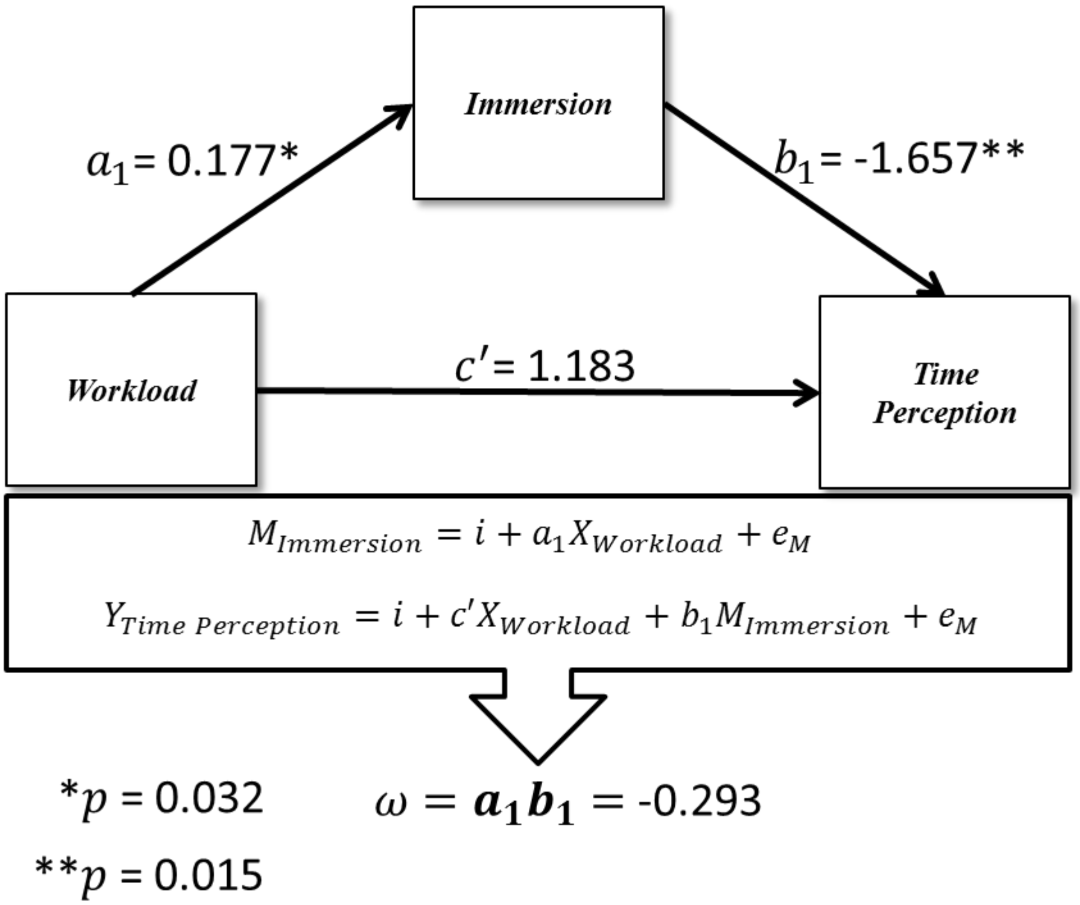


Figure 15: Mediation statistical and conceptual models for prospective duration judgment as outcome with unstandardized coefficients

Table 19: Mediation - Prospective Duration Judgment – Unstandardized Regression Coefficients with Confidence Intervals

		Immersion (*M*)			Duration Judgment Ratio	
		Coeff.(Std Error)	95% CI		Coeff. (Std Error)	95% CI
Workload (*X*)	$a_1 \rightarrow$	0.1771*(0.0815)	0.0164,0.3377	$c' \rightarrow$	1.1830(0.8141)	-0.4217, 2.7878
Immersion (*M*)				$b_1 \rightarrow$	-1.6567**(0.6769)	-2.9910,-0.3223
Constant	$i_M \rightarrow$	123.8048(5.0213)	113.9069,133.7027	$i_Y \rightarrow$	937.7525(97.3873)	745.7809,1129.7242
		$R^2 = 0.0217$			$R^2 = 0.0329$	
		$F(1, 213) = 4.7196$, p = .0309			$F(2, 212) = 3.4184$, p = .0346	

* $p = .0309$

**$p = .0152$

It should be addressed that although there was not a significant main effect of work load on prospective duration judgment, there was still an indirect effect through immersion. This is a case of inconsistent mediation where one or more of the mediated effects has a different sign than the direct effect, suppressing the direct effect (MacKinnon, Krull, & Lockwood, 2000; MacKinnon, Fairchild, & Fritz, 2007). In contrast with Hayes' conditional process model, traditional mediation analysis methods assume a consistent indirect effect, and don't allow for testing of an inconsistent indirect effect that was found in the present study (Baron & Kenny, 1986; Hayes, 2009; Hayes, 2013)

The same statistical procedure was used to test subjective duration judgment as the dependent variable. Holding MWL constant, participants reporting higher levels of game immersion also reported higher subjective duration judgment scores (i.e., time had passed quickly), unstandardized $b_1 = 0.0270$, 95% CI = 0.0219 to 0.0320, $p < 0.0001$ (See Figure 16 and Table 20). The direct effect was not found to be significant, unstandardized $c = -0.0029$, 95% CI = -0.0090 to 0.0032, $p = 0.3492$. However, the 95% bootstrap confidence interval for the index of mediation is 0.0003 to 0.0099, unstandardized $\omega = 0.0048$, indicating an indirect effect of workload on subjective duration judgment via immersion significantly different from zero. These results support complete mediation because the direct effect is not significant with the indirect effect in the model.

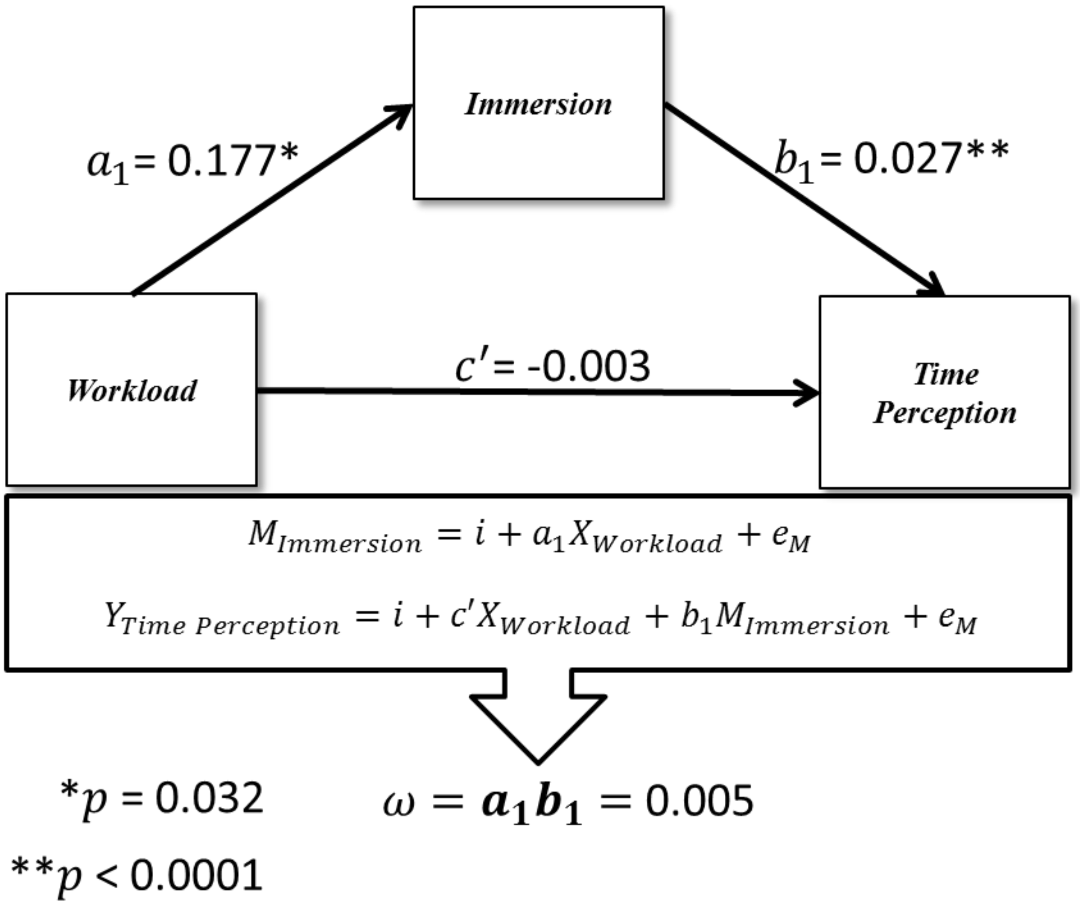


Figure 16: Mediation statistical and conceptual models for subjective duration judgment as outcome with unstandardized coefficients

Table 20: Mediation - Subjective Duration Judgment – Unstandardized Regression Coefficients with Confidence Intervals

		Immersion (*M*)			Duration Judgment Ratio	
		Coeff.(Std Error)	95% CI		Coeff. (Std Error)	95% CI
Workload (*X*)	$a_1 \rightarrow$	0.1771*(0.0815)	0.0164,0.3377	$c' \rightarrow$	-0.0029(0.0031)	-0.0090,0.0032
Immersion (*M*)				$b_1 \rightarrow$	0.0270**(0.0026)	0.0219,0.0320
Constant	$i_M \rightarrow$	123.8048(5.0213)	113.9069,133.7027	$i_Y \rightarrow$	1.3152(0.3710)	0.5839,2.0466
		$R^2 = 0.0217$			$R^2 = 0.340$	
		$F(1, 213) = 4.7196$, p = 0.0309			$F(2, 212) = 54.8493$, p < 0.0001	

*$p = 0.0309$

**$p < 0.0001$

To test duration judgment accuracy, conditional process modeling was used where in the first regression equation, IEQ is the dependent variable regressed on the predictor variable of the MWL raw score from the NASA-TLX, and in the second regression equation, the prospective duration judgment ratio is the dependent variable regressed on the predictor variables of the IEQ total score and the MWL raw score from the NASA-TLX (See Figure 17). Holding constant MWL, participants reporting higher levels of game immersion report a lower prospective duration judgment ratio, unstandardized $b_1 = -.0034$, 95% CI = -0.0061 to -0.0006, $p = 0.0158$ (See Table 21). The direct effect was not found to be significant, unstandardized $c = 0.0022$, 95% CI = -0.0011 to 0.0055, $p = 0.1954$. However, the 95% bootstrap confidence interval for the index of mediation is -0.0018 to -0.0001, unstandardized $\omega = -0.0006$, indicating an indirect effect of workload on prospective duration judgment ratio via immersion significantly different from zero. These results support complete mediation because the direct effect is not significant with the indirect effect in the model.

