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Author
Craighead, Britney Nicole

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The Dynamics of Rewards and Punishments in Video Games: A Content Analysis

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by

Britney Nicole Craighead

Committee in Charge:

Professor René Weber, Chair

Professor W. James Potter

Professor Daniel Linz

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The Thesis of Britney Nicole Craighead is approved.

W. James Potter

Daniel Linz

René Weber, Committee Chair

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Britney Nicole Craighead

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ABSTRACT

The Dynamics of Rewards and Punishments in Video Games: A Content Analysis

by

Britney Nicole Craighead

In recent years, concerns over video game addiction have increased. Both individual factors (such as impulsivity and reward sensitivity) and content features in video games (such as reward and punishment features) play a role in the development of video game addiction. In the current study, a content analysis coding procedure is developed in order to categorize the reinforcement schedules of three existing commercial video games from three different genres. Our findings indicate that the reward features in the game *The Mighty Quest for Epic Loot* resembles a partial reinforcement schedule while the reward features in the games *Team Fortress 2* and *Destination Sol* resemble a continuous reinforcement schedule. This key finding demonstrates that the reward content features in commercial video games can be classified along a theoretically meaningful dimensions put forth by Operant Conditioning Theory. Furthermore, in this study we pilot tested several outcome measures related to video game addiction that will be crucial to our conceptualization of video game addiction in the future including a measure of playing time, game enjoyment, trait impulsivity, a measure of behavioral impulsivity, and the game addiction scale. We found that the video game with a partial reinforcement schedule was significantly more enjoyable than the video games with a continuous reinforcement schedule.

The Dynamics of Rewards and Punishments in Video Games: A Content Analysis

The purpose of the current study is to develop a content analysis coding procedure and codebook to identify the reinforcement schedules in existing commercial video games from various genres. In recent years, concerns over video game addiction have grown (Griffiths, Kuss, & King 2012). Video game addiction is a behavioral addiction that occurs when content features in video games (e.g., reinforcement schedules) interact with individual factors (e.g., impulsivity) to produce negative outcomes (e.g., conflict, problems, displacement). In the current study, we focus on one side of this equation: the content features in video games. Operant Conditioning Theory (Ferster & Skinner, 1957), more specifically the partial reinforcement schedule of rewards, has been identified as one of the most important game features influencing video game addiction (Király, Griffiths, & Demetrovics, 2015; King, Delfabbro, & Griffiths, 2010a). It is assumed that video games employ sporadic, partial reinforcement reward schedules and that partial reinforcement schedules influence player behavior (King et al., 2010a). Game designers often allude to Operant Conditioning Theory when discussing development strategies for successful reward and punishment mechanisms within games. However, game companies do not make information about the actual payout of rewards and punishments in their video games publically available. Thus, there is a disconnect between the actual reward schedules in commercial video games and knowledge about those reward schedules in academic circles. To bridge this gap, we create a content analysis coding procedure to map the frequency and duration of reward and punishment features in existing commercial video games. Mapping the content in video games is an important first step toward understanding how content affects player behavior.

This current study predominately focuses on the content features in video games. However, understanding how individual differences influence video game addiction will be vital to conceptualizing and measuring video game addiction in the future. To gain more insight, we also conducted a pilot study of outcome measures related to addiction including measures of trait impulsivity, behavioral impulsivity, and video game addiction scale scores. To present this information clearly, the current thesis has been divided into three chapters. Chapter 1 presents the theoretical definitions of video game addiction and impulsivity, describes the rationale and hypotheses for the content analysis study, and describes the method. Chapter 2 presents the results and discussion of the content analysis study. Finally, in Chapter 3 we present the results and discussion of our pilot test of the outcome measures that are related to video game addiction.

Chapter 1: Theoretical Definitions and Rationale

Video Game Addiction

Broadly speaking, there are two types of addiction: chemical and behavioral. Traditionally, chemical addictions are characterized by a dependence on a substance that pharmacologically hijacks the reward circuitry in the brain (Karim & Chaudhri, 2012). By comparison, behavior is motivated by an interaction between the environment and evolved systems that motivate individuals to engage in rewarding activities while avoiding negative experiences (Lang, 2009). Crucially, even in the absence of drug taking, behaviors can induce chemical changes in the brain's reward networks that are similar to those seen in substance addiction (Koepp, et al., 1998) transforming naturally occurring rewards into repetitive craving or seeking behaviors (Karim & Chaudhri, 2012). Video game addiction has been conceptualized as a behavioral addiction (Kuss & Griffiths, 2012; Kuss, Louws, &

Wiers, 2012; Ng & Weimer-Hastings, 2005). The term behavioral addiction has been applied to a variety of behaviors including gambling, Internet and media use, eating disorders, physical exercise, and pathological working (Alavi et al., 2012). The terms video game addiction, excessive game use, problematic game use, and Internet gaming disorder (among others) are used within the literature, yet they appear to be different terminology for similar phenomenon and outcomes (Griffiths et al., 2012). For the sake of clarity and consistency, we use the term video game addiction to describe this phenomenon, except when citing others. The following section will provide a broad overview of the current state of video game addiction research focusing on two topics that have been explored extensively: the prevalence of video game addiction and the correlates or outcomes of video game addiction.

Prevalence of Video Game Addiction

Estimates of the prevalence of video game addiction vary widely. One review of studies from various Western countries indicated that video game addiction affects between 1.5% and 11.6% of gamers (Kuss, van Rooij, Shorter, Griffiths, & van de Mheen, 2013). A representative sample in Germany found that 0.2% of individuals across all age groups are addicted and that 3.7% are problematic users (Festl, Scharkow, & Quandt, 2014). Some studies have focused specifically on adolescent gamers. For instance, a study in the Netherlands sampled adolescents between the ages of 13 and 16 found that 3% of adolescent online gamers are addicted (van Rooij, Schoenmakers, Vermulst, van den Eijnden, & van de Mheen, 2011). A stratified nationally representative sample of adolescent in the United States identified 11.9% of boys and 2.9% of girls as pathological (addicted) game users

(Gentile, 2009). A survey in Singapore classified 9.9% of adolescents as pathological (addicted) gamers (Gentile et al., 2011).

One factor that may be contributing to the variation in findings is the lack of a conceptual definition of video game addiction. Definitive criteria for diagnosing video game addiction do not yet exist. Video game addiction scales have been based on a variety of criteria. These scales are typically derived from measurement scales developed for other addictive or problematic behaviors. For instance, the game addiction scale (GAS; Lemmens, Valkenberg, & Peter, 2009) is informed by the Diagnostic and Statistical Manual (DSM; American Psychiatric Association, 2013) criteria for gambling disorder and the scale includes seven dimensions (salience, tolerance, mood modification, withdrawal, relapse, conflict, and problems). The video game addiction test (VAT; van Rooij, Schoenmackers, van den Eijnden, Vermulst, & van de Mheen, 2012) is adapted from a compulsive Internet usage scale and includes five dimensions (loss of control, conflict, preoccupation/salience, coping/mood modification, and withdrawal symptoms). The problem video game playing scale (PVP; Tejeiro Salguero & Bersabé Morán, 2002) is based on the DSM criteria for substance dependence and pathological gambling and includes six dimensions (preoccupation, tolerance/loss of control, withdrawal/escape, lies and deception, disregard for physical or psychological consequences, and family/schooling disruptions).

Each scale includes similar dimensions, yet the scales use a variety of cut-off points to assess addiction. This may contribute to the variation in estimates of the prevalence of video game addiction. In some cases, the scales do not specify cut-off points. Tejeiro Salguero and Bersabé Morán (2002) indicated that further research is needed to determine the cut-off points for classifying addicted individuals with the PVP scale. This body of research suggests that video game addiction is a problem—at least for some individuals—yet there is disagreement about how to define and diagnose this problem. Understanding how content features and individual factors contribute to addictive outcomes may help us to address these issues.

Correlates of Video Game Addiction

Several studies have examined the correlates of video game addiction focusing on personality, biological, and environmental factors that predict or are associated with video game addiction. Predictors of video game addiction for adolescents include living in single-parent households, game playing time, and the use of violent games (Rehbein & Baier, 2013). Children who demonstrate impulsive behavior, who have lower social competence and empathy, or who have poor emotion regulation are more likely to develop an addiction to video games (Gentile et al., 2011). Negative consequences of video game addiction include forfeiting time for family, friends, work, education, and sleep. Video game addiction is associated with increased stress and decreased psychological well-being (Griffiths et al., 2012). Pathological gaming in children is associated with lower grades and poorer parent-child relationships (Gentile et al., 2011). Video game addiction is also associated with negative physiological consequences such as epileptic seizures, obesity, wrist and neck pain, sore tendons, numbness of extremities, and sleep abnormalities (Griffiths et al., 2012).

Previous findings indicate that adolescent and young-adult males are most likely to develop an addiction to video games (Rehbein & Baier, 2013; Zanetta Dauriat et al., 2011; Ko, Yen, Chen, Chen, & Yen, 2005). In a sample of German school children, Rehbein and Baier (2013) found that male gender was the strongest predictor of video game addiction in adolescents. Zanetta Dauriat and colleagues (2001) used a self-selected sample of gamers and analyzed video game addiction and motivations to play, specifically in the context of massively multiplayer online role-playing games (MMORPGs). They concluded that gender was a significant predictor of video game addiction finding that males are more likely to be addicted to video games. Ko et al. (2005) recruited junior high school students in Taiwan to examine the role of gender in video game addiction. They found that male adolescents were more likely to be addicted to online video games than female adolescents. Taken together, these results suggest that video game addiction may be more prevalent amongst adolescent and young adult males. Conversely, others have found that the differences in rates of video game addiction between male and females are small and non-significant. Festl et al. (2013) found that 4.1% of males and 3.2% of females are problematic gamers. King, Delfabbro, and Griffiths (2013) found that gender is not significantly related to video game addiction. Perhaps the finding that males are more likely to be addicted to video games is an artifact of sampling bias. Many studies rely on self-selected samples and males are over-represented in these samples (Griffiths et al., 2012). Another issue that could contribute to these differences in findings is that gender and sex are not clearly defined within these studies. While each of these studies used the term gender, it is important to note that the researchers measured participants' self-identified biological sex. They did not measure participants' gender—a term which refers to social or cultural differences rather than biological ones. Although the terms gender and sex are often used interchangeably within video game studies (Lucas & Sherry, 2004), researchers should be mindful of how they define and use these terms. Based on current video game addiction research, it is unclear sex differences exist in the rates of video game addiction. If there are in fact differences in rates of addiction between males and females, it would be useful to determine if there are underlying biological factors that contribute these differences or if these differences are an artifact of socialization and culture.

