Investigating the Effect of Pace Mechanic on Player Motivation and Experience

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Hala Anwar

Abstract

Games have long been employed to motivate people towards positive behavioral change. Numerous studies, for example, have found people who were previously disinterested in a task can be enticed to spend hours gathering information, developing strategies, and solving complex problems through video games. While the effect of factors such as generational influence or genre appeal have previously been researched extensively in serious games, an aspect in the design of games that remains unexplored through scientific inquiry is the pace mechanic—how time passes in a game. Time could be continuous as in the real world (real-time) or it could be segmented into phases (turn-based). Pace mechanic is fiercely debated by many strategy game fans, where real-time games are widely considered to be more engaging, and the slower pace of turn-based games has been attributed to the development of mastery. In this thesis, I present the results of an exploratory mixed-methods user study to evaluate whether pace mechanic and type of game alter the player experience and are contributing factors to how quickly participants feel competent at a game. 36 participants were invited to play one session of a real-time game and one session of a turn-based game, and asked to provide feedback about their experience. The results of the study highlight some of the differences between these two pace mechanics. Drawing inspiration from previous work in game design, these differences are then used to present implications for the design of games for both play and serious tasks (e.g., educational games).

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List of Acronyms and Terms

RT	Real-Time
TB	Turn-Based
AI	Artificial Intelligence
SAM	Self-Assessment Manikin
GEQ	Game Engagement Questionnaire
PENS	Player Experience of Needs Satisfaction
IMI	Intrinsic Motivation Inventory
C	Card Games
H	Chess Games
V	Video Games
n.s.	Not Significant
SiG	Social Innovation Generation
SI Lab	Social Innovation Lab
COTS Games	Commercial Off-The-Shelf Games

Chapter 1
Introduction

In this thesis, we investigate whether pace mechanic (how time passes in a game) and type of game alter the player experience and are contributing factors to how quickly participants feel competent at a game. Two factors motivated our work: the necessity of engaging participants quickly through the design of the game while still allowing them to plan ahead in collaborative settings, and the lack of attention in the previous literature to assessing the impact of pace mechanic on player experience.

1.1 Background

1.1.1 Serious Games

Games are structured forms of play which are usually engaged in for diversion or amusement (Merriam-Webster: "Game", 2016). Increasingly, digital games are being used for the purposes of training, advertising, simulation, education, or solving a problem. These ‘serious games’ leverage the motivational virtues of games to captivate and engage players towards the achievement of predefined objectives, such as learning and positive behavioral change (Corti, 2006; Susi, Johannesson, & Backlund, 2007; Sawyer & Smith, 2008; Bogost, 2007).

Simulations and strategy games are two key genres of games that have traditionally been adopted as educational and training tools. Prensky (2007) describes games as simulations with added elements of abstraction, fun, play, rules, goals, and/or competition. Strategy games are described in the next section while simulations are further discussed in Section 2.1.

1.1.2 Strategy Games with a Purpose

Strategy games are a genre of video games which challenge players through conquest, exploration, and trade to employ higher order thinking, planning and problem solving skills in order to achieve victory against one or more opponents (Adams, 2014). These games require players to identify a desired goal and then manipulate discrete but interconnected game elements in a way that brings about that outcome; depending on the game, players must employ a series of superior strategies to accumulate wealth and power, manage an economy, engage in trade, collaborate with human or artificial intelligence (AI) allies, solve problems, combine strategy with tactics, and reduce enemy forces while outthinking their opponents. Many of the skills that are required to succeed at strategy games are thus easily transferable to real-world tasks.

Sid Meier's Civilization is one such game series through which various researchers have explored game-based learning (Squire, DeVane, & Durga, 2008). Kurt Squire (2006) has dedicated an extensive portion of his research career to investigating the potential of games in learning and training environments with a focus on the Civilization game series. His early work incorporated the game into a high school history class and then reported the reactions and impressions of the students. He found the game was an effective way of engaging disenfranchised kids in learning history; however, not all the students were on board as many found Civilization to be too difficult to play. While Squire reasoned this was because the students were skeptical of the educational value of the game and this new way of learning, we propose investigating elements of the game—such as pace mechanic—that could have contributed to the negative outcome.

1.1.3 Pace Mechanic

While the effect of factors such as generational influence or genre appeal have previously been researched extensively in serious gaming (see Chapter 2 for details), an aspect in the design of strategy games that remains unexplored through scientific inquiry is the pace mechanic. The strategy genre has long been divided in terms of pace mechanic (how time passes in game): time could be continuous as in the real world (termed 'Real-Time') or it could be segmented into phases (termed 'Turn-Based'); expert game designers find each of these has its advantages (Shafer, 2013; Pape & Graham, 2010).

In turn-based games such as Civilization, usually only one player acts at a time during phases designed to restrict player activity. The player is allowed a period of analysis to consider the benefits of one choice over another before committing to a game action, ensuring the thinking process is seperated from the game flow. At the end of the current player's turn, the next player is allowed to play and the clock moves forward. Once every player has taken their turn, any special shared processing is done. This is followed by the next round of play (Pape & Graham, 2010; Adams, 2014). Since players have more time to make decisions, game designers report they are encouraged to add complexity to turn-based game in order to provide players with more choices (Johnson, 2009; Shafer, 2013). They report this can make turn-based games too difficult to play for some players and can "strangle gameplay" (Shafer, 2013).

On the other end of the pace mechanic spectrum, real-time games evolved from turn-based games. They have added time pressure as players perform actions simultaneously as opposed to in sequential turns and players do not have exclusive time to ponder their moves. Players must perform actions with the knowledge that their opponents are actively working against them. Game time progresses continuously according to the game clock and the constantly changing game state requires the player to think quickly (Pape & Graham, 2010; Adams, 2014). As a result, expert game designers note real-time games typically feature less complexity and are considered more engaging than turn-based games (Shafer, 2013).

Many strategy game fans prefer one pace mechanic over the other and the debate between these groups frequently grows contentious (Shafer, 2013). Real-Time games are considered to be more "viscerally exciting" by designers and players (Johnson, 2009; Adams, 2014) while the slower pace of Turn-Based games has been attributed to players being able to develop mastery of these games (Shafer, 2013). Even though there has been a great deal of conversation amongst expert game designers pertaining to this topic, there has been little to no evidence collected empirically on the differing player experiences between turn-based strategy games and their real-time counterparts (Juul, 2004). Investigating this will contribute to a better understanding of the role of pace mechanic in the strategy game genre as well as inform the design of strategy games to be used in time-critical collaborative decision-making environments such as the Social Innovation Lab.

1.1.4 Social Innovation Lab

The Waterloo Institute for Social Innovation and Resilience (WISIR) in partnership with the JW McConnell Foundation and the MaRS Solutions Lab at the University of Waterloo (collectively called "Social Innovation Generation" or 'SiG@Waterloo") is developing a cooperative multiplayer strategy game to be used as one of the tools in the Social Innovation Lab (SI Lab). The SI Lab is a collaborative setting where experts from various fields meet, gain system insight, and work together on developing innovative, interdisciplinary solutions for complex social problems (such as addressing employment of disabled youths or food system challenges). The players of the game are expected to be activists, innovators or policy makers who will most likely have limited experience with video games and could be dismissive of the concept of serious games altogether. As the workshops will be taking place over 2.5-6 day sessions and participants will be spending only a fraction of that time with the strategy game, there is a small window of time for participants to learn how the game works, accept it as a valid and useful analysis tool, and maximize the information obtained from its use. The main dilemma faced by the designers of this game is whether to adopt real-time or turn-based mechanics. The purpose of our research is to empirically help with this design problem by identifying the pace mechanic elements that would best suit the game's purpose and aid people in making positive behavioral changes in this setting.

1.2 Motivation

Two factors motivated the work within this thesis: the necessity of engaging participants quickly through the design of the game while still allowing them to plan ahead in collaborative settings (such as the Social Innovation Lab), and the lack of attention in the previous literature to assessing the impact of pace mechanic on player experience.

To explore this area, we ran an exploratory mixed-methods user study in which participants played one session of a Real-Time game and one session of a Turn-Based game. To evaluate whether the effect of the pace mechanic (or lack thereof) extends beyond strategy games, the games varied between three different types: card game, chess game, and video game. During and after the game sessions, participants were asked a few questions about the state of the game at that moment in time and their mental workload. Our study explored whether the pace mechanic and type of game alter the player experience and are contributing factors to how quickly participants feel competent at the game.

1.3 Research Questions & Objectives

Three main questions concerning pace mechanic emerge from a careful consideration of the needs of participants in the aforementioned collaborative environments, and the popular beliefs surrounding strategy games. The questions are largely built on assertions from expert game designers' rich experience in the industry, which are described in the sections that follow. Answering these questions will contribute to a better understanding of the role of pace mechanic in the strategy game genre and advance the research in serious games. Additionally, it will inform the design of the cooperative strategy game currently under development at SIG@Waterloo.

1.3.1 Research Question 1 (Engagement)

Since participants in settings like the SI Lab will only have a small window of time to learn how the game works and accept it as a valid and useful analysis tool, it is critical for the game to hold the player's attention. If the player quits early, it will not matter how useful the game is and can even dissuade others from playing (Cheung, Zimmermann, & Nagappan, 2014). This drove us to our first research question:

What effect does pace mechanic have on engagement and preference for continued play in a time-critical environment?

Pacing is the rate at which events occur in a game such that players can make decisions, experience something new or be rewarded (Shafer, 2013; Linehan, Bellord, Kirman, Morford, & Roche, 2014). If this happens too often, designers report players do not have enough time to digest and can become overwhelmed and confused; if this seldom happens, designers find players get bored waiting for something to happen. Game designer Shafer (2013) describes pacing as integral to engagement and as the biggest difference between the turn-based and real-time mediums.

According to game designer Soren Johnson (2009), turn-based games can feel a "little stodgy" to players used to faster paced action titles since designers have "virtually no control over when, in terms of actual seconds or minutes, events will take place" (Shafer, 2013). In real-time games, the time pressure exerted on players is an additional element of challenge. This timing introduces an element of chaos which ensures "players are not able to reduce each situation down to a repeatable series of moves and counter-moves" (Johnson, 2009). The realistic progression of time also provides a "sense of familiarity" which can be comforting to many players, especially casual ones (Shafer, 2013). Real-time is therefore considered by many players and game designers to be more immersive and "viscerally exciting" than turn-based gaming (Adams, 2014; Johnson, 2009). These reasons lead us to hypothesize that, in our study, there would be a positive correlation between arousal, immersion, interest-enjoyment, engagement, and the real-time pace mechanic.

1.3.2 Research Question 2 (Planning)

While some players relish timed challenges, others can experience extreme feelings of anxiety if real-time games are not well-paced (Johnson, 2009; Shafer, Turn-Based vs Real-Time, 2013); this can affect decision making and leads to our second research question.

How does pace mechanic facilitate planning ahead in a decision-making environment?

Real-time strategy games have been criticized by players and designers for their reliance on player reflexes. Game theorists have observed that real-time games have a tendency to devolve into a "click-fest" which rewards manual dexterity, the ability to multitask, and rapid mouse-clicking over planning (Adams, 2014). Real-time games reportedly provide little time for fine-tuning strategy and require players to micromanage hundreds of units under threat of imminent attack. When every second counts, simply putting any army into the field takes priority over the army's exact composition or the specific plot of land they are going to (Shafer, 2013). Often, designers find players throwing groups of units at the situation, hoping they are triggered properly. In this way, real-time games are thought to support chaotic unpredictable gameplay, and reward pattern-recognition and fast action (Adams, 2014).

Miller's law states that the number of objects an average person can hold simultaneously in working memory is about seven (Miller, 1956; Shafer, Make a Better Game - Limit the Player, 2012). In real-time games, a player's attention is split between multiple independent units all moving simultaneously while racing against the clock. Players attempting to control numerous units, buildings, production and many different events that are all happening simultaneously may experience strong feelings of anxiety and frequent adrenaline rushes. We therefore expect to find a positive correlation between tension as well as valence and the real-time pace mechanic.

In contrast, designers note turn-based games offer periods of analysis through which players are able to ponder decisions and make more strategic choices (Johnson, 2009). In order to plan ahead, participants must feel in control of their decision making. We therefore expect to find higher feelings of perceived choice, autonomy, and dominance in association with the turn-based pace mechanic.

1.3.3 Research Question 3 (Competence)

Self-Determination Theory (Deci & Ryan, 2003) is a theory of motivation that identifies competence (i.e., seeking control over outcomes and mastery) as one of three universal innate psychological needs. Similarly, Daniel Pink (2011) identifies autonomy, mastery and purpose as the three elements that drive us to grow and do our best work. In order to promote self-efficacy and mastery experiences through games in the SI Lab setting, we need to answer the following question:

What effect does pace mechanic have on the perceived sense of competence and mastery in an attention-demanding environment?

Micromanagement refers to minor, detailed decision-making in games which game designer Shafer (2013) describe as the route to developing mastery. As discussed previously, in turn-based strategy games, players find they can take their time learning how the game works, make decisions at their own pace and plan their moves to a greater degree, ensuring their units are behaving intelligently (Johnson, 2009). In this way, turn-based games are thought to reward players for analysis, preparation, big-picture thinking and execution of the best possible solution for a situation (Shafer, 2013). This leads us to predict that effort-importance and competence will be positively correlated with turn-based games in our study.

1.4 Thesis Contributions

The main contributions of this thesis are:

1. We performed an exploratory study investigating the effect of pace mechanic and three different types of games (card, chess, and video) on player experience. The study provided evidence that there are differences in arousal, valence, immersion, presence, flow, absorption, engagement, autonomy, interest-enjoyment, effort-importance, and pressure-tension depending on pace mechanic (see Chapter 3 and Chapter 4 for details).

2. Based on the findings from our study, we suggested a set of design guidelines for strategy games in time-critical collaborative decision-making environments (see Chapter 4 for details). Our main message is: in settings that require rapid decision making for complex planning while using games as a tool, speeding up the pace may lead to higher engagement and immersion, but might also increase pressure and tension.

1.5 Thesis Organization

The thesis is organized as follows:

- **Chapter 2 – Related Work**: presents a review of existing research literature related to pace mechanic and serious games that are relevant to the topic of our thesis;
- **Chapter 3 – User Study**: describes the design of the mixed-methods user study used to investigate the impact of pace mechanic and game type on player experience;
- **Chapter 4 – Study Results and Discussion**: presents an in-depth statistical analysis of the results from the study. These findings are then situated in the larger context of game design by presenting a qualitative analysis of our results followed by design guidelines;
- **Chapter 5 – Conclusion and Future Work**: summarizes how the research objectives were met, discusses the limitations of our work, and presents recommendations for future work.

Chapter 2
Related Work

In the previous chapter, we briefly introduced serious and strategy games, the Social Innovation Lab, and pace mechanic in order to outline the motivation for our research. We now expand on these concepts by presenting related work that may contribute towards our understanding of the problem and help answer our research questions:

1. *What effect does pace mechanic have on engagement and preference for continued play in a time-critical environment?*
2. *How does pace mechanic facilitate planning ahead in a decision-making environment?*
3. *What effect does pace mechanic have on the perceived sense of competence and mastery in an attention-demanding environment?*

The chapter begins with a brief overview of serious games, followed by strategy games. By defining what serious strategy games are, we aim to narrow the scope and position this thesis with regard to current serious games literature. We then look at how pace mechanic has been discussed in existing literature before presenting findings from studies that have previously utilized real-time and turn-based pacing. The chapter concludes with a look at the requirements of the collaborative environment, and the factors that could affect successful deployment of a serious game in this setting.

2.1 Serious Games

Serious games refer to the application of game design techniques for the solution of problems faced in training, advertising, simulation, education, business, etc. (Susi, Johannesson, & Backlund, 2007). As the name implies, serious games are games that do not have entertainment, enjoyment, or fun as their primary purpose. In recent years, there has been a great deal of interest in leveraging the motivational virtues of games to engage people in the achievement of predefined objectives, such as learning and positive behavioral change, and serious games have been deployed quite successfully in this regard (Corti, 2006; Susi, Johannesson, & Backlund, 2007; Sawyer & Smith, 2008; Bogost, 2007). The entertaining and engaging nature of games that rises out of various competitive activities with feedback, rules, goals, interaction, and outcomes lends itself to the transformational and pedagogical potential of games (Boyle, Connolly, & Hainey, 2011). Various studies (Squire, 2005; Tannahill, Tissington, & Senior, 2012) have found students who were previously disinterested in classes and homework can be enticed to spend hours gathering information, developing strategies, and solving complex problems through videogames. The virtual environment of games provides a safe platform for players to experiment with unfamiliar strategies and receive immediate feedback that may otherwise be undesirable for cost, time, logistical or safety reasons (Corti, 2006). The U.S. Army, for example, uses an online multiplayer first person shooter (FPS) game, America's Army, to introduce civilians to the life of a soldier and to simulate real world battles for tactical and strategic training. Prospective enlistees have successfully used the game to virtually explore the army and determine if soldiering matches their goals, interests and abilities (Gee, Shaffer, Squire, & Halverson, 2005; Luppa & Borst, 2007).

A significant amount of incidental learning can occur during gameplay (Brown & Thomas, 2006; Rogers, 1997). For example: when players team up in-game to undertake a quest, they often need to attempt a challenge repeatedly through trial-and-error until they find a blend of skills and actions that allows them to succeed and proceed to the next challenge (Brown & Thomas, 2006). During this time, players can be so engrossed in the game that they may not realize they are learning adaptive behavior, leadership skills, resource management, and problem solving (Hussain & Coleman, 2014). Hussain & Coleman (2014) reason that this is a more natural way of learning and is "superior to intentional training because it is contextual, situated, and social". Similarly, Tannahill & Senior (2012) find video games "have been linked to increased motivation, more varied learning methodologies, and performance at least equal to that achieved by traditional means, but with greater enjoyment of the learning process itself".

The Social Innovation Lab game will be one such game provided to participants during each workshop to aid with informed decision making. The purpose of the game will be to help participants visualize complex information about and develop deeper understanding of the focal problem of each workshop. The game is intended to begin with the participants agreeing on a set of desirable outcomes and selecting a role that determines their decision making authority (e.g. farmer, government). While playing the game, participants will be challenged by game elements (e.g. natural disasters), given feedback about their goal achievement, and rewarded by unlocking more complex policies as they progress. At any point, participants should be able to go back any number of time steps to implement alternate initiatives (these can be unlocked policies or the same ones with altered parameters) resulting in new timelines. Participants could then compare these timelines across several criteria (including the goals they specified at the start of the game) and take the set of initiatives that led to the best desirable outcome under advisement when recommending a course of action at the end of the workshop. Since the game in question has predefined objectives which exclude entertainment as a primary purpose, it can be considered a serious game.

Simulations and strategy games are two key genres of games that have traditionally been adopted as educational and training tools. Simulations refer to modelling or representations of a system through a different system (such as a video game) which maintains some of the behaviors of the original system (Frasca, 2003). Amory et al.'s (1999) research investigated different game genres to find the one best suited for learning and identified game elements that students found most appealing within the different genres. They found the combination of graphics, sound, technology, and storylines in adventure and strategy games lends itself well to engaging students in the learning process while simulation games fared poorly. Using flight simulators, for example, people can spend hours training to fly planes without risking expensive equipment or their lives; this training, however, can become mundane without game elements such as goals (e.g., 'land successfully 10 times'), rules, challenges, and/or narrative (e.g., 'you are deep in enemy territory…'). Prensky (2007), in fact, describes games as simulations with added elements of abstraction, fun, play, rules, goals, and/or competition. Therefore, even though the SI Lab game may be considered a simulation at its core, we will focus our thesis on leveraging the benefits of game elements to improve player engagement and motivation in the SI Lab setting.

2.2 Strategy Games

Strategy games are a genre of video games that largely consist of three mutually interdependent activities: conquest, exploration, and trade, which combine in varying degrees to determine the overall game (Adams, 2014). They require players to employ skillful thinking and superior planning in order to overcome economic, strategic, tactical, and logistical challenges, and achieve victory. Strategy games also feature a range of diplomatic options and elements of warfare such that outthinking and/or reducing enemy forces is often a key goal (Adams, 2013). The player is usually presented with an aerial god-like view of the game world through which they can more effectively form big-picture strategies while commanding game units (Rollings & Adams, 2003). Strategy games can be categorized by their handling of pacing and the main focus of the game: strategy or tactics. Both of these are described in turn below.

Pace mechanic refers to how time passes in game and can be thought of as a continuum that stretches from real-time (time-based restrictions) on one end to turn-based (player action restrictions) on the other (Pape & Graham, 2010). ‘Time-based restrictions’ pace the game by limiting how frequently players can perform actions while ‘player action restrictions’ limit a players’ ability to perform actions depending on the actions of other players. Expert game designers have recently started to blend both real-time and turn-based elements in order to bring a little interest and innovation into the genre (Johnson, 2009; Shafer, Turn-Based vs Real-Time, 2013). These hybrid games lie at different points along the pace mechanic continuum depending on the blend used and can be seen in Table 1 below. For this table, we built on Pape and Graham’s (2010) classification of coordination policies to include hybrid and other variations of pace mechanic we gathered from various sources. This is not an exhaustive list as game designers introduce new variations frequently, but serves to situate our research. Our study is limited in scope to examining the two endpoints of the pace mechanic continuum. The other pace mechanics are identified as opportunities for future research.

Pace Mechanic	**Description**	**Examples**
Time-Based Restrictions		
Real-Time	Game time progresses continuously according to the game clock and players can take any action at any time with the consideration that their opponents may act at any moment (Pape, 2010; Adams, 2014)	Dune II Command & Conquer Warcraft Starcraft Age of Empires Dawn of War Company of Heroes Age of Mythology
Timed Actions	Players may take actions simultaneously but must take into consideration these actions take time to complete (usually shown using animation) e.g. moving a piece between two points may take 10 seconds to complete (Pape, 2010).	Star Trek Armada Farmville Frozen Synapse EVE online

Pace Mechanic	Description	Examples
Trickle Points	Players may take actions simultaneously which are instantaneously executed as long as the player has action points available; these action points are collected by players over time in the course of the game (Pape, 2010).	Dungeons & Dragons
Pausable Real-Time	Players are able to pause the flow of time to analyze the situation and issue orders such that once a game is resumed, the orders are put into effect (Shafer, 2013).	Baldur's Gate Homeworld Dragon Age Distant Worlds
	Variation: players can slow down time (rather than pausing).	Max Payne Red Dead Redemption
	Variation: players can pause to take aim with a weapon.	Fallout 3
	Variation: players can pause to apply preferences to the AI routines of partner characters.	Final Fantasy
Hybrids		
Real-Time Strategy with Turn-Based Combat	Overall gameplay takes place in real-time (such that exploration and other parts of the game where meticulous actions are not essential to player success are sped up) while localized tactical engagements are planned out in detail through turns.	Final Fantasy X, XII, XIII Empire at War, Battle for Middle-Earth
Real-Time and Turn-Based	Players can choose to play in either turn-based or real-time mode using a configuration setting or game speed options that allow players to speed up the pace to real-time or slow it down to simulate the turn-based pace mechanic.	Paradox's Europa Universalis X-COM: Apocalypse Fallout Tactics Arcanum

Pace Mechanic	Description	Examples
Turn-Based Strategy with Real-Time Combat	Long-term strategic gameplay takes place in turns while localized tactical engagements occur in real time.	Rome: Total War
Player Action Restrictions		
Timed Turns	Players make moves with an upper limit set on the time that can be taken to make the turn.	Worms Using stop clocks in Chess
Barrier Synchronization	Players do their turns simultaneously using assigned sets of action points. Once the slowest player has consumed their action points and completed their turn, each player is allotted a new set of points. The overall pace of the game is therefore matched to the slowest player's (Pape, 2010).	Various board games
Turn-Based	Players can take their turns simultaneously (called 'We-Go') or sequentially (called 'I-Go-You-Go'). Once every player has taken their turn, the current phase is over, any special shared processing is done and the next round of play begins. The game clock only moves forward at the end of a phase (Pape, 2010; Adams, 2014).	Civilization Advanced Wars XCOM: Enemy Unknown Fire Emblem Final Fantasy Tactics Heroes of Might and Magic Master of Orion

Table 1: Categorization of Games by Pace Mechanic

Strategy games also differ in the mix of strategy and tactics they employ. Tactics refers to the art and science of maneuvering forces in combat and fighting battles (e.g. focusing on location, troop placement, and formations in an individual battle) whereas strategy encompasses employing political, economic, psychological, and military forces to meet the enemy in combat under advantageous conditions i.e. big-picture and large-scale planning (Merriam-Webster: "Strategy", 2015; Merriam-Webster: "Tactics", 2015). Game reviewers and designers debate which pace mechanic sacrifices strategy in favor of tactics. Some (Walker, 2002) reason that players in turn-based strategy games dwell too much on micromanaging each unit and thereby, get caught up in the tactics of individual battles. Others (Toronto, 2008; Rollings & Adams, 2003) argue that real-time strategy games, by nature, do not require much strategic thinking as their fast pace causes players' actions to become reactionary and repetitive with only one viable strategy for victory: to produce units faster than they consume them. This debate, which was previously touched on in Chapter 1 and has not been explored empirically, serves as part of the motivation for our research.