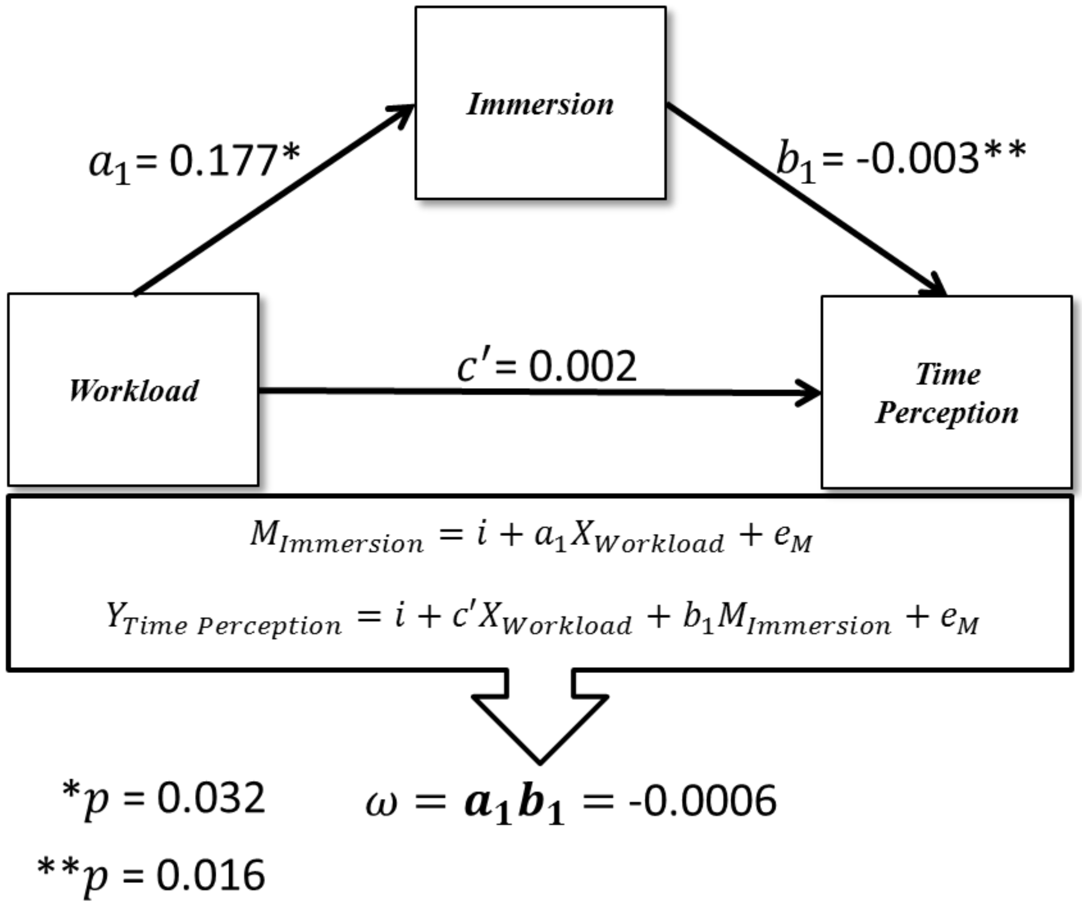


Figure 17: Mediation statistical and conceptual models for prospective duration judgment ratio as the outcome with unstandardized coefficients

Table 21: Mediation - Prospective Duration Judgment Ratio – Unstandardized Regression Coefficients with Confidence Intervals

		Immersion (*M*)			Duration Judgment Ratio	
		Coeff.(Std Error)	95% CI		Coeff. (Std Error)	95% CI
Workload (*X*)	$a_1 \rightarrow$	0.1761*(0.0813)	0.0157,0.3364	$c' \rightarrow$	0.0022(0.0017)	-0.0011,0.0055
Immersion (*M*)				$b_1 \rightarrow$	-0.0034**(0.0014)	-0.0061, -0.0006
Constant	$i_M \rightarrow$	123.8642(5.0117)	113.9853,133.7431	$i_Y \rightarrow$	1.5141(0.2007)	1.1186, 1.9097
		$R^2 = 0.0215$			$R^2 = 0.0312$	
		$F(1, 213) = 4.6851$, p = .0315			$F(2, 212) = 3.4184$, p = .0346	

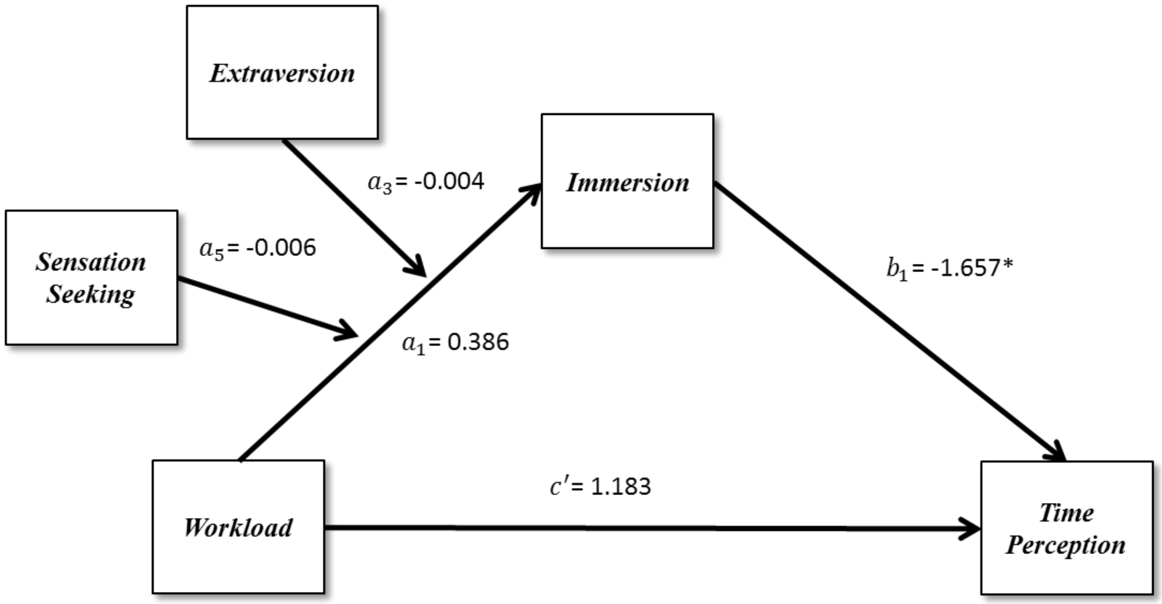
*$p = 0.0315$

**$p = 0.0158$

Hypothesis 5

Hypothesis 5 states that there will be a moderated mediation relationship where the relationship between the prospective duration judgment and work load will be mediated by level of immersion in the cognitive task and that this mediation will be moderated by the participant's levels of extraversion and sensation seeking. To test hypothesis 5, conditional process modeling was used where in the first regression equation, IEQ is the dependent variable regressed on the predictor variables of the MWL raw score from the NASA-TLX, the BFI Extraversion subscale score, and the SSS-V score, and in the second regression equation, the prospective duration judgment is the dependent variable regressed on the predictor variables of the IEQ total score and the MWL raw score from the NASA-TLX (See Figure 18).

A moderated mediation relationship was not found (See Table 22), as the 95% bootstrap confidence interval for the index of moderated mediation for extraversion is -0.0335 to 0.0750, unstandardized $\omega = 0.00001$, indicating that the indirect effect of workload on prospective duration judgment ratio through immersion is not moderated by extraversion. Additionally, the 95% bootstrap confidence interval for the index of moderated mediation for sensation seeking is -0.0277 to 0.0807, unstandardized $\omega = 0.00002$, indicating that the indirect effect of workload on prospective duration judgment ratio through immersion is not moderated by sensation seeking. The direct effect was not found to be significant, unstandardized $c = 1.1830$, 95% CI = -0.4217 to 2.7878, $p = 0.1477$.



$$M_{Immersion} = i + a_1 X_{Workload} + a_2 W_{Extraversion} + a_3 X_{Workload} W_{Extraversion} + a_4 Z_{Sensation\ Seeking} + a_5 X_{Workload} Z_{Sensation\ Seeking} + e_M$$

$$Y_{Time\ Perception} = i + c' X_{Workload} + b_1 M_{Immersion} + e_M$$

*p = 0.0152

$$\omega = \boldsymbol{a_1 b_1} + (\boldsymbol{a_3 b_1})\boldsymbol{W} + (\boldsymbol{a_5 b_1})\boldsymbol{Z}$$

Figure 18: Moderated mediation statistical and conceptual models for prospective duration judgment as the outcome with unstandardized coefficients

Table 22: Moderated Mediation - Prospective Duration Judgment – Unstandardized Regression Coefficients with Confidence Intervals

		Immersion (*M*)			Prospective Duration Judgment	
		Coeff.	95% CI		Coeff.	95% CI
Workload (*X*)	$a_1 \rightarrow$	0.3855(0.3683)	-0.3406, 1.1117	$c' \rightarrow$	1.1830(0.8141)	-0.4217, 2.7878
Immersion (*M*)				$b_1 \rightarrow$	-1.6567*(0.6769)	-2.9910,-0.3223
Extraversion (W)	$a_2 \rightarrow$	0.0009(0.9495)	-1.8709, 1.8727			
$\boldsymbol{X} \times \boldsymbol{W}$	$a_3 \rightarrow$	-0.0040(0.0151)	-0.0338, 0.0257			
Sensation Seeking (Z)	$a_4 \rightarrow$	0.1843(0.8707)	-1.5322, 1.9009			
$\boldsymbol{X} \times \boldsymbol{Z}$	$a_5 \rightarrow$	-0.0062(0.142)	-0.0342, 0.0217			
Constant	$i_M \rightarrow$	120.7202(21.8231)	77.6985, 163.7419	$i_Y \rightarrow$	937.7525(97.3873)	745.7809,1129.7242
		$R^2 = 0.0270$			$R^2 = 0.0329$	
		$F(5, 209) = 1.1608$, p = .3297			$F(2, 212) = 3.6052$, p = .0289	

* $p = .0152$

Using subjective duration judgment as the dependent variable, a moderated mediation relationship was not found (See Figure 19 and Table 23), as the 95% bootstrap confidence interval for the index of moderated mediation for extraversion is -0.0010 to 0.0006, unstandardized ω = -0.0001, indicating that the indirect effect of workload on subjective duration judgment through immersion is not moderated by extraversion. Additionally, the 95% bootstrap confidence interval for the index of moderated mediation for sensation seeking is -0.0009 to 0.0005, unstandardized ω = -0.0002, indicating that the indirect effect of workload on subjective duration judgment through immersion is not moderated by sensation seeking. The direct effect was not found to be significant, unstandardized c = -0.0029, 95% CI = -0.0090 to 0.0032, p = 0.3492.