Finding personality, biological, and environmental correlates of video game addiction has enhanced our understanding of the factors involved in video game addiction. Yet, these factors are broad. The observation that adolescent male players have a stronger tendency towards addiction does not help us to make meaningful predictions about who is most susceptible to video game addiction. Game content features have the potential to influence gameplay behavior, including addiction. In the following section, we elaborate on the link between game content features and video game addiction. Focusing on the content features in games may be one way to enhance our ability to predict susceptibility to video game addiction.

Reward and Punishment Features in Video Games

Video game content features likely influence player behavior, including addiction (King et al., 2010a). Specific game content features have largely been overlooked in previous research, yet several studies have indicated that game genre is associated with video game addiction. For instance, addicted individuals tend to play MMORPGs (Berle, Starcevic, Porter, & Fenech, 2014; Zagalo & Gonçalves, 2014; van Rooij et al., 2011; Ng & Weimer-Hastings, 2005), first person shooter games, action adventure games, or gambling games (Elliott, Golub, Ream, & Dunlap, 2012). This line of research suggests that, for some players, some video games may have a higher addiction potential than others. Playing MMORPGs is often associated with video game addiction, yet it is important to note that the majority of gamers who play MMORPGs do not exhibit signs of addiction (van Rooij, Kuss, Griffiths, Shorter, Schoenmakers, & van de Mheen, 2014). Focusing broadly on game genre as a predictor of video game addiction ignores the specific content features within games (such as reward schedules) that influence gameplay behavior.

In the area of problematic gambling, researchers recognize that the structural characteristics of slot machine programs contribute to the continued use of slot machines (Griffiths & Wood, 2000). Various structural characteristics of gambling machines, including the probability of winning, light and sound effects, and event frequency, have the potential to promote excessive gambling and can produce psychologically rewarding experiences, even while players are losing these games (Griffiths, 1993). While there are many types of gambling games, research on slot machine usage is particularly informative for video game addiction research. Parallels have been drawn between disordered slot machine gambling and video game addiction (Griffiths & Woods, 2000). However, there are important differences between the stimuli involved in these problematic behaviors (i.e., slot machines and video games). The reward structures in slot machine games and video games share similarities, but one key difference between gambling and gaming is that video games do not typically feature monetary rewards. Moreover, one of the latest trends in video game development is the inclusion of social features as an integral aspect of gameplay. Gambling sometimes involves multiple participants or social features. However, in video game play, the social features themselves are often highly rewarding. Furthermore, gambling games do not involve narratives and stories as many video games do and it is well known that humans are inherently attracted to stories as a form of survival-relevant information exchange (Ohler & Nieding 2005).

Drawing on this body of research, some scholars have explored the relationship between specific video game features and excessive use of video games. Early work in this area identified typologies of content features that players find enjoyable or important to the gameplay experience. Based on a self-selected sample of gamers, Wood, Griffiths, Chappell, and Davies (2004) identified 12 content features that are important to all gamers (sound, graphics, background and setting, duration of game, rate of play, advancement rate, use of humor, control options, game dynamics, winning and losing features, character development, brand assurance, and multiplayer features). King, Delfabbro, and Griffiths (2010a) identified psycho-structural elements that may be related to problematic game play. They developed a game feature taxonomy that includes social, manipulation and control, narrative and identity, reward and punishment, and presentation features. An empirical follow-up study demonstrated that reward and punishment features (i.e., winning or losing points, finding rare items) were rated as the most important and enjoyable aspects of gameplay (King, Delfabbro, & Griffiths, 2010b). While useful for conveying which content features in games are meaningful to players, typologies do not explain why players engage in specific gameplay behaviors, or which game features may be contributing to addiction.

Taking this work a step further, one experiment examined the link between content features in video games and player behavior. Chumbley and Griffiths (2006) examined the effects of reward and reinforcement features on self-reported affective response and willingness to continue gameplay. They found that an increase in the ratio of positive reinforcement to negative reinforcement features increased self-reported propensity to continue playing and to return to gameplay in the future. This provides evidence that manipulating content features in games, such as reward structures, may lead to an increase in playing time.

Operant Conditioning Theory suggests that it is not rewards that influence behavior, but rather the schedule of rewards (Ferster & Skinner, 1957). Operant Conditioning Theory posits that rewards are dispersed according to various reward schedules. For instance, in a continuous reinforcement schedule, individuals are consistently rewarded for performing a particular behavior. In a partial reinforcement reward schedule, individuals are rewarded sporadically for a particular behavior, or the amount or type of reward they receive may vary each time. Importantly, the partial reinforcement schedule is more effective at maintaining behavior than the continuous reinforcement schedule (Jenkins, 1962; Theios, 1962). Video games often feature sporadic rewards that mimic the partial reinforcement schedule. It is common for video games to feature rewards that are easily obtained early on in gameplay. As players progress through the game, reward schedules become less predictable and in-game rewards become more difficult to achieve. When playing games with sporadic rewards (i.e., partial reinforcement effects), players are less likely to quit gameplay when compared to playing games with predictable rewards (King et al., 2010a). It is assumed that these sporadic reward schedules motivate gameplay behaviors and play a critical role in video game addiction (Király et al., 2015; King et al., 2010a). However, with few exceptions (Chumbley & Griffiths, 2006), this assumption has not been tested empirically. Traditionally, researchers who used an Operant Conditioning framework manipulated reward schedules and observe behavioral outcomes. In the current study, we take a different approach and use a content analysis coding procedure to identify existing reinforcement schedules within video games, analyzing the types, prevalence, and duration of rewards and punishments in video games.

Existing typologies of content features in games provide a useful starting point for defining and identifying rewards and punishments in video games (King et al., 2010a; Wood et al., 2004). In broad terms, reward and punishment features refer to the ways in which players are reinforced for their playing behavior. In video games, rewards are primarily psychological in nature (i.e., players rarely receive monetary or external rewards). King and colleagues (2010a) identified multiple reward and punishment content features in games including general reward type, punishment, meta-game reward, negative reward, and near-miss features. In addition, they identified features that pertain to the frequency and disbursement of rewards including event frequency, event duration, and intermittent reward features. Reward features can include in-game currency, points, in-game items, or access to new levels or areas of the game map. Punishments are essential in order to establish the contextual worth of rewards and to show players that progress is skill-based. Punishment features can include failing an objective, losing an in-game item or resource, or being required to restart a level. Game designers often allude to or directly discuss Operant Conditioning Theory when discussing reward and punishment mechanisms in video games (Hopson, 2001; Isigan, 2010). However, information about the payout of rewards and punishments within existing commercial video games is not publically available. It is assumed that reward schedules are sporadic, yet scholars know little about the frequency or proportion of rewards and punishments in existing video games or how reinforcement schedules vary across games from different genres.

Impulsivity and Impulse Control

Impulsivity and impulse control are related to both chemical and behavioral addictions. In broad terms, impulsivity is the tendency to engage in inappropriate or maladaptive behaviors (de Wit, 2008) or to act spontaneously without consideration for consequences (Carver, 2005). Impulsivity involves irrationality, which manifests as a failure to maximize one's own best interest (Monterosso & Ainslie, 1999). Impulsive behavior is thought to be the result of an inability to process the magnitude of rewards or an inability to delay rewards (Cardinal, Winstanly, Robbins, & Everitt, 2004). As mentioned previously, there is currently no agreed upon definition or measure for video game addiction. Gaining a better understanding of how impulsivity and impulse control interact with video game addiction scales may settle ambiguities in measuring video game addiction.

Impulsivity has been conceptualized as a multidimensional construct, though scholars differ somewhat in their classifications of these dimensions. Dawe and Loxton (2004) assert that impulsivity is comprised of the sub-dimensions of reward sensitivity and rash spontaneous impulsivity. There is individual variation in sensitivity to rewards and some individuals are highly sensitive to naturally rewarding stimuli such as eating, socializing, and participating in novel activities. Rash spontaneous impulsivity involves the inability to control or inhibit behavior and is associated with the inability to resist cravings. Cross, Cooping, and Campbell (2011) conceptualize impulsivity as increased sensitivity to reward and decreased sensitivity to punishment. Unconditioned and conditioned rewards, along with the absence of punishment, drive approach motivation. Impulsive individuals are willing to tolerate risks in pursuit of novel experiences and stimuli. Heightened sensitivity to rewards can generate feelings of hope, elation, and satisfaction. This can lead to movement towards goals, not just towards risky behaviors or sensation-seeking behaviors. However, impulsive behavior manifests when individuals are less sensitive to punishment and negative consequences. Individuals who are sensitive to punishment feel negative emotions, such as anxiety, in response to actual or anticipated punishment. They have a heightened awareness of negative consequences that could result from their actions. Lower punishment sensitivity may lead individuals to behave in ways that go against their own best interest.

Impulsivity has been widely studied in relation to addiction and drug use. Deficiencies in impulse control have been linked to drug addiction (Fillmore, 2003; Bechara, 2005; Brewer & Potenza, 2008), gambling (Brewer & Potenza, 2008), Internet addiction disorder (Dong, Zhou, & Zhao, 2010) and video game addiction (van Rooij et al., 2014). Trait impulsivity has been implicated in drug experimentation (Brewer & Potenza, 2008; de Wit, 2008) and the development of substance use disorders (de Wit, 2008). In a study of cocaine users, Moeller et al. (2001) found that trait impulsivity was significantly related to self-reported daily cocaine use and severity of withdrawal symptoms. In a study of alcohol use, researchers found that drinking for enhancement reasons (i.e., to increase positive affect or feelings of euphoria) was related to a diminished ability to inhibit behavior while drinking for social or coping reasons was not (Colder & O’Connor, 2002).

Impulsivity and impulse control have also been studied in relation to video game addiction. Indeed, some have conceptualized video game addiction as an impulse control disorder (Desai, Krishnan-Sarin, Cavallo, & Potenza, 2010; Gentile et al., 2011). Findings suggest that video game addiction shares psychological and neural mechanisms with other impulse control disorders and with chemical addictions (Hellman, Schoenmakers, Nordstrom, & van Holst, 2013). One study examined the relationship between online gaming addiction, aggression, self-control, and narcissistic personality traits (Kim, Namkoong, Ku, & Kim, 2007) and found that self-control is negatively correlated with online gaming addiction. In a study comparing professional video game players to addicted gamers, Han, Lyoo, and Renshaw (2012) found that participants with online gaming addiction showed higher scores of trait impulsivity compared to professional video game players. Taken together, these studies indicate that impulsivity and impulse control are important constructs for understanding behavioral addictions including video game addiction.

Rationale

A common assumption in previous work is that the reward and punishment features in video games influence video game addiction. Over the past several decades, research using an Operant Conditioning Theory framework has indicated that reinforcement schedules influence behavior. Seeing the similarities between the partial reinforcement effect and reward mechanisms in video games, scholars have postulated that video game reinforcement schedules are a crucial factor in addictive behavior. Based on observations of the reward mechanisms and content features present in commercial video games, it is logical to assume that video games employ a partial reinforcement schedule of rewards. The vanguard in video game addiction research is to generate empirical research to test this assumption.