2.3 Related Studies

We now turn to related literature on pace mechanic in the field of game studies. There is a great deal of work that has been done using strategy games for game-based learning, but research with a specific focus on pace mechanic is relatively under-explored.

2.3.1 Related Studies: Pacing

As mentioned in Section 2.2, pacing is the rate at which challenges and events are introduced in a game so that players are able to make decisions, experience something new or be rewarded (Shafer, Turn-Based vs Real-Time, 2013; Linehan, Bellord, Kirman, Morford, & Roche, 2014). If this happens too often, designers report players do not have enough time to digest and can become overwhelmed and confused; if this seldom happens, designers find players get bored waiting for something to happen. Pacing is therefore considered to be a key determinant in the enjoyment of a game as well as the difficulty and learning experienced by game players (Linehan, Bellord, Kirman, Morford, & Roche, 2014).

In order to understand how to best pace challenges in games, Linehan, et al. (2014) took the behavioral psychologist approach of analyzing how design features of highly engaging existing games support problem solving. They examined the number of individual actions necessary to complete puzzles in four COTS (Commercial Off-The-Shelf) games and coded them as either new actions or new combinations of old actions. They then charted this information to observe the pace with which new information is introduced in these games. Their findings suggest that main skills should be introduced separately in-game through simple puzzles focusing only on that skill. In this way, complex skills are broken into simpler components and introduced gradually. The player should then be presented with opportunities to practice and integrate that skill with previously learned skills. Complexity of the skills and consequently, the puzzles presented to the player increase in complexity over the course of game play. Linehan, et al.'s (2014) findings are highly relevant to the design of the

SI Lab game and to our study. Both studies share the same goal of analyzing pacing and challenge in games. Linehan, et al.'s (2014) approach was to analyze features of successful games in an observational manner (essentially, reverse-engineering them), while we identified pace mechanic as a game design element that affects challenge and then ran a study focusing on player experience to determine its effects. We refer to this work again in the discussion portion of this thesis (see Section 4.5).

Pape and Graham (2010) built two games for multi-touch digital tabletop surfaces and explored how social interaction in a group setting is altered by pace mechanics. While not examining strategy games specifically, they found that turn-taking in games can lead to considerable downtime (during other players' turns) which introduces more opportunities for players to socialize with others. In real-time, this interaction time is lost due to the fast paced nature of the game. If there is too much downtime in turn-based games, however, other players can grow frustrated with waiting. This can happen if a player is able to take as long as they want to think about what to do next and ends up in a state of analysis paralysis (i.e., the state of over-analyzing a situation in search of the optimal solution resulting in a decision never being made, in effect paralyzing the player). In single-player turn-based games, this is not an issue as the artificial intelligence (AI) does not mind waiting. Pape and Graham's (2010) classification of coordination policies (a.k.a. 'pace mechanic') was especially useful in the construction of the pace mechanic continuum previously presented in Table 1.

2.3.2 Related Studies: Real-Time Games

There have been several studies involving RealTimeChess (Stanley, Pinelle, Bandurka, McDine, & Mandryk, 2008; Gutwin, Barjawi, & de Alwis, 2008; Chaboissier, Isenberg, & Vernier, 2011) in recent years. While this work is related in their manipulation of pacing to ours, it has largely focused on multiplayer interactions exclusive to shared tabletop surfaces.

Stanley et al.'s (2008) research investigated how players' real-world activity, recorded using sensors, could be used to modify the RealTimeChess game state. Different level of activity and the environment in which the activity was performed (indoors vs outdoors) afforded a player different moves in-game. Their research found almost all of the participants altered their behaviors to enhance their performance in the game. While not directly related, an overview of Stanley et al's (2008) study was included in this literature review for completeness. Gutwin et al. (2008) used RealTimeChess to explore high-speed coordination in distributed environments. They found that coordination was difficult at the higher pace of the game and, as a result, some players adapted new coordination techniques (such as sending quick voice messages to the partner) to overcome this difficulty.

More closely related to our study, Chaboissier et al (2011) examined the effects of pace mechanic on awareness by adjusting the pace of their RealTimeChess implementation along a continuum from high-paced simultaneous to low-paced turn-based gameplay. They found the higher-paced a game gets, the more difficult it is for players to stay aware of other players' actions outside of their focus region. Chaboissier et al. (2011) describe this effect as "change blindness", which can result in much frustration for the players who lose the game without understanding what happened. They also found that, in line with our hypothesis, the increased game pace caused by the removal of turns lead to players employing less complex strategies until the cooldown periods were introduced. These wait times encouraged players to deliberate on strategy and prevented fast players from overwhelming their opponent and kept the game from "devolving into a clickfest" (Hack, 2013). Chaboissier et al.'s (2011) study yielded many insights on the effects of pace mechanic relevant to our hypotheses. They identified examining the effect of different multi-touch interaction techniques and game settings on overall player interaction as goals for future work. Our study aims to generalize their findings beyond the tabletop setting.

2.3.3 Related Studies: Turn-Based Games

Sid Meier's Civilization is a commercial off-the-shelf historical turn-based strategy game series. Different versions of this game have been used extensively as serious games over the years (Klopfer, Osterweil, Groff, & Haas, 2009). In this section, we look at two key studies which involved Civilization. Rigby and Ryan (2007) used Civilization as one of the games used to evaluate the 'Player Experience of Need Satisfaction' (PENS) model which was developed based on self-determination theory (SDT). We then take a look at Kurt Squire (2008)'s study, which introduced Civilization III to a high school history class and documented the students' reception of the game.

Rigby and Ryan (2007) ran a study examining how different game genres satisfy needs differently. Player engagement was measured for four games from different genres (Adventure/Role-Playing, Massive Multiplayer Online, First-Person Shooter, and Strategy Games) using the 'Player Experience of Need Satisfaction' (PENS) model. Each game was scored on three basic psychological needs: Autonomy, Competence and Relatedness. Our own study uses this model in a similar manner (see Chapter 3 for details); however, in their study, Rigby and Ryan did not make a distinction between turn-based and real-time strategy games. They used Civilization IV to represent the strategy game genre as a whole. For the purposes of our study, their results can be interpreted for the turn-based video game group.

Focusing on their strategy games group, their research found that the greatest predictor of enjoyment in strategy games (much higher than in other genres) was the player's experience of autonomy. Autonomy is the experience of volition or choice in one's actions and decisions (Rigby & Ryan, 2007). When people feel they have the freedom of choice and are creating experiences of their own will, they are more likely to be energized and intrinsically motivated to engage in those activities. Their results were not as strong for Competence in strategy games as with the other genres. Rigby and Ryan (2007) describe the lack of a significant relationship between Competence and Immersion in strategy games as expected since "feeling competent at adjusting city production during a round of Civilization IV is not as likely to 'pull you in' to the game world nearly as much as making an uber headshot during a heated round of Counter Strike [a First-Person Shooter Game]." As in our study, Rigby and Ryan (2007) excluded the relatedness measure for strategy games.

They then combined all three of the aforementioned motivational needs into a Composite PENS variable and correlated this with reported enjoyment, immersion, commercial outcomes (such as game ratings), perceived value, sustained engagement, and a player's intent to recommend the game or purchase sequels (Rigby & Ryan, 2007). The results of their study for strategy games have been recreated in Table 2 below. The biggest takeaway from their study was that open-ended gameplay and abundant choices are the major contributors to enjoyment of strategy games. We refer to this work again in the discussion portion of this thesis (see Section 4.5).

	Player Outcomes				
	Fun/Enjoyment	**Feel Immersed**	**Value Game**	**Will Buy More of Developer's Games**	**Recommend Games to Others**
Experience of Competence	**	-	*	**	**
Experience of Autonomy	***	***	***	***	***
Composite PENS	***	**	**	**	**

*Table 2: Relationship between PENS measures and Important Outcomes for Strategy Games (Rigby et al, 2007; *** = very strong relationship, ** = strong relationship, * = significant relationship, - = no significant relationship)*

In a study focused on game-based learning, Kurt Squire (2008) incorporated Civilization III into the curricula of a high school history class and reported the reactions and impressions of the students. He found the game was an effective way of engaging students who had been poorly served by traditional schooling methods. These students (most of whom were doing poorly in school) loved playing the game and displayed better understanding of geography as well as “more robust concepts of world history” in post-study interviews (Squire, 2005). The rest of the students, however, frequently questioned the purpose of the game and the reason why they had to play it. 25% of them eventually opted out of the experiment and chose to participate in reading groups instead because they found the game too difficult and did not believe it would help them on college entrance exams. Squire, et al.’s (2008) experiment highlights that one game cannot appeal to everyone and as described as future work in their paper, researchers need to “explore how different players experience different games of different genres, and what their principles might mean for learning.” Our study aims to do precisely that.

2.4 Collaborative Environments

Our goal is to determine how players in collaborative settings such as the Social Innovation Lab might experience real-time and turn-based games, and what these pace mechanics might mean for player experience. As a first step toward understanding how to design for such a context, we now take a closer look at the specifics of the setting such as the kinds of interaction that will take place with the game.

The SI Lab provides a physical and intellectual space where experts from various fields can meet, gain system insight, collaborate on developing innovative, interdisciplinary solutions for complex social problems (such as addressing employment of disabled youths or food system challenges) and foster relations that can directly support the propagation and development of innovations. During a workshop, participants will be guided along several stages involving group work:

Early Stage: At the beginning of the workshop, participants will be encouraged to ‘unfreeze their perspectives’ by considering the problem in context of the whole system.

Central Stage: Participants will then brainstorm a breadth of innovations that could potentially solve the problem. This could involve developing designs for adapting existing innovations to work better, or developing strategies and recommendations for shifting the current system so that it can better accommodate existing innovations.

Prototyping Stage: Throughout the workshop, participants will be supplied with a variety of visualizations and tools to aid in the processing and analysis of research materials. At this stage, participants will run candidate solutions through the SI Lab game in order to understand the consequences of their solutions.

Rollout Stage: Depending on the outcome of the game, the end result of the workshop will be a set of recommended interventions for catalyzing cultural, economic or policy change to solve a problem.

2.4.1 Time

The ‘first hour’ refers to the first time a player encounters a game and becomes familiar with it (Cheung, Zimmermann, & Nagappan, 2014). This initial play session can span anywhere from a few minutes to 5 hours and serves to draw players in to the full experience of the game. If the game does not hold the player’s attention, players may give up on the game and even dissuade others from playing. Game designers therefore consider the first hour to be critical for engagement. During this time, they recommend minimizing barriers to entry, providing an interesting start situation, and gradually increasing the number of decisions that have to be made as the game progresses (Cheung, Zimmermann, & Nagappan, 2014).

In their paper, Cheung, et al. (2014) present additional design recommendations for the ‘first hour’ after analyzing over 200 game reviews and interviews with industry professionals. They found that players spend considerable time during the ‘first hour’ with a game assessing if they will enjoy its gameplay elements into the future. Cheung, et al. (2014) therefore recommend using intrigue and information to pull players in so they will want to continue playing.

Since participants in the SI Lab setting only have a short period of time to spend with our game in each workshop, it is imperative to engage the participant as quickly as possible. We believe Cheung, et al.’s (2014) recommendations to incorporate intrigue (through various elements) are complementary to the design recommendations from our study and will be useful to implement in this regard.

2.4.2 Participants

The SI Lab intends to host a carefully chosen group of 12-18 participants each workshop based on their experience, expertise, and social/political clout related to the focal problem of that workshop. Together, the participants will represent a variety of viewpoints, skills, and other relevant categories of diversity (ethnicity, education, gender, age, etc.). As such, the players may span both sexes, all ages, and all levels of gaming experience; the game must therefore be widely accessible.

Hussain & Coleman (2014) note researchers have found a correlation between people's generational affiliation and their perception of gaming. At the time of writing, the educational, military and industrial instructional system will most likely consist of a combination of the following three generational groupings: Baby Boomers (born between 1945 and the mid-1960s), Generation X (born between 1965 and 1980) and Millennials (born from 1980 to the turn of the century).

Recognizing the differences between the perceptions of these generations can provide critical insights into and help alleviate conflicts that may arise while attempting to integrate serious games into an environment such as the Social Innovation Lab. The oldest of the lot, Boomers, were not exposed to videogames in their youth and are likely to think of games as distractions. This unfamiliarity may prove to be a strong deterrent to the successful employment of games. Generation X are typically techno-literate (despite not having grown up with computers either) and a large percentage of them play games for entertainment with preference given to single-player games over social or online play. Millennials, on the other hand, prefer social (multiplayer or with spectators) or online games and play more frequently and for longer timeframes than the other generations (Hussain & Coleman, 2014). This research will be taken into consideration when discussing design recommendations in this thesis (see Section 4.5).

2.4.3 Group Interaction

Wehbe & Nacke (2015) studied the effects of different social gameplay conditions on player experience to assess if they are comparable. The purpose of the study was to investigate whether any experiential differences between these conditions are caused by the physical presence of another person or by factors in multiplayer interaction with either a computer-controlled character or human player. They varied gameplay across the following three conditions:

1. **Cooperative multiplayer condition:** The player and experimenter played on the same team against two computer-controlled characters.

2. **Competitive multiplayer condition:** The player and computer-controlled character on one team competed against the experimenter and computer-controlled character on another team.
3. **Computer-controlled single-player condition:** The player and computer-controlled character competed against two computer-controlled characters with no involvement from the experimenter.

Wehbe & Nacke (2015) did not find any significant differences between social gameplay conditions using physiological measures (EEG, HR, HRV, SC); however, they were able to find some measurable differences in player experience using self-reported SAM scores.

- **Cooperating with person vs competing against person:** Based on previous literature, Wehbe & Nacke (2015) predicted cooperating with a person was more likely to inspire empathy, while competing against a person was more likely to yield higher positive affect and aggression. However, no significant difference in SAM scores were found.
- **Cooperating with person vs competing against AI:** In the study, perceived arousal was higher when cooperating with a person rather than competing against AI.
- **Competing with person vs competing against AI:** Based on previous literature, Wehbe & Nacke (2015) predicted competing against a computer would cause players to be more aggressive than when playing against fellow humans. In their study, however, perceived pleasure (valence) and arousal were higher when competing against a person.

In the SI Lab, participants will generally be cooperating with other participants in order to devise solutions for the focal problem of each workshop. Wehbe & Nacke's (2015) results suggest arousal scores would be higher in this case (i.e., when cooperating with people). Their study, however, looked only at co-located play with two players sitting side by side in all conditions; this differs from the SI Lab setting where there would be one point of input and deliberation amongst players would take place out-of-game. In effect, the group of players would be acting as a single player interacting with the game and competing against the game's AI. Additionally, there may be situations when the group would be dispersed and the game could be used in separate instances by individual participants. As a result, we modelled the SI Lab participants as a single player interacting with the game in our study design.

2.5 Summary

In this chapter, we looked at how pace mechanic has been discussed in prior literature. We found that much research has examined the effects of using strategy games as learning tools and online commentaries about the possible effects of pace mechanic on player experience abound, but the empirical literature on leveraging pacing to increase motivation and engagement is sparse. In the current game design literature, two studies stood out as being directly related to ours. Chaboissier et al (2011) found that, in line with our hypothesis, an increased game pace caused by the removal of turns leads to players employing less complex strategies. Our study aims to generalize their findings beyond the tabletop setting. Linehan, et al.'s (2014) study shared our goal of analyzing pacing and challenge in games but adopted an observational approach of analyzing features of successful games rather than testing them. The current investigation, therefore, supports and extends this very small literature on pacing effects.

Chapter 3
User Study

Our literature review revealed that the few published studies to date on pacing (Linehan, Bellord, Kirman, Morford, & Roche, 2014; Pape & Graham, 2010) have not adequately tested our hypotheses. In order to inform the design of strategy games to be used as collaborative tools in time-critical decision-making environments and investigate the impact of pace mechanic on player experience, we seek to answer the following questions:

1. What effect does pace mechanic have on engagement and preference for continued play in a time-critical environment?
2. How does pace mechanic facilitate planning ahead in a decision-making environment?
3. What effect does pace mechanic have on the perceived sense of competence and mastery in an attention-demanding environment?

For this purpose, we conducted a mixed-methods user study where participants were invited to play one session of a real-time game and one session of a turn-based game, and provide feedback about their experience. In this chapter, we describe the design and implementation of this study to provide context for the results, which are presented and discussed in Chapter 4.

3.1 Study Method

In our experiment, we examined the effects of game type and pace mechanic (independent variables) on affect (arousal, valence, dominance), engagement (presence, immersion, flow, absorption), needs satisfaction (competence-control, autonomy, presence-immersion, intuitive controls), and motivation (interest-enjoyment, effort-importance, value-usefulness, pressure-tension, perceived competence, and perceived choice) using four different questionnaires. Each questionnaire, along with our reasoning for its selection, is described in detail in Section 3.3. The experiment was thus a 3 game type (card vs. chess vs. video) × 2 pace mechanic (real-time vs. turn-based) mixed design, with game type being between-participants and pace mechanic being within-participants (see Section 3.2 for details of study conditions).

3.1.1 Setting & Apparatus

The study was carried out on the University of Waterloo campus. Upon arrival, participants were welcomed and seated at a laptop on a table opposite the Student Investigator. The laptop was equipped with a built-in camera and an external mouse. Participants were permitted to move around if they pleased during the session. If Room 3646 was not immediately available, an alternative room in its vicinity would be used. All materials including surveys and software used for data collection are described in Sections 3.2 and 3.3.

3.1.2 Participants

Recruiting material was posted around the university campus and at local board game and hobby stores (with the permission of the owners). Recruiting emails were sent to university mailing lists as well as the customer databases of these stores. Our participant pool therefore consisted of students and experienced board game players.

Twelve participants were recruited for each group (chess, card and video games) with no overlap between groups, for a total of 36 participants. Their demographic information is presented in Table 3 below.

	Total	**Male / Female**	**Age Range**	**Median Age**
Card Games	12	5 / 7	19-36	29
Chess Games	12	10 / 2	19-29	23
Video Games	12	12 / 0	19-35	24

Table 3: Demographic information for study participants

Few females participated in the Video Game (0 female) and Chess groups (2 females), while making up roughly half of the Cards group. A majority of the study participants had either attended high school or some college but had not obtained a degree (15 participants), or had a Master's degree (12 participants). About half the participants in each group (and consequently half the participants overall) self-identified as active video game players.

All the participants were compensated with a $15 gift card for their time. The approval letter to run this study, which we received from the University of Waterloo Research Ethics Committee, can be seen in Appendix A Recruitment.

3.1.3 Procedure

To give participants ample playing time with the assigned games, participants were scheduled to come to the university for 1.5 hours. The student investigator asked each participant to read and sign a consent form, read a brief overview of the study, and familiarize themselves with instructions that explained how to play the games from the group to which they were assigned. Any questions raised by the participant were answered and, if needed, a quick demonstration of the games, controls and interface was provided.

Participants were then given fifteen minutes to practice the games on the computer. To help them remember the rules, participants were provided with a written set of game instructions. Once both the investigator and the participant were ready, the investigator gave the signal to begin playing the game and informed the participant she would interrupt them in 10 minutes. Participants were instructed to resume or restart the game if they won/drew/lost the game or encountered an error before the time was up. Meanwhile, the investigator took notes observing the players' actions who were asked to think-aloud.

Games were played in counterbalanced order to control for order effects: half the participants in a group were randomly assigned to start with a turn-based game and the other half a real-time game. Participants played the games in succession for a total of sixty minutes. After the first ten minutes of gameplay, participants were asked to pause the game in order to collect their affective and cognitive data. The affective measure was a short pictorial self-assessment scale followed by a 19-point cognitive measure called the Game Engagement Questionnaire (see Sections 3.3.2 and 3.3.3 for details). These were collected once more at the 20-minute mark of gameplay. At any point, participants could refer back to their responses to the previous questionnaire(s) and change them if needed (see Section 3.4 for details).

After 30 minutes of gameplay, participants were asked to stop playing and save their game file on the computer. They were then asked to fill out a more detailed questionnaire that consisted of Self-Assessment Manikin and Game Engagement Questionnaire (both collected previously) along with Intrinsic Motivation Inventory and Player Experience of Need Satisfaction (see Sections 3.3.4 and 3.3.5 for details). Once the measures for the first game had been collected, the investigator asked the participant to wait until signaled to begin a 30-min playing session for the second game. The same measures were collected every ten minutes for the second game (at the 10, 20 and 30-minute mark).

At the end of the second session, participants filled out a background questionnaire (see Section 3.3.1 for details) recording their age, gender and occupation, as well as their gaming habits. This questionnaire concluded with a debriefing statement briefly explaining the study and a reminder that any data pertaining to the participant would be kept confidential. Before they left, the players were informally interviewed about their opinion of the game, any problems they met, and general suggestions, then thanked for their time and compensated.

3.2 Study Conditions: Real-Time and Turn-Based Games

For our study, we wanted to compare the effects of the real-time and turn-based pace mechanic on player experience. We chose RealTimeChess (and its turn-based counterpart, traditional Chess) as it has been used in academic studies on multiplayer pacing in the past (see Chapter 2 for details) and allows the pace mechanic to vary from real-time to turn-based (and vice versa) with minimal changes in other aspects of the game (such as rules).

In order to triangulate differences due to pace mechanic (rather than differences specific to a game) and generalize our results to the breadth of games, we collected data from two other types of games–cards and video–that also utilize turn-based and real-time pace mechanics. We selected two commercial-off-the-shelf video games (Age of Empires 3 and Civilization 5) that have already been adopted as serious games in the past (see Chapter 2 for details) and are representative of games people would actually play (as well as the planned game under development for the SI Lab). They are similar in many aspects and popular enough to ensure a large sample of participants (who are familiar with both games) would be available to us. We considered this superior to building a custom game for the study as our game would not be as hi-fidelity as these established games.

We selected cards as our third group since some of the first science-based games to be developed for educational purposes consisted solely of cards as the playing materials (Ellington, 1981). Within this group, we chose Solitaire as our turn-based card game due to its popularity (especially on the Windows platform) and because solitaire is one of the formats that "the great majority of educational card games are based on" (Ellington, 1981). In addition, some types of solitaire games are considered mentally challenging and there have been several reported cases of solitaire addiction (Moursund, 2006). According to Ellington (1981) and game designer Johnson (2009), single-player games like Solitaire can be considered turn-based as the passage of time and the deviser of the game system are regarded as adversaries of the game. Finally, we chose Speed as the real-time counterpart to Solitaire since it also involves identifying cards in sequence, but differs from Solitaire in that players race to discard all their cards as quickly as possible.

The games used in our study are tabulated below and are described in detail in the following sections.

Game Type / Pace Mechanic	Turn-based	Real-Time	Cost
Card Game	Solitaire	Speed	Free to download
Chess Game	Traditional Chess	Real-Time Chess	Free to download
Video Game	Civilization 5	Age of Empires 3	Purchased

Table 4: Games employed in our study

In order to limit training time required, our recruiting material specified that participants needed to be familiar with the games that they would play. For the group with card games, the participants were all familiar with the rules of Solitaire, although a majority reported 'almost never' having played it in the past year. Very few participants had ever played Speed or one of its variations and therefore needed a tutorial on the rules and a practice round. Similarly, every participant knew how to play Chess but none of them had ever played Real-Time Chess before. For the group that played the video games, many participants reported they had been active players of the games in the past but had not played in a while, and thus needed a reminder of the rules as well as the practice session.

3.2.1 Solitaire (Turn-Based, Cards)

Solitaire is a card game in which players must build four decks with cards of identical suit in ascending sequence from Ace to King. At the start of the game, 28 cards are placed face down in seven columns (the number of cards in each column increases from left to right respectively) to form the tableau. The card at the top of each pile is visible while the other cards are inaccessible until the card on top is moved. The remaining cards in the deck are placed face down to form the stock.

The cards facing up in the Tableau piles and the cards in the Stock pile are available for play. These cards can either be transferred to a foundation of the same suit if they follow the ascending sequence or to a column if they form a descending sequence of alternating colors, e.g. ***6***♥ on ***7***♣ or ***Q***♠ on ***K***♥. As each Ace card is uncovered, it may be transferred to a row above the tableau to start one of the four foundations. The game is won when all cards are moved into the 4 foundations in ascending order.

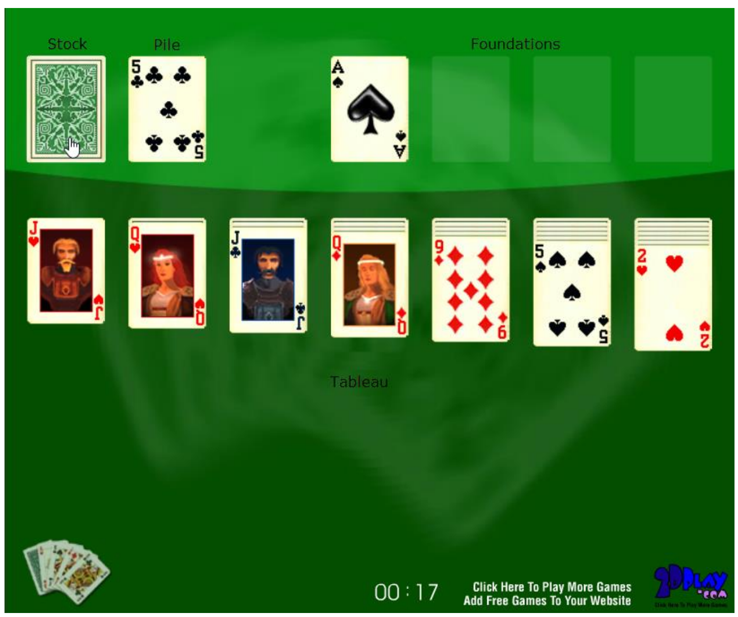


Figure 1: Solitaire

3.2.2 Speed (Real-Time, Cards)

Speed is a card game in which players compete to discard their cards as quickly as possible. Each player is dealt four cards to form a hand and a face-down stockpile to draw from. Two cards are placed face up in the center. Without waiting to take turns, both players then play either a higher or lower card (in rank) from their hand to the two center piles. The Ace card is considered one value above a King as well as one below a Two so that the cards form a looping sequence. The suits of the cards do not matter. Additional information about the mechanics of the game can be found in Appendix B Study Material.