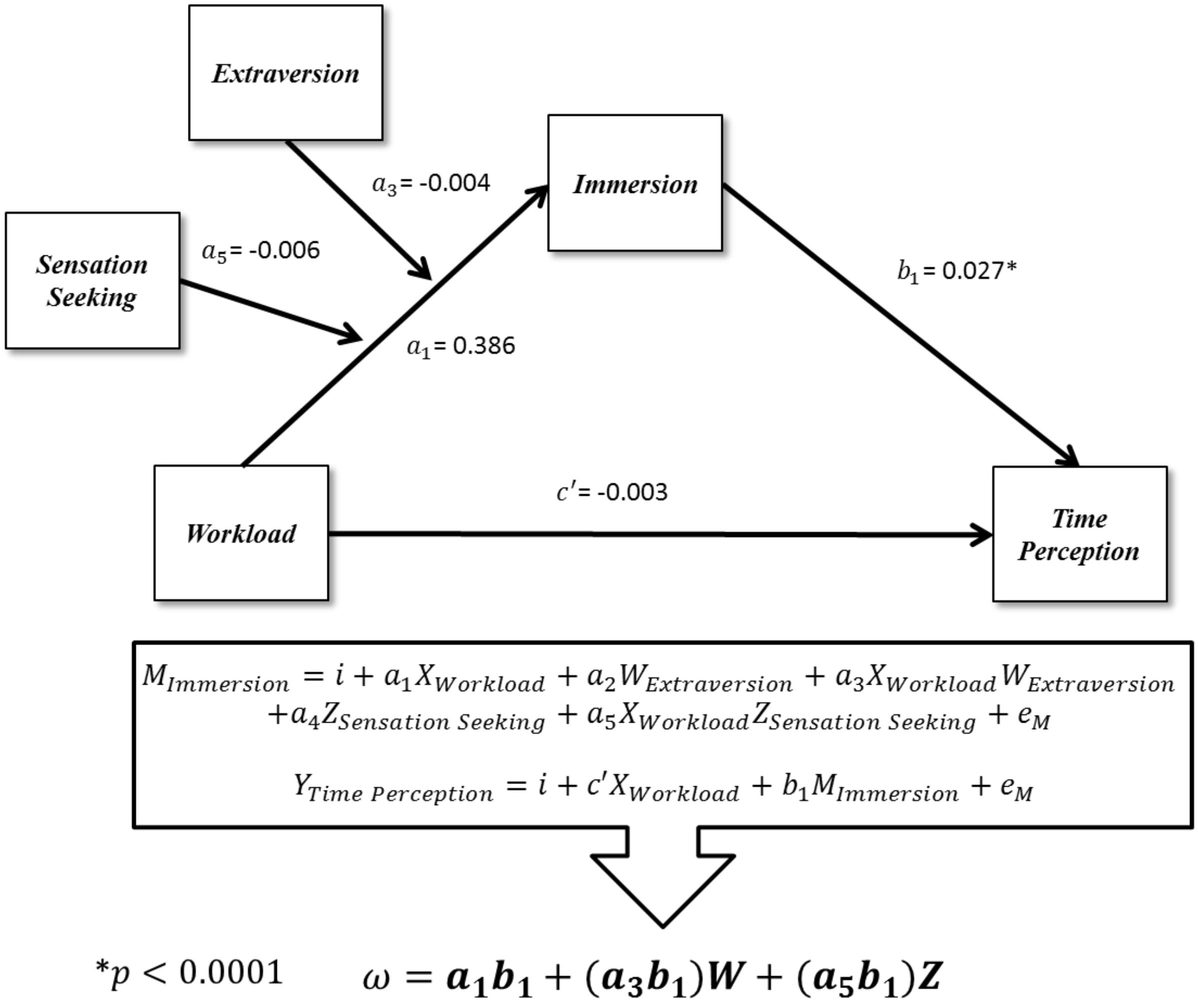


Figure 19: Moderated mediation statistical and conceptual models for subjective duration judgment as the outcome with unstandardized coefficients

Table 23: Moderated Mediation - Subjective Duration Judgment – Unstandardized Regression Coefficients with Confidence Intervals

		Immersion (M)			Subjective Duration	
		Coeff.	95% CI		Coeff.	95% CI
Workload (X)	$a_1 \rightarrow$	0.3855(0.3683)	-0.3406, 1.1117	$c' \rightarrow$	-0.0029(0.0031)	-0.0090,0.0032
Immersion (M)				$b_1 \rightarrow$	0.0270*(0.0026)	0.0219,0.0320
Extraversion (W)	$a_2 \rightarrow$	0.0009(0.9495)	-1.8709, 1.8727			
$\boldsymbol{X} \times \boldsymbol{W}$	$a_3 \rightarrow$	-0.0040(0.0151)	-0.0338, 0.0257			
Sensation Seeking (Z)	$a_4 \rightarrow$	0.1843(0.8707)	-1.5322, 1.9009			
$\boldsymbol{X} \times \boldsymbol{Z}$	$a_5 \rightarrow$	-0.0062(0.142)	-0.0342, 0.0217			
Constant	$i_M \rightarrow$	120.7202(21.8231)	77.6985, 163.7419	$i_Y \rightarrow$	1.3152(0.3710)	0.5839,2.0466
		$R^2 = 0.0270$			$R^2 = 0.3410$	
		$F(5, 209) = 1.1608$, p = .3297			$F(2, 212) = 54.8493$, p < 0.0001	

*$p < 0.0001$

Using prospective duration judgment ratio as the dependent variable, a moderated mediation relationship was not found (See Figure 20 and Table 24), as the 95% bootstrap confidence interval for the index of moderated mediation for extraversion is -0.0001 to 0.0001, unstandardized $\omega = 0.00001$, indicating that the indirect effect of workload on prospective duration judgment ratio through immersion is not moderated by extraversion. Additionally, the 95% bootstrap confidence interval for the index of moderated mediation for sensation seeking is -0.0001 to 0.0002, unstandardized $\omega = 0.00002$, indicating that the indirect effect of workload on prospective duration judgment ratio through immersion is not moderated by sensation seeking. The direct effect was not found to be significant, unstandardized $c = .0022$, 95% CI = -0.011 to 0.0055, $p = 0.1954$.

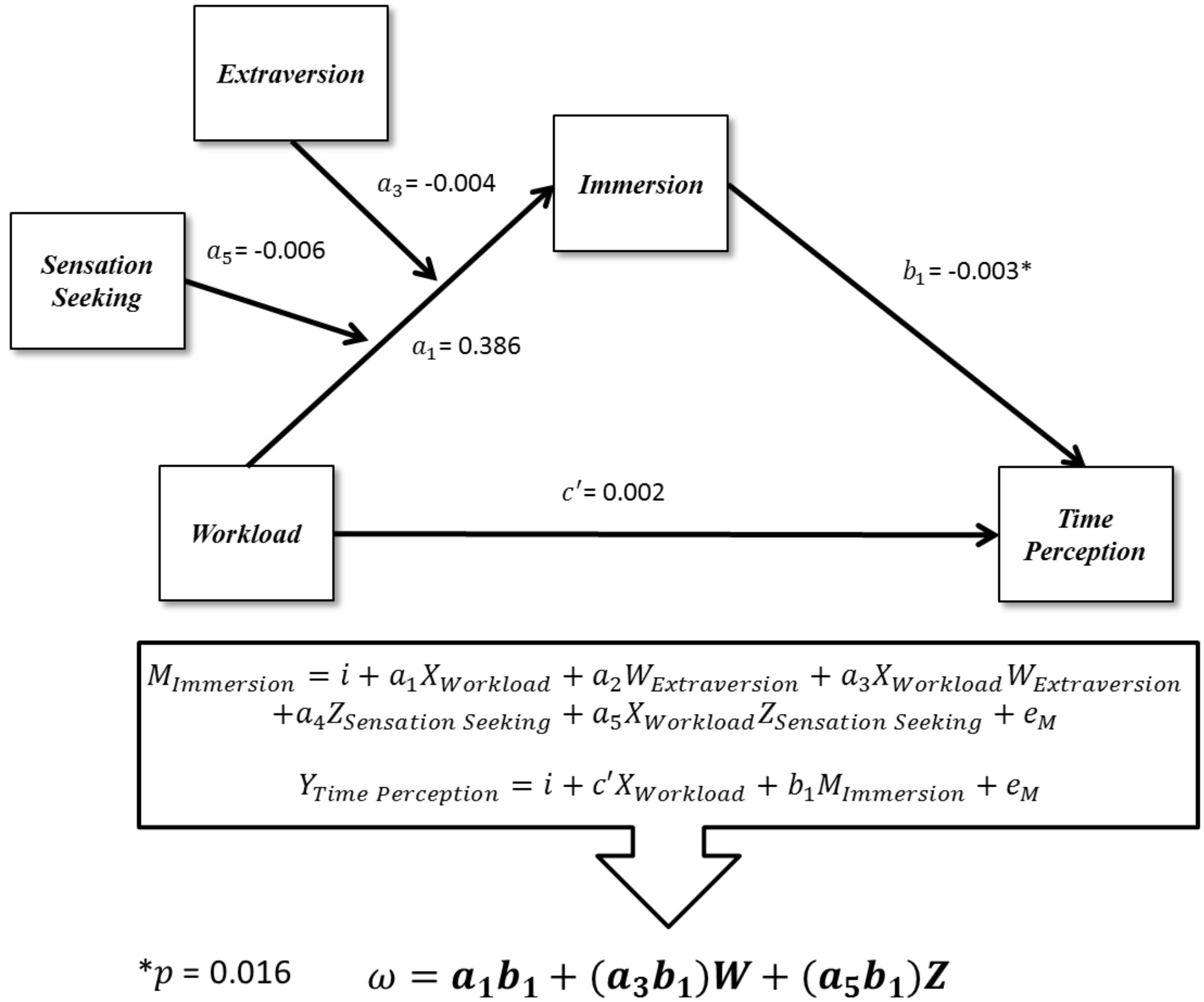


Figure 20: Moderated mediation statistical and conceptual models for prospective duration judgment ratio as the outcome with unstandardized coefficients