Reward and punishment mechanisms vary across game titles. It is likely that in some games, rewards resemble a continuous reinforcement schedule while in other games they resemble a partial reinforcement schedule with other games falling somewhere along this continuum. To address this issue, in the current study we develop a content analysis coding procedure that can be applied to video games from a variety of genres. Reward schedules are likely to vary across games from different genres. For instance, in first-person shooter games, the goal is to harm other avatars while avoiding harm making it likely that first-person shooter games will contain more punishment features and less reward features than strategy games.

To develop the codebook and coding procedure, three games were selected from different genres. These games have unique, genre-specific goals that influence gameplay content features (e.g., harming enemies vs. collecting resources) and differing gameplay mechanics (e.g., timed matches versus open-ended gameplay) that are likely to influence reward schedules. For instance, *Team Fortress 2* (TF2) is an online first-person shooter game. In TF2, event duration is predetermined and players are given a fixed amount of time to complete an objective, a feature that is common in first-person shooter games. Reward type features include finding in-game items, shooting opponents, and cooperatively completing objectives that allow the team to win the round. Punishment features include being a part of a losing team or temporary removal from gameplay during respawn periods when an avatar dies. TF2 is a competitive first-person shooter game where the goal is to harm avatars on the other team while trying to avoid being harmed. Because harm avoidance is a central component of TF2, it is likely to have more punishment features than the other two video games in this study. *The Mighty Quest for Epic Loot* (MQEL) is a strategy and castle-defense game. As is common in strategy games, players must develop strategies to protect their fortress from other players. Players can choose to attack other castles (including castles created by other players) or they can invest time in building and defending their own castle. When looting other castles, players encounter reward type features including in-game currency and items that enhance an avatar's abilities. In-game currency can be used to buy items to fortify their castle's defenses. Event duration is not predetermined. Players often receive multiple reward features as a result of one in-game action and it is likely that MQEL will contain more reward features than the other games. *Destination Sol* (DS) is a single-player, space-themed, role-playing game. Players start off the game as a small spaceship and can explore an open-ended, space-themed map. Players can defeat enemy ships, harvest resources and money from asteroids, and buy or find equipment to build new ships. Because it is a role playing game, players have freedom to choose which locations on the map they would like to explore and to choose which in-game goals they would like to pursue. Reward type features include finding in-game items that can be used to make improvements to the player's ship, weapons for the ship, and in-game currency. Event duration is not predetermined and gameplay is open-ended. Because these game genres have different gameplay mechanisms and content features, the games in our sample are likely to contain different frequencies of reward and punishment features.

> H1: The frequency of reward and punishment content features will vary across the three games. TF2 will have the most punishment features while MQEL will have the most reward features. DS will have the fewest of both reward and punishment features.

In addition to examining the frequency of reward and punishment events, the current content analysis will examine the duration of reward and punishment events. The duration of these events could be an indicator the magnitude of reward and punishment features. For instance, smaller rewards may occur frequently during gameplay but the reward events may be short leading to a high number of reward events but a short duration of time spent experiencing reward events. Larger rewards may occur infrequently but last much longer leading to longer reward event durations. Thus, in addition to determining the frequency of events, the current content analysis coding scheme will examine the length of time that participants spend experiencing reward and punishment events during gameplay. The timing and duration of reward and punishment events will be recorded to allow us to examine the temporal information about reward and punishment features (i.e., the duration of rewards and punishments in games) to provide more information about the reinforcement schedule featured in each game.

> H2: The duration of reward and punishment events will vary across the games. MQEL will have the longest duration of reward events while TF2 will have the longest duration of punishment events. DS will have a shorter duration of both reward and punishment events.

In hypothesis 1 and hypothesis 2, we make predictions about the frequency and duration of all reward and all punishment content features. To provide a description of the reward and punishment features measured in this study in the codebook, content features were categorized into several subcategories including: major rewards, general rewards, health rewards, narrative rewards, violent rewards, major punishments, and general punishments. While we do not have preexisting predictions about which games will have a higher frequency of rewards or punishments within each of these categories, we will examine these frequencies in order gain a better sense of how rewards and punishments vary across the video games from different genres.

Operant Conditioning Theory (Ferster & Skinner, 1957) indicates that the schedule of rewards influences behavior in predictable ways. Individuals who experience a continuous reinforcement schedule are more likely to quit a behavior (i.e., behavioral extinction) than individuals who experience a partial reinforcement schedule. Operant Conditioning Theory, specifically the partial reinforcement schedule, has been identified as one of the most important game mechanisms influencing video game addiction (Király et al., 2015). Traditionally, researchers who use an Operant Conditioning framework manipulate reinforcement schedules and then observe behavioral outcomes. In the current study, we take a different approach and use a content analysis coding scheme to identify existing reinforcement schedules in video games, analyzing the types, prevalence, and temporal dynamics of rewards and punishments in video games. We expect that reinforcement schedules will vary across games from different genres and that some games will resemble a partial reinforcement schedule while others will resemble a continuous reinforcement schedule. To measure reinforcement schedules, we will examine how the frequency of reward and punishment events change over the course of video game play.

> H3: Video game reinforcement schedules will vary across the three video games. In some games, the reward features will more closely resemble a partial reinforcement schedule while in other games, the reward features will more closely resemble a continuous reinforcement schedule.

Method

Sample

In the current content analysis study, reinforcement schedules within existing commercial video games are the population of interest. Reinforcement schedules are an outcome of the distribution of reward and punishment content features in video games and these game content features emerge as a result of video game play. It is necessary to generate gameplay content for this study. It is not feasible to sample all video game titles, thus three video game titles from different genres were used in this study in order to develop the content analysis coding procedure. These games include *Team Fortress 2* (TF2; a violent, social, first-person shooter game), *The Mighty Quest for Epic Loot* (MQEL; a fantasy-themed, castle defense game), and *Destination Sol* (DS; an open-ended, space themed, role playing game). These games were selected because they are (1) free-to-play games that are easy for participants to download through the STEAM website (store.steampowered.com), (2) rated highly by players on the STEAM website, and (3) they represent different genres and are likely to contain different reward and punishment content features.

Data Generation Procedure

To generate gameplay recordings for this content analysis, a 6-week longitudinal study was conducted. Participants were recruited from undergraduate courses in the Department of Communication at the University of California, Santa Barbara (*n* = 16; female = 14). The mean age of participants was 20.13 years (range = 18 to 25, *SD* = 1.708). Participants were randomly assigned to play the games (TF2 *n* = 5; MQEL *n* = 5; DS *n* = 6). To control for player skill, only novice players were recruited. This decision was made to ensure that any differences in content observed across the three games are not due to player skill. The subjects participated in lab sessions during week 1 and week 6 of the study. During the 4 weeks in between lab sessions, participants played the assigned game from home and responded to weekly questionnaires. The detailed procedure is listed below.

During lab session 1, participants completed an initial questionnaire that included items related to demographic information, gameplay experience, perceived gameplay skill, and gameplay preferences. The questionnaire also included gaming addiction short scale items (GAS; Lemmens et al., 2009; see Table 1) and trait impulsivity scale items (BIS-11; Patton et al., 1995; see Table 2). To measure behavioral impulsivity, participants completed a cued go/no-go task (Fillmore et al., 2003). In the first lab session, participants were randomly assigned to play one of the video games. In the lab, participants played the game for 20 minutes while their gameplay was recorded. Participants received instructions to download the assigned game on their personal computer.

During the 4 weeks between lab sessions, participants played the assigned video game from home. This allowed participants to gain gameplay experience and ensured that the game recordings we collected during the two lab sessions were representative of typical gameplay content and not solely the content that occurs early on in gameplay, such as tutorials and introductory sequences. Participants also completed weekly questionnaires where they self-reported their playing time, enjoyment of the game, and indicated whether they played any other games during the week. Participants played the games from home on their personal computers and gameplay was not recorded during these four weeks of gameplay.

During week 6, participants returned to the lab for session 2. In this final lab session, participants completed a final questionnaire, which included repeated measures of several of the items participants completed in the first questionnaire. The questionnaire included items about gameplay skill, enjoyment, and preferences, the BIS-11 (Patton et al., 1995) trait impulsivity items, and the gaming addiction scale (Lemmens et al., 2009) items. Participants completed the go/no-go task (Fillmore et al., 2003), a task which measures behavioral impulsivity. Participants played the assigned game for 20 minutes while gameplay was recorded. For each participant, a total of 40 minutes of gameplay were recorded.

Coding Variables

The codebook contains several broad categories including: (1) major rewards, (2) general rewards, (3) health rewards, (4) narrative rewards, (5) violent rewards, (6) major punishments, and (7) general punishments (see Table 3).

Major rewards are rewards that are rare or valuable. Players often receive major rewards early on in gameplay. For instance, it is common for a player to receive a large amount of currency or to receive a weapon that allows players to begin their journey. As gameplay progresses, major rewards become more challenging to obtain and may require additional time and effort to procure. Major reward variables include: leveling up, beating a level or winning a match, receiving rare in-game items or rewards, completing a major game objective or quest, receiving bonus points or large amount of currency, gaining access to a previously hidden level or map, achieving a major goal, and purchasing expensive/rare in-game item. General rewards have a lower value associated with them and are more common than major rewards. For example, a player may obtain experience points frequently during gameplay. Once the player collects enough experience points, their avatar levels-up. Leveling up is a major reward and may give the avatar advantages such as increased health points or increased strength. General rewards include: obtaining points, obtaining in-game currency or coins, obtaining a resource or item, finding an ammo pack, increasing health point capacity, equipping an item, purchasing a small item, building or organizing the gameplay space, selling a small item, crafting or making an item, and the player's team achieving a minor in-game goal.

Three additional reward categories (i.e., narrative, health, and violence) were created in order to further refine the codebook. There are many reward features in games and separating general rewards into these categories made the task of coding more efficient for the coders. Narrative rewards include: receiving a new game objective, completing a game objective, and narrative encouragements. Receiving a new objective or completing a minor objective can drive the game narrative forward. Narrative encouragements are narrative elements of the game that encourage certain behaviors or allow the gameplay narrative to progress. Narrative encouragements often appear in the form of text (e.g., "critical hit" or “victory!”). Health rewards are reward features that improve the avatar’s health status and include obtaining health points, using a healing potion, or receiving health points from a teammate. Violence rewards categorize the types of opponents that were killed or destroyed by the avatar. Avatars can kill or destroy other avatars (characters controlled by another human player), small opponents (non-player characters), or inanimate objects (asteroids or machines). The opponents killed variable is a continuous variable that indicates the number of opponents that the avatar killed or destroyed during the time interval.