Once a card is played, a replacement card is drawn from the player's stockpile to replenish their hand. When neither player can play from their hand, the cards in the central piles are replaced. A player wins by running out of cards in his hand and stockpile before the other player. When playing against the computer, the AI gets increasingly faster at discarding its cards with every level.

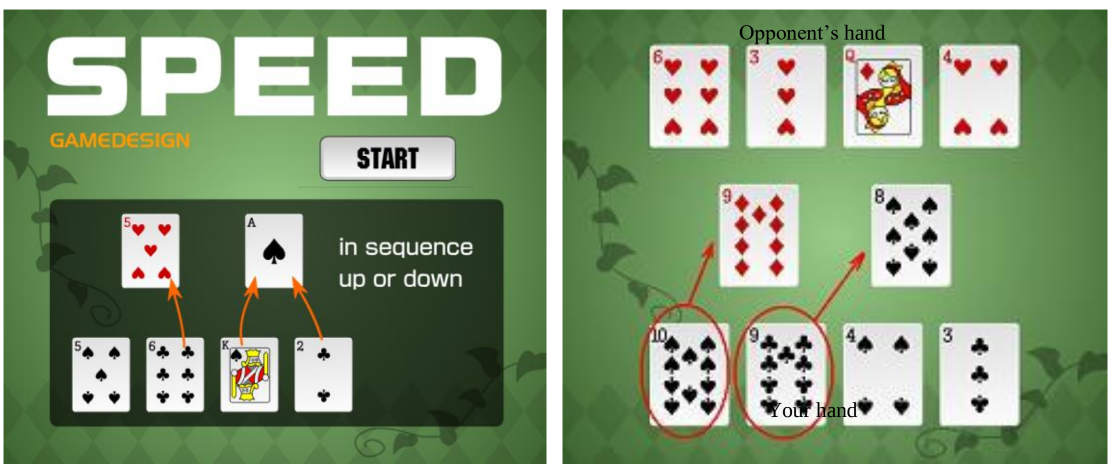


Figure 2: Speed

Players must play cards from their hand that are either one above or one below one of the center cards e.g. a center pile with a 5 on top may have a 4 or a 6 placed on it, but not another 5.

3.2.3 Traditional Chess (Turn-Based, Chess)

We selected a freeware game, flashChess III, from numerous chess games as this version implemented the chess rules in a similar interface and fashion to the real-time chess game we would be using. Participants could then switch between the two games effortlessly without requiring an extended period of adjustment. While we initially planned on asking participants to play on the lowest (novice) difficulty level, pilot testing revealed this was too easy. All participants therefore played on the medium (casual) difficulty level for our study.

Figure 3: Traditional Chess

The green spaces on the board highlight all valid moves the selected Chess piece can make.

3.2.4 Real-Time Chess (Real-Time, Chess)

In Real-Time Chess, players follow most standard chess rules with a notable exception: rigid turn-taking is relaxed in favor of the real-time pace mechanic (Pape & Graham, 2010; Pape J. A., 2012). A player can move a piece at any time without waiting for the other player to take a turn. Once a move is made though, that specific piece cannot be moved again until a fixed time has elapsed (referred to as ‘cooldown time’, see Figure 4). The game ends when a player’s King piece is captured. One round is usually completed within “tens of seconds” even with the time-based restrictions on pieces slowing down the pace (Pape & Graham, 2010). The speed and difficulty of the game can be adjusted by varying the cooldown time. Since the computer needs to continuously monitor which pieces were moved and when, this variation of Chess would not be possible in the traditional tabletop format.

While other researchers (Stanley, Pinelle, Bandurka, McDine, & Mandryk, 2008; Gutwin, Barjawi, & de Alwis, 2008; Chaboissier, Isenberg, & Vernier, 2011) have run studies involving Real-Time Chess, their implementations have been multiplayer versions which were designed for tabletop displays and therefore, would be difficult to incorporate in our study. For our study, we used a version of Real Time Chess (Robbestad, n.d.) available online in which the player competed against artificial intelligence, freeing up the experimenter to make observations and take notes.

Figure 4: Real-Time Chess.

Recently moved Black and White pieces have timers that are shown counting down (in Blue and Pink respectively). These pieces cannot be moved again until this cooldown time has elapsed. Other pieces can still however be moved. The green spaces on the board highlight all valid moves the selected Chess piece can make.

3.2.5 Civilization V (Turn-Based, Video)

Sid Meier's Civilization V (Firaxis Games, 2010) is a turn-based strategy game in which players represent leaders of different nations and must guide the growth of their civilization over the course of time. During their turn, players can direct civilian and military units to explore the world, build new cities, or battle opponent forces. On a higher level, players can negotiate diplomacy with other civilizations or invest in the growth of their own technology, culture, food supply, and economics. We selected Civilization V for our study as the series has garnered high praise for years and has been described as a “fantastic turn-based strategy game” and “the best representation of the series and certainly the most accessible for new and old players alike” (Eckstein, 2010).

The game ends after achieving one of the victory conditions—for the purposes of our study, we specified the player could either win through military conquest or by surviving until the end of the time period, at which point the highest-scoring player (based on several factors) would be declared the winner.

There are 18 playable nations in Civilization V. We set up the player as Bismarck of Germany who was allied with Suleiman (the Ottomans) and waging war against Queen Elizabeth (England) and Napoleon (France). The game took place on a large island map with difficulty set to ‘Normal’. Since we wanted the player to dive right into the gameplay during our study, we gave the players a ‘Legendary Start’ with a substantial starting amount of resources and set the game pace to ‘Quick’.

Figure 5: Civilization V

3.2.6 Age of Empires III (Real-time, Video)

The Age of Empires series is a set of popular historical real-time strategy games released by Ensemble and Microsoft Studios. Players control a variety of civilian and military units and use them to gather resources, wage war against opponents, and advance their civilizations. We selected Age of Empires III (Ensemble Studios, 2005) for our study as the game has received favorable reviews and has been considered a benchmark for real-time strategy games for years (Kosak, 2005).

Players can choose between eight European civilizations to play within the game, each with its own unique strengths, weaknesses and technologies. For our study, we wanted to maximize the similarities between the real-time and turn-based games we asked participants to play. Similar to the Civilization V configuration, we set up the player as the German civilization teamed with the Ottomans who were allied against England and France. The game was also played on a large island terrain with both the speed and difficulty set to 'Moderate'.

In order to win, players were required to eliminate all of their opponents' units capable of defeating them. As this could easily take several hours and our study time was limited, we opted to start the player off with a substantial amount of resources (Food, Wood, Gold, and Stone) using the option for 'Skirmish Deathmatch' as a game type, so they could forgo gathering resources and focus on advancing through the game.

Figure 6: Age of Empires III

3.3 Data Collection & Analysis

For this study, we collected data from several sources and at several stages during our session with the participants. Our research questions determined the measures and consequently, the questionnaires used in our study. The reasoning for our research questions and the associated measures were described in detail in Section 1.3 and are summarized in Table 5 below.

#	Research Question	Measure
1	What effect does pace mechanic have on engagement and preference for continued play in a time-critical environment?	Engagement Arousal Immersion Interest-Enjoyment
2	How does pace mechanic facilitate planning ahead in a decision-making environment?	Perceived Choice Autonomy Dominance Pressure-Tension Valence
3	What effect does pace mechanic have on the perceived sense of competence and mastery in an attention-demanding environment?	Competence Effort-Importance

Table 5: Research Questions and associated Measures

We interrupted multiple times throughout gameplay to assess affect and engagement using the SAM and GEQ scales (see Sections 3.3.2 and 3.3.3). This method provided a better cross-section of the effect of pace mechanic on gameplay instead of relying on the memory of the participants to recall how they felt or a summary of participants' post-hoc feelings. Motivation and needs satisfaction was measured at the end of each game using the PENS and IMI scales. Each of these scales is described in detail in this section.

		Game 1			Game 2			
Assessment	**Pre**	**10-min**	**20-min**	**30-min**	**10-min**	**20-min**	**30-min**	**Post**	**Components**
SAM		✓	✓	✓	✓	✓	✓		Arousal Valence Dominance
GEQ		✓	✓	✓	✓	✓	✓		Immersion Presence Flow Absorption
IMI				✓			✓		Interest-Enjoyment Effort-Importance Value-Usefulness Perceived Competence Pressure-Tension Perceived Choice
PENS				✓			✓		Competence-Control Autonomy Presence-Immersion Intuitive Controls
Background								✓	
Unstructured Interview								✓	

Table 6: Data collected in our study

3.3.1 Background Questionnaire

Our background questionnaire was administered at the end of the session and collected basic information about the participant such as gender, age, occupation, education and experience playing games. The primary purpose of this questionnaire was to ascertain how much prior experience participants had with their assigned games. Additional information, not used in the current study, was collected about the participants' preferred genre and favorite games.

3.3.2 Self-Assessment Manikin (SAM)

The Self-Assessment Manikin (Lang, 1980) is a graphical rating system that uses 5-point pictorial scales to measure the three dimensions of affective valence, dominance, and arousal. In our study, participants marked their level of experienced emotion at the 10, 20 and 30-minute mark during gameplay, and then repeated this for the second game.

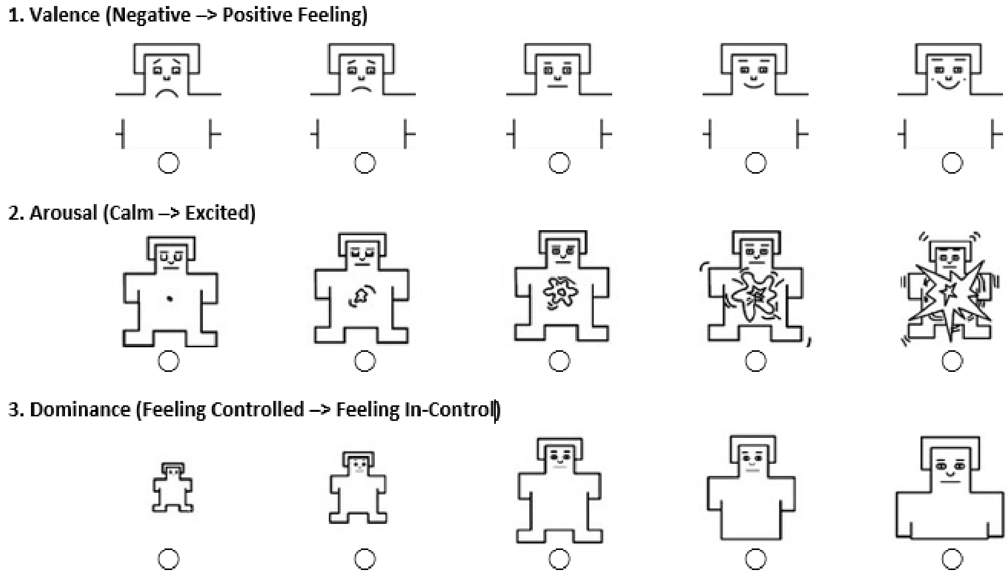


Figure 7: Self-Assessment Manikin (SAM)

We selected the Self-Assessment Manikin over longer, verbal options because Morris (1995) finds a three-dimensional approach is sufficient for accurately assessing emotional response and it is quick to perform. He found SAM can be completed in less than 15 seconds, holds attention longer than verbal self-reporting and causes less respondent wear-out than verbal alternatives. This was vital as we were planning to poll respondents for their emotional response repeatedly over the course of gameplay and the other scales in our questionnaire were lengthy and verbal. One of the reported drawbacks of using SAM is the dominance scale is not always easily understood by participants (Bradley & Lang, 1994). The student investigator therefore made sure to verbally clarify all three dimensions when requesting participants to fill out the questionnaire during the study.

With the SAM scale, we collected the following three dimensions at the 10, 20 and 30-minute mark during a game session:

1. Valence: positive (e.g. joy) or negative feeling (e.g. anger or anxiety) caused by gameplay.
2. Arousal: the perceived level of vigilance ranging from boredom to excitation during gameplay.
3. Dominance: how much the participants felt in control of the situation in the game (a small manikin means the participant felt like were not able to handle the situation and were making only reactive decisions in-game).

For each participant, we then computed the overall valence, arousal and dominance scores for a game by averaging the ratings (from three different time points) provided.

3.3.3 Game Engagement Questionnaire (GEQ)

The GEQ is a 19-item positively-worded questionnaire with a seven-point rating scale ranging from -3 ('Strongly Disagree') to 3 ('Strongly Agree'). It was designed to measure an individual's potential for becoming engaged in video games (Brockmyer, Fox, Curtiss, McBroom, & Burkhart, 2009). While the focus of the questionnaire is ultimately to identify negative impact through video game violence, Brockmyer, et al. (2009) identified four constructs—immersion, presence, flow and absorption—from associated research which they hypothesize are increasing levels of engagement (lowest, mediate low, mediate high and highest, respectively) along a single-dimensional scale.

For each game, at the 10, 20 and 30-minute mark during gameplay, participants were asked to indicate their level of agreement to 19 statements such as "Things seem to happen automatically" and "I really get into the game". We then computed a score for immersion, presence, flow and absorption for each participant/game by summing the responses to the relevant statements (See Appendix B Study Material for details). According to Brockmyer, et al. (2009), these four constructs are similar but denote slightly different aspects of subjective experience in games:

1. Immersion: describes the experience of becoming engaged in gameplay while maintaining some awareness of one's true surroundings;
2. Presence: describes the experience of feeling like one is inside a virtual game environment;
3. Flow: describes the enjoyable state of optimal experience in which a balance between skill and challenge is achieved while performing an intrinsically motivating and rewarding activity;
4. Absorption: describes an altered state of consciousness like in flow but with negative affect (e.g. anxiety and frustration) and negative motivation such that rational thought is suspended.

These 4 subscales were then averaged into a composite for Engagement.

3.3.4 Player Experience of Needs Satisfaction (PENS)

The Self-Determination Theory (SDT) proposes that three basic psychological needs influence motivational energy: competence, autonomy, and relatedness (Ryan, Rigby, & Przybylski, 2006; Rigby & Ryan, 2007). Ryan, et al. (2006) developed two additional constructs specific to gaming (presence-Immersion and intuitive control) that they found enhances a player's fun, enjoyment, and value of games. PENS states that the rewards players truly value in a game and that keep on contributing to deep need satisfaction are those that enhance the player's ability to experience greater satisfaction of these 5 constructs.

After playing each game for 30 minutes, participants responded to statements representing the following subscales of PENS on a uniform 7-point scale (from ‘Strongly Disagree” to “Strongly Agree”):

1. Competence-Control: is the intrinsic need to feel effective, and experience mastery and control over the outcome of a challenge. A three-item scale measured players’ perception that the game provided clear objectives, positive feedback, plenty of opportunities to acquire new skills or abilities, and a challenging but not demotivating difficult experience. Items included: “I feel very capable and effective when playing” and “My ability to play the game is well matched with the game’s challenges”;
2. Autonomy: refers to the degree to which participants feel in control of the situation and their sense of willingness when doing a task. This was assessed using a 3-item scale measuring perceptions that the game offered meaningful opportunities and choices during play. Items included “I experienced a lot of freedom in the game” and “The game provides me with interesting options and choices”;
3. Presence-Immersion: is the sense that the player has been transported to the game world which is as real and authentic as possible with a compelling story line, as opposed to experiencing the game through controls or characters. The questionnaire assessed physical presence (“When moving through the game world I feel as if I am actually there”), emotional presence (“I experience feelings as deeply in the game as I have in real life”), and narrative presence (“When playing the game I feel as if I was part of the story”);
4. Intuitive Controls: is the degree to which input controls can be easily mastered, seem natural and do not interfere with the player’s sense of presence. The questionnaire assessed intuitive controls through level of agreement with statements such as “When I wanted to do something in the game, it was easy to remember the corresponding control”;
5. Relatedness: refers to a sense of support that arises out of interacting with other players or feeling connected to a group. This construct is primarily relevant in multiplayer contexts and thus was not assessed in our study.

Subscale items were then averaged to create overall construct scores for each participant/game.

3.3.5 Intrinsic Motivation Inventory (IMI)

The Intrinsic Motivation Inventory (IMI) is a multi-dimensional self-reporting tool used to assess subjective motivation and experience associated with a particular activity (Ryan, Deci, & Hoefen, n.d.). Similar to PENS (see Section 3.3.4 above), it is based on Self-Determination Theory (SDT) and uses a 7-point Likert-scale, ranging from 1 ('Not at all true') to 7 ('Very true'), to assess the following subscales:

1. Interest-Enjoyment: is considered the primary measure of intrinsic motivation, even though the overall questionnaire is referred to as IMI. Interest-Enjoyment was measured based on the participant's agreement with seven statements such as "I enjoyed playing this game very much" and "This game did not hold my attention at all" (reversed);
2. Effort-Importance: We measured whether the participant is cognitively invested and trying hard using five statements such as "I put a lot of effort into playing this game";
3. Value-Usefulness: These statements prodded participants to comment on the most useful and beneficial aspects of playing each game. This seven-item subscale differed from the others in that it included three free-form fill-in-the-blank statements;
4. Pressure-Tension: is a negative predictor of intrinsic motivation and was measured using statements such as "I was very relaxed when playing this game" (reversed);

5-6. Perceived Competence and Perceived Choice: are both positive predictors of behavioral measures of intrinsic motivation and were measured using statements such as "I think I did pretty well at this game compared to other participants" and "I made some decisions because I had to" (reversed), respectively.

After post-hoc data was collected for each participant/game, we reverse-scored the responses to the negative statements by subtracting the item responses from 8 and used the resulting numbers as the item scores e.g. if a participant responded to "I made some decisions because I had to" (reversed) with a 5, we would subtract 5 from 8 and use the resulting value of 3 in our calculation for Perceived Choice. Overall construct scores were then calculated by averaging all the responses for the subscale. With the exception of Pressure-Tension, the higher the construct score was, the more motivated the participant were deemed to be.

3.3.6 Video Recordings

At the start of their session, participants were informed the computer would automatically be recording video of all gameplay. The games were recorded using a screen recording software called 'Action!' while audio and video of the participants was recorded using the built-in camera of the laptop. This was done to correlate game events with real world events such as the participant exhibiting emotion (e.g. a shout of excitement or a sigh of defeat). In addition, the short unstructured post-hoc interviews were also recorded. During the course of the sessions, the student investigator was present in the room and made notes. These videos were later used to verify interesting occurrences the investigator had noted.

3.4 Data Collection Limitations & Challenges

During data collection, we faced the following challenges:

1. For our study, we collected self-reported measures from the participants during and after gameplay. This method was based on the Situation Awareness Global Assessment Technique (Endsley, 1995) which avoids problems collecting data post trial (Stanton, Salmon, & Rafferty, 2005) but is intrusive to the natural flow of the task and may inadvertently have other effects on the game. An alternative method would have been to use biometrics (e.g., heart rate monitor and galvanic skin response) which are automatically measured during a game session. This method sidesteps the problems incurred with self-reports, but the presence of sensors can themselves be invasive, affecting the player's experience. Furthermore, these devices can be noisy and research is still ongoing for how to get accurate measures of affect using them (Mandryk, 2008; Mirza-Babaei, Long, Foley, & McAllister, 2011).
2. We asked participants to play strategy games over half-hour with measures collected every 10 minutes. To maintain consistency, participants were asked to do the same in the Cards and Chess group. However, as matches of these games have a shorter time span than their video game counterparts, participants could complete several rounds of Chess or Cards before even the first ten minutes were up. As a result, by the end of the 30 minutes with one game, some participants made comments such as "I have played this so many times already" and may have experienced repetition-induced boredom.
3. Our study was limited by the games that we explored. We selected Age of Empires III[1] and Civilization V[2] as the main focus of the study due to their popularity as strategy games. Our goal was to control for possible differences between the two games as much as possible; however, the games differ in other dimensions besides pace mechanic (such as the sophistication of the

[1] Age of Empires III was awarded 'Best Real-Time Strategy Game of 2005' by GameSpy, was one of the best-selling games of 2005, and had sold over 2 million copies by 2007 (Ensemble Studios, 2007).
[2] Civilization V has received critical acclaim from various game reviewers and has sold more than 8 million copies on Steam (online game platform) as of 2016 (Galyonkin, 2016).

Artificial Intelligence and thus, the opponent) that may have an effect on our measures. The games in the Card and Chess group were more closely matched.

4. A problem with self-reported measures arises when participants restrict themselves to responding moderately early-on in anticipation of experiencing more intense emotion further into gameplay (Li & Epley, 2009). Therefore, we allowed participants to refer to their previous responses and change them if they saw fit.
5. Our choice of games only covered the extreme ends of the pace mechanic spectrum: with real-time games on one side and turn-based games on the other. Future studies could look at the gameplay experience with hybrid games that feature a combination of the two pace mechanics, such as X-COM: Apocalypse (see Section 2.2 for more information on hybrid games).
6. Some limitations of the participant pool should be noted. Given that mostly males were recruited in the Chess and Video Games groups, it is possible that females may respond differently to the games. Additional work is needed to determine how the games perform with other samples, including participants from more diverse geographical areas and age groups.
7. Our decision to recruit only experienced players helped us to limit training time and remove the learning curve of the games as a factor, allowing us to better focus on the games themselves. However, this approach may have introduced pre-existing biases into the data as many experienced players are known to personally prefer one pace mechanic over the other. Including novice players in the study may yield different responses. Novice players would also allow us to explore how pace mechanic can help players learn a game, a benefit which we previously listed in Chapter 1 as a potential benefit of turn-based games.
8. In three rounds (1 Card, 1 Chess, 1 Video), we were forced to take a longer break between the two game sessions due to software issues (in one case, the operating system stopped responding; in another case, the video files were erased). There is no reason to suspect that this fault would have had a significant effect on our results, though the possibility should not be ruled out. Additionally, participants reported a few gameplay issues post-hoc (unrelated to pace mechanic and were not encountered in the pilot study) when trying to make legal moves in the freeware Real-Time Chess and Solitaire games. Participants quickly counteracted this by making alternate moves instead.

3.5 Summary

In this chapter, we detailed the design of a mixed-methods user study to assess possible differences in the player experience between real-time and turn-based games. The games varied depending on whether the participant had opted to play the card, chess, or video games (see Section 3.2 for details). Each participant made the choice based on past experience with one or both of the games in the group and was only allowed to participate in one of the game-type groups (see Section 3.1.2 for details). We used a number of methods to capture data from the game sessions. This included background questionnaires, post-condition questionnaires, informal interviews, video recordings of the sessions, and saved games (see Section 3.3 for details). In the next chapters we will present and discuss the results from this user study.

Chapter 4
Study Results and Discussion

The data collected during our mixed-methods user study revealed a number of effects of pace mechanic and game type on player experience. Players reported finding real-time games more exciting, enjoyable, engaging, as well as requiring more effort and consequently being more stressful than their turn-based counterparts. Another objective was to evaluate whether the pace mechanic and type of game are contributing factors to how quickly participants are able to feel competent at the game. In our study, participants felt more competent playing real-time games except in the case of video games; for video games, participants felt more competent playing the turn-based version. In this chapter, we present detailed statistical data from our study using context from our research questions.

4.1 Hypotheses

Based on our research questions (described in Section 1.3), we expected to find the following proposed relationships amongst games in our study:

#	Proposed Relationship	Questionnaire	Dependent Variable
1	Real-time games are more arousing than turn-based games.	SAM	Arousal
2	Real-time games are more interesting/enjoyable than turn-based games.	IMI	Interest-Enjoyment
3	Real-time games are more engaging than turn-based games.	GEQ	Engagement
4	Real-time games are more immersive than turn-based games.	PENS GEQ GEQ	Presence-Immersion Presence Immersion
5	Real-time games are more stressful than turn-based games.	IMI	Pressure-Tension
6	Real-time games invoke stronger feelings than turn-based games.	SAM	Valence
7	Turn-based games offer more control over choices and decisions than real-time games.	IMI SAM PENS	Perceived Choice Dominance Autonomy
8	Turn-based games require more cognitive investment than real-time games.	IMI	Effort-Importance
9	Turn-based games evoke greater feelings of competence than real-time games.	IMI PENS	Perceived Competence Competence-Control

Table 7: Hypotheses

4.2 Data Validity & Preparation

The statistics in this chapter are based on data from N=36 participants (27 males; 9 females; age range 19-36; see Section 3.1.2 for details). After matching participants to a game-type group based on prior experience with the games, we assigned participants to play the games in a random order with care being taken to have the same number of participants in all the conditions in order to be comparable.

