Winter 2018

The Impact of Exposure Time and Interference from Cognitive Activity on the Frequency of Involuntary Videogame Thoughts

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Accepted in Partial Completion
Of the Requirements for the Degree
Master of Experimental Psychology

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Master's Thesis

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February 5, 2018

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A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment
Of the Requirements for the Degree
Master of Science

by
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February 2018

Abstract

Involuntary thoughts of all kinds come to mind, including those about videogames. Amount of exposure and cognitive activity can affect involuntary thought frequency. I explored the effects of exposure time, task type, and cognitive load on involuntary videogame thought frequency experienced immediately after gameplay and 24-hours later. I found that the higher amount of exposure time to a videogame leads to an increase in involuntary thought frequency 24-hours later. I also found that involuntary thoughts are less likely to come to mind during a higher cognitive load activity, than a low cognitive load activity. Though there is a need for replication, videogames can be used to induce and investigate involuntary thoughts.

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Introduction

People frequently experience involuntary thoughts, which are those that come to awareness without any conscious retrieval attempt. Involuntary thoughts can involve any subject, such as memories, semantics, or imagery. People also experience involuntary thoughts about videogames. After playing a videogame, people may re-experience game elements such as images and sounds as involuntary thoughts (Kusse et al., 2012; Ortiz de Gortari & Griffiths, 2012, 2014, 2015; Stickgold et al., 2000; Wamsley et al., 2010). These involuntary videogame thoughts can be present for minutes, hours, or even potentially days. However, the factors that increase the likelihood of videogame visual and auditory imagery returning as involuntary thoughts are not well known. Time spent playing the game may have a significant effect on the frequency of subsequent involuntary thoughts. Current cognitive activity can also interfere with the formation of involuntary thoughts. A task that is similar to the involuntary thought may compete with it in working memory to decrease the frequency of the involuntary thought. An extremely difficult task can also prevent an involuntary thought coming to mind by causing a high amount of cognitive load. In this thesis, I will explore how gameplay time and post-gaming cognitive activity affect an individual's experience of involuntary videogame thoughts immediately after game play and 24-hours later.

Voluntary and involuntary thoughts differ in the nature of retrieval; that is the presence of purposeful and goal-oriented effort to retrieve the thought or memory. Voluntary thoughts come to mind under conscious control, with deliberate effort and formation. Involuntary thoughts, in contrast, do not come to mind through conscious effort. Involuntary thoughts are a normal and frequent experience (Beaman & Williams, 2010; Berntsen & Jacobsen, 2008; Halpern & Bartlett, 2011; Hyman et al., 2013; Liikkanen, 2008, 2012a).

People may experience involuntary thoughts about a great variety of topics. An individual may have involuntary memories of past events (Berntsen & Rubin, 2002; Mace, 2004) semantic knowledge (Kvavilashvili & Mandler, 2004), or music, which is also known as having a song stuck in one's head (Hyman et al.,2015; Liikkanen, 2008). Playing videogames can also lead to involuntary thoughts (Kusse et al., 2012; Ortiz de Gortari & Griffiths, 2012, 2014, 2015; Stickgold et al., 2000; Wamsley et al., 2010). As people play videogames, they experience a wide variety of stimuli. Videogames involve visual stimulation through graphics and animations on a screen. In addition, games include auditory stimulation in the form of sound effects and music. Involuntary thoughts involving videogames tend to consist of some of the visual and auditory features experienced in the videogame (Kusse et al., 2012; Ortiz de Gortari & Griffiths, 2012, 2015; Stickgold et al., 2000; Wamsley et al., 2010). Of these many types and variations of stimuli, why certain videogame elements become part of involuntary thoughts is worth investigating.