Major punishments are punishments associated with a high cost to the player. These include: the death of the player’s avatar, respawn periods (the avatar is temporarily removed from gameplay), running out of time to complete an objective, opponent(s) achieves a major goal, the player or the player’s team loses the game or match, the player fails to achieve a major objective or goal. General punishments are less costly to the player and tend to occur more often. For instance, losing mana (strength points) is inconvenient and slows down gameplay, but it does not exert a major cost on the player. General punishments include: losing health points, losing shield points or other defenses, losing an in-game item, setting off a bomb or trap, opponent(s) achieves a minor goal or reward, the player’s avatar is injured by a crash or fall, in-game discouragements (e.g., “you fail!”), and losing mana or strength points.

Coders

Two undergraduate research assistants served as the coders for this study. In exchange for assisting with this project, the coders received course credit. The coders received extensive training and participated in pilot testing early versions of the content analysis codebook. Pilot testing served the purpose of training the coders and ensuring that the codebook contained an exhaustive list of reward and punishment codes. Once the researcher and coders were satisfied that the codebook was exhaustive, intercoder reliability was assessed for practice recordings (video game recordings that were not generated by participants in this study). Using the practice recordings allowed the coders to ask questions and to ensure that they understood when and how to apply the codes.

Once the coders reached high intercoder reliability (Krippendorff's alpha of .70 or above) for the majority of codes in the practice recordings, the coders then coded the actual game recordings for the study. For each of the three video games, 40% of the video game recordings were coded by both of the coders. Krippendorff's alpha (Hayes & Krippendorff, 2007) was used to calculate intercoder reliability for these game recordings. The coders achieved high reliability for the majority of the variables in the coding scheme (see Table 4). For a small number of the variables, low intercoder reliability was obtained (in TF2, discouragements and obtained points; in MQEL, increase health point capacity; and in DS, purchase small item).

Unitizing

For this content analysis, it was necessary to construct coding units by unitizing reward and punishment events within the games. To accomplish this, the principal researcher coded the start and end times of all reward and punishment events that occurred within the game recordings. Reward and punishment events are in-game events that lead to either a reward or punishment outcome. To unitize these events, we recorded the start time as the second that an event leading to a reward or punishment began and recorded the end time as the second in which the outcome (reward/punishment feature) was last seen on screen. For example, in TF2, if a participant's avatar lost health points as a result of being shot by an opponent, the event trigger is the ammunition leaving the opponent's weapon and the event ends when the avatar's health points decrease. Alternatively, in MQEL, a participant might find a reward in the last room in the level. The reward event is triggered when the avatar enters the room and the event ends when the avatar collects the reward. The time intervals capture the duration of the event. After these events were unitized, two undergraduate coders then coded the reward and punishment features that occurred within each time interval.

Materials

Video Games. In order to develop a content analysis coding scheme that can be applied to multiple game titles, video games form three different genres were used in this study. STEAM (store.steampowered.com), an online game distributor, allows players to create a free online account and provides many popular free-to-play games. Three free-to-play games were selected from the STEAM online store. The STEAM store allows players to rate and recommend games. Each of the games selected for this study received positive ratings from gamers in the STEAM community. *Team Fortress 2* (TF2) is a first-person shooter game, which incorporates character customization and in-game trading. *The Mighty Quest for Epic Loot* (MQEL) is a single-player strategy/action game. It is a modern castle-defense game where players can build defenses in their castles or raid other castles to find loot. *Destination Sol* (DS) is a space themed single-player arcade-style role-playing game where players start off as a pilot of a small fighter ship on the edge of a star system. Gameplay is open-ended and players are free to land on planets, fight enemies, and mine resources from asteroids.

Gameplay Recording Software. Open Broadcaster Software (OBS) was used to record gameplay during lab sessions. During each lab session, participants played the video game in the lab for 20 minutes. The participants gameplay screen was recorded in order to allow coders to later content-analyze the video game recordings. OBS is free, open-source software that can be used to record high performance game streaming (obsproject.com).

Chapter 2: Content Analysis Results and Discussion

Results

Individually Generated Gameplay Content

Video games are an interactive medium and players generate unique content during gameplay. It is likely that the gameplay content generated within one video game title is similar across all players of the game. However, it is also possible that individuals with different gameplay skill levels generate different content. To control for differences in gameplay skill, we selected a sample of novice video game players to generate game content for this sample (total n = 16: TF2 n = 5; MQEL n = 5; DS n = 6). Participants' self-reported general gameplay skill remained low throughout the duration of the study (see Figure 1).

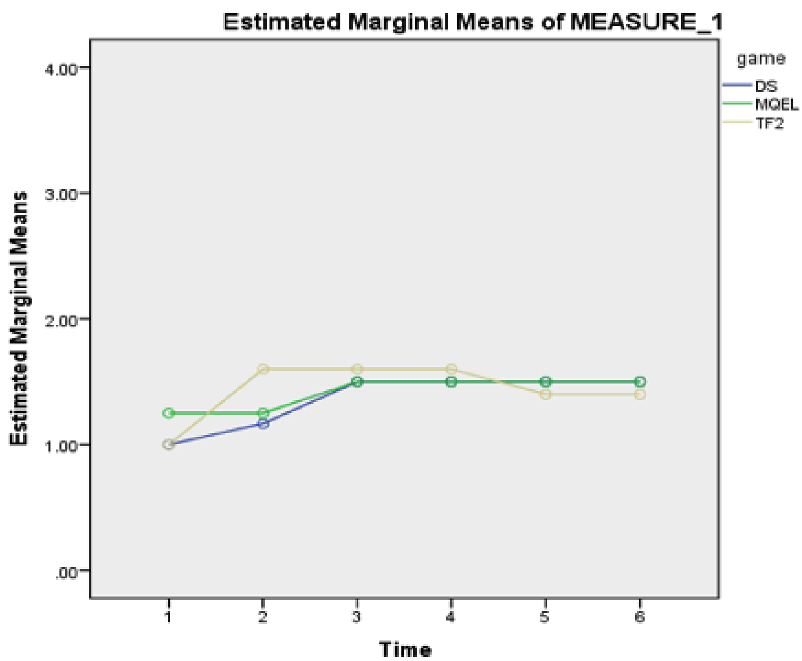


Figure 1. Self-reported general gameplay skill reported each week over the 6-week period. Time (week) is on the x axis and the mean self-reported skill is on the y-axis. Self-reported skill is measured on 4-point scale.

To check for potential differences in gameplay content, we conducted an intraclass correlation analysis in order to determine if players generated similar content within each video game title. Intraclass correlations can be used to measure the reliability of coders or to calculate correlations between pairs of observations that do not have an obvious order such as outcome measures in twin studies (Shrout & Fleiss, 1979). In the current study, we utilized intraclass correlation to determine if players generated similar content within each video game title. We calculated the intraclass correlation for the frequency of reward and punishment events across participants within each video game condition. This allows us to determine if gameplay content is similar within each video game condition. The intraclass correlation analysis utilizes a Cohen’s alpha coefficient to measure the correlation between observations. Because gameplay features are likely to change over time, we calculated separate intraclass correlations for gameplay at time 1 and time 2 separately. For gameplay at time 1, we found moderate to high correlations for reward content features indicating that participants generated similar reward content features (TF2 $\alpha = .714$; MQEL $\alpha = .546$; DS $\alpha = .29$). The games TF2 and DS each have a tutorial that most players chose to play through in the first lab session. The players who completed the tutorial are likely to generate similar gameplay content. When we examined only the participants who played the tutorial during the first session, the correlation coefficient improved for both TF2 ($\alpha = .774$) and for DS ($\alpha = .688$). The correlation coefficients were lower for punishment features and for both the reward and punishment features during time 2 (see Table 5). Thus, we conclude that participants generated similar reward content during the first gameplay session, but game content became less similar during time 2. Perhaps 4 weeks of independent gameplay led the participants to play through different levels of the video games or allowed them to achieve different skill levels during the second lab session.

Table 5

Intraclass correlations

Game	Lab Session	Content Features	Participants	Cronbach's alpha	Single Measure	Significance	Average Measure	Significance
TF2	1	Rewards	all	.714	.249	.000	.623	.000
TF2	1	Rewards	tutorial	.774	.384	.000	.714	.000
TF2	1	Punishments	all	.383	.087	.011	.322	.011
TF2	1	Punishments	tutorial	.363	.105	.014	.320	.014
TF2	2	Rewards	all	.005	-.101	.999	-.841	.999
TF2	2	Punishments	all	.087	-.020	.707	-.110	.707
MQEL	1	Rewards	all	.546	.146	.000	.462	.000
MQEL	1	Punishments	all	.226	.043	.117	.183	.117
MQEL	2	Rewards	all	.055	.005	.425	.027	.425
MQEL	2	Punishments	all	-.151	-.040	.872	-.237	.872
DS	1	Rewards	all	.290	.022	.221	.118	.221
DS	1	Rewards	tutorial	.688	.188	.000	.480	.000
DS	1	Punishments	all	.223	.010	.348	.059	.348
DS	1	Punishment	tutorial	.439	.137	.002	.388	.002
DS	2	Rewards	all	-.060	-.026	.817	-.183	.817
DS	2	Punishments	all	.095	.001	.465	.008	.465

Intraclass correlations were calculated to determine if participants played the game similarly. Reward features and punishment features were assessed separately. Lab session 1 (time 1) and lab session 2 (time 2) were assessed separately. During lab session 1, some participants chose to play a tutorial. Intraclass correlations were calculated separately for these participants.

Frequency of Reward and Punishment Content Features

Hypothesis 1 predicted that the frequency of reward and punishment content features would vary across the three games such that MQEL would contain the most reward features, TF2 would contain the most punishment features and DS would contain the least reward and punishment features. To test this hypothesis, we calculated the frequency (sum) of reward and punishment features that occurred within each game condition. We found that MQEL has the highest frequency of rewards followed by TF2 and DS (see Table 6). This finding supports the prediction in Hypothesis 1 (rewards: MQEL > TF2 > DS). Contrary to Hypothesis 1, DS had the highest frequency of punishments followed by TF2 and MQEL (punishments: DS > TF2 > MQEL) Chi-Square = 912.07, *df* = 2, *p* < .001.