Each participant responded to 5 different sets of questions and statements over the course of their session: SAM, GEQ, PENS, IMI, and Background (see Section 3.3 for details). Once tallied, the 7972 (total) responses captured measures for 17 dependent variables. We opted to use paper-based questionnaires to allow participants to refer to and review their previous responses alongside the current questionnaire (see Section 3.4 for details). As a result, we were not able to enforce mandatory input fields.

We inspected the data for the presence of blank/missing responses. In our study, each dependent variable was a composite of various statements and questions. When less than 20% of the responses in a category (e.g. Interest-Enjoyment (IMI)) were blank, the value was mediated with an average (see Table 25 in Appendix C Statistical Analysis Details for a full list). We reasoned these questions may have been left unanswered as a result of inadvertent human error.

A pattern emerged, both in terms of participants and dependent measures, from examining blank PENS and IMI responses. Participants were instructed to answer the best they could and many participants vocally reported having trouble rating the statements in the Presence-Immersion section from the PENS questionnaire for Card and Chess games. Table 26 in Appendix C Statistical Analysis Details provides a breakdown of the statement and the frequency of the occurrence compared to the total number of times the variable was measured. For Card and Chess games which lack an obvious narrative and exploration component, statements like “When playing the game I feel as if I was part of the story” and “Exploring the game world feels like taking an actual trip to a new place” did not seem relevant to the participants. In this case, blank responses were most likely deliberate as a ‘Not Applicable’ response was not provided. There were 75 blank responses out of 7972 collected responses, with 68% coming from the Presence-Immersion (PENS) section. The bulk of the blank responses (71%) were from three participants (1 Cards; 2 Chess). When more than 20% of the questions for a measure were unanswered, the composite was changed to a missing value (6 Presence-Immersion (PENS) values; 4 other PENS values; 4 IMI values).

We then performed a data cleaning procedure on the data set that involved identifying outliers according to Tukey's (1977) exploratory data techniques and evaluating the skewness and kurtosis to determine normality of distributions. The goal was to exclude unusually high or low values; however, since all data points were plausible and did not demonstrate these problems, no changes were made.

4.3 Data Analysis

Following the data preparation procedure outlined above, the next step was to analyze the effects of pace mechanic and game type on the measures collected. As dependent variables were measured more than once under different conditions for each participant, we ran a *3 (game type) x 2 (pace mechanic) repeated measures analysis of variance (RM-ANOVA)* on PENS and IMI measures in SPSS in order to test the equality of means.

- **Game Type** was manipulated **between-subjects** so three mutually exclusive groups of participants played each type of game (Card, Chess, Video).
- **Pace Mechanic** was varied **within-subjects** so participants in a game-type group took part in both real-time and turn-based conditions (e.g., played both real-time chess and turn-based chess) and rated both for the dependent variables.

For measures collected through SAM and GEQ, a 3 (game type) x 3 (trial) x 2 (pace mechanic) repeated measures ANOVA was carried out.

- We were able to develop a time-course by measuring the SAM and GEQ dependent variables every ten minutes for each participant during a game (e.g., at 10, 20 and 30-minutes for real-time chess). These variables were then measured in this manner again for the same participant during the second game (e.g. turn-based chess). This resulted in a second **within-subjects** factor, **Trial**, with three levels.

With the data collected, inspection of the marginal mean scores for each significant effect (using the alpha criterion of .05 to define statistical significance) and post-hoc comparisons using the Bonferroni correction then clarified the nature of the relationships between variables. For all statistically significant effects, the post-hoc pairwise comparisons highlighted where the differences occurred.

As we were using standardized questionnaires, we noticed some subscales in the questionnaires overlapped such that similar variables were being measured more than once in a condition (e.g., Presence (GEQ), Immersion (GEQ), and Presence-Immersion (PENS)). Since the measurement of these subscales was dispersed throughout the questionnaire, this made the redundancy less salient to most participants. Even though shorter versions of the questionnaires were available (that would make the redundancy even less apparent), we opted to use the longer versions as multiple item subscales consistently outperform single items and have better external validity (Ryan, Deci, & Hoefen, n.d.). This also afforded us the opportunity to make comparisons between similar variables from different questionnaires as part of our qualitative analyses.

4.4 Study Results

The results from our study are presented in this section. This is followed by a discussion of the trends encountered in the data. The notable findings, situated within the research questions, are used to highlight the differences and trade-offs between the two pace mechanics. Drawing inspiration from previous work in game design, our results are then extended into recommendations for the design of games for both play and serious tasks. Finally, some limitations of the study method are discussed.

The SAM and GEQ results include main effects for game type, pace mechanic, and trial as well as any two and three-way interactions for the main effects. The PENS and IMI sections include main effects for game type and pace mechanic, along with their two-way interactions. None of the three-way interactions were significant in our study so they will not be elaborated on.

4.4.1 Affect

We measured affective arousal, valence, and dominance in our study using a graphical rating system called the Self-Assessment Manikin (SAM). Table 8 provides an overview of all the effects related to the SAM variables which were captured at three different time points for each game.

	Arousal			Valence			Dominance		
	F	***p***	η_p^2	***F***	***P***	η_p^2	***F***	***p***	η_p^2
Game Type	$F_{2,33}$=1.815	***.000****	*.396*	$F_{2,33=}$.198	*.821*	*.012*	$F_{2,33}$=2.713	*.081*	*.141*
Pace Mechanic	$F_{1,33}$=47.287	***.000****	*.589*	$F_{1,33=}$7.110	***.012****	*.177*	$F_{1,33}$=.016	*.901*	*.000*
Trial	$F_{2,32}$=3.793	***.028****	*.103*	$F_{2,32=}$2.305	*.108*	*.065*	$F_{2,32}$=4.744	***.012****	*.126*
Pace Mechanic × Game Type	$F_{2,30}$=1.519	*.234*	*.084*	$F_{2,30=}$1.819	***.000****	*.396*	$F_{2,30}$=7.639	***.002****	*.316*
Pace Mechanic × Trial	$F_{2,32}$=.759	*.472*	*.022*	$F_{2,32}$=3.508	***.036****	*.0960*	$F_{2,32}$=3.802	***.027****	*.103*
Game Type × Trial	$F_{4,66}$=1.149	*.342*	*.065*	$F_{4,66=}$.889	*.476*	*.0510*	$F_{4,66}$=1.504	*.211*	*.084*
Pace Mechanic × Game Type × Trial	$F_{4,66}$=1.200	*.319*	*.068*	$F_{4,66=}$1.440	*.231*	*.0800*	$F_{4,66}$=1.282	*.286*	*.072*

Table 8: Repeated Measures ANOVA Results for SAM Subscales

(= p < .05; ** = p < .01; *** = p < .001)*

Within the SAM variables, the main effects for pace mechanic on arousal ($F_{1, 33} = 47.29, p < .001$) and valence ($F_{1, 33} = 7.1, p = .012$) were statistically significant. This is illustrated in Figure 8 below.

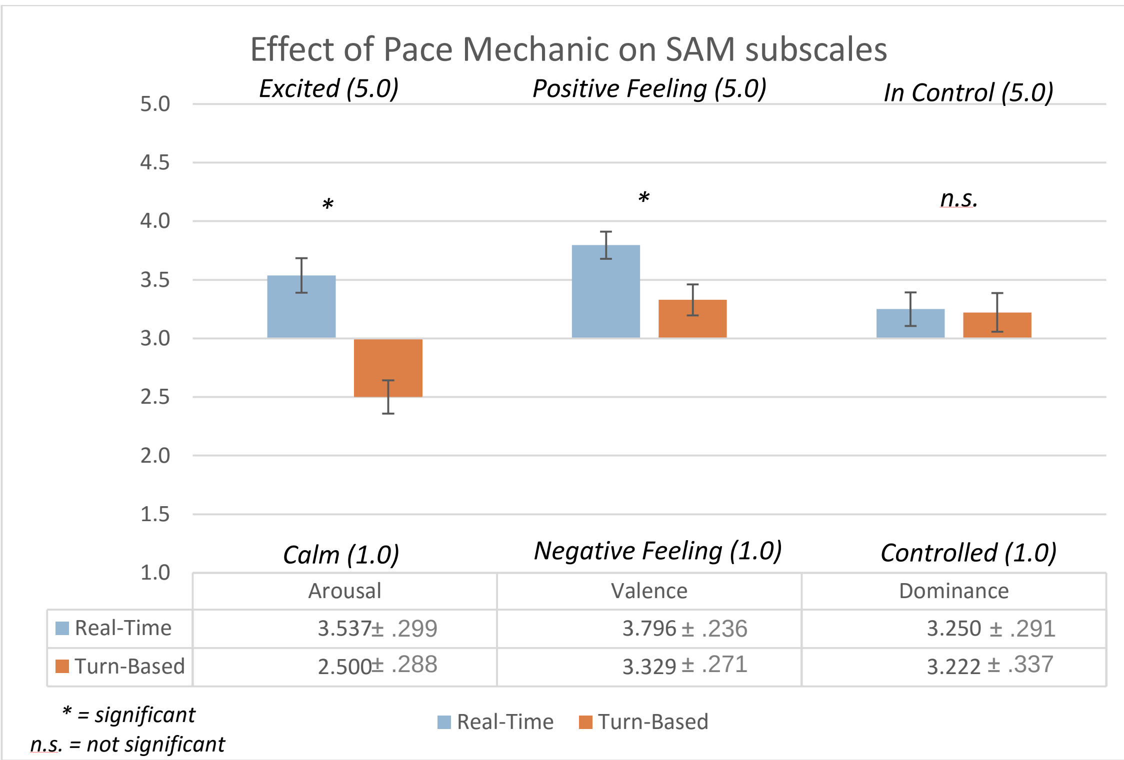


Figure 8: Effect of Pace Mechanic on SAM subscales

4.4.1.1 Mapping SAM measures to the Circumplex Model of Emotion

The data from SAM can be used to classify emotions in the two-dimensional Valence-Arousal space referred to as the circumplex model of emotion (Russell, 1980). As described in Section 3.3.2, arousal refers to intensity (calm to excited) while valence is the pleasantness or hedonic value (negative to positive feeling). Emotions such as joy in the first quadrant are thus captured in SAM with high arousal and high valence, stress by high arousal and low valence, calmness by low arousal and positive valence, and in the fourth quadrant, boredom with low arousal and low valence. As can be seen in Figure 9, the marginal means, along with the overall mean, of the real-time games are predominantly located in the Joyful quadrant while the turn-based means are spread out towards the Calm-Boredom quadrants. This is consistent with the written feedback received from participants (through the Value-Usefulness IMI measure detailed in Section 4.4.3) stating Solitaire is useful for "passing time out of boredom" and "relaxing".

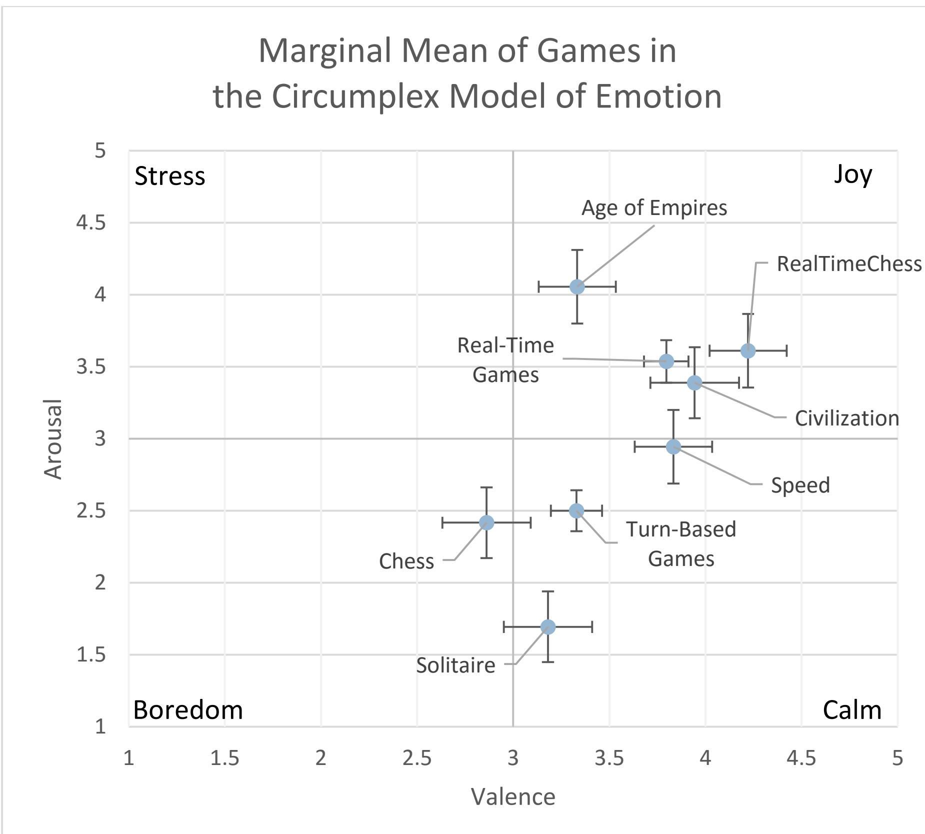


Figure 9: Marginal Mean of Games in the Circumplex Model of Emotion

4.4.1.2 Mapping SAM measures to the Flow Channel Chart

We were also able to map the SAM measures of Arousal and Dominance to Challenge (Low → High Arousal) and Skill (Low → High Efficacy), respectively, based on Csikszentmihalyi's flow channel chart (1991) to get an estimate of flow. Flow refers to the delicate balance of challenge and skill such that when in flow, players are able to experience intense feelings of engagement, discovery, and learning. As shown in Figure 9 and Figure 10, participants playing Age of Empires experienced an alert/excited reaction due to the higher level of arousal compared to dominance. The closer match of challenge-skill for Civilization V can be credited for the happy/elated emotion participants experienced. This is consistent with the plotting of arousal-valence in the circumplex model of emotion in Figure 9 where we found the marginal means, along with the overall mean, of real-time games were predominantly located in the Joyful quadrant while the turn-based means were spread out towards the Calm-Boredom quadrants.

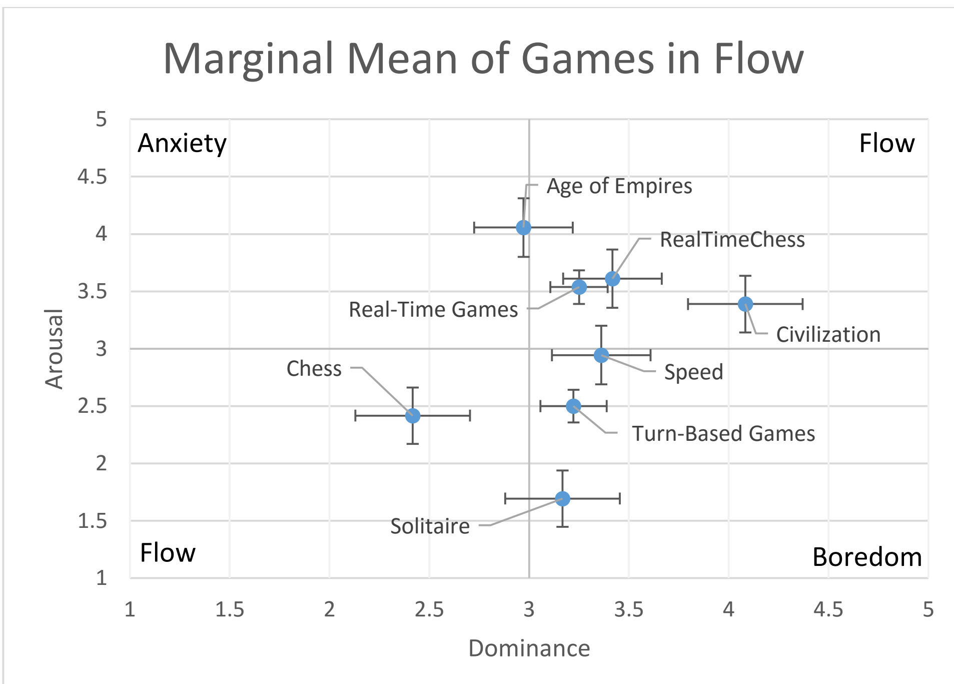


Figure 10: Marginal Mean of Games in Flow

4.4.1.3 Effect of Pace Mechanic on Arousal

Participants playing the real-time games had a significantly ($p < .001$) higher mean arousal score ($M_{RT} = 3.5, SE = .15$) than when they played the turn-based games ($M_{TB} = 2.5, SE = .14$). We can therefore reject the null hypotheses in favor of the alternative hypothesis: *real-time games are more arousing than turn-based games*.

4.4.1.4 Effect of Pace Mechanic on Valence

Mean valence scores for real-time games ($M_{RT} = 3.79, SE = .12$) were significantly higher than mean valence scores for turn-based games ($M_{TB} = 3.33, SE = .13$). Statistical significance indicates the effects are reliable and that we can reject the null hypotheses in favor of the alternative hypothesis: *real-time games invoke more emotion than turn-based games.*

4.4.1.5 Effect of Pace Mechanic on Dominance

Since there is no statistically significant effect of pace mechanic on dominance ($F_{1, 33} = .016, p = .901$), we do not have sufficient evidence to reject the null hypothesis in favor of the alternative hypothesis: *Turn-based games offer more control over choices and decisions than real-time games*.

4.4.1.6 Effect of Pace Mechanic on Valence by Game Type

A significant effect was obtained for the two-way interaction Pace Mechanic×Game Type ($F_{2,33} = 10.82, p < .001$) on the valence measure. This effect was significant because of the striking difference in valence scores for video games relative to the valence scores for card and chess games. Real-time games elicited higher mean valence scores than their turn-based counterparts except in the case of video games. The valence scores were flipped for video games with a lower mean score for real-time video games ($M_{RT} = 3.33, SE = .20$) compared to the mean score for turn-based video games ($M_{TB} = 3.94, SE = .23$). As can be seen in Figure 8 above, Civilization V (turn-based video game) is further along the positive (valence) x-axis than Age of Empires (real-time video game). Even though both invoke a positive arousal/valence response, a closer look at the mapping of emotions in the quadrants suggests Civilization V is situated close to the happy/elated emotion while playing Age of Empires results in an alert/excited reaction (Russell, 1980).

4.4.1.7 Effect of Pace Mechanic on Dominance by Game Type

A significant effect was also obtained for the two-way interaction Pace Mechanic×Game Type ($F_{2,30} = 7.64, p < .01$) on dominance and is shown in Figure 11 below. The marginal mean value for dominance was statistically higher for turn-based video games ($M_{TB} = 4.08, SE = .29$) than real-time video games ($M_{RT} = 2.97, SE = .25$). In other words, as expected, participants felt significantly more in control playing Civilization V than Age of Empires III. Surprisingly, however, participants felt more dominant playing Real-Time Chess ($M_{RT} = 3.417, SE = .25$) rather than Chess ($M_{TB} = 2.42, SE = .29$).

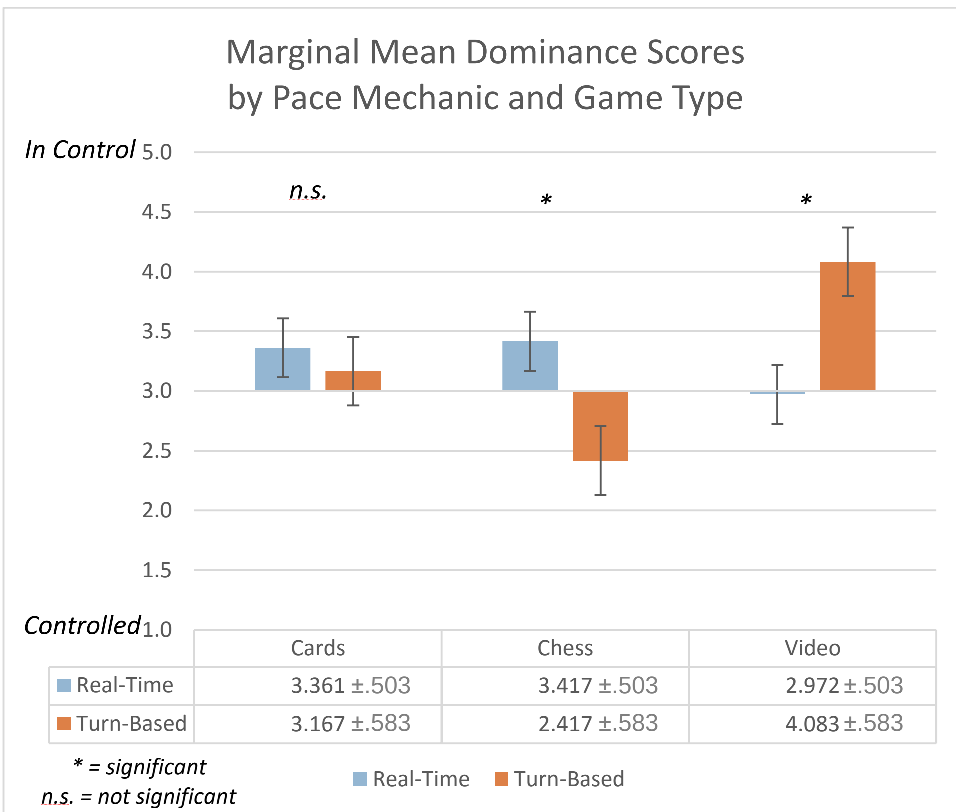


Figure 11: Marginal Mean Dominance Scores by Pace Mechanic and Game Type

4.4.2 Engagement

GEQ measures deepening engagement along a continuum from presence to absorption (Brockmyer, Fox, Curtiss, McBroom, & Burkhart, 2009). Table 9 provides a snapshot of all the effects related to the GEQ variables. Presence, Immersion, Flow, and Absorption were measured at three different time points for each game in our study. Engagement was then calculated as a composite of these four variables.

	Immersion			Presence			Flow		
	F	p	η_p^2	F	p	η_p^2	F	p	η_p^2
Game Type	$F_{2,33}=9.001$	***.001****	.353	$F_{2,33}=3.738$	***.034****	.185	$F_{2,33}=4.309$	***.006*****	.266
Pace Mechanic	$F_{1,33}=17.751$	***.000*****	.350	$F_{1,33}=32.158$	***.000*****	.494	$F_{1,33}=24.287$	***.000*****	.386
Trial	$F_{2,32}=2.386$	.100	.067	$F_{2,32}=.569$	.569	.017	$F_{2,32}=4.025$	.954	.003
Pace Mechanic × Game Type	$F_{2,30}=3.967$	***.029****	.194	$F_{2,30}=8.467$	***.016****	.221	$F_{2,33}=3.239$	.153	.153
Pace Mechanic × Trial	$F_{2,32}=2.206$	.118	.063	$F_{2,32}=.323$	.725	.010	$F_{2,32}=3.603$	.414	.054
Game Type × Trial	$F_{4,64}=.542$	.504	.049	$F_{4,64}=.690$	.601	.040	$F_{4,64}=1.818$	.514	.049
Pace Mechanic × Game Type × Trial	$F_{4,64}=.641$	.635	.037	$F_{4,64}=.165$	.955	.010	$F_{4,64}=.228$	.329	.069

	Absorption			Engagement		
	F	p	η_p^2	F	p	η_p^2
Game Type	$F_{2,33}=4.309$	***.022****	.207	$F_{2,33}=7.260$	***.002*****	.306
Pace Mechanic	$F_{1,33}=24.287$	***.000*****	.424	$F_{1,33}=33.849$	***.000*****	.506
Trial	$F_{2,32}=4.025$	***.028****	.201	$F_{2,32}=3.208$	.054	.167
Pace Mechanic × Game Type	$F_{2,33}=3.239$	.052	.164	$F_{2,30}=4.834$	***.014****	.227
Pace Mechanic × Trial	$F_{2,32}=3.603$	***.039****	.184	$F_{2,32}=2.001$	.152	.111
Game Type × Trial	$F_{4,64}=1.818$	.136	.103	$F_{4,64}=1.674$	.161	.096
Pace Mechanic × Game Type × Trial	$F_{4,64}=.228$	.922	.014	$F_{4,64}=.387$	.604	.030

Table 9: Repeated Measures ANOVA Results for GEQ Subscales

(= p < .05; ** = p < .01; *** = p < .001)*

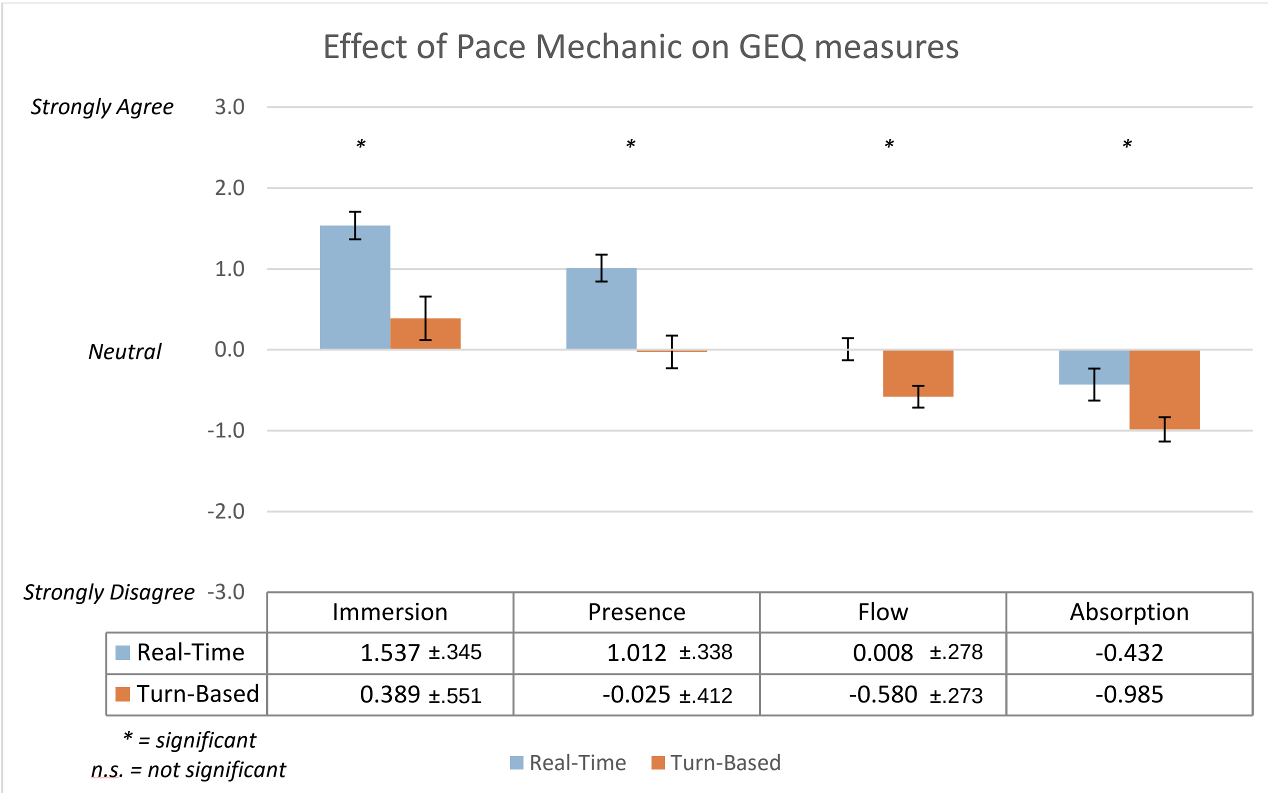


Figure 12: Effect of Pace Mechanic on GEQ measures

As shown in Figure 12, there were significant main effects of pace mechanic on all the GEQ measures: immersion ($F_{1,33} = 17.751, p < .001$), presence ($F_{1,33} = 32.16, p < .001$), flow ($F_{1,33} = 20.789, p < .001$), and absorption ($F_{1,33} = 24.287, p < .001$). There was a significant effect of pace mechanic on engagement ($F_{1,33} = 33.849, p < .001$) as well; however, engagement was not included in Figure 12 above as it is a composite variable and therefore, has different bounds.