Several factors may influence the occurrence and nature of involuntary thoughts. Recency is one of these factors, where individuals are more likely to have involuntary thoughts of recently perceived stimuli. In surveys and diary studies, participants report that recent exposure to music can trigger involuntary musical imagery (Bailes, 2007; Halpern & Bartlett, 2011; Hyman et al., 2013; Liikkanen, 2012b; Williamson et al., 2012). In experimental studies in which participants listened to songs, the song that the participants heard last was most likely to return as involuntary musical imagery afterwards (Byron & Fowles, 2015; Hyman et al., 2013; Hyman et al., 2015). Gamers, or people who play videogames regularly, also anecdotally describe on online gaming forums that they experience involuntary videogame thoughts soon after playing a game (Ortiz de Gortari & Griffiths, 2012, 2014).

Cues are another factor that influences the frequency of involuntary thoughts. Though an involuntary thought may seemingly come to awareness spontaneously, cues play a role in evoking them (Berntsen, 1996; Berntsen & Jacobsen, 2008; Berntsen & Rubin, 2002; Byron & Fowles, 2015; Halpern & Bartlett, 2011; Hyman et al., 2013; Williamson et al., 2012). For instance, cues in the environment can elicit involuntary recollection of memories and involuntary thoughts about possible future events (Berntsen, 1996; Berntsen & Jacobsen, 2008). These cues can be activities, objects, and other people. Someone, for example, may hear a neighbor's dog barking, and experience thoughts of owning a dog in the future (Berntsen & Jacobsen, 2008). Reading song lyrics can also induce an experience of having a song stuck in one's head (Liikkanen, 2009). Perceiving a certain word or a phrase may trigger involuntary musical imagery as well, even if the word is not present in the song lyrics (Williamson et al., 2012). The surrounding context can also act as a cue. A person may hear a song in a certain context and form an association, and subsequently re-experience the song when something related to that context cues them. For example, a person may have listened to a song in class and then re-experienced the song while working on classwork (Hyman et al., 2013).

In addition to cues perceived from the external environment, internal cues can also trigger involuntary thoughts. Aspects of one's internal or mental environment, such as moods and feelings, can serve as cues for involuntary memories (Berntsen, 1996). Similarly, mood will influence involuntary musical imagery. A person who is in a bad mood may mentally hear a song that matches their mood (Williamson et al., 2012). Other mental elements such as recollections, stress, and emotions can also cue involuntary musical imagery (Williamson et al., 2012). A song that has any kind of association, such as with certain memories, stressful situations, or emotions, may come to mind whenever a person experiences those memories, situations, or emotions.

As a wide range of cues can trigger involuntary autobiographical memories and musical imagery, the same may apply for involuntary thoughts about videogames. In anecdotal accounts on online gaming forums, gamers reported that cues and associations played a role in involuntary game thought experiences (Ortiz de Gortari & Griffiths, 2012). Consider the popular videogame *Assassin's Creed*, which involves the player's character climbing walls and buildings. In one online forum post, a gamer described seeing walls and then involuntary imagined themselves climbing the walls after playing the game (Ortiz de Gortari & Griffiths, 2012). Another gamer wrote an anecdotal report that involved music as a cue. The videogame *Guitar Hero* features a visual interface resembling guitar frets with notes moving down the screen. The player described visualizing notes moving downwards in the same manner when generally listening to music. Other visuals and sounds are likely to have a similar effect, given they resemble the videogame enough to serve as a cue. Ortiz de Gortari and Griffiths (2012) provided additional online anecdotal reports about how internal states become associated with videogames, and then lead to involuntary videogame thoughts. For example, one gamer who played *World of Warcraft* reported experiencing relevant imagery when feeling exhilarated while playing a football game.

Cognitive load is another factor that may influence the occurrence of involuntary thoughts. However, the relationship between cognitive load and involuntary thoughts is complex. Mental work and effort occupy the limited capacity of conscious working memory. The amount of cognitive load a person experiences reflects how much mental activity is occupying their mental capacity (Sweller, 1988). A person using a lot of their cognitive capacity may be processing many stimuli or engaging in a cognitive activity that requires a great amount of mental effort. They would be experiencing high cognitive load. In contrast, a person experiencing low cognitive load would be working on a less difficult cognitive activity and not putting forth much conscious work or effort.