Table 24: Moderated Mediation - Prospective Duration Judgment Ratio – Unstandardized Regression Coefficients with Confidence Intervals

		Immersion (*M*)			Duration Judgment Ratio	
		Coeff.	95% CI		Coeff.	95% CI
Workload (*X*)	$a_1 \rightarrow$	0.3855(0.3683)	-0.3406, 1.1117	$c' \rightarrow$	0.0022(0.0017)	-0.0011, 0.0055
Immersion (*M*)				$b_1 \rightarrow$	-0.0034*(0.0014)	-0.0061, -0.0006
Extraversion (W)	$a_2 \rightarrow$	0.0009(0.9495)	-1.8709, 1.8727			
$\boldsymbol{X} \times \boldsymbol{W}$	$a_3 \rightarrow$	-0.0040(0.0151)	-0.0338, 0.0257			
Sensation Seeking (Z)	$a_4 \rightarrow$	0.1843(0.8707)	-1.5322, 1.9009			
$\boldsymbol{X} \times \boldsymbol{Z}$	$a_5 \rightarrow$	-0.0062(0.142)	-0.0342, 0.0217			
Constant	$i_M \rightarrow$	120.7202(21.8231)	77.6985, 163.7419	$i_Y \rightarrow$	1.5141(0.2007)	1.1186, 1.9097
		$R^2 = 0.0270$			$R^2 = 0.0312$	
		$F(5, 209) = 1.1608$, p = .3297			$F(2, 212) = 3.4184$, p = .0346	

*$p = .0158$

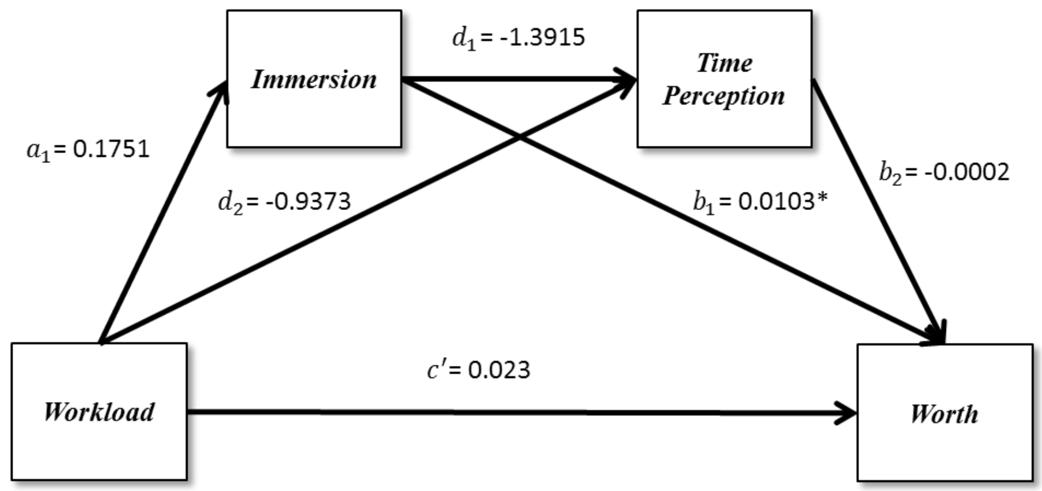
Additional analysis was conducted on the aforementioned models while controlling for sex, annual pass status, and frequency of visits. Using prospective duration judgment as the dependent variable, a moderated mediation relationship when controlling for these variables was not found, as the 95% bootstrap confidence interval for the index of moderated mediation for extraversion is -0.0013 to 0.0005, unstandardized $\omega = 0.0212$, indicating that the indirect effect of workload on prospective duration judgment through immersion is not moderated by extraversion. Additionally, the 95% bootstrap confidence interval for the index of moderated mediation for sensation seeking is -0.0011 to 0.0007, unstandardized $\omega = 0.0040$, indicating that the indirect effect of workload on prospective duration judgment through immersion is not moderated by sensation seeking. The direct effect was not found to be significant, unstandardized $c = 0.7496$, 95% CI = -0.9902 to 2.4895, $p = 0.3962$.

Using subjective duration judgment as the dependent variable, a moderated mediation relationship when controlling for these variables was also not found, as the 95% bootstrap confidence interval for the index of moderated mediation for extraversion is -0.0213 to 0.1087, unstandardized $\omega = -0.0004$, indicating that the indirect effect of workload on prospective duration judgment through immersion is not moderated by extraversion. Additionally, the 95% bootstrap confidence interval for the index of moderated mediation for sensation seeking is -0.0293 to 0.1000, unstandardized $\omega = 0.0001$, indicating that the indirect effect of workload on prospective duration judgment through immersion is not moderated by sensation seeking. The direct effect was not found to be significant, unstandardized $c = -0.0040$, 95% CI = -0.0109 to 0.0028, $p = 0.2475$.

Using prospective duration judgment ratio as the dependent variable, a moderated mediation relationship when controlling for these variables was also not found, as the 95% bootstrap confidence interval for the index of moderated mediation for extraversion is 0.0000 to 0.0002, unstandardized $\omega = 0.00004$, indicating that the indirect effect of workload on prospective duration judgment ratio through immersion is not moderated by extraversion. Additionally, the 95% bootstrap confidence interval for the index of moderated mediation for sensation seeking is -0.0001 to 0.0002, unstandardized $\omega = 0.000008$, indicating that the indirect effect of workload on prospective duration judgment ratio through immersion is not moderated by sensation seeking. The direct effect was not found to be significant, unstandardized $c = 0.0014$, 95% CI = -0.0021 to 0.0050, $p = 0.4338$.

Worth the Wait

Although not part of the original hypotheses, further analysis was conducted to determine if there was an effect of mental workload on the participants' feelings of if the virtual roller coaster was worth the wait duration, mediated by immersion and time perception (See Figure 21). An indirect effect was not found indicated by the 95% bootstrap confidence interval for the index of mediation of -0.0005 to 0.0052, unstandardized $\omega = 0.0016$. However, there was an effect of immersion on worth of wait holding workload and time perception constant, unstandardized $b = .0.0103$, $p = 0.0069$



*p = 0.0017

Figure 21: Multiple mediation statistical and conceptual models for worth of wait as the outcome with unstandardized coefficients

CHAPTER FIVE: DISCUSSION

Implications of Research

There is a growing trend within amusement and theme park attraction design to incorporate the queue into part of the attraction. Some designers go so far as adding interactive elements into the queue itself to occupy the guests' time while waiting for the main attraction (Ledbetter et al., 2013). This is done to not only improve the guests' experience by adding value to their wait, but to also engage guests as to influence their perception of wait time considering that overcrowding and waiting in lines is the top complaint of guests (O'Brien, 2000) However, despite the ever increasing trend toward designing themed and amusement attractions with queues to engage guests, there has been no empirical research conducted to examine any effect that occupying guests' time has on their perception of wait time in an attraction queue. The present dissertation study is the first to empirically test this effect.

Much of the research involving waiting for service has focused around the effect of occupying customers' time on perception of service quality As previously discussed, waiting in service queues has been a popular area of research with applications in movie theaters, banks, and phone on-hold queues (Antonides et al., 2002; Barlow, 2000; Katz et al., 1991).Trends in theme and amusement park attraction designs include the design of the waiting queue for attractions literature (Ledbetter et al., 2013).

The present study seeks to examine the relationship between mental workload and perception of time broken down into five hypotheses. Hypothesis 1 stated that there would be a main effect of mental work load on perception of time where participants' prospective duration judgment will decrease as the level of mental work load increases. The results of the full study did not indicate a significant main effect for mental work load on perception of time. There are several possible explanations to why the present study was unable to replicate the results of other studies related to workload affecting time perception. First, much of the previous research involved shorter durations than in the present study. Duration length has been found to moderate the effect of work load on time estimation (Block et al., 2010). Additionally, much of the research involving the effect of workload on time estimation has not involved a waiting environment where there is an end goal at the completion of the task, i.e. riding a virtual roller coaster. Lastly, there is the possibility that there is an underlying variable or variables that may be masking any effect work load has on time estimation.

Hypothesis 2 stated that there would be a main effect of immersion on perception of time where participants' prospective duration judgment will decrease as the level of immersion increases. The results of the study did indicate a significant main effect for immersion on perception of time. A 1 SD increase in immersion results in a 9.18s decrease in perceived wait time. This is noteworthy for amusement and theme park designers. It shows that immersion of an interactive queue plays an important role in altering a guest's perception of wait time and it provides justification for amusement and theme park operators to consider this variable to counteract the number one complaint of guests – having to wait in long lines.