Table 6

Reward and punishment frequency (events)

	Game Title			
	TF2	MQEL	DS	Total
Reward Frequency	517	2334	548	3399
Expected Count	678.3	1814.2	906.5	3399
Row	15.20%	68.70%	16.10%	100%
Column	48.70%	82.20%	38.60%	63.90%
Punishment Frequency	544	504	870	1918
Expected Count	382.7	1023.8	511.5	1918
Row	28.40%	26.30%	45.40%	100%
Column	51.30%	17.80%	61.40%	36.10%
Total Frequency	1061	2838	1418	5317
Expected Count	1061	2838	1418	5317
Row	20%	53.40%	26.70%	100%
Column	100%	100%	100%	100%

Chi-square = 912.07, *df* = 2, *p* < .001

It is possible that the reward and punishment features players are exposed to change over time as players' progress through a video game. The games TF2 and DS include a tutorial, which most participants chose to play through during the first lab session. MQEL includes a narrative sequence that introduces players to the gameplay world and allows players to choose an avatar. Because the gameplay narrative develops over time, game content features may vary from the first lab session to the second lab session. To observe how individual game content features change over time, we examined the overall mean frequency of each reward and punishment content feature, as well as the mean frequencies of content features in lab session 1 and lab session 2 (see Table 8 in Appendix). The frequency of some reward and punishment features changed over time. For instance, in TF2 players receive and complete more minor objectives during session 1. Participants who completed the TF2 tutorial received and completed several minor objectives that helped them to learn about the gameplay mechanics. During normal gameplay, larger objectives were more common. In MQEL, more narrative encouragements were received during session 2, more health points were lost during session 2, and avatars lost more mana during time 2. This suggests that some punishment features were more prevalent during the second gameplay session. In DS, more small opponents (i.e., spaceships) were destroyed during session 1 while more inanimate objects (i.e., asteroids) were destroyed during session 2. Perhaps this indicates that spaceships become more difficult to destroy over time or that players become more skilled at extracting resources from inanimate objects such as asteroids over time and spend less time engage in combat against other spaceships.

Some reward and punishment content features are more dependent on time than others. For instance, when an avatar dies in TF2, the player is temporarily removed from gameplay and the player is required to wait for respawn. The length of time that the player spends waiting for respawn is determined by the game. Likewise, matches within TF2 last for a period of time determined by the game. Thus, beating a level or winning a match can only occur after a predetermined amount of time. Leveling up requires players to obtain a certain number of experience points, which must be collected over time. In MQEL, a player can lose mana (strength points) when they use certain weapons and players must wait for mana to regenerate before they can use the weapon again. The reward and content features that are likely to be time-dependent are identified in Table 7 in the appendix.

Reward and punishment features were separated into the categories of major reward, general reward, narrative reward, health reward, violence reward, major punishment, and general punishment. Next we examined the summed event frequency of rewards and punishments within each of these reward and punishment categories for both events (see Table 8).

Table 8

Reward and punishment frequency (event)

	Game Title			
	TF2	MQEL	DS	Total
Major Reward	**15**	**95**	**1**	**111**
Expected Count	23.4	53.9	33.6	111
Row	13.50%	85.60%	0.90%	100%
Column	1.50%	4.20%	0.10%	2.40%
General Reward	**116**	**997**	**237**	**1350**
Expected Count	285.1	656.1	408.8	1350
Row	8.60%	73.90%	17.60%	100%
Column	11.70%	43.80%	16.70%	28.80%
Narrative Rewards	**205**	**207**	**151**	**563**
Expected Count	118.9	237.6	170.5	563
Row	36.40%	36.80%	26.80%	100%
Column	20.7%	9.1%	10.6%	12.0%
Health Rewards	**87**	**183**	**43**	**313**
Expected Count	66.1	152.1	94.8	313
Row	27.80%	58.50%	13.70%	100%
Column	8.8%	8.0%	3.0%	6.7%
Violence Rewards	**94**	**384**	**116**	**594**
Expected Count	125.4	288.7	179.9	594
Row	15.80%	64.60%	19.50%	100%
Column	9.5%	16.9%	8.2%	12.7%
Major Punishments	**208**	**14**	**57**	**297**
Expected Count	58.9	135.6	84.5	297
Row	74.60%	5.00%	20.40%	100%
Column	21.0%	0.6%	4.0%	6.0%
General Punishments	**264**	**396**	**813**	**1473**
Expected Count	311.1	715.9	446	1473
Row	17.90%	26.90%	55.20%	100%
Column	26.70%	17.40%	57.30%	32%
Total Frequency	**989**	**2276**	**1418**	**4683**
Expected Count	989	2276	1418	4683
Row	21.10%	48.60%	30.30%	100%
Column	100.00%	100.00%	100.00%	100%

Chi-square = 1546.67, $df = 12$, $p < .001$

Duration of Reward and Punishment Events

Hypothesis 2 predicted that the duration of reward and punishment features would vary across the three video games with MQEL having the longest duration of reward features, TF2 having the longest duration of punishment features and DS having the shortest duration of both reward and punishment features. To test this, we calculated the frequency of event seconds for reward events and punishment events within game recordings. In line with Hypothesis 2, MQEL had the longest duration of reward event seconds followed by TF2 and DS (see Table 9; reward seconds: MQEL > TF2 > DS). Contrary to Hypothesis 2, DS had the highest number of punishment event seconds followed by MQEL, and TF2 (punishment seconds: DS > MQEL > TF2). This is similar to the pattern of punishment event frequencies observed in Hypothesis 1 with one exception: TF2 had a higher mean frequency of punishment events than MQEL, but MQEL had a longer duration of punishment seconds than TF2 (Chi-Square = 3410.62, $df = 2$, $p < .001$). In the content analysis coding scheme, reward and punishment features were separated into the categories of major reward, general reward, narrative reward, health reward, violence reward, major punishment, and general punishment. Next we examined the summed frequency of reward and punishment event seconds within each of these reward and punishment categories (see Table 10).

Table 9

Reward and punishment duration (seconds)

	Game Title			
	TF2	MQEL	DS	Total
Reward Frequency	7370	24400	9538	41308
Expected Count	8456	21038.3	11813.7	41308
Row	17.80%	59.10%	23.10%	100%
Column	58.70%	78.10%	54.30%	67.30%
Punishment Frequency	5194	6859	8015	20068
Expected Count	4108	10220.7	5739.3	20068
Row	25.90%	34.20%	39.90%	100%
Column	41.30%	21.90%	45.70%	32.70%
Total Frequency	12564	31259	17553	61376
Expected Count	12564	31259	17553	61376
Row	21%	50.90%	28.60%	100%
Column	100%	100%	100%	100%

Chi-square = 3410.162, $df = 2$, $p < .001$

Table 10

Reward and punishment frequency (second)

	Game Title			
	TF2	MQEL	DS	Total
Major Reward	**51**	**844**	**169**	**1064**
Expected Count	326.2	517.2	220.6	1064
Row	4.80%	79.30%	15.90%	100%
Column	0.30%	2.60%	1.20%	1.60%
General Reward	**3723**	**12402**	**1361**	**17486**
Expected Count	5361	8500	3624.7	17486
Row	21.30%	70.90%	7.80%	100%
Column	18.50%	38.80%	10.00%	27%
Narrative Rewards	**2844**	**2585**	**3078**	**8507**
Expected Count	2608.1	4835.4	1763.4	8507
Row	33.40%	30.40%	36.20%	100%
Column	14.1%	8.1%	22.6%	12.9%
Health Rewards	**801**	**2442**	**1212**	**4455**
Expected Count	1365.8	2165.7	923.5	4455
Row	18.00%	54.80%	27.20%	100%
Column	4.0%	7.6%	8.9%	6.8%
Violence Rewards	**4722**	**8030**	**2614**	**15336**
Expected Count	4711	7469.7	3185.2	15336
Row	30.70%	52.30%	17.00%	100%
Column	23.4%	25.1%	19.2%	23.4%
Major Punishments	**502**	**170**	**2602**	**3274**
Expected Count	1003.8	1591.6	678.6	3274
Row	15.30%	5.20%	79.50%	100%
Column	2.5%	50.0%	19.1%	5.0%
General Punishments	**7513**	**5486**	**2592**	**15591**
Expected Count	4780	7579.1	3231.9	15591
Row	48.20%	35.20%	16.60%	100%
Column	37.30%	17.20%	19.00%	24%
Total Frequency	**20156**	**31959**	**13628**	**65743**
Expected Count	20156	31959	13628	65743
Row	30.70%	48.60%	20.70%	100%
Column	100.00%	100.00%	100.00%	100%

Chi-square = 15480.32, $df = 12$, $p < .001$

Assessing Reinforcement Schedules in Video Games

The analyses for hypotheses 1 and 2 provide information about the frequency of reward/punishment events and the duration of reward/punishment events. In order to categorize the reinforcement schedules in games, it is important to determine how reward/punishment features are distributed over time. For Hypothesis 3, we examined how the frequency of reward and punishment event seconds changed over time. Participants played the assigned video game for 20 minutes during each lab session. For the following analyses, these game recordings were partitioned into 80 segments (each segment contained 15 seconds of gameplay activity). Time series plots were generated to compare the mean number of reward and punishment features that occurred within each 15-second segment (see Figure 2). The time series plots demonstrate that the frequency of reward seconds within the time segments is higher in the game MQEL. In each of the games, punishment features increase over the 20-minute time period, perhaps indicating that gameplay becomes more challenging over time. For each video game, a linear regression analysis was conducted using reward or punishment means as the criterion variable and time segments as the predictor variable (see Table 11). For reward content features, the linear regressions were not significant. For punishment features, the linear regressions for TF2 and for DS were significant. However, the linear regression for punishments for MQEL was not significant. This suggests that the punishment features for TF2 and for DS vary more across time segments while the punishment features in MQEL are more consistent across time segments.

Table 11

Linear regressions examining the change in content features over time

Game	Content Feature	*F*	*t*	β	Significance
TF2	Rewards	.312	-.558	-.065	.578
TF2	Punishments	5.232	2.287	.259	.025
MQEL	Rewards	.105	.324	-.037	.747
MQEL	Punishments	.506	.711	.081	.479
DS	Rewards	.026	-.160	-.018	.873
DS	Punishments	8.767	2.961	.320	.004

Linear regression analyses examining the change in content features over time for each video game. The predictor variable is time segment (80, 15 second time segments) and the criterion is the type of content feature (rewards or punishments).

While the linear regression for rewards in MQEL was not significant, the time series plots suggest that MQEL has more reward features per time interval than the other two video games and that there is more variation in the frequency of reward features across the time segments. In a partial reinforcement schedule, we would expect the number of rewards to vary over time. In a continuous reward schedule, we would expect the number of rewards received to be consistent over the time intervals. The time series plots suggests that the frequency of reward features in MQEL vary across the 80, 15-second time segments. This may indicate that individuals sometimes receive multiple rewards for their actions during gameplay and sometimes they receive few rewards for their actions during gameplay. These findings led us to conclude that the reinforcement schedule in MQEL resembles a partial reinforcement schedule while the reinforcement schedules in TF2 and DS resemble a continuous reinforcement schedule.