Involuntary thoughts may come to mind in both high and low cognitive load contexts (Hyman et al., 2013). A person experiencing low cognitive load may leave a greater amount of mental capacity available for involuntary thoughts to come to mind. Many routine and automatic activities tend to involve low levels of cognitive load. When cognitive load is low, mind wandering may occur leading to involuntary thoughts. In a collection of self-reports from radio listeners about songs stuck in their heads, a dominant theme among reports involved mind wandering or doing repetitive tasks where the individual can be on autopilot (Williamson et al., 2012). In diary studies, people also reported that music came back to mind as involuntary imagery during low load and automatic activities (Hyman et al., 2013, Kvavilashvili & Mandler 2004). In similar anecdotal reports on internet forums, gamers described that involuntary videogame thoughts occur during daydreaming and routine activities as well (Ortiz de Gortari & Griffiths, 2012). Moments of low cognitive load also include when people are falling asleep or waking up. In experimental studies, participants experienced videogame imagery coming to mind while falling asleep or waking up after playing videogames for hours over a few days (Kusse et al., 2012; Wamsley et al., 2010). This even occurs for participants who are densely amnesic such that they do not remember playing the game (Stickgold et al., 2000). Anecdotal reports from online gaming forums are similar, with some gamers describing involuntary videogame thoughts at times around sleep (Ortiz de Gortari & Griffiths, 2012, 2014).

However, people also experience involuntary thoughts in high cognitive load contexts. In an experimental study, participants re-experienced the most recent song they heard as involuntary imagery more frequently during difficult tasks than during easy tasks (Hyman et al., 2013). If a high cognitive load task is difficult that it is extremely hard to succeed, mind wandering may occur, leading to potential involuntary thoughts. The relationship between cognitive load and involuntary thoughts appears complicated and requires further study. Because involuntary thoughts come to mind during both high and low cognitive load, the same may occur for involuntary videogame thoughts after a period of gameplay.

Cognitive activity also influences involuntary thoughts. Aside from the cognitive load from mental activity, the content of the mental activity itself is another contextual factor that may affect the frequency of involuntary thoughts. Cognitive activity can occur in different forms, which can interfere with involuntary thoughts of a similar kind and decrease their frequency. For example, in a study comparing verbal and nonverbal tasks, the two tasks had a different effect on participants' involuntary musical thoughts (Hyman et al., 2013). These participants listened to a series of three songs and then worked on either an anagram task, which is a verbal task, or a Sudoku puzzle task, which is a nonverbal task. Songs returned as involuntary musical imagery more often for participants who worked on the Sudoku puzzles than for participants who worked on the anagram task. A verbal task such as with anagrams, which is the formation of words by rearranging letters, has features in common with the songs, which involves lyrics. The words from the anagrams may have competed with the songs, leaving less capacity in the phonological loop in working memory for songs to come to mind. Therefore, a task that shares features with a stimulus is likely to interfere with the formation of involuntary thoughts of that stimulus. Thus, a verbal task interfered with musical imagery (Hyman et al., 2013). Sudoku, a nonverbal task involving numbers, has fewer features in common with the experience of listening to songs. Therefore, the nonverbal task shares fewer features with and interferes less with involuntary musical imagery in comparison.

Playing videogames have also provided interference against other involuntary thoughts involving imagery. Participants who played *Tetris* after watching a video with traumatic scenes experienced fewer involuntary traumatic thoughts than people who did not play *Tetris* (Holmes, James, Coode-Bate, Deeprose, 2009; James et al., 2015a). Playing *Tetris* can also interfere with and reduce cravings, which are theorized to involve sensory imagery about the desired substance or activity (Skorka-Brown, Andrade, Whalley, May, 2015). Therefore, involuntary videogame thoughts should compete for cognitive resources with other cognitive activities, particularly those involving visual imagery. More generally, imagery competes with other imagery, and may decrease the frequency of involuntary thoughts about them.