Hypothesis 3 stated that there would be a main effect of mental work load on immersion where participants' level of immersion will increase as the level of mental work load increases. The results of the study indicated a significant main effect for mental work load on immersion. If immersion plays a significant part in affecting guests' estimation of wait time, then this finding indicates that amusement and theme park designers can increase the level of immersion of an interactive queue by increasing the perceived work load of the interactive queue elements.

Hypothesis 4 stated that there would be an indirect relationship between mental work load and perception of time via immersion where the level of immersion mediates the relationship between mental workload and prospective duration judgment. Despite the fact that hypothesis 1 was not supported by the results, the indirect effect between mental work load and perception of time via immersion was found to be significant. A 1 SD increase in immersion results in a 1.47s decrease in perceived wait time. Since the direct effect is not significant with the indirect effect in the model, these results support complete mediation. This result is considered an inconsistent indirect effect where the effect of work load on immersion and the effect of immersion on time perception offset each other due to a sign difference in the effects (β) of each (MacKinnon et al., 2000; MacKinnon et al., 2007). Although an indirect effect was found, this effect was weak, $R^2 = 0.0041$.

Hypothesis 5 stated that there would be a moderated mediation relationship where the relationship between the prospective duration judgment ratio and mental work load will be mediated by level of immersion in the cognitive task and that this mediation will be moderated by the participant's levels of extraversion and sensation seeking tendencies. The results of present study did not indicate a moderated mediation relationship. These results did not change with the addition of controls (e.g., sex, annual passholder status, and frequency of visitation to amusement parks). Although there was not a moderated mediation effect found with extraversion and sensation seeking, this does not mean that there are no variables that would moderate the indirect effect found between work load and time perception through immersion. In fact, identifying the appropriate individual differences that impact time estimation has been a difficult task (Doob, 1971, p. 223) It simply means that any possible variables moderating this indirect effect was not found but could still exist which certainly commands for follow up studies to examine this.

Further analysis beyond the hypotheses tests found no significant indirect effect of workload on the participants' feeling that the virtual roller coaster was worth the wait. However, there was an effect of level of immersion of the participants' feeling that the ride was worth the wait. This makes sense anecdotally, because if park operators provide an immersive (i.e., engaging and enjoyable) wait experience for the guests, they will feel as though the attraction is worth the wait.

The implications of the research are three-fold. First, there is an economic impact for amusement and theme park operators. By designing the wait experience to be more engaging and immersive, the queue is essentially perceived as part of the attraction. Guests who feel that their wait experience is worthwhile will be more inclined to continue visiting these parks. Conversely, if guests feel as though visiting a crowded park is not worth waiting in line for attractions, they will look for other opportunities to spend their leisure time.

In addition to the economic impact, there is the potential to mitigate risk. As previously discussed, there exists the potential for queue rage when guests are waiting for an event in a large group. Building off the idea that an immersive queue becomes part of the attraction, the risk of queue rage can be mitigated because guests would have a positive view of the wait experience because they no longer have such a strong desire for the wait experience to end.

Lastly, this research is viewed as the starting pointing in a line of research examining other variables and the levels of these variables that would create the optimum design to alter a consumer's wait time estimation. Furthermore, this research need not be limited to the amusement park industry but can ultimately be applied to other settings such as waiting in line at airport screening or waiting at a doctor's office.

Study Limitations

Although the present study was successful in identifying the indirect effect that workload has on wait time estimation through immersion, there are some limitations of the study that could be improved upon for future research. One of the most glaring issues with this research, and one that is shared by other wait time estimation laboratory studies, is the question of external validity. Some may argue that because the present study was conducted in a laboratory setting, the results of the participants' behavior may not transfer to a real world situation. Although this argument has merit, the alternative of conducting a field study poses more issues. As shown in previous field study research (Barlow, 2000; Jones & Peppiatt, 1996; Katz et al., 1991), lack of control makes it very difficult to determine whether any effects that are found are related to the tested variables in the study or are the result of confounding variables that were unaccounted for. The laboratory setting of the present study allowed for higher control for confounding variables. Furthermore, the present study attempted to replicate a typical attraction queue by providing participants with a virtual roller coaster to wait to ride. Also, participants were asked to stand at a kiosk to play the interactive game, which is a typical set up for an interactive attraction queue.

Despite the efforts to design the laboratory setting similar to an attraction queue, there are several issues besides the environment that impact external validity. The participant pool for this study consisted solely of undergraduate psychology students which limited the results to this age group and the results may not transfer to different age brackets. The purpose of limiting the research to university undergraduate students was due to the abundant participant pool. With the type of analysis that was conducted in the present dissertation study, statistical power becomes an issue and therefore a larger sample size is generally needed to mitigate the risk of Type II error. There was not a large enough participant pool for other age groups.

Other limitations that should be corrected in future studies involve the virtual roller coaster ride and the interactive game. The virtual roller coaster was deemed to be an adequate substitute for a real-life amusement park attraction. It was presented using state of the art technology in the Oculus Rift. However, participants in the study were not given the option of riding a different type of ride other than the roller coaster whereas in a real life situation, guests of an amusement park would certainly have the choice of which rides they would want to ride. This is an important distinction because as previously discussed, the goal motivation plays an important role in time estimation. If a participant had an aversion to roller coasters, they may perceive the wait duration differently than a participant who enjoyed and was excited to ride the virtual roller coaster. Similarly, the interactive game that was chosen as the interactive queue element was a math skills game of which participants may have varied perceptions. Some may loathe performing math problems and therefore having to play the game may have been a very unpleasant experience while others may have viewed the game as fun. Although the IEQ takes into consideration the level of enjoyment of the game, the external validity may be impacted considering a math skills game in an amusement park interactive queue seems unlikely in reality.

Future Research

One of the primary objectives of this study was to establish an empirical starting point for further research. The different variables affecting time estimation are quite numerous and the different environments in which this research can be applied are broad. Therefore, there should be no shortage of future opportunities within this line of research.

Although this study's scope was limited to workload, immersion, extraversion, and sensation seeking, there are countless other variables that could impact a guest's wait time perception. Some have been alluded to already but involve the perception of the attraction that the guest is waiting to experience. Specifically, does the perceived thrill of an attraction play a role? Does the novelty of the attraction where the number of times a guest has experienced the same or similar attractions make a difference on perception of wait time? Furthermore, do certain design elements within the queue such as lighting, sound, color, or physical layout have an impact on a guest's perceived wait time? Considering the idea that a queue should be an extension of the attraction, should the theming of a queue match that of the attraction as well? Ledbetter et. al.(2013) provide several opportunities for future research related to the effect that queue design has on perceived wait time.

As previously discussed in the study limitations, there are countless individual differences that may play a part in wait time estimation. Some may involve personality traits similar to those that were included in this study, i.e. sensation seeking and extraversion. But things such as level of fatigue, caffeine consumption, and general health could play a significant role in a person estimating wait time. In essence, these factors contribute to a guest's level of immersion, engagement, and enjoyment of the queue that has been shown to play a significant role in the guest's perceived wait time.

One intriguing opportunity for future research has a practical application in today's amusement and theme park experience. Several parks employ methods of providing a preferred experience for special guests where they do not have to wait in the standard long queue, but are provided a separate queue where there is little to no wait. This preferred treatment can lead to what some view as social injustice (Larson, 1987; Ledbetter et al., 2013). If a guest feels social injustice has occurred because they witness other guests bypassing the queue, is the guest's perceived wait time changed because of this? Furthermore, does an interactive queue mitigate any negative impact that the perceived social injustice has made on a guest's perceived wait time?

Finally, the scope of this dissertation was interactive amusement and theme park queues. As previously mentioned, could these results also apply to settings that the general public has a negative opinion of such as medical waiting rooms, airport screening queues, or the line at the DMV? If future research finds that the present study findings also apply to these settings, the negative view of these environments could be changed for the better.

Unfortunately, human factors research in the amusement and theme park industry remains limited. Hopefully this dissertation provides visibility to this untapped human factors field whether it is perceived wait time in attraction queues or one of many other topics such as ride design, guest and employee safety, or any other general theme park design issues.

APPENDIX A: EXPERIMENT 1 IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Jonathan Ledbetter** and Co-PIs if applicable:

Date: **August 27, 2015**

Dear Researcher:

On 08/27/2015, the IRB approved the following human participant research until 08/26/2016 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	Assessing mental workload of an iPad game: A dissertation pilot study
Investigator:	Jonathan Ledbetter
IRB Number:	SBE-15-11519
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 08/26/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 08/27/2015 10:02:39 AM EDT

IRB manager

APPENDIX B: EXPERIMENT 1 CONSENT FORM

University of Central Florida

Informed Consent

Study Title: Assessing mental workload of an iPad game: A dissertation pilot study

Principal Investigators: Jonathan Ledbetter

Investigational Site(s): University of Central Florida, Department of Psychology

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 30 participants at UCF. You have been asked to take part in this research study because you are a student of the university. You must be 18 years of age or older to be included in the research study.

The person doing this research is Jonathan Ledbetter, PhD Graduate Student of the Psychology Department.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to empirically examine the level of mental workload of a math skills game.

What you will be asked to do in the study: You will be playing a math skills game where you move through a labyrinth of math skill challenges. After the simulation, you will be given surveys asking about your experience. The entire study should last approximately half an hour.

Location: The entire study will be conducted in the Department of Psychology building.

Time required: We expect that you will be in this research study for 30 minutes.

UCF University of Central Florida IRB
IRB NUMBER: SBE-15-11519
IRB APPROVAL DATE: 08/27/2015
IRB EXPIRATION DATE: 08/26/2016

Risks: There are no reasonably foreseeable risks or discomforts involved in taking part in this study.

Benefits: There are no expected benefits associated with this study. However, the results of this study may help researchers understand the design and development of products catering to the capabilities and convenience of the user.

Compensation or payment:
You will receive 1/2 SONA credit for your participation, and you credit will be posted within 48 hours of completion of the study. Extra credit will be offered if the study exceeds the expected duration of 30 minutes.