4.4.2.1 Effect of Pace Mechanic on Immersion and Presence

Participants felt significantly ($p < .001$) more involved (Immersion: $M_{RT} = 1.54, SE = .169$; Presence: $M_{RT} = 1.012, SE = .166$) in the real-time virtual game environment rather than in the turn-based environment (Immersion: $M_{TB} = .39, SE = .271$; Presence: $M_{TB} = -.025, SE = .202$). In the turn-based games, participants did not feel immersed or present at all (neutral).

4.4.2.2 Effect of Pace Mechanic on Flow and Absorption

Participants felt out of flow ($M_{TB} = -.580, SE = .134$) in the turn-based games while they did not feel in flow (neutral) in real-time games ($M_{RT} =.008, SE =.137$). Absorption describes an altered state of consciousness like flow but with negative affect (e.g. anxiety and frustration) and negative motivation, resulting in moral ambiguity (Brockmyer, Fox, Curtiss, McBroom, & Burkhart, 2009). Participants in both conditions reported disagreeing with the absorption statements (significantly more so in the case of turn-based games: $M_{TB} = -.985$, $SE - .151$ vs $M_{RT} = -.432$, $SE = .198$).

4.4.2.3 Effect of Pace Mechanic on Engagement

Participants playing the turn-based games, on average, responded neutrally to or disagreed with the statements on the GEQ. It comes as no surprise then that participants, overall, felt marginally disengaged in turn-based games ($M_{TB} = -1.202$, $SE = .677$) compared to real-time games ($M_{RT} = 2.124$, $SE = .557$). We can therefore reject the null hypothesis in favor of the alternate hypothesis: *real-time games are more engaging than turn-based games.*

It is important to note that high levels of engagement on the GEQ continuum are not necessarily desirable as they represent a non-pathological form of dissociation, where players may be more susceptible to negative game content (such as violence). In our study, participants felt only moderate levels of engagement with real-time games by endorsing or only partially endorsing "experiences that are consistent with the experience of presence ('things seem to happen automatically') and possibly with flow ('playing makes me feel calm')" (Brockmyer, Fox, Curtiss, McBroom, & Burkhart, 2009).

4.4.2.4 Effect of Pace Mechanic on Immersion, Presence and Engagement by Game Type

Looking at the two-way interactions between game type and pace mechanic, we noticed similar significant effects for immersion ($F_{2, 30} = 3.97$, $p = .029$), presence ($F_{2, 30} = 8.47$, $p = .016$), and engagement ($F_{2, 30} = 4.834$, $p = .014$). For all three measures, there were considerable differences between the values for real-time and turn-based cards and chess games but not for video games. In other words, participants found real-time cards and chess games to be more immersive, involving, and engaging than their turn-based counterparts (which only elicited negative or neutral responses) but the same cannot be said for video games. The marginal means and corresponding standard error for each of these variables is tabulated in Table 10. This effect is illustrated in Figure 13 below for engagement; the charts for immersion and presence were similar.

	Cards				Chess				Video			
	M_{RT}	*SE*	M_{TB}	*SE*	M_{RT}	*SE*	M_{TB}	*SE*	M_{RT}	*SE*	M_{TB}	*SE*
Immersion	*.889*	*.293*	*-1.056*	*.469*	*1.944*	*.293*	*.556*	*.469*	*1.778*	*.293*	*1.667*	*.469*
Presence	*.639*	*.288*	*-.868*	*.350*	*1.361*	*.288*	*.007*	*.350*	*1.035*	*.288*	*.785*	*.350*
Engagement	*.125*	*.964*	*-5.042*	*1.173*	*3.422*	*.964*	*-.468*	*1.173*	*2.827*	*.964*	*1.904*	*1.173*

Table 10: Significant Game Type × Pace Mechanic interactions for Immersion, Presence and Engagement (GEQ)

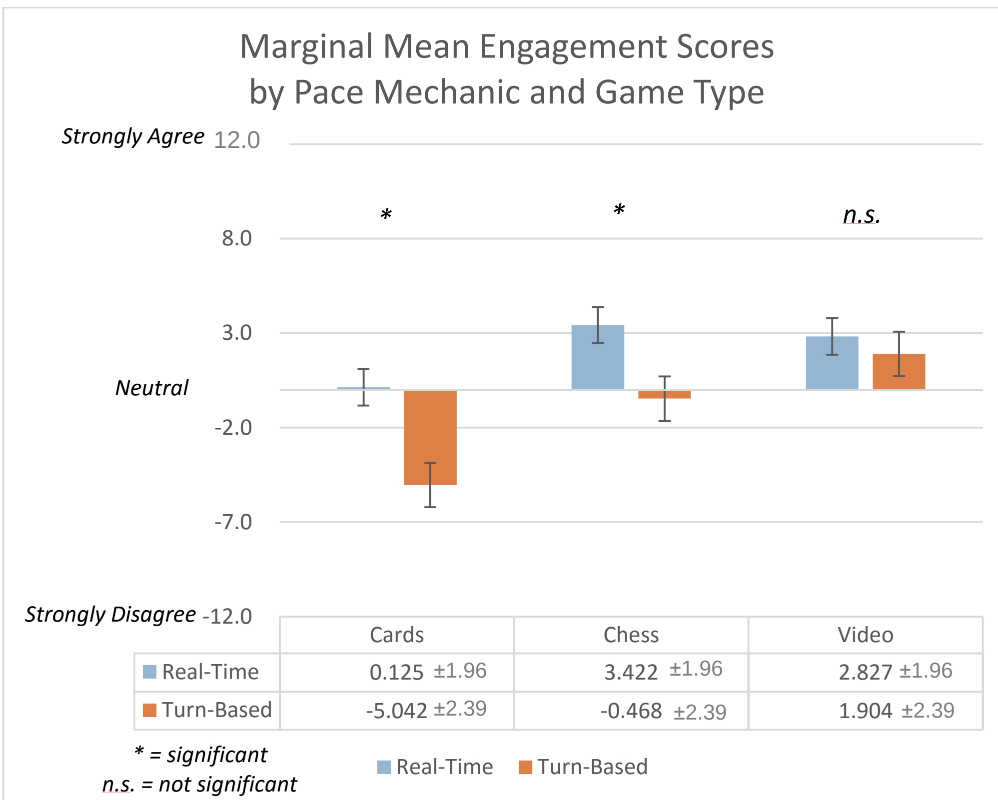


Figure 13: Marginal Mean Engagement Scores by Pace Mechanic and Game Type

4.4.3 Motivation

We adopted the 'Intrinsic Motivation Inventory' developed by Deci and Ryan (2003) to assess participants' subjective motivation through several subscales: Interest-Enjoyment, Effort-Importance, Perceived Competence, Perceived Choice, Pressure-Tension, and Value-Usefulness. Table 11 and Table 12 provide an overview of all the effects related to these variables.

	Interest-Enjoyment			**Effort-Importance**			**Perceived Competence**		
	F	**p**	η_p^2	**F**	**p**	η_p^2	**F**	**p**	η_p^2
Game Type	$F_{2,33}=9.269$	***.001****	*.360*	$F_{2,33}=2.717$	*.137*	*.113*	$F_{2,33}=1.150$	*.329*	*.065*
Pace Mechanic	$F_{1,33}=9.014$	***.005***	*.215*	$F_{1,33}=11.724$	***.002***	*.262*	$F_{1,30}=2.447$	*.125*	*.070*
Pace Mechanic × Game Type	$F_{2,33}=2.072$	*.142*	*.421*	$F_{2,33}=1.345$	*.274*	*.075*	$F_{2,33}=7.737$	***.002***	*.319*

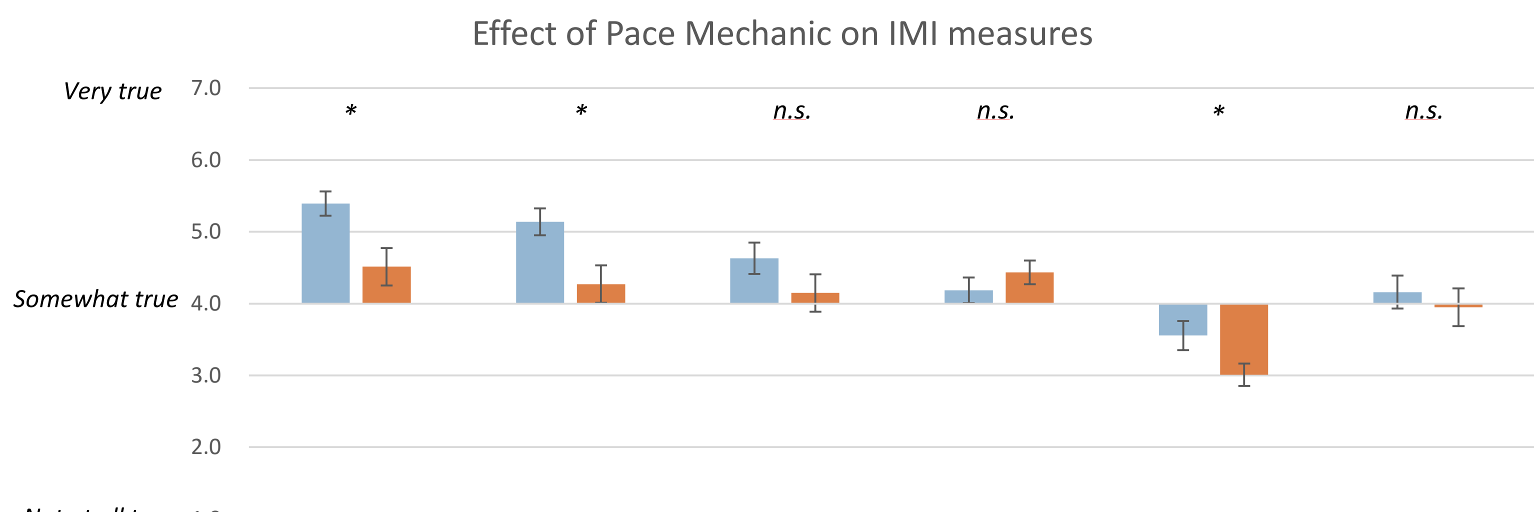
Table 11: Repeated Measures ANOVA Results for IMI Subscales

(= p < .05; ** = p < .01; *** = p < .001)*

	Perceived Choice			**Pressure-Tension**			**Value-Usefulness**		
	F	**p**	η_p^2	**F**	**p**	η_p^2	**F**	**p**	η_p^2
Game Type	$F_{2,30}=1.043$	*.365*	*.065*	$F_{2,33}=1.381$	*.180*	*.099*	$F_{2,33}=4.839$	**.014***	4.802
Pace Mechanic	$F_{1,30}=2.000$	*.168*	*.062*	$F_{1,33}=6.408$	***.016****	*.163*	$F_{1,33}=.945$	.338	3.951
Pace Mechanic × Game Type	$F_{2,30}=4.126$	***.026****	*.216*	$F_{2,33}=.641$	*.533*	*.037*	$F_{2,33}=.967$	.571	.033

Table 12: Repeated Measures ANOVA Results for IMI Subscales (Continued)

(= p < .05; ** = p < .01; *** = p < .001)*



	Interest-Enjoyment	Effort-Importance	Perceived Competence	Perceived Choice	Pressure-Tension	Value-Usefulness
Real-Time	5.393 ±.349	5.139 ±.383	4.630 ±.446	4.184 ±.365	3.556 ±.413	4.160 ±.466
Turn-Based	4.513 ±.531	4.272 ±.531	4.149 ±.530	4.433 ±.336	3.011 ±.317	3.951 ±.535

** = significant*
n.s. = not significant

Real-Time Turn-Based

Figure 14: Effect of Pace Mechanic on IMI measures

4.4.3.1 Effect of Pace Mechanic on Interest-Enjoyment

The Interest-Enjoyment scale is considered the primary measure of intrinsic motivation. As shown in Figure 14, there was a significant main effect of pace mechanic ($F_{1,33} = 9.014, p < .005$) on interest and enjoyment. Participants reported enjoying real-time games ($M_{RT} = 5.39, SE = .171$) more than turn-based games ($M_{TB} = 4.51, SE = .261$). We can therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games are more interesting/enjoyable than turn-based games.*

4.4.3.2 Effect of Pace Mechanic on Effort-Importance

Results indicated a significant main effect of pace mechanic on effort-importance scores ($F_{1, 33} = 11.72, p < .05$). In our reasoning for the Effort-Importance hypothesis *'turn-based games require more effort than real-time games'*, we surmised that micromanagement in turn-based gaming entails detailed decision-making and therefore would require more effort with greater importance given to each decision. Contrary to our hypothesis, however, participants playing real-time games ($M_{RT} = 5.14, SE = .188$) reported putting in more effort and trying harder than participants playing turn-based games ($M_{TB} = 4.27, SE = .261$).

4.4.3.3 Effect of Pace Mechanic on Perceived Competence

Pace mechanic did not have a statistically significant effect on perceived competence scores ($F_{1, 30} = 2.447, p = .125$). Therefore, there is not enough evidence against the null hypothesis in favor of the hypothesis '*turn-based games offer more control over choices and decisions than real-time games'* and we do not reject H_0. There was, however, a significant interaction effect between pace mechanic and game type ($F_{2, 33} = 7.737, p = .002$), such that perceived competence levels were significantly higher for the real-time chess ($M_{RT} = 5.29, SE = .38$ vs $M_{TB} = 3.35, SE = .45$) and the turn-based video game ($M_{TB} = 3.58, SE = .45$ vs $M_{RT} = 4.58, SE = .38$) than their counterparts.

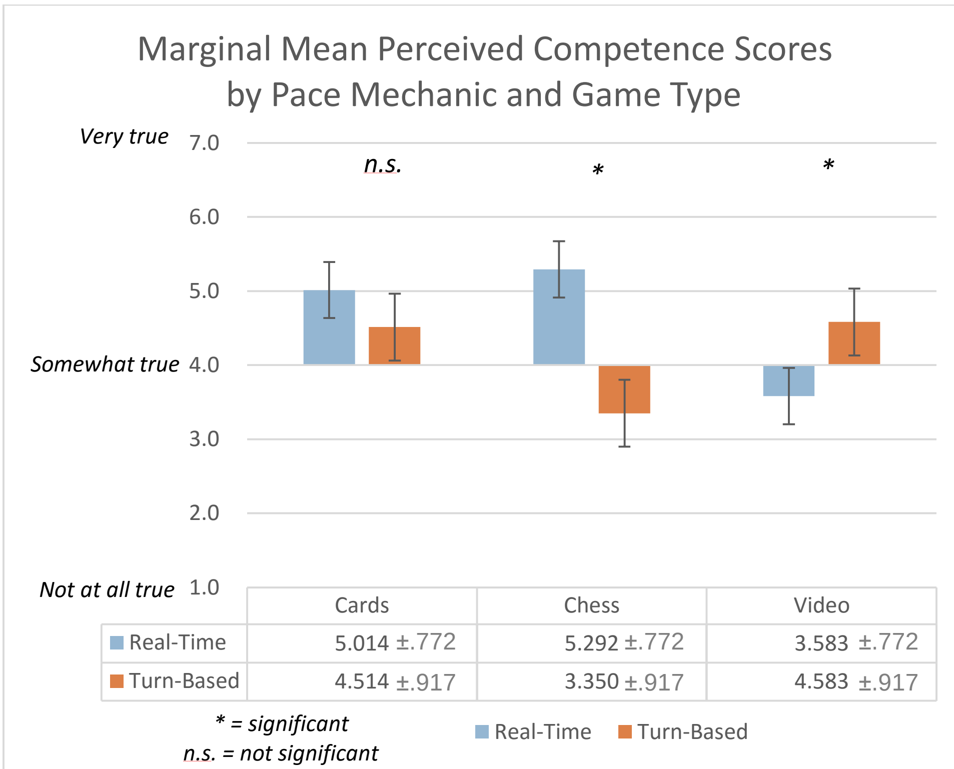


Figure 15: Marginal Mean Perceived Competence (IMI) Scores by Pace Mechanic and Game Type

4.4.3.4 Effect of Pace Mechanic on Perceived Choice

Similarly, pace mechanic had no statistically significant effect on perceived choice scores ($F_{1, 30} = 2.000$, $p = .168$). However, there was a significant interaction effect between pace mechanic and game type ($F_{2, 30} = 4.13$, $p = .026$), such that perceived choice levels were significantly higher for turn-based ($M_{TB} = 5.06$, $SE = .451$) over real-time video games ($M_{RT} = 4.17$, $SE = .380$). This is illustrated in Figure 16 below.

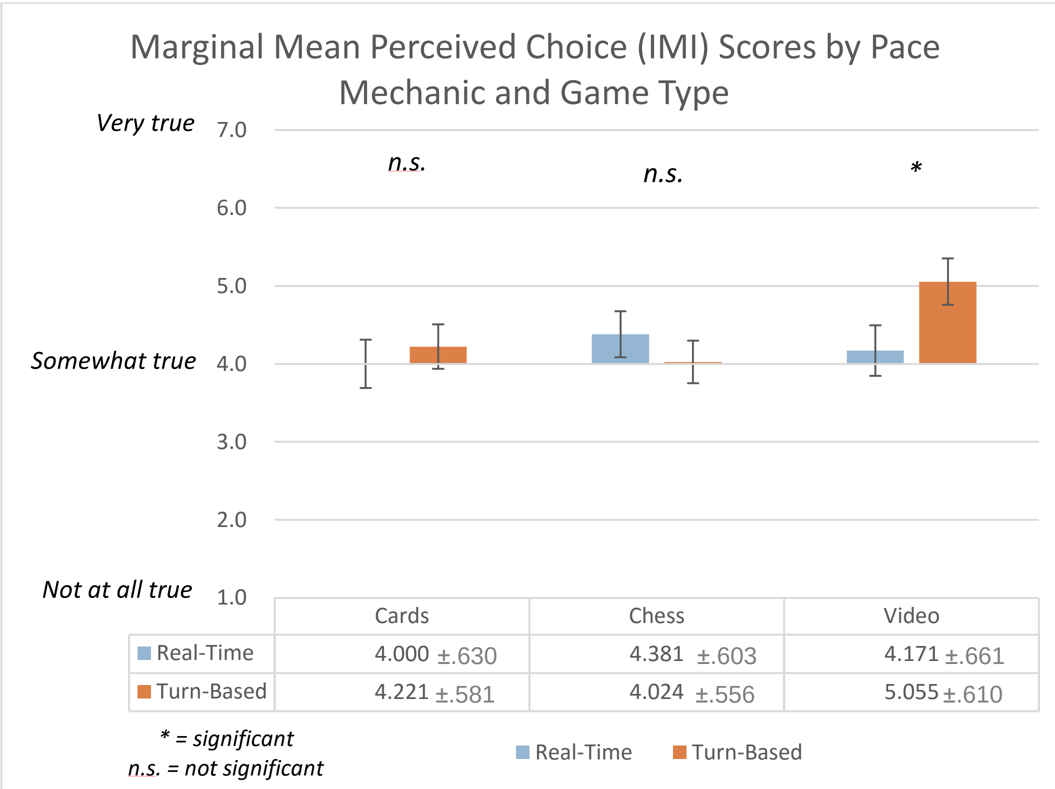


Figure 16: Marginal Mean Perceived Choice (IMI) Scores by Pace Mechanic and Game Type

4.4.3.5 Effect of Pace Mechanic on Pressure-Tension

Results showed a statistically significant effect of pace mechanic on the pressure and tension participants experienced ($F_{1, 33} = 6.408$, $p = .016$). As expected, participants reported feeling more pressure and tension while playing real-time games ($M_{RT} = 3.56$, $SE = .203$) than when playing turn-based games ($M_{TB} = 3.01$, $SE = .156$). We can therefore reject the null hypothesis in favor of the hypothesis: *real-time games are more stressful than turn-based games*.

4.4.3.6 Effect of Pace Mechanic on Value-Usefulness

Overall, participants rated both real-time and turn-based games as being ‘somewhat’ valuable/useful so there was no statistical difference between the two means. The Value-Usefulness subscale also had three free-form fill-in-the-blank statements which prompted participants to comment on the most useful and beneficial aspects of playing each game. The statements were “I think that playing this game is useful for…”, “I think playing this game is important to do because it can…”, and “I think playing this game could help me to…” Table 13 shows the most common responses for each game with the frequency of occurrence (broken down both in terms of participants who responded and total participants). It should be noted that the results from the free-form comments sections of the IMI questionnaire are autonomous. When we report the number of similar comments for a condition, it is possible that more participants felt the same way but did not report it.

		Real-Time			Turn-Based		
		Response(s)	**% of Responses**	**% of Total**	**Response(s)**	**% of Responses**	**% of Total**
Cards	**Useful for…**	Thinking quickly	70%	58%	1. Passing time out of boredom 2. Organizational practice, decision making and strategic thinking	36%	33%
	Important to…	Improve pattern recognition skills and response times	78%	58%	Improve patience levels	33%	25%
	Helpful to…	Think quickly	70%	58%	Relax and pass time	67%	50%
Chess	**Useful for…**	Improving strategy, micromanagement, decision making and critical thinking abilities	67%	67%	Researching and long term planning Improving decision making and critical thinking abilities	83%	83%
	Important to…	Improve focus, multitasking and “quick” thinking	64%	58%	Teach you to think “deep” and long term, and be more analytical	73%	83%
	Helpful to…	Prioritize, think faster and multitask	91%	83%	Focus and think ahead	73%	83%
Video	**Useful for…**	Improving focus, coordination, multitasking and fast reactive thinking	75%	50%	Long term “deeper” planning and methodological strategy	71%	42%
	Important to…	Improve micromanagement, quick thinking and problem solving skills in chaotic situations	67%	50%	Improve your planning skills through an understanding of interactions and consequences	75%	50%
	Helpful to…	Multitask, manage and think on my feet	57%	33%	Plan ahead and manage	57%	33%

Table 13: Free-form responses to Value-Usefulness subscales

4.4.4 Needs Satisfaction

PENS was developed by Ryan et al. (2006) to measure the subjective satisfaction of needs in video games and has been used to evaluate how different game genres satisfy needs differently (see Chapter 2 for details). Table 14 provides a glimpse of all the effects related to the PENS variables in our study.