Cognitive activities can influence the frequency of involuntary thoughts due to competing for similar cognitive resources. Because of this, it is also important to consider the content of involuntary thoughts themselves. The content of involuntary thoughts tends to feature material with repetitiveness. For instance, the music that people experience during involuntary musical imagery is typically a familiar song (Beaman & Williams, 2010; Byron & Fowles, 2015; Halpern & Bartlett, 2011; Hyman et al., 2013; Hyman et al., 2015; Liikkanen, 2008) rather than new tunes or melodies. Furthermore, involuntary musical imagery usually involves brief fragments of songs (Beaman & Williams, 2010; Hyman et al., 2013, Liikkanen, 2012a) especially the repeatedly played chorus. These repetitive pieces are more likely to become part of involuntary musical imagery, rather than of entire songs. In general, stimuli that have repetitive features may be likely to become involuntary thoughts.

Similar to involuntary imagery about music, involuntary imagery of videogames also features specific, repetitive elements of personally familiar videogames (Ortiz de Gortari & Griffiths, 2012). One gamer's anecdotal report from an online forum involves involuntary thoughts of the videogame *Civilization* (Ortiz de Gortari & Griffiths, 2012). *Civilization* is a videogame series that involves the management of virtual people and units on a map. This individual reported experiencing involuntary imagery of units moving. In Stickgold et al. (2000), participants played *Tetris* over three days. In *Tetris* gameplay, the game constantly displays geometric pieces falling from the top of the screen and rotating at the player's control. Participants therefore had high exposure to this game animation. The participants experienced these repetitive game animations as involuntary imagery and rarely experienced involuntary thoughts of other, less frequent animations in *Tetris*.

However, there are mixed results on how frequent exposure affect involuntary thoughts. For example, the player is constantly exposed to *Tetris* interface which involves the scoreboard, but the scoreboard does not appear in involuntary images that come to mind after playing (Stickgold et al.; 2000). Therefore, a high amount of exposure to a stimulus by itself does not seem to consistently cause a high frequency of involuntary thoughts. Overall, elements of a stimulus that gamers experience frequently or repeatedly experience seem to often be the subject of involuntary thoughts, though not necessarily.

As repetition is an important factor for the occurrence of involuntary thoughts, behavior and personal habits that increases repetition may increase the frequency of involuntary thoughts. Thus, the more an individual experiences exposure to a stimulus, the more likely they will experience it as an involuntary thought. Participants who listened to a new song six times were more likely to experience involuntary musical imagery of that song than participants who only listened to a song twice (Byron & Fowles, 2015). A similar effect may apply to videogames. A gamer who frequently plays a videogame may experience many involuntary thoughts of that particular videogame. Indeed, respondents who categorized themselves as hardcore gamers were more likely to experience involuntary game thoughts than those who did not (Ortiz de Gortari & Griffiths, 2015). Involuntary visual imagery of videogames has also been associated with long sessions of gameplay, such as sessions lasting over three hours at a time (Ortiz de Gortari & Griffiths, 2014, 2015).

However, there are limitations of some existing research on involuntary videogame thoughts that should be considered. Ortiz de Gortari and Griffiths (2012, 2014) based their research on anecdotal reports collected from online gaming forums. First, there is likely to be heavy selection bias. Online gaming communities generally do not consist of people who play the game inconsistently or casually. Consequently, samples involving online gaming forums would have a bias towards people who play videogames often. Using this biased sample could suggest such involuntary videogame thoughts are common, and that high amounts of videogame playtime increases the frequency of involuntary game thought experiences. However, people who do not participate in online gaming forums, which may include those who do or do not frequently play video games, may also experience frequent involuntary videogame thoughts. Selection of self-report posts by the Ortiz de Gortari and Griffiths could further this bias as well. There could also be gamers who play videogames often and participate in gaming forums, but do not experience involuntary game thoughts. Therefore, members of gaming forums are also not entirely representative of people who play videogames, and relying on their reports may suggest characteristics of involuntary game thoughts that are not widely shared. Based on the anecdotal forum posts, gameplay time appears to strongly affect frequency of involuntary thoughts. However, this may not be the case.