Anonymous research: This study is entirely confidential. This means no personally identifiable information will be collected during the study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has hurt you, talk to Jonathan Ledbetter, Graduate Student, Applied Experimental and Human Factors Psychology Program, College of Sciences, r by email at jledbetter@knights.ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study:
If you decide to leave the research study, there will be no penalty of losing credit, and you will be compensated for the amount of time contributed to this study. If you decide to leave the study, contact the investigator so that the investigator can stop the session and erase any collected data from your participation you choose to do so. The person in charge of the research study can remove you from the research study without your approval. Possible reasons for removal include failure to follow instructions of the research staff, or the facilitator decides that the research study is no longer in your best interest. We will tell you about any new information that may affect your health, welfare or choice to stay in the research.

UCF
University of Central Florida IRB
IRB NUMBER: SBE-15-11519
IRB APPROVAL DATE: 08/27/2015
IRB EXPIRATION DATE: 08/26/2016

APPENDIX C: EXPERIMENT 2 IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Jonathan Ledbetter**

Date: **October 05, 2015**

Dear Researcher:

On 10/05/2015, the IRB approved the following human participant research until 10/04/2016 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	Interactive Theme Park Queues: How do mental workload and immersion of video games affect guests' perception of wait time.
Investigator:	Jonathan Ledbetter
IRB Number:	SBE-15-11632
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 10/04/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 10/05/2015 10:54:03 AM EDT

IRB Manager

APPENDIX D: EXPERIMENT 2 CONSENT FORM (ONLINE PHASE)

Interactive Theme Park Queues: How do mental workload and immersion of video games affect guests' perception of wait time.

Informed Consent

Principal Investigator: Jonathan L. Ledbetter, M.S.

Faculty Advisor: Janan A. Smither, PhD

Investigational Site(s): University of Central Florida, Main Campus

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 1000 people at UCF . You have been asked to take part in this research study because you are a student at the University of Central Florida. You must be 18 years of age or older to be included in the research study.

Individuals who have a prior history of seizures cannot take part in this study.

The person doing this research is Jonathan L. Ledbetter, PhD Graduate Student of the Psychology Department.

Because the researcher is a graduate student, he is being guided by Janan A. Smither, PhD, a UCF faculty advisor in the Psychology Department.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.

University of Central Florida IRB
IRB NUMBER: SBE-15-11632
IRB APPROVAL DATE: 10/13/2015
IRB EXPIRATION DATE: 10/04/2016

- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: There exists a proliferation of interactive queues in theme design and development. The goal of this dissertation study is to examine the effect that an interactive queue has on a guest's perception of time waiting for ana attraction. This study will examine the effects of mental workload and immersion of a cognitive game on an individual's ability to perceive the passage of time while waiting for an amusement attraction. Additionally, individual differences will be examined for any moderating effects.

What you will be asked to do in the study: In this study, you will be asked to take part in several questionnaires realted to your personality. These questionnaires are intended to measure your level of extraversion and sensation seeking tendancies. These questionnaires will be completed online.

Location: This portion of the study takes place online.

Time required: We expect that you will be in this research study for less than 30 minutes.

Risks: There are no reasonably foreseeable risks or discomforts involved in taking part in this study.

Benefits:
There are no expected benefits to you for taking part in this study.

Compensation or payment:
You will receive ¼ SONA credit for your participation, and your credit will be posted within 48 hours of completion of the study.

Anonymous research: This study is anonymous. That means that no personally identifiable information will be collected dring the study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has hurt you, talk to Jonathan Ledbetter, Graduate Student, Applied Experimental and Human Factors Psychology Program, College of Sciences, (9 by email at jledbetter@knights.ucf.edu

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway,

UCF
University of Central Florida IRB
IRB NUMBER: SBE-15-11632
IRB APPROVAL DATE: 10/13/2015
IRB EXPIRATION DATE: 10/04/2016

Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study:
If you decide to leave the research study, there will be no penalty of losing credit, and you will be compensated for the amount of time contributed to this study. If you decide to leave the study, contact the investigator so that the investigator can stop the session and erase any collected data from your participation you choose to do so.

The person in charge of the research study can remove you from the research study without your approval. Possible reasons for removal include failure to follow instructions of the research staff, or the facilitator decides that the research study is no longer in your best interest.

We will tell you about any new information that may affect your health, welfare or choice to stay in the research.

UCF University of Central Florida IRB
IRB NUMBER: SBE-15-11632
IRB APPROVAL DATE: 10/13/2015
IRB EXPIRATION DATE: 10/04/2016

APPENDIX E: EXPERIMENT 2 CONSENT FORM (LAB PHASE)

Interactive Theme Park Queues: How do mental workload and immersion of video games affect guests' perception of wait time.

Informed Consent

Principal Investigator: Jonathan L. Ledbetter, M.S.

Faculty Advisor: Janan A. Smither, PhD

Investigational Site(s): University of Central Florida, Main Campus

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 1000 people at UCF . You have been asked to take part in this research study because you are a student at the University of Central Florida. You must be 18 years of age or older to be included in the research study.

Individuals who have a prior history of seizures cannot take part in this study.

The person doing this research is Jonathan L. Ledbetter, PhD Graduate Student of the Psychology Department.

Because the researcher is a graduate student, he is being guided by Janan A. Smither, PhD, a UCF faculty advisor in the Psychology Department.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.

University of Central Florida IRB
IRB NUMBER: SBE-15-11632
IRB APPROVAL DATE: 10/05/2015
IRB EXPIRATION DATE: 10/04/2016

- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: There exists a proliferation of interactive queues in theme design and development. The goal of this dissertation study is to examine the effect that an interactive queue has on a guest's perception of time waiting for ana attraction. This study will examine the effects of mental workload and immersion of a cognitive game on an individual's ability to perceive the passage of time while waiting for an amusement attraction. Additionally, individual differences will be examined for any moderating effects.

What you will be asked to do in the study: You are waiting in line to ride a virtual roller coaster. While you are waiting, you will be playing a math skills game where you move through a labyrinth of math skill challenges. After the simulation, you will be given surveys asking about your experience.

Location: UCF Psychology Department lab

Time required: We expect that you will be in this research study for less than 1 hour.

Risks: There is a small risk that people who take part will develop what is ordinarily referred to as simulator sickness. It occurs once in awhile to people who are exposed to prolonged continuous testing in simulated environments. Symptoms consist of nausea and a feeling of being light- headed. The risk is minimized as a result of the short duration of each session in the simulator. If you experience any of the symptoms mentioned, please tell the researcher and remain seated until the symptoms disappear.

Benefits:
There are no expected benefits to you for taking part in this study.

Compensation or payment:
You will receive 1 SONA credit for your participation, and your credit will be posted within 48 hours of completion of the study.

Anonymous research: This study is anonymous. That means that no personally identifiable information will be collected dring the study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, or think the research has hurt you, talk to Jonathan Ledbetter, Graduate Student, Applied Experimental and Human Factors Psychology Program, College of Sciences, (r by email at jledbetter@knights.ucf.edu

University of Central Florida IRB
IRB NUMBER: SBE-15-11632
IRB APPROVAL DATE: 10/05/2015
IRB EXPIRATION DATE: 10/04/2016

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study:
If you decide to leave the research study, there will be no penalty of losing credit, and you will be compensated for the amount of time contributed to this study. If you decide to leave the study, contact the investigator so that the investigator can stop the session and erase any collected data from your participation you choose to do so.

The person in charge of the research study can remove you from the research study without your approval. Possible reasons for removal include failure to follow instructions of the research staff, or the facilitator decides that the research study is no longer in your best interest.

We will tell you about any new information that may affect your health, welfare or choice to stay in the research.

UCF
University of Central Florida IRB
IRB NUMBER: SBE-15-11632
IRB APPROVAL DATE: 10/05/2015
IRB EXPIRATION DATE: 10/04/2016

APPENDIX F: EXPERIMENT 2 GUIDE AND SCRIPT

Interactive Theme Park Queue Research Study Guide

Interactive Theme Park Queues Study

Overview

Thank you for serving as a Research Assistant for the Interactive Theme Park Queue Study. This guide is intended to provide you with step-by-step instructions. While this guide is intended to be fully exhaustive with as much detail as possible, it still lacks instructions for each scenario which may arise. Therefore, please do not hesitate to ask a fellow Research Assistant or the Principal Investigator, Jonathan Ledbetter, any questions for events that are not in this guide.

Abstract

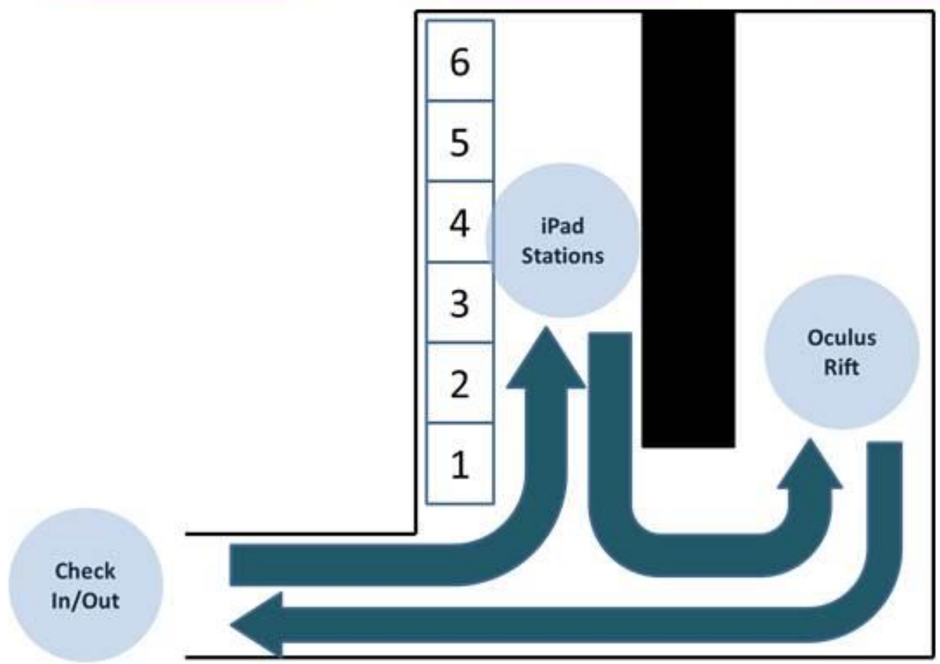
There exists a proliferation of interactive queues in theme design and development. The goal of this dissertation study is to examine the effect that an interactive queue has on a guest's perception of time waiting for an attraction.