	Autonomy			**Competence-Control**			**Presence-Immersion**			**Intuitive Controls**		
	F	**p**	η_p^2	**F**	**P**	η_p^2	**F**	**p**	η_p^2	**F**	**p**	η_p^2
Game Type	$F_{2,32}$=34.996	**.000*** **	.686	$F_{2,32}$=1.675		.095	$F_{2,30}$=2.480	.101	.686	$F_{2,32}$=4.019	**.028***	.201
Pace Mechanic	$F_{1,33}$=2.333	.136	.068	$F_{1,32}$=2.088	.158	.061	$F_{1,30}$=3.656	.065	.109	$F_{1,32}$=1.179	.286	.036
Pace Mechanic × Type	$F_{2,33}$=2.456	.102	.133	$F_{2,32}$=11.620	**.000*** **	.421	$F_{2,30}$=1.208	.313	.075	$F_{2,32}$=4.019	.092	.139

Table 14: Repeated Measures ANOVA Results for PENS Subscales

(= p < .05; ** = p < .01; *** = p < .001)*

4.4.4.1 Effect of Pace Mechanic on Autonomy and Competence-Control

Since there were no significant effects of pace mechanic on autonomy ($F_{1,33}=2.333$, $p = .136$), competence ($F_{1,32}=2.088$, $p = .158$), or the other PENS variables, there is not enough evidence from the PENS measures in favor of the following hypotheses: '*turn-based games offer more control over choices and decisions than real-time games*' and '*turn-based games evoke greater feelings of competence than real-time games*'.

4.4.4.2 Effect of Pace Mechanic on Competence by Game Type

The only statistically significant effect for Competence (PENS) was for the two-way interaction Pace Mechanic×Game Type ($F_{2, 32} = 11.62, p < .001$) and is shown in Figure 17. Similar to the Competence (IMI) results from the previous section, competence levels were significantly higher for real-time chess ($M_{RT} = 5.55, SE = .36$ vs $M_{TB} = 3.58, SE = .46$) and the turn-based video game ($M_{TB} = 4.67, SE = .34$ vs $M_{RT} = 3.44, SE = .44$) than their counterparts. The convergence of findings across similar measures in PENS and IMI lends validity to our data.

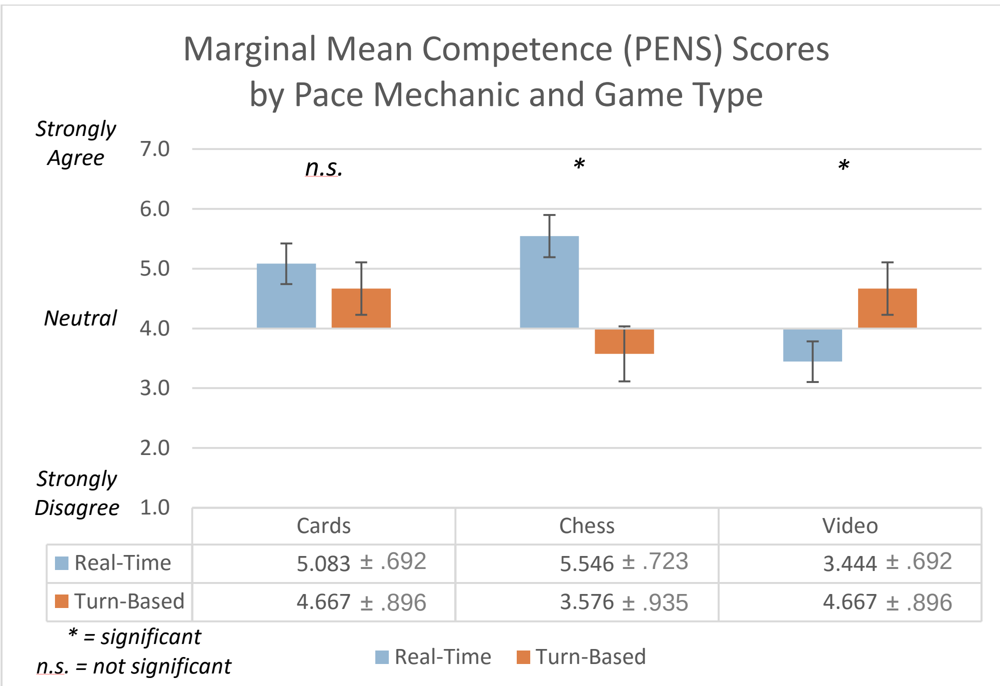


Figure 17: Marginal Mean Competence (PENS) Scores by Pace Mechanic and Game Type

4.4.4.3 Effect of Pace Mechanic on Presence-Immersion

There were no statistically significant effects of either of the independent variables on the PENS measure of presence-immersion. As discussed in Section 4.2, participants reported having difficulty rating cards and chess games on the Presence-Immersion subscales. The data in this case was reduced to a smaller data set when 6 values (3 participants out of 36 total) were marked as missing. This may have contributed to the lack of significant results for presence-immersion, even though the GEQ measures of presence and immersion both had statistically significant effects due to pace mechanic.

4.4.4.4 Effect of Pace Mechanic on Intuitive Controls

For intuitive controls, the main effect for game type ($F_{2,32} = 4.019, p = .028$) was statistically significant. We take a look at the pairwise comparisons for intuitive controls in detail for the three different game types in the next section.

4.4.5 Significant Effects of Game Type

With the exception of intuitiveness of controls, game type had a similar significant effect on 9 of the 18 total measures: arousal ($F_{2,33} = 10.82, p < .001$), immersion ($F_{2,33} = 9.00, p < .001$), presence ($F_{2,33} = 3.74, p = .034$), flow ($F_{2,33} = 5.991, p < .01$), absorption ($F_{2,33} = 4.309, p = .022$), engagement ($F_{2,33} = 7.26, p < .01$), autonomy ($F_{2,32} = 34.996, p<.001$), interest-enjoyment ($F_{2,33} = 9.269, p < .001$), and value-usefulness ($F_{2,33} = 4.84, p = .014$). In these cases, the marginal means of the card games were significantly lower than the marginal means of video games and in most cases, chess games as well. There were no significant differences between the marginal means of chess and video games (not considering differences due to pace mechanic).

One possible explanation for this trend lies in the simplicity of card games used in our study compared to chess and video games. During the informal interview when participants in the cards group were asked about employing particular strategies, only one reported coming up with a strategy for Speed where they planned ahead and queued up cards to use in a “frenzy” of moves (Participant 26; interesting to note that this participant advanced furthest in the game). In the free-form responses to the Value-Usefulness subscales, participants reported the card games were useful for improving response times, relaxing, or passing time, whereas chess and video games elicited more complex responses from the participants.

This theory is consistent with the results for intuitiveness of controls ($F_{2,32} = 4.019, p = .028$). It is likely that the higher reported level of Intuitive Controls for card games is due to the simplicity of these games ($M_C = 6.028 \pm .310$ vs $M_H = 5.682 \pm .324$ vs $M_V = 4.819 \pm .310$). With limited options, designers can afford to lay out the controls in a straightforward way. The thought process in both Speed and Solitaire, for the most part, involved picking out which card to click on (with no other options). This is captured in the very low marginal mean autonomy score for card games ($M_C = 2.667 \pm .265$ vs $M_H = 5.097 \pm .254$ vs $M_V = 5.542 \pm .254$) which measures perceptions of meaningful opportunities and choices in a game. The significant effects of game type on both Intuitive Controls and Autonomy are illustrated in Figure 18.

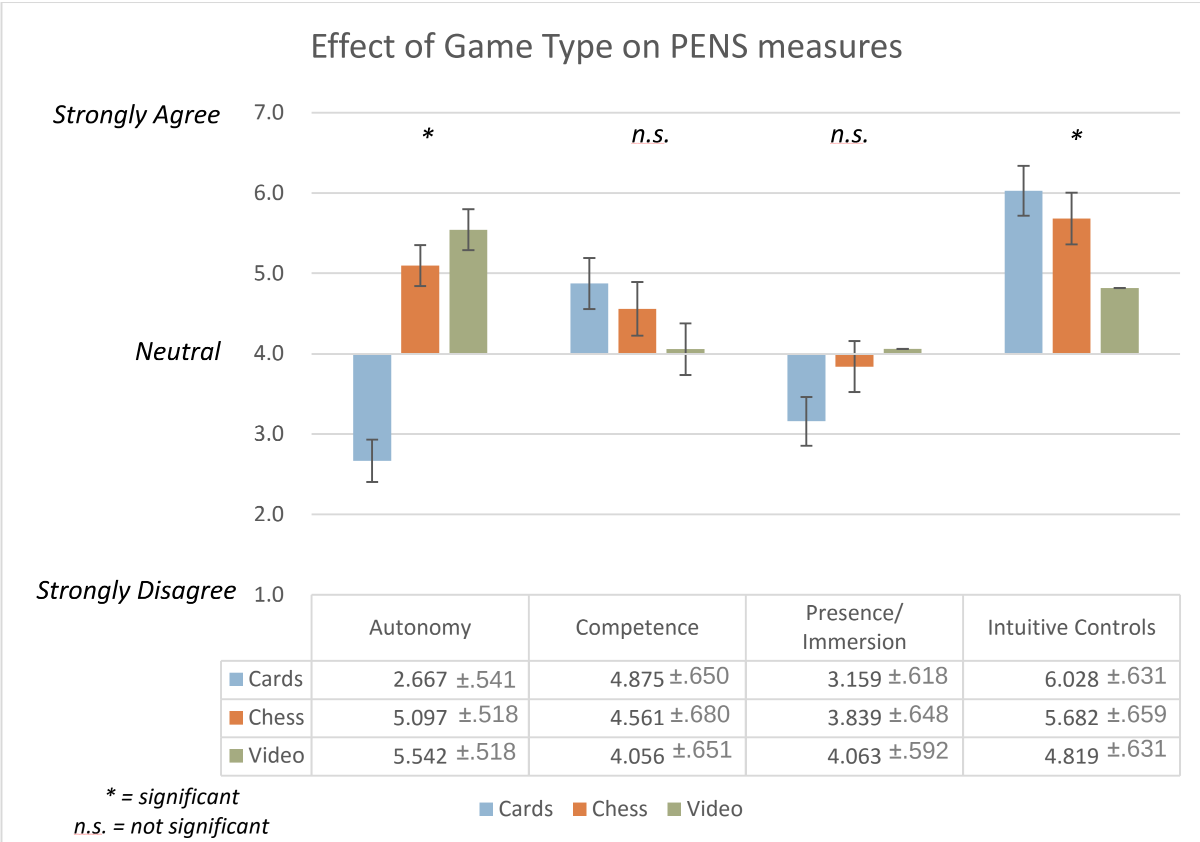


Figure 18: Effect of Game Type on PENS measures

	Cards			Chess			Video		
	M_C	*SE*	*± CI*	M_H	*SE*	*± CI*	M_V	*SE*	*± CI*
Arousal	2.319	.213	.433	3.014	.213	.434	3.722	.213	.434
Immersion	-.083	.312	.635	1.25	.312	.635	1.722	.312	.635
Presence	-.12	.278	.566	.684	.278	.566	.91	.278	.567
Flow	-.858	.206	.42	-.097	.206	.42	.097	.206	.419
Absorption	-1.403	.290	.589	-.360	.290	.589	-.364	.290	.589
Engagement	-2.459	.953	1.938	1.477	.953	1.939	2.365	.953	1.938
Autonomy	2.67	.265	.540	5.10	.254	.518	5.54	.254	.518
Interest-Enjoyment	4.02	.286	.581	5.10	.286	.581	5.74	.286	.581
Value-Usefulness	3.14	.385	.783	4.229	.385	.783	4.802	.385	.783
Intuitive Controls	6.03	.310	.631	5.682	.324	.659	4.82	.310	.631

Table 15: Significant Effects of Game Type

(Marginal Means, Standard Error, 95% Confidence Intervals)

4.4.6 Significant Effects of Trial

Trial was only a factor for 8 of the variables we measured, out of which we encountered a significant effect for arousal ($F_{2, 32} = 3.79, p = .028$), dominance ($F_{2, 32} = 4.74, p = .012$), and absorption ($F_{2, 32} = 4.025, p = .028$). Marginal means for all three variables increased gradually over the course of gameplay. We believe this was a result of participants becoming familiar with their games.

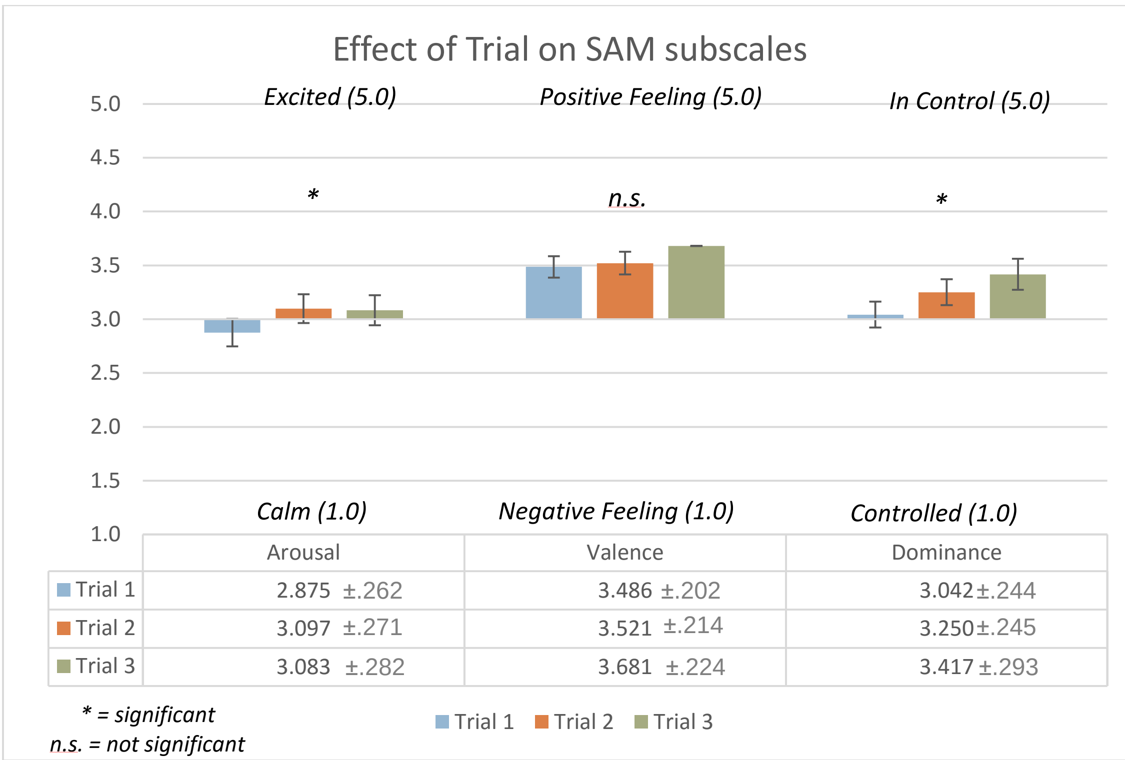


Figure 19: Effect of Trial on SAM subscales

	Trial 1			Trial 2			Trial 3		
	M_1	*SE*	*CI*	M_2	*SE*	*CI*	M_3	*SE*	*CI*
Arousal	*2.88*	*.13*	*.262*	*3.097*	*.134*	*.271*	*3.08*	*.139*	*.282*
Dominance	*3.04*	*.12*	*.244*	*3.25*	*.12*	*.245*	*3.42*	*.144*	*.293*
Absorption	*-.797*	*.155*	*.315*	*-.629*	*.171*	*.349*	*-.700*	*.187*	*.38*

Table 16: Significant Effects of Trial

(Marginal Means, Standard Error, 95% Confidence Intervals)

4.4.6.1 Effect of Trial on Arousal and Absorption

For arousal and absorption, the scores rose significantly in the first ten minutes, plateaued 20 minutes into gameplay and did not appreciably increase.

4.4.6.2 Effect of Trial on Dominance

Similarly, participants' dominance levels rose but over a longer time span such that there was only a significant ($p = .026$) increase at the 30-minute mark. In other words, participants' dominance levels increased gradually over the course of 30 minutes of gameplay such that participants ended gameplay feeling significantly more in control than when they started playing. A longer study is needed to establish whether dominance continues to rise with game play or whether there is a point at which it plateaus as well.

4.4.6.3 Effect of Pace Mechanic on Dominance by Trial

Taking a look at the dominance measure individually for real-time and turn-based games over time, we notice a significant effect ($F_{2, 32} = 3.80$, $p = .027$). While the mean dominance score for participants playing turn-based games starts out higher, it remains fairly constant as the mean dominance level for participants playing the real-time games increase over time. As a result, there is a statistical difference between the mean dominance level for real-time games at trial 1 ($M_{RT1} = 2.92$, $SE = .17$) and trial 2 ($M_{RT2} = 3.19$, $SE = .19$) as well as with trial 3 ($M_{RT3} = 3.64$, $SE = .20$). The important takeaway from this is: while the mean dominance score for participants playing turn-based games started out higher, we observed that as participants get accustomed to the real-time game, their average dominance level increases beyond that with the turn-based game.

4.4.6.4 Effect of Pace Mechanic on Valence by Trial

There was a significant effect of Pace Mechanic×Trial ($F_{2,66} = 3.51, p = .036$) on the Valence measure as well. While the mean valence scores for participants playing real-time games were higher at all time points than for participants in the turn-based condition, this difference was much larger at the third trial. 30 minutes into the game, real-time games elicited a mean valence score of 4.08 (*SE* = *.14*) compared to the mean of 3.28 for turn-based games (*SE* = *.19*). As shown in Figure 20, while valence scores remained nearly constant (close to neutral) for turn-based games, they increased over time for real-time games.

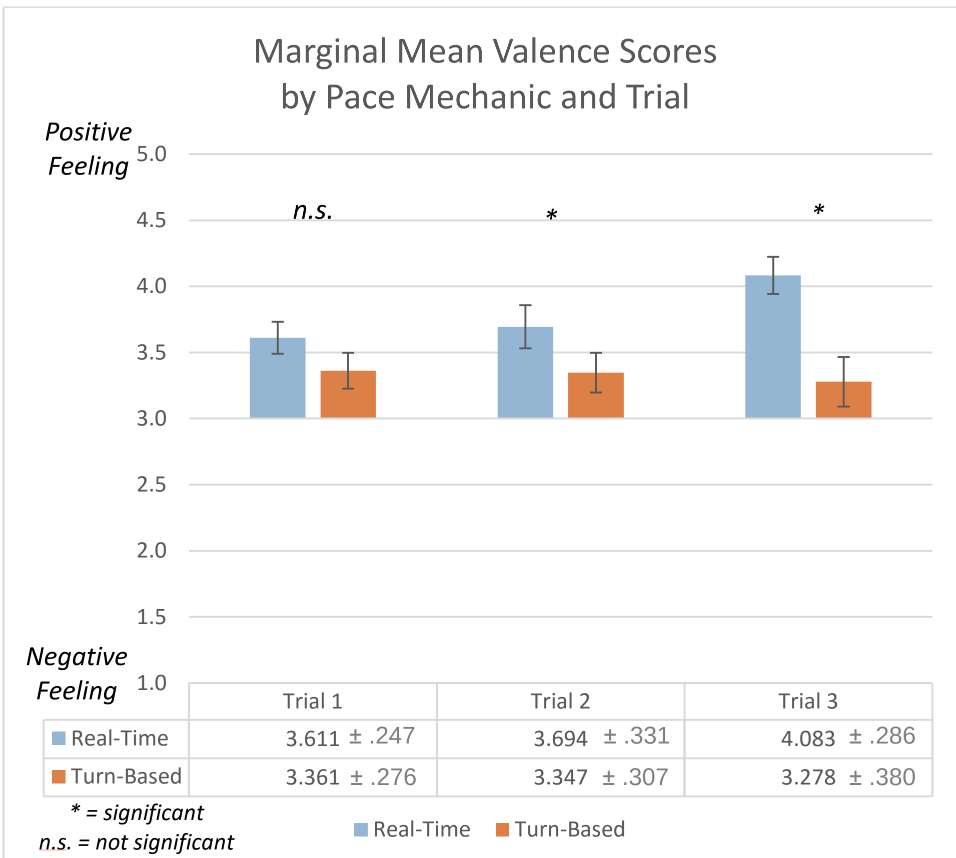


Figure 20: Marginal Mean Valence Scores by Pace Mechanic and Trial

4.5 Research Questions

4.5.1 Research Question 1 (Engagement)

What effect does pace mechanic have on engagement and preference for continued play in a time-critical environment?

The "first hour" refers to the first time a player encounters a game and becomes familiar with it (Cheung, Zimmermann, & Nagappan, 2014). This initial play session can span anywhere from a few minutes to 5 hours and serves to draw players in to the full experience of the game. If the game does not hold the player's attention, players may give up on the game and even dissuade others from playing. Game designers therefore consider the first hour to be critical for engagement and continued play (Cheung, Zimmermann, & Nagappan, 2014). Since participants in the SI Lab setting only have a short window of time to learn how the game works, accept it as a valid and useful analysis tool, and maximize the information obtained from its use, it is imperative to grab the player's attention right away during this 'first hour'.

In order to measure engagement in our study, we used the Game Engagement Questionnaire (GEQ). Brockmyer et al. (2009) characterize engagement in GEQ as a series of deepening degrees from immersion to absorption. Our investigation into pace mechanic identified that real-time games were, as expected, more engaging than turn-based games. Participants rated real-time games positively for immersion and presence (the first and second level of engagement) while turn-based games received only a nominal positive score for immersion. In the written free-form responses, there was a common theme of needing to "think quickly" for all three real-time games. One participant in the cards group attributed enjoying RealTimeChess more due to the sense of time going faster, higher predictability, winning more often, and being able to try more things. Similarly, one participants commented that he felt Age of Empires was "faster", "more lively" and "more competitive" than Civilization.

Post-hoc tests with game type, however, revealed the significant differences in engagement were between turn-based and real-time cards and chess games with no significant difference between video games (i.e., Age of Empires III and Civilization V). By studying the structure of Civilization which has been one of the few hugely successful turn-based games, we can learn some general, practical lessons about engaging players in traditional turn-based gaming. The designer of the Civilization series, Sid Meier, believes, the game "almost cannot reward the player enough" during the initial play session so that it "foreshadows all the cool stuff that's going to happen later in the game" (Cheung, Zimmermann, & Nagappan, 2014). Cheung, et al. (2014) identify one way this is done in Civilization is by offering nine difficulty levels through which players can progress at their own pace while feeling mastery and increasing levels of challenge.

This matching of challenge to skill is one of the main ways of designing for 'flow' and maintaining engagement, and is one of the most prominent concepts of psychology embraced by game designers today (Csikszentmihalyi, 1991). The 'first hour' must help players achieve a careful balance of skill and challenge so that players are put on the path to entering a flow state (Cheung, Zimmermann, & Nagappan, 2014). Players will not be motivated to play if the game is not challenging enough (in which case, repetition or triviality of choice will lead to boredom) or if it is overly difficult (which can lead to anxiety or frustration). Ultimately, being in a flow state enhances both motivation and learning, and is a desirable goal for games (Csikszentmihalyi, 1991).

In our study, on average, participants felt out of flow (i.e., disagreed with flow statements) while playing turn-based games and they did not feel in flow (i.e., responded neutrally to flow statements) while playing real-time games. Having an immediate performance feedback structure is one technique designers can incorporate to promote flow (Brockmyer, Fox, Curtiss, McBroom, & Burkhart, 2009). One participant remarked they enjoyed Age of Empires more because of the superior feedback mechanism as "accomplishments in this game, while smaller, were signified more greatly" than in Civilization. With participants reportedly being out of flow in turn-based games, it comes as no surprise then that they described enjoying and found real-time games much more interesting than turn-based games (as evidenced by the scores in the Interest-Enjoyment IMI measure). In line with this, we found the marginal means, along with the overall mean, of real-time games were predominantly located in the Joyful quadrant while the turn-based means were spread out towards the Calm-Boredom quadrants when we mapped the SAM measures to the Circumplex model of emotion and Csikszentmihalyi's flow channel chart (1991). These consistent results across questionnaires lead to our conclusion that real-time gaming is indeed more immersive, exciting and engaging than turn-based gaming.

Looking specifically at game types, we found card games were rated significantly lower for flow than chess and video games. Csikszentmihalyi (1991) notes one cannot do the same thing at the same level for long without growing bored or frustrated. As mentioned in Section 3.4, a round of cards takes less time than a round of chess or video games so participants were able to complete several rounds of cards and chess before the first ten minutes were up. As a result, participants may have experienced repetition-induced boredom. Moreover, as a player's skills improve over time, the challenge needs to increase as well. While Speed and RealTimeChess did offer increasing level of challenge as participants progressed through the levels (by speeding up the AI opponent), their turn-based counterparts did not. The overall lower challenge of card games and the lack of increase in challenge for turn-based cards and chess games most likely resulted in their lower flow scores.

4.5.2 Research Question 2 (Planning)

How does pace mechanic facilitate planning ahead in a decision-making environment?

The ultimate goal of the Social Innovation Lab is to bring experts from various fields together so they can gain system insight and work together on developing innovative, interdisciplinary solutions for complex social problems. One of the tools provided to these experts will be the cooperative strategy game currently under development at SiG@Waterloo. The intention is for experts to use this game to play out prospective solutions for problems and see the effects their solutions have on various demographics and variables. While our first research question tackled the problem of engaging people quickly when they may not have hours to spend playing a game, our second question looks to identify pace mechanic aspects that would enable participants to adopt big picture thinking.