Second, the forum posts collected have a lot of variation and uncertainty. Ortiz de Gortari and Griffiths (2012, 2014) collected experiences with involuntary videogame thoughts from publicly available online videogame discussion forums. Forums serve as an online place where people can interact and socialize rather than a controlled environment. Therefore, the involuntary experiences reported in the forum posts are missing important information. The reports do not include when or how the involuntary experiences occurred. It is also unknown if the gamers writing these reports are describing involuntary experiences that occurred recently or a long time ago. The reports do not reliably indicate what people were doing when the videogame thought came to mind. Other contextual information such as each person's gaming habits is missing. This limited information makes the relationship between gameplay and involuntary game experiences extremely unclear.

Further experimental study on involuntary videogame thoughts may help clear up these issues. Studying involuntary videogame thoughts will also aid in further understanding involuntary thoughts in general, as involuntary videogame thoughts share many traits with other kinds of involuntary thoughts. Exposure time and interference from cognitive activity are both factors that affect frequency of involuntary thoughts, and should be studied.

The current study

In this study, I examined two features that may influence the frequency of involuntary videogame thoughts. I compared the influence of different amounts of exposure time on involuntary thought frequency by having participants play a videogame for either five or thirty minutes. A five-minute exposure time was designed to simulate brief, casual gaming sessions while thirty minutes represented longer gaming sessions. I also investigated how the content of cognitive activities after gameplay affects involuntary thought frequency. Participants worked on either a verbal task (a word completion task) or a visual task (mazes) for five minutes after their gameplay session. A visual task may be more likely to compete for the same cognitive resources as videogame thoughts, since videogames are a visual stimulus. Therefore, participants who worked on the verbal task may have a higher frequency of involuntary videogame thoughts than those who worked on the visual task following game play.

I assessed the frequency of involuntary thoughts with a questionnaire on their involuntary game thoughts experienced immediately after gameplay. I also asked participants to complete similar questionnaire in a 24-hour follow-up concerning the continuation and contexts of involuntary game thoughts. To investigate involuntary videogame thoughts, I used the puzzle videogame *Bejeweled 2*. *Bejeweled 2* controls and objectives are simple and the game is easy to learn such that newcomers are able to play comfortably in little time. Gameplay consists of swapping gem-like objects on a grid-shaped interface to create matching rows or columns of three or more of the same shape (Figure 1). Arranging gems so a combination of three or more of the same kind in a row or column causes the gems to disappear. This in turn causes more gems to fall from the top into the display to replace the disappeared gems. Matching gems earns the player points. Earning set numbers of points will progress the player through levels. The player must match gems every turn. The game ends when the player cannot match any more gems.

Bejeweled 2 features repetitive elements of geometric shapes moving, comparable to the classic game *Tetris*. The videogame *Tetris* is extremely well known and has been previously used in involuntary videogame thought research (Holmes, James, Coode-Bate, & Deeprose, 2009; Skorka-Brown, Andrade, Whalley, & May, 2015; Stickgold et al., 2000). Both games utilize geometric pieces in a grid-shaped organization and require the player to arrange these pieces constantly throughout gameplay. There are also different animations that the player constantly sees. In *Tetris*, pieces are constantly falling from the top to the bottom of the screen. In *Bejeweled*, gem pieces often swap positions with other pieces beside them under the control of the player. New gem pieces cascade down from the top to fill open spaces. Both these games are prime candidates for involuntary videogame thought research due to their repetitive features.