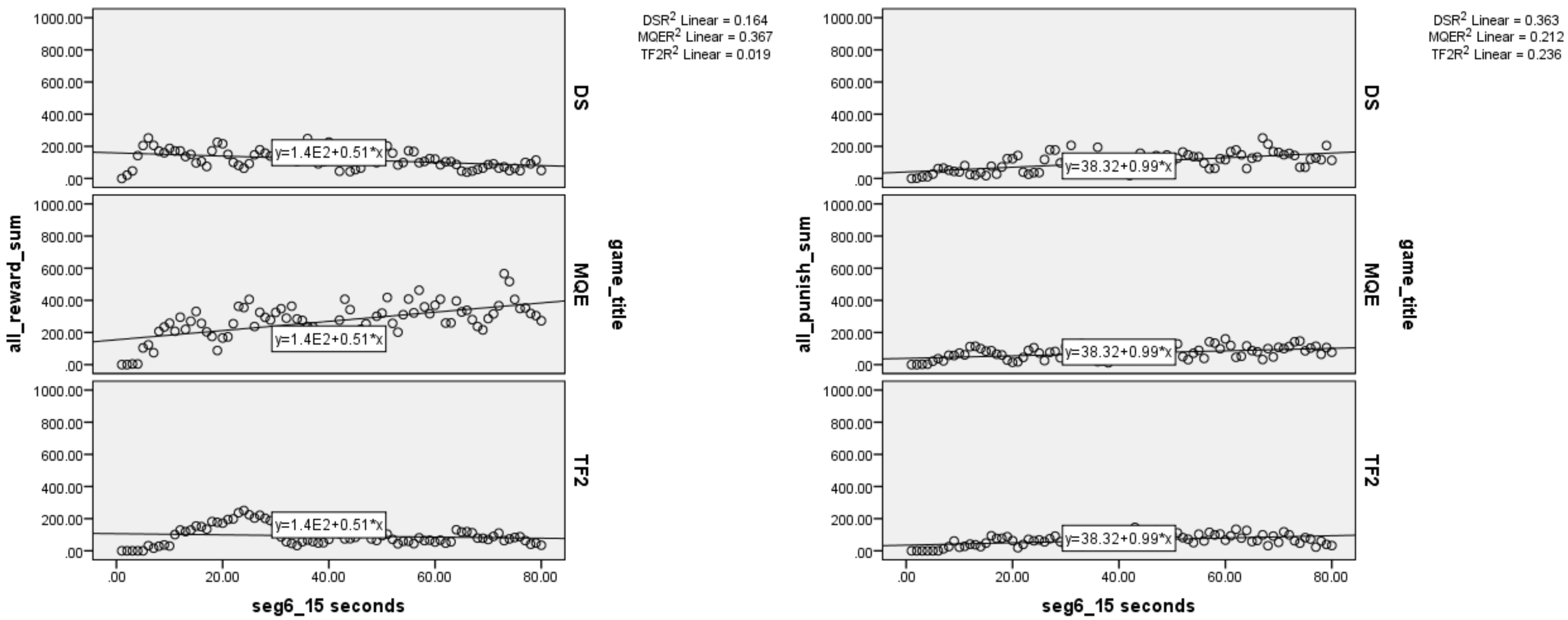


Figure 2. *Scatter plots of sum of reward features (left) and sum of punishment features (right) content features within each 15-second time segment.*

Discussion: Reinforcement Schedules in Games

While many scholars have promoted the assumption that video game use a partial reinforcement schedule of rewards, the current study uses a novel content analysis coding procedure to provide the first empirical evidence to test this assumption. We suggest that video game reinforcement schedules are likely to vary across games from different genres. We found support for this idea in our study—our findings demonstrate that MQEL has a reinforcement schedule that resembles a partial reinforcement schedule while TF2 and DS have reinforcement schedules that resemble a continuous reinforcement schedule. Operant Conditioning Theory, specifically the partial reinforcement schedule of rewards, is thought to be an important factor in the development of video game addiction (Király et al., 2015; King et al., 2010a). Identifying the reinforcement schedules in games is an important first step towards testing this theory. The current study provides evidence that reward and punishment content features vary and can be categorized along a theoretically meaningful dimension (a partial reinforcement schedule versus a continuous reinforcement schedule).

We theorize that video game addiction occurs when individual factors (i.e., impulsivity and reward sensitivity) interact with game content features (i.e., reward features in games) to produce negative outcomes such as addiction. In the current study, we focused predominately on one side of this equation—video game content features. Our findings indicate that reward features do in fact vary across games from different reward schedules and that some video games do have a more partial reinforcement schedule than other games. An important next step in this program of research will be to use experimental procedures to test how these reinforcement schedules in video games influence behaviors related to video game addiction. In the current study, we categorized reinforcement schedules in existing commercial games. In future empirical studies, we plan to use the knowledge we have gained about the reward schedules in existing commercial games to manipulate the reward and punishment features within an experimental video game. For instance, our lab has developed *Asteroid Impact* an open-source computer video game that provides a high degree of experimental control to researchers. The goal of the game is to navigate a spaceship with the cursor in order to collect targets (crystals) while avoiding objects (asteroids). Hitting an asteroid means the game is over for the player. In future empirical research, we can use the knowledge we have gained about reinforcement schedules in existing commercial video games to create distinct experimental conditions (i.e., partial reinforcement and continuous reinforcement conditions) in the game *Asteroid Impact* allowing us to empirically test the influence reinforcement schedules exert on addiction related outcomes.

In this study, we successfully achieved our goal of creating a content analysis coding scheme and our findings point to exciting new directions for research, yet there are some limitations to be noted. The content analysis coding scheme captures variation in content features, but does not capture the magnitude of rewards and punishments that occur during each event. For example, the coding scheme does not distinguish between an event that leads to an outcome of 5 experience points and an event that leads to an outcome of 10 experience points. In future content analyses, quantifying the magnitude and duration of each individual reward and punishment feature may lead to a more nuanced understanding of reinforcement schedules in commercial games, yet this task may be beyond the scope of what a team of human coders can accomplish. Finding additional ways to code reward and punishment features, such as gathering this information from game output files, may be useful in future research.

Chapter 3: A Pilot Test

Outcome Variables Related to Video Game Addiction

The purpose of the current study was to develop a content analysis coding scheme to categorize the reinforcement schedules in games. We theorize that the reinforcement schedules in games interact with individual differences in order to produce behavioral changes such as addiction. In addition to analyzing video game content, in the current study we collected data on several outcome measures. With our small sample of 16 participants (TF2 n = 5, MQEL n = 5, DS n = 6), we did not expect to find significant differences in these outcome measures. Instead, we included these measures in order to determine if there are trends in the relationship between individual differences and game reinforcement schedules and to see if these measures are a good fit for behavioral addiction research within an experimental context.

We expect that participants who play a game with a partial reinforcement schedule would have a larger increase in behavioral impulsivity (cued go/no-go task) scores than participants who play the game with a continuous reinforcement schedule. To test this expectation, we compared the change in cued go/no-go scores from session 1 to session 2 for the participants who played MQEL (the game with a partial reinforcement schedule game) to scores for the participants who played TF2 and DS (the games with continuous reinforcement schedules). The cued go/no-go task measures two aspects of behavioral control: response inhibition and response execution (Fillmore, 2003). Response inhibition is measured by calculating the number of incorrect no-go trials (instances where participants incorrectly press a button in response to a no-go stimulus). Executive control plays an important role in the regulation of impulsivity. If executive control is reduced, it is expected that individuals will have a higher number of incorrect go trials. Response execution is measured by calculating participants' average reaction times to the correct go stimulus (instances where participants correctly press a button in response to a go stimulus). The cued go/no-go task has traditionally been used in the context of drug and alcohol studies. External stimuli (e.g., alcohol or drugs) interfere with executive control. This interference leads to slower rates of information processing, especially when conflicting go and no-go cues are presented. In previous studies, higher doses of the external stimuli led to increased impulsivity (more incorrect gos) and increased reaction times to correct go trials. To measure the average reaction time to correct go trials, we calculated the harmonic mean. The harmonic mean is commonly used for reaction time scores because it takes into account outliers and missing data when calculating a mean reaction time (Ratcliff, 1993; Lachaud & Renaud, 2011). One participant who played DS was excluded from this analysis because they did not complete the go/no-go task at time 1 (cued go/no-go: partial reinforcement schedule n = 5; continuous reinforcement schedule n = 10).

If the partial reinforcement schedule increases behavioral impulsivity, we should expect to see the number of incorrect go trials increase from time 1 to time 2 for participants who played the partial reinforcement schedule game. A two-way repeated measures ANOVA (see Table 14) indicated that there was no significant difference between incorrect-go scores at time 1 and scores at time 2 for participants who played the game with a partial reinforcement schedule versus participants who played the game with the continuous reinforcement schedule $F(1, 13) = .006$, $p = .937$. At both time 1 and time 2, participant who played the continuous reinforcement game had a higher number of incorrect gos than participants who played the partial reinforcement game (see Figure 3). Incorrect gos decreased from time 1 to time 2 for participants in both reinforcement schedules.

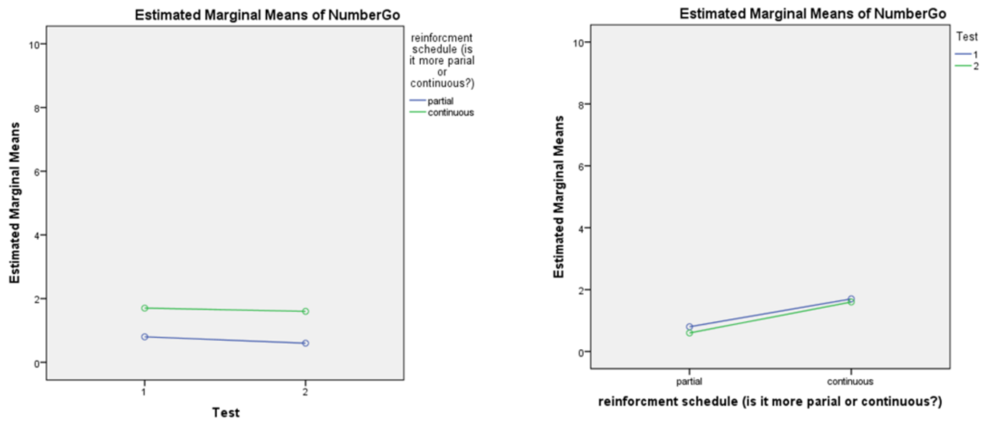


Figure 3. *Number of incorrect gos for participants in the partial reinforcement schedule and continuous reinforcement schedule at time 1 and time 2.*

If the partial reinforcement schedule has an effect on cognitive control that is similar to other external stimuli (i.e., alcohol), then we would expect participants in the partial reinforcement schedule to have longer reaction times than participants in the continuous reinforcement schedule at time 2. A two-way repeated measures ANOVA indicated that there was no significant difference between correct-go reaction time scores for participants who played the partial reinforcement schedule versus participants who played the games with a continuous reinforcement schedule $F(1, 13) = .040$, $p = .845$. We found that participants in the partial reinforcement condition had longer reaction times to correct go trials than participants in the continuous reinforcement schedule (see Figure 4). However, from time 1 to time 2, reaction times went down for participants in both groups.