Expert game designers assert that planning ahead is harder to do in real-time games due to added time pressure. In order to evaluate this, we measured pressure and tension using the IMI questionnaire in our study. Pressure-Tension is a negative predictor of intrinsic motivation which evaluates whether participants felt pressured to succeed in an activity (Deci & Ryan, 2003). As expected, participants reported feeling more pressure and tension while playing real-time games (with an overall response of 'somewhat true') than when playing turn-based games (with an overall response of 'slightly true'). Since our study only featured experienced participants, we predict this difference in pressure-tension would be even more significant for novice players.

In real-time games, expert game designers reason players are susceptible to anxiety and frequent adrenaline rushes as a result of increased pressure and tension with player attention being split between numerous units, buildings, production and many different events that are all happening at once (Shafer, 2013). In our study, we found that overall valence was indeed higher for real-time games, except in the case of video games. For video games, a closer look at the mapping of emotions revealed Age of Empires resulted in an alert/excited reaction while Civilization V evoked a happy/elated response (even though Civilization had higher valence than Age of Empires; see Figure

9). The overall mean for real-time games was in the high-arousal/high-valence Joyful quadrant while the overall mean for turn-based games was in the low-arousal/high-valence Calm section. Participants can be quoted having said that Solitaire was useful for "passing time out of boredom" and "relaxing" while Chess was good as a "calm[ing]" influence. The results of the current investigation therefore suggest that turn-based games are more calming than real-time games.

Game theorists have remarked that real-time games have a tendency to devolve into a "click-fest" which rewards manual dexterity, the ability to multitask, and rapid mouse-clicking over planning (Adams, 2014). Our free-form responses from the participants support this statement with multiple participants reporting they felt real-time games were useful for developing "fast reactive thinking" and improving response times in "chaotic" situations. One participant commented that he did not think of RealTimeChess as a strategy game at all as it was "all about speed now".

With participants experiencing higher pressure-tension and possible anxiety while playing real-time games, we expected to find higher scores of perceived choice, autonomy, and dominance for turn-based gameplay. Surprisingly, however, we did not have significant effects for pace mechanic on these three variables. For their seminal study, Ryan et al. (2006) compared four different game genres (massive multiplayer online, first-person shooter, adventure/roleplaying, and strategy games) on the PENS measures. While choosing genres, they did not make a distinction between real-time and turn-based games, and used Civilization III to be representative of the strategy game genre as a whole (a choice we previously questioned in Chapter 2). Amongst the four genres they sampled, they found the experience of autonomy was highest for strategy games. Since there was no significant difference for pace mechanic on autonomy or any of the PENS variables in our study, our result lends support to Ryan, Rigby, & Przybylski (2006)'s decision to use Civilization III to be representative of the strategy game genre without making a distinction between pace mechanics.

Even though our results for dominance, perceived choice, and autonomy were not statistically significant in favor of the overall turn-based pace mechanic, the free-form responses did highlight a common theme amongst turn-based games. The majority of participants remarked that they thought turn-based games were useful for "improving patience levels", "long term deeper planning", and "thinking ahead". In addition, the marginal mean values for dominance and perceived choice were both statistically higher for turn-based over real-time video games. In other words, participants felt significantly more in control playing Civilization V (with more options available to them than in Age of Empires). Surprisingly, the marginal mean dominance level was also higher for Real-Time Chess (over Chess). This unexpected result for Chess suggests further exploration with more statistical power or with multiple games may be necessary to make any claims about pace vs game mechanics and determine which aspects of RealTimeChess contributed to higher dominance levels.

4.5.3 Research Question 3 (Competence)

What effect does pace mechanic have on the perceived sense of competence and mastery in an attention-demanding environment?

According to Self-Determination Theory (Deci & Ryan, 2003), people are intrinsically motivated to seek out opportunities of experiencing control over outcomes. This question was important to answer for designing the SI Lab game as we wanted participants to maximize the information obtained from the game and feel effective using it to solve problems. In addition, Linehan et al. (2014) identified several studies that found playing a game is fun only once the player has mastered a sufficient proportion of the game challenges.

In our study, we used the Perceived Competence and Competence-Control measures from IMI and PENS, respectively, to measure how effective individuals felt when they were playing our selected games. Based on assertions about pace mechanic shared by expert game designers, we expected participants to feel more competent playing turn-based games. Surprisingly, there was no significant difference between the overall competence means for real-time and turn-based games. The marginal competence means were, however, significantly higher for the real-time chess and the turn-based video game than their counterparts. In other words, participants felt more competent playing RealTimeChess (over Chess) and Civilization (over Age of Empires). As noted previously, our hypotheses were based on video game literature and these significant interaction effects give us reason to believe a follow-up study focusing on video games is necessary. Additionally, a follow-up qualitative study would be useful to determine which aspects of RealTimeChess and Civilization V contributed to higher competence levels.

Looking at Effort-Importance, we surmised that micromanagement in turn-based gaming entails detailed decision-making and therefore would require more effort with greater importance given to each decision. Contrary to our hypothesis, however, participants playing real-time games reported putting in more effort and trying harder than participants playing turn-based games. A plausible explanation for this unexpected result can be obtained through a closer look at the statements that comprise the Effort-Importance measure such as “I put a lot of effort into playing this game” and “I tried very hard at this game”. While we were anticipating these statements would capture the minutiae activity that is characteristic of turn-based gameplay, they could just as well have been interpreted by participants to refer to taxing tasks in real-time games that require players to split their attention between multiple events happening at once. This is supported by the bulk of the free-form responses to the Value-Usefulness measure which describe the need to think quickly to succeed at real-time games, and fits well with the findings of Chaboissier et al.'s (2011) study, who found that it becomes increasingly difficult to keep track of actions and events outside a small focus the higher-paced a game gets.

4.6 Design Recommendations

Serious games leverage the motivational virtues of games to captivate and engage players towards the achievement of predefined objectives (Corti, 2006). Depending on what the objective of the game is, we recommend incorporating some aspect of real-time or turn-based mechanics into the gameplay. Our study was initiated to identify the pace mechanic elements most suitable for collaborative time-critical decision-making environments (such as the Social Innovation Lab) that would best aid people in making positive behavioral changes.

We found that, in settings that require rapid decision making for complex planning while using games as a tool, speeding up the pace may lead to higher engagement and immersion, but might also increase pressure and tension. Based on the results of our study, we suggest the following design recommendations: response chaining of twitch games and pace adjustment.

In strategy games, players must employ higher order thinking and problem solving skills while in twitch games, players must react quickly to the immediate circumstances to continue playing and win the game (Jones, 1999). Strategy games are ideal for seeing how different variables interact within a much larger system (Tannahill, Tissington, & Senior, 2012) but in turn-based games, the results of actions may not be immediately recognized. We recommend incorporating immediate feedback through twitch mini-games within a larger unifying problem to be solved. This reduces the feedback time through trial and error which in turn keeps the player actively engaged while reducing the learning curve for the overall game. A combination of twitch and strategy offers immediate results while still offering a greater feeling of accomplishment and satisfaction (Jones, 1999). One example of adding twitch gameplay to an existing turn-based game is to integrate short time limits for moves in traditional chess.

Based off of the work of behavioural psychologist B.F. Skinner, Linehan, et al. (2014) suggest game designers structure problem solving in games in such a way that it is a combination of previously learned responses. They recommend games teach players the discrete components of a complex skill individually before prompting them to chain the learned skills together to solver larger problems.

Adapting Linehan, et al.'s (2014) suggestion with our results on pace mechanic, we recommend introducing main skills separately in the SI Lab game as mini-twitch games. The player is then given the option to practice this new skill along with previously learnt skills, slowly building up the number of skills that can be chained together until players are expected to use all of them to solve the larger problem of the workshop. This process of gradually introducing simple behaviors, with challenge and complexity increasing slowly as the game progresses, also taps into flow components discussed in Section 4.5.1. In this manner, the game can keep new players constantly motivated and engaged with better feedback and appropriate bite-sized goals.

In their research on RealTimeChess, Chaboissier et al. (2011) introduced cool-down times (for pieces just moved) in order to encourage players to think about strategy in a fast-paced game. Similarly, we recommend providing players with the option to scale game and animation speeds in the SI Lab game. By doing so, player can select a pace that matches their skills: novice players can replay and review the execution phase of their move at will while advanced players can speed up to get to their next move.

Designers can mimic adapting pace to players by catering to both novice and expert players through separate levels of command (a beginner mode and an advanced mode e.g. keyboard shortcuts) such that inexperienced players have clear and easy ways to find commands whereas advanced players have quick access. Novice players can take their time figuring out the controls while advanced players are easily able to multi-task.

4.7 Summary

In this chapter, a series of repeated-measures analysis of variance (RM-ANOVA) statistical tests were conducted to examine differences between the data collected from four questionnaires (SAM, GEQ, PENS and IMI) during our study. Post-hoc pairwise comparisons with Bonferroni adjustment were then performed, for an alpha-value of $\alpha = .05$. Analysis of this data focused on identifying significant effects in support of our hypotheses and revealed differences between real-time and turn-based games. The findings from our data analysis are summarized in this section.

Summary of SAM Results	
Arousal	Mean arousal scores for real-time games were significantly higher than for turn-based games. We therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games are more arousing than turn-based games.* The marginal mean for arousal rose significantly in the first ten minutes as participants became familiar with the games, plateaued 20 minutes into gameplay and did not appreciably increase.
Valence	Mean valence scores for real-time games were significantly higher than for turn-based games. We therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games invoke more emotion than turn-based games.* Real-time games elicited higher mean valence scores than their turn-based counterparts except in the case of video games, which were flipped (i.e. valence for turn-based video game was higher than for real-time video games). Even though both invoked a positive arousal/valence response, a closer look at the mapping of emotions in the quadrants suggests Civilization V is situated close to the happy/elated emotion while playing Age of Empires results in an alert/excited reaction. Valence scores for real-time games rose over time, regardless of whether they started out lower or higher than the scores for turn-based games; for turn-based games, they remained fairly steady over the course of gameplay. A long-term study is needed to determine whether this persists after 30 minutes of gameplay.

Emotion	The marginal means, along with the overall mean, of real-time games were predominantly located in the Joyful quadrant while the turn-based means were spread out towards the Calm-Boredom quadrants. This is consistent with the written feedback from participants stating Solitaire (turn-based card game) is useful for "passing time out of boredom" and "relaxing", Chess is good as a "calm[ing]" influence, while RealTimeChess is "more exciting" and "fun".
Flow	Participants playing Age of Empires experienced an alert/excited reaction due to the higher level of arousal compared to dominance. The closer match of challenge and skill for Civilization V can be credited for the happy/elated emotion participants experienced.
Dominance	There was no significant difference between overall dominance means for real-time and turn-based games. We therefore do not have enough evidence to reject the null hypothesis. The marginal mean value for dominance was statistically higher for turn-based video games than real-time video games. In other words, as expected, participants felt significantly more in control playing Civilization V than Age of Empires III. Surprisingly, however, participants felt more dominant playing Real-Time Chess rather than Chess. Participants' dominance levels increased gradually over the course of 30 minutes of gameplay such that participants ended gameplay feeling significantly more dominant than when they started playing. A longer study is needed to establish whether dominance continues to rise with game play or whether there is a point at which it plateaus.

Table 17: Summary of SAM Results

Summary of GEQ Results	
Immersion-Presence	Mean immersion and presence scores for real-time games were significantly higher than for turn-based games. We therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games are more immersive than turn-based games.* In our study, participants found real-time cards and chess games to be more immersive, involving, and engaging than their turn-based counterparts (which only elicited neutral or negative responses); there was no significant difference between video games.
Flow	On average, participants felt out of flow (negative response) playing turn-based games while they did not feel in flow (neutral) playing real-time games.
Absorption	Participants in both conditions disagreed with the absorption statements (significantly more so in the case of turn-based games).
Engagement	Participants playing the turn-based games, on average, responded neutrally to or disagreed with the statements on the GEQ. Participants felt moderate levels of engagement playing real-time games by endorsing mostly presence and immersion statements. We therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games are more engaging than turn-based games.* Participants found real-time cards and chess games to be more engaging than their turn-based counterparts, but there was no significant difference between video games.

Table 18: Summary of GEQ Results

Summary of PENS Results	
Autonomy	Pace mechanic had no statistically significant effect on autonomy scores. We therefore do not have enough evidence to reject the null hypothesis.
Competence	There was no significant difference between overall competence means for real-time and turn-based games. We therefore do not have enough evidence to reject the null hypothesis. Our hypotheses were based on video game literature and the significant interaction effects show that the marginal mean scores for both Competence (PENS) and Perceived Competence (IMI) are higher for turn-based video games (over real-time video games) and real-time chess (over traditional chess). This, however, did not extend to card games and gives us reason to believe a follow-up study focusing on video games is necessary.
Presence-Immersion	There were no statistically significant effects of either of the independent variables on the PENS measure of presence-immersion. Many participants vocally reported having trouble rating the Presence-Immersion statements for Card and Chess games as these games lacked an obvious narrative and exploration component. In our study, there were 75 blank responses out of 7972 collected responses, with 68% coming from the Presence-Immersion (PENS) section.
Intuitive Controls	The only significant effect for Intuitive Controls was for game type. Please see Table 21 below.

Table 19: Summary of PENS Results

Summary of IMI Results	
Interest-Enjoyment	Mean interest-enjoyment scores for real-time games were significantly higher than for turn-based games. We therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games are more interesting/enjoyable than turn-based games*.
Effort-Importance	Mean effort-important scores for real-time games were significantly higher than for turn-based games. *Real-time games therefore require more effort than turn-based games*. This is consistent with feedback from participants stating real-time games felt more competitive and required participants to think quickly in order to succeed; thereby, requiring more effort.
Perceived Competence	Our results for Perceived Competence (IMI) were consistent with those for Competence (PENS). Please see Table 19 above.
Perceived Choice	Pace mechanic had no statistically significant effect on perceived choice scores. We therefore do not have enough evidence to reject the null hypothesis. There was a significant interaction between pace mechanic and game type such that perceived choice levels were significantly higher for turn-based over real-time video games.
Pressure-Tension	Participants reported feeling more pressure and tension while playing real-time games (with an average response just below “somewhat true” to the subscales) than when playing turn-based games (with an average response of “slightly true” to the subscales). We therefore reject the null hypothesis in favor of the alternative hypothesis: *real-time games are more stressful than turn-based games*.
Value-Usefulness	The only significant effect for Value-Usefulness was for game type. Please see Table 21 below.

Table 20: Summary of IMI Results

Summary of Game Type Results	
Arousal Presence Value-Usefulness	The marginal means of the card games were significantly lower than the marginal means of video games. There were no significant differences between the marginal means of chess and video games.
Immersion Flow Absorption Engagement Autonomy Interest-Enjoyment	The marginal means of the card games were significantly lower than the marginal means of chess and video games. There were no significant differences between the marginal means of chess and video games.
Intuitive Controls	The marginal Intuitive Controls mean of card games was significantly higher than the marginal means of chess and video games. There were no significant differences between the marginal means of chess and video games. It is likely that the higher reported level of Intuitive Controls for card games is due to the simplicity of these games.

Table 21: Summary of Game Type Results

Chapter 5
Conclusion and Future Work

In this thesis, we reported about an exploratory mixed-methods study used to evaluate the effect of pace mechanic and game type on player experience, motivation, and competence. The data collected allowed us to study a wide variety of interaction effects (such as real-time vs turn-based, cards vs chess vs video games, and trial 1 vs trial 2 vs trial 3) on affect, engagement, motivation, and needs satisfaction. Though the existence of a pace mechanic effect on gameplay cannot be unequivocally established on the basis of one study, our in-depth analysis of the results revealed a number of differences between the real-time and turn-based pace mechanic.

5.1 Contribution

We performed an exploratory study investigating the effect of pace mechanic and three different types of games (card, chess, and video) on player experience. The study provided evidence that there are differences in arousal, valence, immersion, presence, flow, absorption, engagement, autonomy, interest-enjoyment, effort-importance, and pressure-tension depending on pace mechanic.

Based on the findings from our study, we suggested a set of guidelines for designing strategy games to be used in time-critical collaborative decision-making environments. Our main message is: in settings that require rapid decision making for complex planning while using games as a tool, speeding up the pace may lead to higher engagement and immersion, but might also increase pressure and tension.

5.2 Future Work

Overall, we conclude that our study provided valuable insights into the different effects of real-time and turn-based pace mechanics. Since this study raised several issues that should be addressed in order to better design for time-critical collaborative decision-making environments, it can be considered only as a preliminary step to fully exploring pacing in serious strategy games. In this regard, the study achieved its initial goal since it was, in fact, intended as an exploratory study to add new research to the currently small and imperfect literature on pace mechanic effects. In this section, we discuss the aforementioned limitations of the study, which should be avoided when designing future studies, and avenues for future research:

1. Our study was intended to be an exploratory look at the effects of the two extreme ends of the pace mechanic spectrum (real-time and turn-based) on gameplay. Future studies may expand the scope by looking at hybrid games which feature a combination of the two pace mechanics (such as 'Pausable Real-Time').
2. The potential benefits of different pace mechanisms, in the context of learning a game for the first time, may be better understood if novice players are recruited. Our decision to recruit only experienced players helped us to limit training time and remove the learning curve of the games as a factor, allowing us to better focus on the games themselves. However, this approach may have introduced pre-existing biases into the data as many experienced players are known to personally prefer one pace mechanic over the other.
3. Some limitations of the participant pool should be noted. Given that mostly males were recruited in the chess and video games groups, it is possible that females may respond differently to the games. Additional work is needed to determine how the games perform with other samples, including participants from more diverse geographical areas and age groups.
4. As our study was short-term, we cannot make claims about the effects of pace mechanic on long-term gameplay. Longer sessions are needed to establish whether valence and dominance scores for real-time games continue to rise and whether the scores for turn-based games remain steady after 30 minutes of gameplay.
5. Our choice of games was restricted by our decision to find experienced participants. We intentionally picked popular games in order to have access to a bigger pool of participants. Our goal was to control for possible differences between the two games as much as possible; however, the games differ in other dimensions besides pace mechanic (such as the sophistication of the AI opponent) that may have had an effect on our measures. While our results do reveal a number of different effects, some of our results may apply more to specific game mechanics than to pace mechanic in general. Including more than one game for a pace mechanic and game type would likely address this issue. Our results are still relevant, however, as these are issues that researchers should be aware of while designing future studies.

Appendix A Recruitment

A. 1 Ethics Approval

From: **ORE Ethics Application System** <OHRAC@uwaterloo.ca>

Date: Thu, Apr 3, 2014 at 4:42 PM

Subject: Ethics Clearance (b) (ORE # 19773)

To: mark.hancock@uwaterloo.ca

Cc: h3anwar@uwaterloo.ca

Dear Researcher:

This is to advise that the ethics review of your application to conduct research:

Title: Effect of Coordination Policies (Real-time vs Turn-based) on Gameplay

ORE #: 19773

Faculty Supervisor: Mark Hancock (mark.hancock@uwaterloo.ca)

Student Investigator: Hala Anwar (h3anwar@uwaterloo.ca)

has been completed through a University of Waterloo Research Ethics Committee. Based on the outcome of the ethics review process, I am pleased to advise you that your project has received ethics clearance.

Note 1: This ethics clearance from a University of Waterloo Research Ethics Committee is valid for one year from the date shown on the certificate and is renewable annually. Renewal is through completion and ethics clearance of the Annual Progress Report for Continuing Research (ORE Form 105).

Note 2: This project must be conducted according to the application description and revised materials for which ethics clearance has been granted. All subsequent modifications to the project also must receive prior ethics clearance (i.e., Request for Ethics Clearance of a Modification, ORE Form 104) through the Office of Research Ethics and must not begin until notification has been received by the investigators.

Note 3: Researchers must submit a Progress Report on Continuing Human Research Projects (ORE Form 105) annually for all ongoing research projects or on the completion of the project. The Office of Research Ethics sends the ORE Form 105 for a project to the Principal Investigator or Faculty Supervisor for completion. If ethics clearance of an ongoing project is not renewed and consequently expires, the Office of Research Ethics may be obliged to notify Research Finance for their action in accordance with university and funding agency regulations.

Note 4: Any unanticipated event involving a participant that adversely affected the participant(s) must be reported immediately (i.e., within 1 business day of becoming aware of the event) to the ORE using ORE Form 106. Any unanticipated or unintentional change which may impact the research protocol, information-consent document or other study materials, must be reported to the ORE within 7 days of the deviation using ORE Form 107.

Best wishes for success with this study.

Julie Joza, MPH
Senior Manager
Office of Research Ethics
NH 1027
519.888.4567 ext. 38535
jajoza@uwaterloo.ca

A. 2 Recruitment Material

UNIVERSITY OF WATERLOO

MANAGEMENT SCIENCES

PARTICIPANTS NEEDED FOR A GAME STUDY

We are seeking participants for a study that will inform the design of strategy simulation games for use in collaborative decision making. If you choose to participate, you will be asked to play two computer games for a short period of time. During and after each game, you will also be asked to fill in a short questionnaire that inquires about your demographic information, the current state of the game and your experience.

We require participants to be familiar with the rules of the game(s) from any one of the following groups:

Group 1:
Chess

OR **Group 2:**
BOTH Age of Empires 3
and Civilization 5

OR **Group 3:**
Solitaire
(or any other traditional card game)

Please contact **Hala Anwar** at h3anwar@uwaterloo.ca or **scan the QR code below** if you are interested in participating in our study. In your email, please specify whether you have experience playing the game(s) in Group 1, Group 2 and/or Group 3. If you specify more than one group, we will assign you to one of the groups.
Please note: You will not be able to participate in more than one group and must be 18 or older.

The session will last approximately 1.5-2 hours and will be held between April 28 and May 23, 2014 in the TouchLab (Room 3641 in Carl Pollock Hall on the University of Waterloo campus).

You will receive a $15 gift card to Amazon.ca or J&J Cards & Collectibles for your participation in this study.

This project was reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee.

Please note: Age of Empires 3 is rated TEEN. Civilization 5 is rated EVERYONE 10+

Recruitment Email

***FOR INTERNAL EMAIL:** This email has been sent to [list name] on behalf of researchers from the Department of Management Sciences at the University of Waterloo.*

***FOR EXTERNAL EMAIL:** This email is a request for [Organization name]'s assistance with a project we are conducting as part of our Master's degree in the Department of Management Sciences at the University of Waterloo under the supervision of Dr. Mark Hancock. It is our hope to connect with people who are regular customers of [Organization name]'s to invite them to participate in our research as we believe you have unique understandings and experiences relating to gaming. To respect their customers' privacy, [Organization name] will be distributing this email to its clientele on our behalf.*

We are seeking participants for a study that will inform the design of strategy simulation games for use in collaborative decision making. If you choose to participate, you will be asked to play two computer games. During and after each game, you will be asked to fill in a short questionnaire that inquires about your demographic information, the current state of the game and your experience.

We require participants to be familiar with the rules of the game(s) from any one of the following groups:

Group 1: Chess
OR
Group 2: BOTH Age of Empires 3 and Civilization 5
OR
Group 3: Solitaire (or any other traditional card game)

Please contact Hala Anwar at h3anwar@uwaterloo.ca if you are interested in participating in our study.
In your email, please specify whether you have experience playing the game(s) in Group 1, Group 2 and/or Group 3. If you specify more than one group, we will assign you to one of the groups.
Please note: You will not be able to participate in more than one group and must be 18 or older

The session will last approximately 1.5-2 hours and will be held between [Date] and [Date] 2014 in the TouchLab (Room 3641 in Carl Pollock Hall on the University of Waterloo campus). You will receive a $15 gift card to Amazon.ca for your participation in this study.

This project was reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. *Please note: Age of Empires 3 is rated TEEN. Civilization 5 is rated EVERYONE 10+.*

Thank you,

Hala Anwar
Student Investigator
Department of Management Sciences
University of Waterloo

A. 3 Consent Form

UNIVERSITY OF WATERLOO

Information Letter

Title of Project:	Effect of Coordination Policies (Real-time vs Turn-based) on Gameplay		
Student Investigator:	Hala Anwar	Management Sciences	h3anwar@uwaterloo.ca
Faculty Supervisor:	Mark Hancock	Management Sciences	mark.hancock@uwaterloo.ca
	☎ 519-888-4567 Ext: 36587		

Summary of the Project:

The purpose of our research is to inform the design of strategy simulation games for use in collaborative decision making. There are many situations in which decision makers only have a small window of time to learn how a simulation works, accept it as a valid and useful analysis tool, and maximize the information obtained from its use. To this end, our research explores whether coordination policies and type of game are contributing factors to how quickly players are able to 'pick up' (learn) the game. For the study, you will be asked to play one session of a Real-Time game and one session of a Turn-Based game on a computer. During and after each game, you will be asked a few questions about the state of the game at that moment in time and your mental workload.