There are two parts to the study. The first part is an online survey and the second part of the study is the in-person study conducted in a laboratory setting. You are serving as a research assistant for Part 2 – In-Person study. Participants are required to complete Part 1 of the study prior to coming into the lab for Part 2 - the in-person study.

Interactive Theme Park Queues Study

Lab Study Process Overview

There are five different roles that you may be asked to perform for the study. Please make sure you are familiar with each role.



Interactive Theme Park Queues Study

1. Check-In Participant

Guidelines	Script
1. Verify that the participant is taking the theme park queue study and confirm participant's SONA ID and scheduled time in the SONA system. (See Appendix for SONA instructions)	"Are you here for the Interactive Theme Park Queue research study in room 306?" "What is your scheduled time and do you have your SONA ID available? I want to make sure that I give you the proper SONA credit."
2. Record participant's SONA ID, scheduled time, and actual arrival time on the Google spreadsheet (see instructions on Google spreadsheet).	
3. Write the participant's SONA ID, Participant # from the Google Sheet, and the Station # from the Google Sheet on a blank index card. Hold this card to provide the next research assistant who will escort the participant into the lab.	
4. Provide participants with informed consent.	"This is the informed consent. It provides you with an overview of the study and what will happen to you. Please note that because the roller coaster takes place in a virtual environment, if you have a history of seizures, you cannot take part in the study. Please review the consent and if you decide to participate, we will continue."

Interactive Theme Park Queues Study

1. Check-In Participant

Guidelines	Script
5. Provide participants with the game instructions.	"This study involves you waiting in line to ride the virtual roller coaster. As you can see, we have several other participants waiting to ride the roller coaster. While you are waiting for the ride, you will be playing a game. When it is time for you ride the roller coaster, we will stop you playing the game. You will be asked questions related to your experience of playing the game while you were waiting. You will also be asked to estimate your wait time while playing the game." "These are some brief instructions on the game and the game's objective. Throughout the game, you will be given some math problems to solve to proceed through the game. The game is pretty straight forward and very intuitive. Please review these instructions and let me know if you have any questions."

Interactive Theme Park Queues Study

1. Check-In Participant

Guidelines	Script
6. Instruct participants to store all personal items – especially phones and any time keeping devices such as watches. – Write down the participant number twice – once on each end of an index card. – Tear the index card in half – Give the participant one half of the index card – Slide the other half of the index card in the clear sleeve of the bin containing the participant's personal belongings.	"Because this study involves measuring mental workload and time estimation, you will need to store your personal items securely with me. This especially includes watches and any cell phones since any distraction may compromise not only your study results, but also the results from other participants in the room."
7. Instruct the participant to wait on the benches outside of the lab while reviewing the Informed Consent and Game Instructions sheet.	"Please have a seat on the bench to review the Informed Consent and the Game Instructions and someone will be with you shortly."

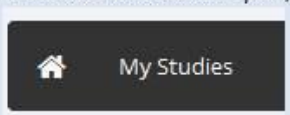
Interactive Theme Park Queues Study

2. Escort Participant to iPad Station and Start Game

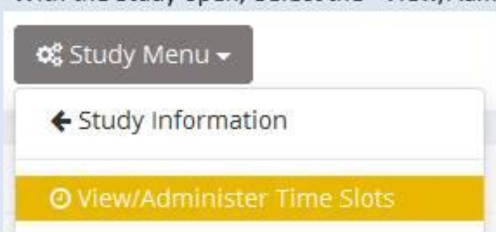
Guidelines

8. Once the participant is escorted into the room by the next research assistant, be sure to give the participant SONA credit

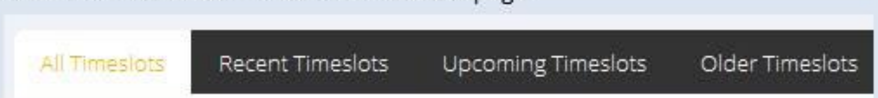
- See full instructions for SONA login and managing timeslots in the Appendix
- With SONA website open, go to "My Studies" at the top menu bar.



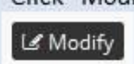
- Click the study titled: *Interactive Theme Park Queues: How do mental workload and immersion of video games affect guests' perception of wait time.*
- With the study open, select the "View/Administer Time Slots" from the drop



- Select "All Timeslots" from the Timeslots page.



- Click "Modify" for the participant you wish to give credit to.



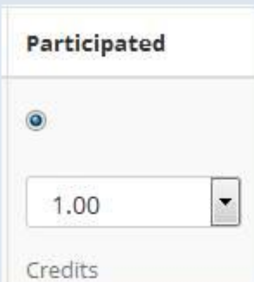
Script

Interactive Theme Park Queues Study

2. Escort Participant to iPad Station and Start Game

Guidelines	Script
8. In the SONA system, give credit to the participant (cont.)	

- Click the radio button under the "Participated" column.



- Confirm that the participant is receiving 1.00 SONA credit.

Interactive Theme Park Queues Study

2. Escort Participant to iPad Station and Start Game

Guidelines	Script
9. Obtain the index card containing the SONA ID, Participant #, and the Station number from the Check-In research assistant.	
10.Ask Participant if they have any questions about the Informed Consent and Game Instructions.	"Do you have any questions regarding the Informed Consent or the Game Instructions?"
11.Take the informed consent and the game instructions from the participant and return them to the check-in station.	
12.Instruct the participant on what to expect in the lab study.	"While waiting to ride the roller coaster, you will play a math skills game. I will escort you to a station where you will play the game . I will provide you with headphones to wear while playing the game. After playing the game for a certain period of time, we will stop you and you will then complete a couple of surveys based on your experience while playing the game. You do not need to wear the headphones while completing the surveys."
13.Ask the participant if they are ready to proceed.	"Are you ready to proceed with the study?"

Interactive Theme Park Queues Study

2. Escort Participant to iPad Station and Start Game

Guidelines	Script
14. Escort the Participant into the room. **15. Obtain the stopwatch from the box that corresponds to the station number on the index card.** **16. Escort the participant to the station number corresponding to the number on the stop watch and the station number on the index card. (The station numbers on the index card and on the stopwatch should correspond to the station number that you escort the participant to.)** **17. Provide the headphones to the Participant to put on.**	

Interactive Theme Park Queues Study

2. Escort Participant to iPad Station and Start Game

Guidelines

18. Click the QD Math icon on the iPad screen to open the game.

19. Click "Choose Player".

20. Select the user at the top of the list.

Script

Interactive Theme Park Queues Study

2. Escort Participant to iPad Station and Start Game

Guidelines	Script
21. Once you select the user, the game will begin.	

21. Once you select the user, the game will begin.

22. IMPORTANT!!! – Once the participant begins playing the game, start the stopwatch timer.

23. After confirming that the stopwatch timer is counting, place the stopwatch and the index card into the corresponding compartment of the box.

Interactive Theme Park Queues Study

3. Stop Gameplay and Start Online Survey

Guidelines	Script
24. When a stopwatch approaches 11 minutes and 42 seconds, take stopwatch and the index card from the box to the corresponding station. 25. When stopwatch is approximately 11 minutes and 42 seconds (does not need to be exact and can actually vary by ~30 seconds), stop the participant from playing the game. 26. As you stop the participant from playing the game, stop the stopwatch.	

Interactive Theme Park Queues Study

3. Stop Gameplay and Start Online Survey

Guidelines | **Script**

27. Press the iPad main button. Large button on the right side of the screen. This will take you to the main screen.

28. From the main screen, click the Survey icon.

Interactive Theme Park Queues Study

3. Stop Gameplay and Start Online Survey

Guidelines	Script
29. Clicking the Survey icon will open the survey. **30. Enter the following information from the index card into the prompts on the first screen of the survey.** • **SONA ID** • **Participant ID** • **Station #** **31. Click the Next button on the survey. Prompt the participant to continue the survey.** **32. Enter the elapsed time from the stopwatch into the correct column in the Participant Log Google sheet. Reset the timer to zero and return the stopwatch to the box.**	

Interactive Theme Park Queues Study

4. Operate the Oculus Rift

Guidelines	Script
33. When participant approaches the oculus station instruct them to sit in the chair. If there is already someone at the oculus station, ask the participant to wait in the chairs provided for waiting participants.	
34. After the participant is seated at the oculus station, remind them of the hazard and instruct them on what to do if they start to become sick.	"As a reminder, if you have a history of seizures, you cannot participate in the roller coaster." "The oculus is a virtual reality headset. You may experience motion sickness. In the event that you start to feel sick, just remember to close your eyes. You are not physically moving, so closing your eyes will alleviate any motion sickness you may start to experience. At any point, if you feel that you cannot continue, you can take the headset off and I will stop the ride."
35. Tell the participant that you will assist them in putting the headset and headphones on.	"I will now help you put the Oculus headset and headphones on."

Interactive Theme Park Queues Study

4. Operate the Oculus Rift

Guidelines	Script
36. Assist the participant in putting the Oculus headset on. Participants will need to remove eyeglasses.	
37. Ask participant if they can see the images through headset.	"Can you see anything through the headset?"
38. Tell the participant you will now help them in putting the headphones on. (Once they put the headset on, they will not be able to hear you give instructions."	"Now you will put on the headphones. Once you put these headphones on, you may not hear me."
39. Assist the participant in putting the headphones on.	
40. Hit the play button to begin playing the roller coaster video.	
41. Monitor the participant for any signs of distress or sickness.	
42. Once the progress bar of the ride has reached the end. You can stop the video.	
43. Assist the participant in removing the headphones first, and then the Oculus headset.	

Interactive Theme Park Queues Study

4. Operate the Oculus Rift

Guidelines	Script
44. Recommend the participant have seat for a few minutes in the side chairs until any motion sickness has passed.	"If you are feeling any signs of motion sickness or dizziness, you should have a seat in these chairs until the symptoms pass"
45. Reset the video for the next participant. (Ask another research assistant if you have any problems with resetting the video.)	