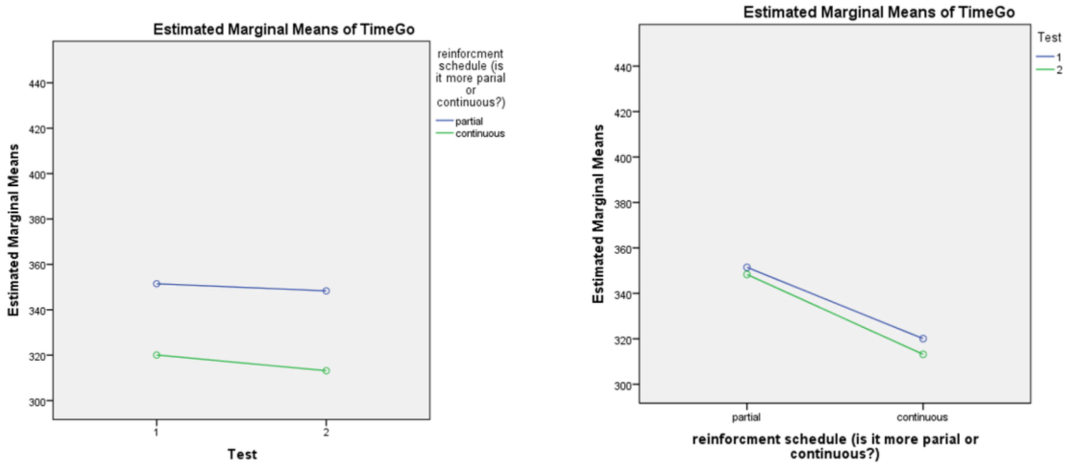


Figure 4. *Reaction times (milliseconds) to correct go trials for participants in the partial reinforcement schedule and continuous reinforcement schedule at time 1 and time 2.*

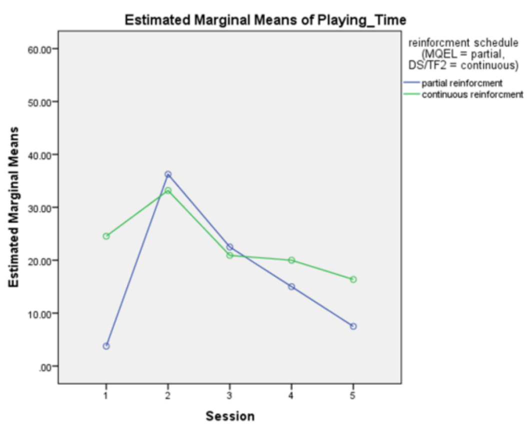
Table 12

Two-way repeated measures ANOVAs for outcome measures

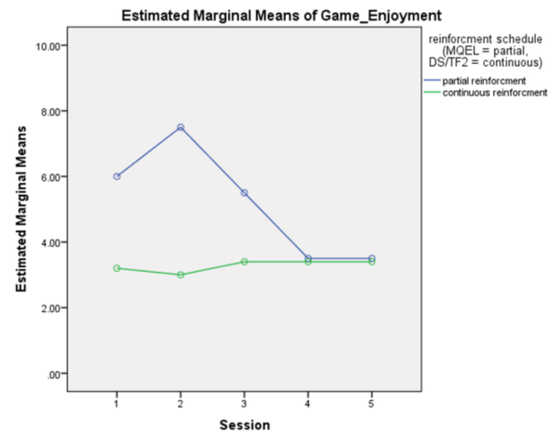
Outcome Variable	Number of Times Measured	*F*	*df*	Significance
Go/no-go task: Incorrect Gos	2 (lab session 1 and 2)	.006	1, 13	.937
Go/no-go task: Correct Gos	2 (lab session 1 and 2)	.040	1, 13	.845
Behavioral Impulsivity (BIS-11)	2 (lab session 1 and 2)	.212	1, 14	.652
Gaming Addiction Scale	2 (lab session 1 and 2)	.235	1, 14	.635
Enjoyment (assigned game)	5 (measured weekly)	3.397	4, 40	.003
Skill (assigned game)	5 (measured weekly)	.474	4, 44	.754
Playing time (assigned game)	5 (measured weekly)	1.699	4, 52	.164

During both lab sessions, we measured trait impulsivity (BIS-11) and gaming addiction (GAS) scores (see Table 12). In a two-way repeated measures ANOVA, no significant difference was found between BIS-11 scores for participants who played the game with a partial reinforcement schedule versus participants who played the game with the continuous reinforcement schedule $F(1, 14) = .212$, $p = .652$. The BIS-1l scale suggests that people are low in trait impulsivity if they fall below a score of 74 and high in impulsivity if they have a score of 75 or higher. All of the participants in this study had a score of 74 or below during both session 1 and session 2 with the exception of one participant (in the DS game condition) who had a score of 74 during session 1 and a score of 76 during session 2. In a two-way repeated measures ANOVA, no significant differences were found in GAS scores for participants who played the partial reinforcement schedule versus participants who played the game with the continuous reinforcement schedule $F(1, 14) = .235$, $p = .635$.

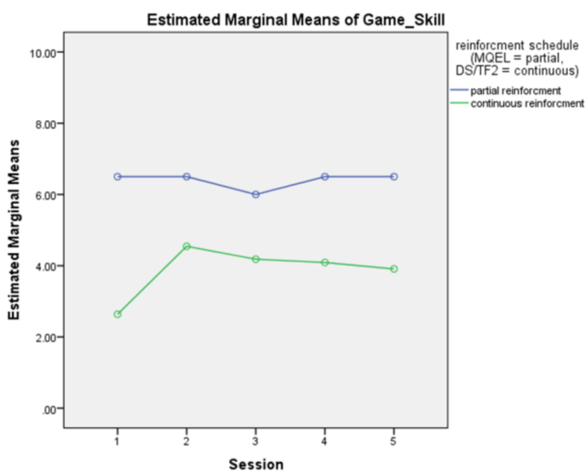
During the four weeks of independent gameplay and the last lab session, we measured participants' self-reported playing time, enjoyment, and skill for the assigned video game. We examined how reinforcement schedule influenced these outcome measures. Each week, participants were asked to self-report their playing time in minutes. No significant differences were found for playing time between participants who played the partial reinforcement game and those who played the continuous reinforcement games $F(4,52) = 1.699$, $p = .164$. Playing time declined over the 5-week period for participants in all game conditions. For enjoyment (enjoyment of the assigned video game), significant differences were found between participants who played the partial reinforcement game and those who played the continuous reinforcement games $F(4, 40) = 3.397$, $p = .003$ (see Table 14). Participants who played the partial reinforcement game (MQEL) reported higher enjoyment during week 1 and week 2, but enjoyment declined over time (see Figure 5). Participants in the continuous reinforcement schedule had consistently lower ratings of enjoyment over the 5-week period. For player skill (of the assigned video game) no significant differences were found between the partial reinforcement group and the continuous reinforcement group $F(4,44) = .474$, $p = .754$. Participants reported relatively high skill for partial reinforcement game throughout the duration of the study. For participants who played the continuous reinforcement game, skill increased in week 2 but declined over time.



a.



b.



c.

Figure 5. a. *Self-reported playing time for the assigned game (in minutes), b. enjoyment for the assigned video game, and c. player skill for the assigned game over the 5-week period for participants in the partial reinforcement game versus participants in the continuous reinforcement game.*

Discussion: Outcome Measures Related to Video Game Addiction

In addition to completing a content analysis, in this study we conducted a pilot test of several outcome measures that are theoretically related to video game addiction. Although we had a small sample of novice players, in the current study, we measured outcomes related to video game addiction including behavioral impulsivity (cued go/no-go task scores), trait impulsivity (BIS-11 scores), and gaming addiction (GAS scores). We predicted that participants in the continuous reinforcement condition would have a greater change in cued go/no-go task scores from lab session 1 to lab session 2. However, over the course of this study, the cued go/no-go task scores did not change dramatically for any of the participants in this study and the reinforcement schedule did not have a significant effect on changes in go/no-go scores. Participants who played the continuous reinforcement games had higher go/no-go task scores at time 1 (that is, they were different to begin with). It is likely that with the small sample size, random assignment was not effective. In order to make conclusions about the relationship between reinforcement schedules and impulsivity, a larger sample size is needed. Similarly, we did not observe significant differences in gaming addiction scale scores or trait impulsivity scores. Because the participants in this study were all low in trait impulsivity, it is not surprising that behavioral impulsivity scores (cued go/no-go task) and gaming addiction scores (GAS) did not change significantly over the course of this study. Initial trait impulsivity scores are likely to influence behavioral impulsivity and susceptibility to addiction. In the current sample, there is little variation in participants' trait impulsivity scores. In future studies, it would be useful to include trait impulsivity scores as a potential covariate to behavioral impulsivity scores.

Interestingly, in this study we did observe a significant difference in game enjoyment ratings. Participants who played the partial reinforcement game (MQEL) had higher ratings of enjoyment than participants who played the continuous reinforcement games (TF2 and DS). Participants rated MQEL as more enjoyable than DS and TF2, yet they indicated that MQEL became less enjoyable over time. The frequency of punishment features increased from time 1 to time 2 within the game MQEL. Perhaps the decline in enjoyment corresponds to increases in punishment features from time 1 to time 2. Participants who played MQEL also reported higher gameplay skill for the assigned video game than participants who played TF2 or DS. In all vido game conditions, participants self-reported general gameplay skill remained low throughout the course of the study. The game DS is an open-ended roleplaying game, which does not seem to require a higher level of player skill than the game MQEL. Perhaps the partial reinforcement schedule of game rewards in MQEL provides participants with more feedback about their gameplay skill and provides players with a greater feeling of mastery over the game and perceptions of higher game-play skill.

In order to generate gameplay content for this content analysis, we recruited a small sample of novice players (TF2 $N = 5$; MQEL $N = 5$, DS $N = 6$). While this sample allowed us to collect a reasonable amount of recorded gameplay data to generate the content analysis coding scheme, the small samples size limits our ability to make judgments about the influence of reward schedule on outcome measures related to video game addiction. In the future, it would be useful to collect data from a larger sample of participants. In the current sample, all participants were low in trait impulsivity. Variation in trait impulsivity is likely to influence behavioral impulsivity and it would be useful to treat trait impulsivity as a covariate to behavioral impulsivity scores in future studies. The cued go/no-go task (Fillmore, 2003) is traditionally used in research on alcohol use. In future studies, it would be helpful to find a behavioral impulsivity task that that is adapted for use in behavioral addiction studies. The cued go/no-go task measures impulsivity, a construct that is important to the study of video game addiction. However, the procedure assumes that increased doses of an external stimulus (e.g., alcohol) will lead to slower response execution (i.e., longer reaction times) to correct go trials—an assumption that may not be valid when the external stimulus is a behavioral task such as a video game.