Procedure:

1. After you have had time to review the information letter/consent form, a quick demonstration of the games, rules and instructions will be provided. You will then be given a few minutes to practice the games on the computer and familiarize yourself with the setting.
2. You will then be asked to play (in random order) one session of a Real-Time game (e.g. Age of Empires 3) and one session of a Turn-Based game (e.g. Civilization 5) on the computer.
3. The computer will automatically log the events and record video of all gameplay. With your agreement, I would like to also video tape the session to correlate game events with real world events such as you exhibiting emotion (e.g. a shout of excitement or a sigh of defeat). No video will be included in the thesis or publication without your explicit consent.
4. Intermittently during the game, you will be interrupted by a pop-up computer prompt asking a few questions about the state of the game at that moment in time and your mental workload.
5. After gameplay, you will be asked to provide demographic information (such as age, gender and experience playing games) and fill in a questionnaire comparing the two game sessions.
6. If further details are required or clarification is necessary, you may be asked to elaborate on your experience in a short unstructured in-person interview.
7. In appreciation of your time, you will receive a $15 gift card to Amazon.ca or J&J Cards & Collectibles for your participation in this study. The amount received is taxable. It is your responsibility to report the amount received for income tax purposes.

519-888-4567 | uwaterloo.ca | 200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1

UNIVERSITY OF
WATERLOO

Risks and Benefits:

There are no known or anticipated risks from participation in this study other than those associated with the normal use of computing devices. By participating in our research, you will contribute directly to our understanding of the role of coordination policy in the design of strategy simulation games.

Confidentiality and Data Security:

All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study; however, with your permission, anonymous quotations may be used. In these cases, participants will be referred to as Participant 1, Participant 2… (or P1, P2…). A pseudonym will be given to any organization participants are recruited from.

All paper notes will be confidentially destroyed after five years. All electronic data (including video and audio recordings) collected during this study will be retained indefinitely with no personal identifiers in locked drawers or on password protected computers in a secure location accessible only to researchers associated with this project.

You will be explicitly asked for consent for the use of video or audio data for the purpose of reporting the study's findings. If consent is granted, this data will be used only for the purposes associated with teaching, scientific presentations, publications, and/or sharing with other researchers and you will not be identified by name. You will be provided with the option to have your face or any identifying marks blurred from the photos or video used for the presentation of research results.

The surveys in the study use Google Forms which is a United States of America company. Consequently, USA authorities under provisions of the PATRIOT Act may access this survey data. Your name will not appear in the survey data; instead, you will only be referred to as Participant 1, Participant 2… (or P1, P2…) so confidentiality will be maintained. If you prefer not to submit your data through Google Forms, please inform the Student Investigator so you can participate using a paper-based questionnaire.

Contact Information and Research Ethics Clearance:

If you have any questions about participation or would like additional information to assist you in reaching a decision about participation, please contact Hala Anwar via email at h3anwar@uwaterloo.ca. You may also contact Mark Hancock (the faculty supervisor) as listed above.

We would like to assure you that this study has been reviewed and has received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact the Office of Research Ethics as listed below:

Dr. Maureen Nummelin, Director of the Office of Research Ethics

☎ 1-519-888-4567 Ext: 36005 / maureen.nummelin@uwaterloo.ca

Thank you for your assistance in this project.

519-888-4567 | uwaterloo.ca | 200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1

Consent Form

- I have read the information presented in the information letter about a study being conducted by **Hala Anwar** of the **Management Sciences** department at the **University of Waterloo** under the supervision of **Prof. Mark Hancock.**
- I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.
- I am aware that I may allow excerpts from my responses during the study to be included in presentations and publications related to this project, with the understanding that any quotations will be anonymous.
- I am aware that I may allow audio and video recordings to be used in presentations and publications related to this project with the understanding that I will not be identified by name.
- I am aware that I may withdraw my consent for any of the above statements or withdraw my study participation at any time without penalty by advising the Student Investigator.
- This project has been reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact Dr. Maureen Nummelin (Director of the Office of Research Ethics) at 1-519-888-4567 Ext: 36005 or maureen.nummelin@uwaterloo.ca.

	Please Circle One		**Please Initial Your Choice**
With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.	**YES**	**NO**	____
I agree to my game sessions being audio and video recorded.	**YES**	**NO**	____
I agree to let my responses during the sessions be directly quoted, anonymously, in presentation of the research results.	**YES**	**NO**	____
I agree to let audio and video recordings be used for presentation of the research results.	**YES**	**NO**	____
I request my face or any identifying marks be blurred from the photos or videos used for presentation of the research results.	**YES**	**NO**	____

Participant Name ______________________________ (Please print)

Participant Signature ______________________________

Witness Name ______________________________ (Please print)

Witness Signature ______________________________

Date ______________________________

Appendix B Study Material

B. 1 Game Instructions

Group 3: Card Game

Klondike Solitaire

SETUP: The game is played with a single pack of 52 playing cards. 28 cards are placed face down to form the tableau which consists of 7 columns of 1, 2, 3, 4, 5, 6 and 7 overlapping cards from left to right respectively. The exposed card at the end of each tableau column is turned face up. The remaining cards are placed face down to form the stock. The game then begins.

OBJECTIVE: Build the four foundations up in ascending suit sequence from Ace to King. e.g. A, 2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K with cards of identical suit.

RULES:

The cards facing up in the Tableau piles and the Stock pile are available for play.

As each Ace becomes available, it may be transferred to a row above the tableau to start one of the four foundations. The foundations are built up in ascending suit sequence to the King.

The exposed card of a tableau column may be transferred to:
1. a foundation of the same suit if it follows the ascending sequence or
2. to another column if it forms a descending sequence of alternating colours, e.g. **6♥** on **7♣** or **Q♠** on **K♥**.

If the movement of a tableau card exposes a face down card, then it is turned face up.

When a tableau column is completely cleared out, the space may only be filled by a King.

When no more moves are available from the tableau, the top card from the stock is dealt face up to the waste pile. When the stock has been exhausted, the waste pile is picked up and turned over to form a new stock and the game continues.

The game is won when all cards are moved into the 4 foundations.

Speed

SETUP: Each player is dealt four cards to form a hand and two cards are placed face up in the center.

OBJECTIVE: Get rid of all your cards as quickly as possible.

RULES:

Players do not take turns.

Using cards from your hand, you must place cards one above or one below either of the center cards, e.g. a pile with a 8 on top may have a 9 or a 7 placed on it, but not another 8. Ace is both a high and low card, considered one value above a King as well as one below a two, so that the cards form a looping sequence.

When both players run out of options for play, the cards in the central piles are replaced.

A player wins by running out of cards in his hand before the other player.

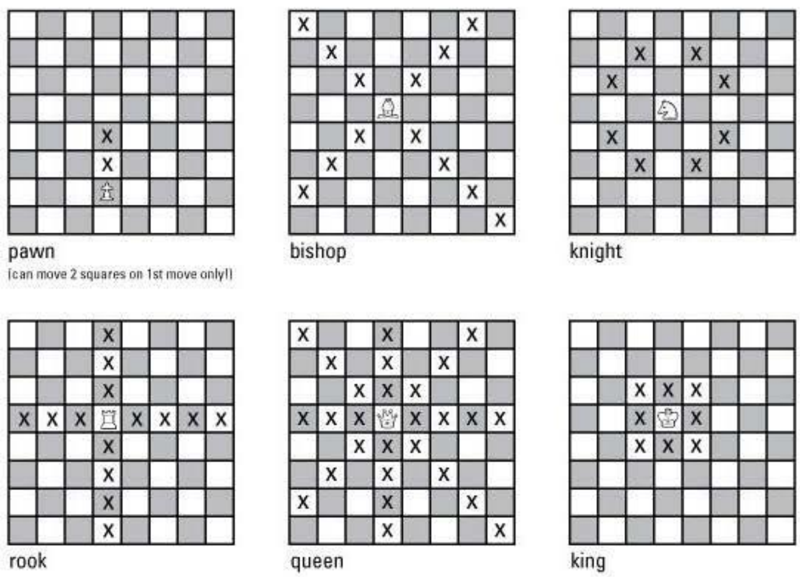
Each level, the computer gets faster at discarding its cards.

Group 1: Chess

Chess

A chess piece's power is tied to its mobility. The more mobile a piece is, the more powerful it is:

- **Pawns:** Pawns can only move forward. On their first move, they can move one or two squares. Afterwards, they can move only one square at a time. They can capture an enemy piece by moving one square forward diagonally.
- **Bishops:** Bishops can move any number of squares diagonally.
- **Knights:** Knights can move only in an L-shape, one square up and two over, or two squares over and one down, or any such combination of one-two or two-one movements in any direction.
- **Rooks:** Rooks can move any number of squares, up and down and side to side.
- **Queens:** Queens can move any number of squares along ranks, files and diagonals.
- **Kings:** Kings can move one square at a time in any direction.



In chess, *check* is an attack on an enemy king; this attack can't be ignored. If the check can't be neutralized, it is *checkmate* and the game is over. *Stalemate* occurs when one player has no legal moves, but his king isn't in check.

Here are a few additional details on check, checkmate, and stalemate in chess:

Check: An attack on a king by either an opposing piece or an opposing pawn is called *check*. When in check, a player must do one of the following:

- Move the king so that it's no longer under attack.
- Block the attack by interposing a piece between the king and the attacker.
- Capture the attacking piece.

Checkmate: When a king is in check and can't perform any of the preceding moves, it has been *checkmated*. If your king is checkmated, you lose the game. The term *checkmate* is commonly shortened to simply *mate*.

Stalemate: *Stalemate* is the relatively rare situation when a player whose king isn't in check has no legal move to make. Stalemate is considered a draw. Neither player wins, but the game is over.

Group 1: Chess

<u>Real Time Chess</u>

OBJECTIVE: Win by capturing your opponent's King.

RULES:

Standard chess rules apply in terms of how the pieces move, but you don't have to wait for your opponent to make a move before making another one of your own.

The only time restriction is on individual pieces, e.g. in the photo below: the Knight on C3 has just moved and is highlighted. The highlight will fade up like a counter and when the color is gone, the piece is free to move again.

The match ends when one of the players' King is captured. There is no check or checkmate.

Group 2: Strategy Games

Age of Empires 3

City Name: StudyVille

Explorer Name: Bismarck

Civilization: Germans
"Free Uhlans with every shipment. Two kinds of villagers. Best units: Skirmisher, Uhlan"

Game Type: Skirmish Deathmatch

Players start with 20,000 Food, 20,000 Wood, 10,000 Gold and 5,000 Stone. The high resources allow players to quickly expand the empire with a strong army and workforce.

Team 1: You (Germany), (Suleiman) Ottomans / **Team 2:** (Elizabeth) England, (Napoleon) France

Map: Hispaniola
"Surrounded by sea, this huge island promises conflict on both land and water. Inland, Carib tribes lives in the jungle around the base of an impassable mountain. Extra starting crates of food will help you jumpstart your early economy. Whales in the western bay are a strategic secondary source of coin. "

Difficulty: Moderate

Starting Age: Industrial Age

Game Speed: Moderate

Group 2: Strategy Games

Civilization 5

Civilization: Bismarck – Germany (Furor Teutonicus)
"Upon defeating a Barbarian unit inside an encampment, there is a 50% change you earn 25 Gold and they join your side. Pay 25% less for land unit maintenance."

Map Type: Pangaea
"All players start on one large landmass. There may be small islands off of the main continent."

Team 1: You (Germany), (Suleiman) Ottomans **at war with** **Team 2:** (Elizabeth) England, (Napoleon) France

Difficult Level: Prince (Normal)

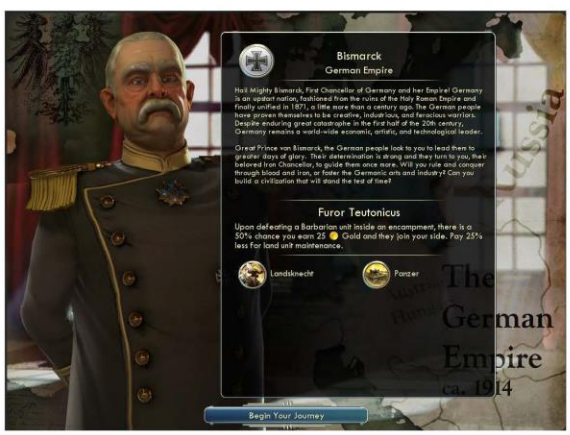
Game Pace: Quick

Game Era: Industrial

Resources: Legendary Start (3000 Gold, 500 Culture and 3 Free Technology)

Victory types: Time, Domination
- Domination: you achieve a domination victory if you are the last player in possession of your original capital. You do not have to wipe out all other players entirely! It does not matter who controls the other capital cities: you can, for example, let another player take all the other capital cities but yours and then take their capital, at which point you win immediately. Also, if two other players capture each other's original capitals, you will win the game even if you weren't at war with either of them.
- Time: Time victory is achieved by the player with the highest score by the end of the time period, assuming that no one has achieved any of the above victory types. The deadline for a time victory is usually the year 2050 AD. Scores are based on the amount of gold in the players' treasuries, the number of resources they possess, the amount of land they own, how many technologies they have researched, the number of wonders in their cities, their total city population, the number of cities, and how many military units they control.

One-City Challenge: Human players are only ever allowed to build or own one city.

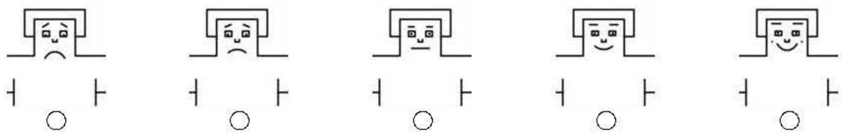


B. 2 Questionnaires

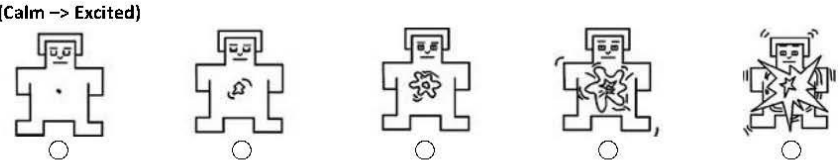
Participant ID: __________ Game: ______________________ ◯1 ◯2 ◯3

Self-Assessment Manikin (SAM)

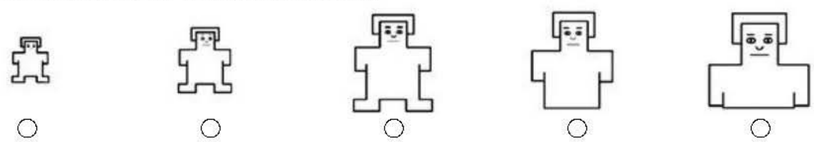
1. Valence (Negative –> Positive Feeling)



2. Arousal (Calm –> Excited)



3. Dominance (Controlled/Reactive –> In-Control/Proactive)



Game Engagement Questionnaire

	Strongly Disagree	Disagree	Moderately Disagree	Neutral	Moderately Agree	Agree	Strongly Agree
I lose track of time.							
Things seem to happen automatically.							
I feel different.							
I feel scared.							
The game feels real.							
If someone talks to me, I don't hear them.							
I get wound up.							
Time seems to kind of standstill or stop.							
I feel spaced out.							
I don't answer when someone talks to me.							
I cannot tell that I'm getting tired.							
Playing seems automatic.							
My thoughts go fast.							
I lose track of where I am.							
I play without thinking about how to play.							
Playing makes me feel calm.							
I play longer than I meant to.							
I really get into the game.							
I feel like I just can't stop playing.							

Participant ID: ___________ Game: _______________________ ◯1 ◯2 ◯3

PENS (Player Experience of Need Satisfaction)

Please reflect on your gaming experience and rank the level of your agreement with the following statements:

	Strongly Disagree	**Disagree**	**Moderately Disagree**	**Neutral**	**Moderately Agree**	**Agree**	**Strongly Agree**
The game provides me with interesting options and choices.							
The game lets you do interesting things.							
I experienced a lot of freedom in the game.							
I feel competent at the game.							
I feel very capable and effective when playing.							
My ability to play the game is well matched with the game's challenges.							
When playing the game, I feel transporte d to another time and place.							
Exploring the game world feels like takin g an actual trip to a new place.							
When moving through the game world I feel as if I am actually there.							
I am not impacted emotionally by events in the game. (-)							
The game was emotionally engaging.							
I experienced feelings as deeply in the game as I have in real life.							
When playing the game I feel as if I was part of the story.							
When I accomplished something in the game, I experienced genuine pride.							
I had reactions to events and characters in the game as if they were real.							
Learning the game controls was easy.							
The game controls are intuitive.							
When I wanted to do something in the game, it was easy to remember the corresponding control.							

Participant ID: ___________ Game: _______________________ ◯1◯2◯3

Intrinsic motivation inventory (IMI)

1 = Not at all true; 4 = Somewhat true; 7 = Very true							
	1	**2**	**3**	**4**	**5**	**6**	**7**
I enjoyed playing this game very much.							
Playing this game was fun to do.							
I thought playing this game was a boring activity. (-)							
This game did not hold my attention at all. (-)							
I would describe this game as very interesting.							
I thought this game was quite enjoyable.							
While I was playing this game, I was thinking about how much I enjoyed it.							
I think I am pretty good at this game.							
I think I did pretty well at this game compared to other participants.							
After playing this game for a while, I felt pretty competent.							
I am satisfied with my performance at this game.							
I was pretty skilled at this game.							
This was a game that I couldn't do very well. (-)							
I put a lot of effort into playing this game.							
I didn't try very hard to do well at this game. (-)							
I tried very hard on this game.							
It was important to me to do well at this game.							
I didn't put much energy into playing this game. (-)							
I did not feel nervous at all while playing this game. (-)							
I felt very tense while playing this game.							
I was very relaxed when playing this game.							
I was anxious while playing this game.							
I felt pressured while playing this game.							

Participant ID: ___________ Game: _______________________ ◯1 ◯2 ◯3

1 = Not at all true; 4 = Somewhat true; 7 = Very true							
	1	**2**	**3**	**4**	**5**	**6**	**7**
I believe I had decision making choices while playing this game.							
I felt like some decisions were not my own choice during the game. (-)							
I didn't really have a choice about making some decisions. (-)							
I felt like I had to make some decisions. (-)							
I made some decisions because I had no choice. (-)							
I made some decisions because I wanted to.							
I made some decisions because I had to. (-)							
I believe playing this game could be of some value to me.							
I think that playing this game is useful for _____________________							
I think playing this game is important to do because it can ____________________							
I would be willing to play this game again because it has some value to me.							
I think playing this game could help me to ____________________							
I believe playing this game could be beneficial to me.							
I think playing this game is an important activity.							

B. 3 Questionnaire Subscales

Game Engagement Questionnaire (GEQ)	
Immersion	I really get into the game.
Presence	Things seem to happen automatically. My thoughts go fast. I play longer than I meant to. I lose track of time.
Flow	I don't answer when someone talks to me. I cannot tell that I'm getting tired. If someone talks to me, I don't hear them. I feel like I just can't stop playing. The game feels real. I get wound up. Playing seems automatic. I play without thinking about how to play. Playing makes me feel calm.
Absorption	I feel scared. I lose track of where I am. I feel different. Time seems to kind of standstill or stop. I feel spaced out.

Table 22: GEQ Subscales

Intrinsic Motivation Inventory (IMI)	
Interest-Enjoyment	I enjoyed playing this game very much. Playing this game was fun to do. I thought playing this game was a boring activity. (-) This game did not hold my attention at all. (-) I would describe this game as very interesting. I thought this game was quite enjoyable. While I was playing this game, I was thinking about how much I enjoyed it.

Perceived Competence	I think I am pretty good at this game. I think I did pretty well at this game compared to other participants. After playing this game for a while, I felt pretty competent. I am satisfied with my performance at this game. I was pretty skilled at this game. This was a game that I couldn't do very well. (-)
Effort-Importance	I put a lot of effort into playing this game. I didn't try very hard to do well at this game. (-) I tried very hard on this game. It was important to me to do well at this game. I didn't put much energy into playing this game. (-)
Pressure-Tension	I did not feel nervous at all while playing this game. (-) I felt very tense while playing this game. I was very relaxed when playing this game. I was anxious while playing this game. I felt pressured while playing this game.
Perceived Choice	I believe I had decision making choices while playing this game. I felt like some decisions were not my own choice during the game. (-) I didn't really have a choice about making some decisions. (-) I felt like I had to make some decisions. (-) I made some decisions because I had no choice. (-) I made some decisions because I wanted to. I made some decisions because I had to. (-)
Value-Usefulness	I believe playing this game could be of some value to me. I think that playing this game is useful for: I think playing this game is important to do because it can: I would be willing to play this game again because it has some value to me. I think playing this game could help me to: I believe playing this game could be beneficial to me. I think playing this game is an important activity.

Table 23: IMI Subscales

Player Experience of Needs Satisfaction (PENS)	
Autonomy	The game provides me with interesting options and choices. The game lets you do interesting things. I experienced a lot of freedom in the game.
Competence	I feel competent at the game. I feel very capable and effective when playing. My ability to play the game is well matched with the game's challenges.
Presence-Immersion	When playing the game, I feel transported to another time and place. Exploring the game world feels like taking an actual trip to a new place. When moving through the game world I feel as if I am actually there. I am not impacted emotionally by events in the game. The game was emotionally engaging. I experienced feelings as deeply in the game as I have in real life. When playing the game I feel as if I was part of the story. When I accomplished something in the game I experienced genuine pride. I had reactions to events and characters in the game as if they were real.
Intuitive Controls	Learning the game controls was easy. The game controls are intuitive. When I wanted to do something in the game, it was easy to remember the corresponding control.

Table 24: PENS Subscales

Appendix C Statistical Analysis Details

C. 1 Missing Values

For SAM and GEQ, all blank responses were independent of one another (all different participants) and were replaced with the mean of the participant's responses for this statement from the other two trials.

Question/Statement	Measure	Questionnaire	Occurrence
n/a	Arousal	SAM	1/216
n/a	Valence	SAM	1/216
n/a	Dominance	SAM	1/216
I feel spaced out	Absorption	GEQ	3/216
Playing seems automatic	Flow	GEQ	1/216
My thoughts go fast	Presence	GEQ	1/216

Table 25: Blank responses from SAM and GEQ Questionnaire

This table provides a breakdown of the PENS and IMI statements that had missing values and the frequency of the occurrence compared to the total number of times the variable was measured.

Question/Statement	Measure	Questionnaire	Occurrence	Percentage breakdown
The game lets you do interesting things.	Autonomy	PENS	1/72	Cards: 100% Chess: 0% Video: 0%
When playing the game, I feel transported to another time and place.	Presence-Immersion	PENS	4/72	Cards: 25% Chess: 50% Video: 25%
Exploring the game world feels like taking an actual trip to a new place.	Presence-Immersion	PENS	8/72	Cards: 50% Chess: 50% Video: 0%
When moving through the game world I feel as if I am actually there.	Presence-Immersion	PENS	8/72	Cards: 50% Chess: 50% Video: 0%
I am not impacted emotionally by events in the game.	Presence-Immersion	PENS	3/72	Cards: 66% Chess: 33% Video: 0%

The game was emotionally engaging.	Presence-Immersion	PENS	2/72	Cards: 100% Chess: 50% Video: 0%
I experienced feelings as deeply in the game as I have in real life.	Presence-Immersion	PENS	4/72	Cards: 50% Chess: 50% Video: 0%
When playing the game I feel as if I was part of the story.	Presence-Immersion	PENS	10/72	Cards: 60% Chess: 40% Video: 0%
When I accomplished something in the game I experienced genuine pride.	Presence-Immersion	PENS	4/72	Cards: 50% Chess: 50% Video: 0%
I had reactions to events and characters in the game as if they were real.	Presence-Immersion	PENS	8/72	Cards: 50% Chess: 50% Video: 0%
Learning the game controls was easy.	Intuitive Controls	PENS	1/72	Cards: 0% Chess: 100% Video: 0%
The game controls are intuitive.	Intuitive Controls	PENS	2/72	Cards: 0% Chess: 100% Video: 0%
When I wanted to do something in the game, it was easy to remember the corresponding control.	Intuitive Controls	PENS	2/72	Cards: 0% Chess: 100% Video: 0%
I would describe this game as very interesting.	Interest-Enjoyment	IMI	1/72	Cards: 0% Chess: 100% Video: 0%
I think I am pretty good at this game.	Perceived Competence	IMI	1/72	Cards: 0% Chess: 100% Video: 0%
I think I did pretty well at this game compared to other participants.	Perceived Competence	IMI	2/72	Cards: 0% Chess: 100% Video: 0%
I felt like some decisions were not my own choice during the game. (-)	Perceived Choice	IMI	1/72	Cards: 100% Chess: 0% Video: 0%
I didn’t really have a choice about making some decisions. (-)	Perceived Choice	IMI	1/72	Cards: 100% Chess: 0% Video: 0%

I felt like I had to make some decisions. (-)	Perceived Choice	IMI	2/72	Cards: 100% Chess: 0% Video: 0%
I made some decisions because I had no choice. (-)	Perceived Choice	IMI	3/72	Cards: 100% Chess: 0% Video: 0%
I made some decisions because I wanted to.	Perceived Choice	IMI	3/72	Cards: 66% Chess: 0% Video: 33%
I made some decisions because I had to. (-)	Perceived Choice	IMI	4/72	Cards: 50% Chess: 0% Video: 50%

Table 26: Blank responses from PENS and IMI Questionnaire

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