Interactive Theme Park Queues Study

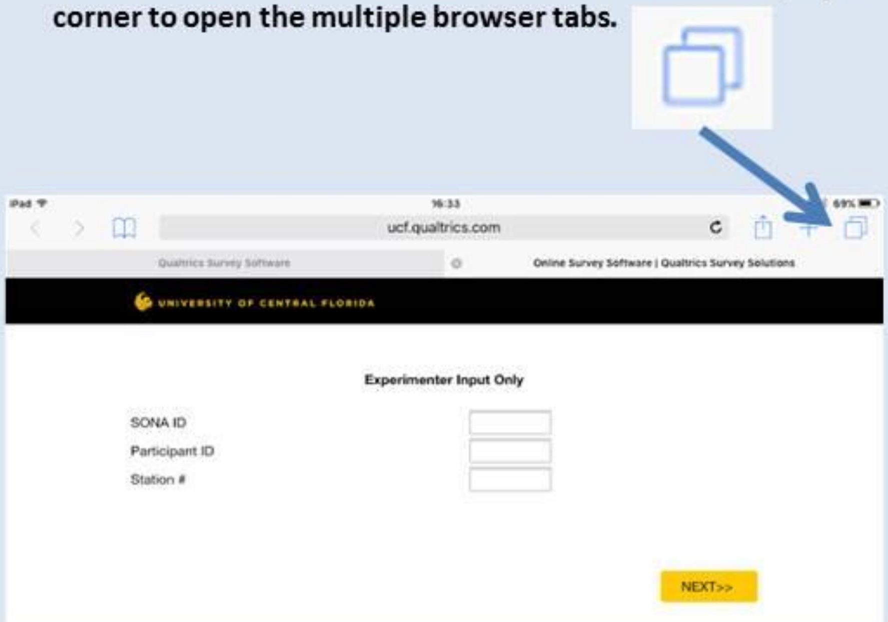
5. Reset iPad for Next Participant

Guidelines	Script
46. Monitor to see when the participant is finished at the iPad station. **47. Escort the participant to the Oculus station if necessary.** **48. Close the survey by closing the browser tab in Safari.** • **Open Safari by going to the main iPad screen.** 	

Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

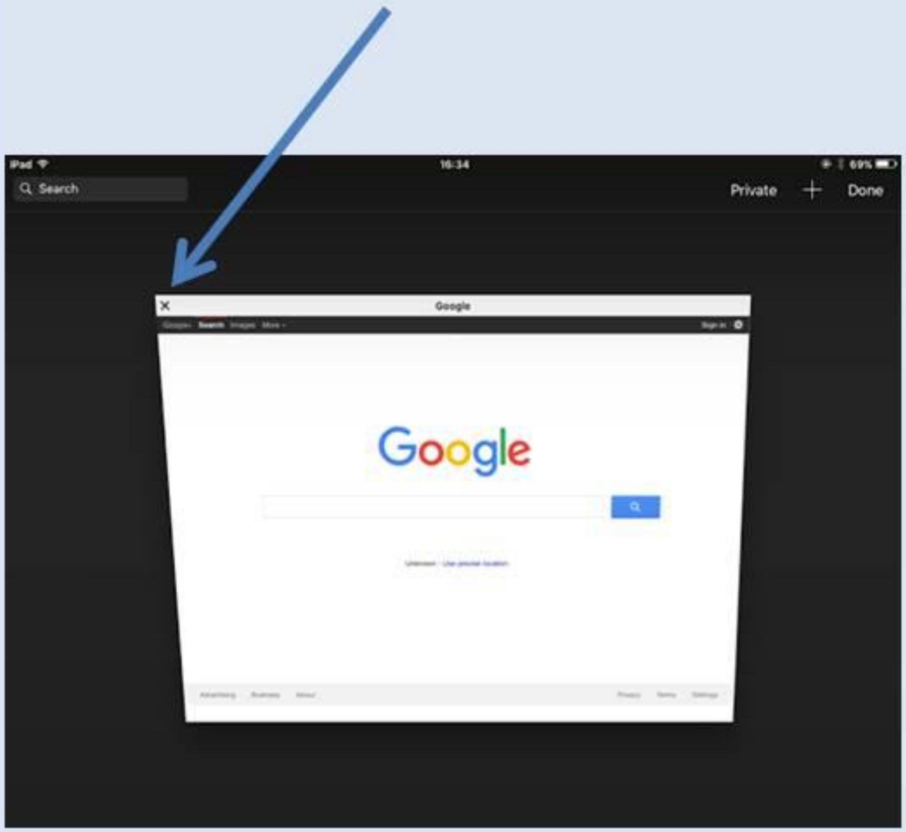
Guidelines	Script
• In the Safari browser window, select the icon in the top right corner to open the multiple browser tabs.	



Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

Guidelines	Script
• Close ALL browser tabs by selecting the X on each tab.	

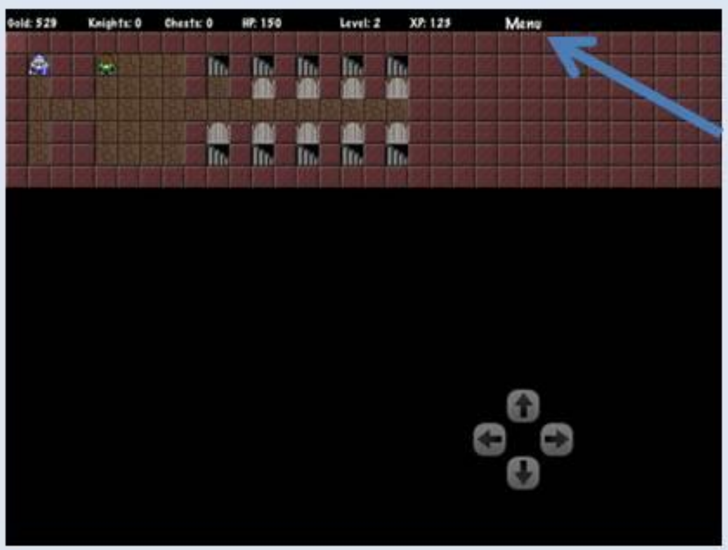


Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

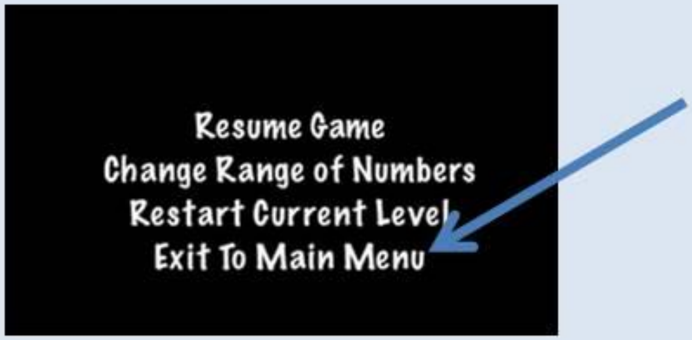
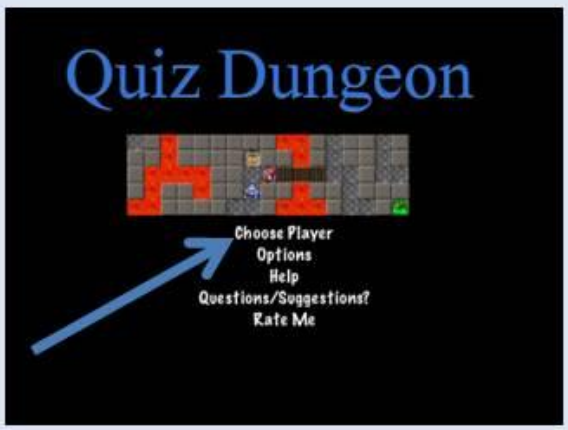
Guidelines	Script
49. Open the QD Math game by clicking on the icon.	

50. If game is in the middle of play, click "MENU" at the top of the screen.



Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

Guidelines	Script
51. Click "Exit to Main Menu"  **52. Click "Choose Player".** 	

Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

Guidelines	Script
53. Click "Delete User" to avoid the next participant playing under the same user.  54. Select the User name to delete.  55. Confirm delete user.	

Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

Guidelines

*****If no user names are present after deleting the last user profile:***

56. After deleting user, click "Add User" to create a profile for the next participant.

57. Enter new user name. User name should be station number, dash, and the next number after the last user profile on the list. For example, for station 3 with the last user profile number ending in 7 (3-7), the next user profile name should be: 3-8

58. Choose the math problems according to the station number as follows:

Station 1: Addition	**Station 4: Multiplication**
Station 2: Add. & Subtraction	**Station 5: Add. & Subtraction**
Station 3: Addition	**Station 6: Multiplication**

Script

Interactive Theme Park Queues Study

5. Reset iPad for Next Participant

Guidelines	Script
****After adding a new user user, you must set up the range of numbers.**	

59. **Click on the name of the user profile you want to change the range of number for.**

60. **Click "Menu" in the top right corner of the screen.**

Interactive Theme Park Queues Study

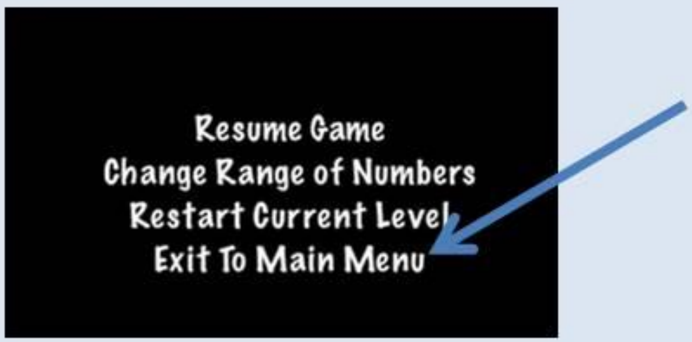
5. Reset iPad for Next Participant

Guidelines	Script

61. Type in the range of numbers based on the iPad station number:

Station 1: 1-10	Station 4: 1-15
Station 2: 10-99	Station 5: 10-99
Station 3: 1-10	Station 6: 1-15

62. Click "Exit to Main Menu".



63. Click the large iPad button to go back to the iPad main screen.

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