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Table 1

Game addiction scale (GAS; Lemmens et al., 2009) items and dimensions

How often during the last six months…
Salience
1. Did you think about playing a game all day long?*
2. Did you spend much free time on games?
3. Have you felt addicted to a game?
Tolerance
4. Did you play longer than intended?
5. Did you spend increasing amounts of time on games?*
6. Were you able to stop once you started playing?
Mood Modification
7. Did you play a game to forget about real life?*
8. Have you played to release stress?
9. Have you played a game to feel better?
Relapse
10. Were you unable to reduce your game time?
11. Have others unsuccessfully tried to reduce your game use?*
12. Have you failed when trying to reduce game time?
Withdrawal
13. Have you felt bad when you were unable to play?*
14. Have you become angry when unable to play?
15. Have you become stressed when unable to play?
Conflict
16. Did you have fights with others (e.g. family, friends) over your time spent on games?*
17. Have you neglected others (e.g. family, friends) because you were playing games
18. Have you lied about time spent on games?
Problems
19. Has your time on games caused sleep deprivation?
20. Have you neglected other important activities (e.g., school, work, sports) to play games?*
21. Did you feel bad after playing for a long time?

Note, response options: (1) never, (2) rarely, (3) sometimes, (4) often, (5) very often.
**Included in the 7-item video game short scale.*

Table 2

Barratt impulsivity scale (BIS-11; Patton et al., 1995) with instructions

Directions: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly

	rarely/never	occasionally	often	almost always/always
1. I plan tasks carefully				
2. I do things without thinking				
3. I make up my mind quickly				
4. I am happy-go-lucky				
5. I don't always "pay attention"				
6. I have "racing" thoughts				
7. I plan trips well ahead of time				
8. I am self controlled				
9. I concentrate easily				
10. I save regularly				
11. I "squirm" at plays or lectures				
12. I am a careful thinker				
13. I plan for job security				
14. I say things without thinking				
15. I like to think about complex problems				
16. I change jobs				
17. I act "on impulse"				
18. I get easily bored when solving thought problems				
19. I act on the spur of the moment				
20. I am a steady thinker				
21. I change residences				
22. I buy things on impulse				
23. I can only think about one thing at a time				
24. I change hobbies				
25. I spend or charge more than I earn				
26. I often have extraneous thoughts when thinking				
27. I am more interested in the present than the future				
28. I am restless at the theater or lectures				
29. I like puzzles				
30. I am future oriented				

Table 3
List of all reward and punishment codes

Category	Description
Rewards	
Major rewards	(1) Level up; (2) beat a level or win the match; (3) receive rare in-game item or reward; (4) complete a major game objective or quest; (5) bonus points or large amount of currency; (6) access previously hidden level or map; (7) achieve a major goal; (8) purchase expensive/rare in-game item
General 1	Obtain points
General 2	Obtain currency or coins
General 3	Obtain resource/item
General 4	Obtain experience points (XP)
General 5	Find/receive ammo pack
General 6	Increase health point capacity
General 7	Equip item
General 8	Purchase small item
General 9	Build, organize, upgrade gameplay space
General 10	Sell item
General 11	Craft an item or retrieve previously crafted item
General 12	Team achieves a minor goal or reward
Narrative 1	Receive new objective
Narrative 2	Minor objective completed
Narrative 3	Narrative encouragement
Health	(1) Obtain health points; (2) healed by teammate; (3) used potion or healing device
Violence	(1) Kill/destroy an avatar; (2) Kill/destroy small opponent; (3) destroy an inanimate object
Opponents	Number of opponents killed/destroyed
Punishments	
Major punishments	(1) Avatar dies; (2) avatar waiting for respawn; (3) run out of time; (4) opponent achieves a major goal; (5) player or team loses the game or match; (6) player failed objective or goal
General 1	Lose health points
General 2	Lose shield points
General 3	Lose an in-game item
General 4	Set off a bomb, trap, or agent-enabled weapon
General 5	Opponent achieves a minor goal or reward
General 6	Avatar injured by crash or fall
General 7	Discouragement
General 8	Lose mana or strength points
Use of Violence	Was violence used during this time interval?

Table 4
Inter-Coder Reliability

Category	Video Game Title		
	Team Fortress 2	The Mighty Quest for Epic Loot	Destination Sol
Rewards			
Major 1	1.00	1.00	-
Major 2	1.00	-	-
Major 3	-	-	-
General 1	.6054	.9587	-
General 2	-	.8816	.9509
General 3	1.00	.8843	.8792
General 4	-	.9898	-
General 5	.7325	-	.8792
General 6	1.00	.0098	-
General 7	-	.9015	.9303
General 8	-	.7704	-.0031
General 9	-	-	-
General 10	-	-	-
General 11	-	-	-
General 12	-	-	-
Narrative 1	.9545	.8850	-
Narrative 2	.9827	.7457	-
Narrative 3	.9062	.9401	-
Health	.8744	.8903	.8484
Violence	.9520	.8508	.8307
Opponents	.9030	.7446	.8701
Punishments			
Major 1	.9931	1.00	.9743
Major 2	1.00	-	-
Major 3	1.00	-	-
General 1	.9110	.9442	.8520
General 2	-	-	.9283
General 3	-	-	-
General 4	.4968	.9181	-
General 5	.4925	-	-
General 6	.8294	-	.9283
General 7	.0021	.7940	.8322
General 8	-	.7831	-
Use of Violence	.8558	.8731	.9258

Krippendorff's alpha was used to calculate inter-coder reliability scores for two coders. If codes do not appear within a particular game, then no inter-coder reliability data is available. There are 8 major reward and 6 major punishment codes. These codes were entered into the columns for Major 1 through Major 3. For example, if major reward 7 and major reward 3 occurred in the same time interval, “3” was entered in the Major Reward 1 column and “7” was entered in the Major Reward 2.

Table 7

Mean frequency of individual rewards and punishments

	Game Title		
	TF2	MQEL	DS
Major Rewards			
1 - level up **		**1.6**	
Time 1		1.8	
Time 2		1.4	
2 - beat a level or match **	**0.6**	**2.5**	
Time 1	0.4	2	
Time 2	0.8	3	
3 - receive rare in-game item		**2.4**	
Time 1		1.2	
Time 2		3.6	
4 - complete major objective/quest	**0.3**	**0.5**	**0.08**
Time 1	0.6	0.2	0.16
Time 2	-	0.8	-
5 - receive bonus points		**1.4**	
Time 1		2.2	
Time 2		0.2	
6 - access previously hidden level or map		**0.1**	
Time 1		0.2	
Time 2		0.2	
7 - team achieves a major goal	**0.6**		
Time 1	0.4		
Time 2	0.8		
8 - purchase expensive or rare item		**1**	
Time 1		1.2	
Time 2		0.8	
General Rewards			
1 - obtain points		**38.7**	
Time 1		40.2	
Time 2		37.2	
2 - obtain currency		**24.9**	**10**
Time 1		21.4	6.75
Time 2		28.4	12.17
3 - obtain resource or item	**0.3**	**6.13**	**5.57**
Time 1	-	3.67	3.33
Time 2	0.6	7.6	7.25
4 - obtain XP		**23.1**	

Time 1		20.4	
Time 2		25.8	
5 - find/receive ammo pack	**3.71**		**5.43**
Time 1	3		3.67
Time 2	4.67		6.75
6 - increase point capacity	**9.43**	**1**	
Time 1	8.33	1	
Time 2	10.25	1	
7 - equip new item		**3.7**	**2.73**
Time 1		4.4	1.8
Time 2		3	3.5
8 - purchase small item		**3.29**	**3.8**
Time 1		3	3.5
Time 2		4	4
9 - build/upgrade gameplay space		**3.25**	
Time 1		4.5	
Time 2		2	
10 - Player sells an item		**2**	**2.2**
Time 1		0	2.5
Time 2		2	2
11 - player crafts an item			
Time 1			
Time 2			
12 - team achieves a minor goal	**3**		
Time 1	3		
Time 2	3		
Narrative Rewards			
1 - receive new objective	**9.22**	**3**	**15.6**
Time 1	13.6	3	16
Time 2	3.75	0	14
2 - minor objective completed	**13.25**	**2.25**	**14.6**
Time 1	17.33	2.67	15
Time 2	1	1	13
3 - encouragement	**7.67**	**18.9**	
Time 1	8.2	13.4	
Time 2	7	24.4	
Health Rewards			
1 - obtain HP	**2.3**	**17.2**	
Time 1	1.6	14.4	
Time 2	3	0.2	

2 - healed by teammate	**6.4**	**0.1**	
Time 1	5	0.2	
Time 2	7.8	0	
3 - used potion or healing device		**1**	
Time 1		0	
Time 2		2	
4 - obtain shield points			**3.58**
Time 1			1.66
Time 2			5.5
Violence Rewards			
1 - kill avatar	**3**		
Time 1	4.6		
Time 2	9		
2 - kill small opponent	**0.5**	**22.6**	**7.66**
Time 1	0.6	18.6	46.66
Time 2	0.4	26.6	10.66
3 - destroy inanimate object	**2.1**	**15.6**	**2**
Time 1	4.2	19.6	0.16
Time 2	0	11.6	3.83
Major Punishments			
1 - avatar dies	**13.2**	**1.2**	**2.08**
Time 1	11.2		1.33
Time 2	15.2	1.2	1.83
2 - waiting for respawn **	**12.6**	**1.2**	**2.66**
Time 1	10.6	0	1.83
Time 2	14.6	1.2	3.5
3 - run out of time		**1**	
Time 1		0.2	
Time 2		0	
4 - opponent achieves a major goal	**1.1**		
Time 1	1		
Time 2	11.2		
5 - player or team loses the level or match	**1.1**		
Time 1	1		
Time 2	0.2		
General Punishments			
1 - avatar loses HP	**22.8**	**16.11**	**21.09**
Time 1	18.2	9.75	18.8
Time 2	27.4	21.2	23
2 - avatar loses shield points			**14.3**

Time 1			12
Time 2			16.6
3 - lose an in-game item			
Time 1			
Time 2			
4 - set off a bomb	**1.5**	**6.67**	
Time 1	1	3.5	
Time 2	1.67	9.2	
5 - opponent achieves a minor goal or reward	**1.86**		
Time 1	2		
Time 2	1.75		
6 - avatar injured by crash or fall	**2.25**		**20.09**
Time 1	1.67		17.6
Time 2	4		22.17
7 - discouragement	**1.6**	**8.6**	**19.73**
Time 1	2.5	5.4	22.2
Time 2	1	11.8	17.67
8 - avatar loses mana **		**17.5**	
Time 1		5	
Time 2		23.75	

First, the mean of all game recordings for a particular game are reported, then the mean at time 1 (lab session 1 recordings) is reported followed by time 2 (lab session 2 recordings). Some reward and punishment features are dependent on time. For instance, the respawn wait time is often determined by the video game. Features that are often dependent on time are indicated by **