I have also elected to use *Bejeweled* to demonstrate that games other than *Tetris* can be used to experimentally induce involuntary videogame thoughts. Exploring specific features of videogames themselves also helps generalize involuntary thought research to other games. It is the repetitive aspects of games that are likely to be in involuntary thoughts, rather than the game itself. As *Bejeweled* has not been used in a study examining involuntary thoughts thus far, players' involuntary thoughts about repetitive features in *Bejeweled* in this study will suggest that any game with repetitive features can influence subsequent involuntary thoughts. Though anecdotal forum reports have limitations, they indicate that a wide variety of videogames can be the subject of involuntary thoughts (Ortiz de Gortari & Griffiths, 2012, 2014).

In this study, after playing the videogame for either five or thirty minutes, participants briefly worked on allow-difficulty verbal or visual task for five minutes. Since cognitive load is a factor in frequency of involuntary thoughts, I chose the tasks to be as easy as possible for participants (Hyman et al., 2013, 2015; Ortiz de Gortari & Griffiths, 2012, 2014; Williamson et al., 2012). The type of task is also important. Working on a verbal task decreases the frequency of involuntary musical imagery compared to a visual task (Hyman et al., 2013). A similar effect should happen for involuntary videogame thoughts. Verbal tasks have more in common with music than visual tasks, thus verbal tasks compete with music for cognitive resources. Videogames, in contrast, feature many forms of visual stimuli. They also have very little, if any, kind of verbal stimuli. Because of this, a nonverbal and visual task like mazes should decrease the frequency of involuntary videogame thoughts. Participants who played *Bejeweled* and then worked on a word completion task should experience more involuntary videogame thoughts in comparison to participants who worked on a maze task. Overall, I predicted that the most repetitive elements of gameplay would be likely to return as involuntary thoughts after a longer period of gameplay during a verbal task, as compared to a shorter period of gameplay during a visual task.

The participants worked on the verbal or visual tasks for five minutes after game play. These five minutes were to allow involuntary thoughts to come to the participants' minds. Participants reported the frequency of involuntary *Bejeweled* thoughts they experienced during this time. Participants also answered additional questions on the type of involuntary *Bejeweled* thoughts, such as the frequency of thoughts involving sounds and visuals from the game. As high amounts of exposure of a stimulus may lead to involuntary thoughts about that stimulus, participants were asked about specific *Bejeweled* sounds and visuals that appear often in the game as well.

I also measured the participants' gaming history. Of their gaming history, I specifically focused on if the participant has played *Bejeweled* or other similar games. As familiar stimuli are more likely to be experienced as involuntary imagery (Beaman & Williams, 2010; Byron & Fowles, 2015; Halpern & Bartlett, 2011; Hyman et al, 2013; Liikkanen, 2008), those who have played *Bejeweled* or *Bejeweled*-like games before would be more likely to experience involuntary *Bejeweled* thoughts. In Stickgold et al. (2000), *Tetris* experts reported experiencing images of past *Tetris* experiences in addition to images of the recent *Tetris* gameplay sessions in the study. Likewise, those who have played *Bejeweled* before may find those past experiences coming to mind as well as involuntary thoughts about the initial gameplay session in the study. Overall, participants that have played *Bejeweled* and other similar games before should experience more involuntary *Bejeweled* thoughts.

One day after the initial gameplay session, I measured participants' involuntary *Bejeweled* thoughts. This was to investigate how long individuals may experience involuntary videogame thoughts after a gameplay experience. However, as participants' gaming behavior can affect how they experience involuntary *Bejeweled* thoughts, I asked about their recent gaming behavior. Specifically, if participants played videogames after the initial gameplay session and before the 24-hour follow-up, and if so what videogames they were. If the participant played another videogame after the initial gameplay session and before the 24-hour follow-up, thoughts about the other videogame would compete with the *Bejeweled* thoughts. The participant would be less likely to experience involuntary *Bejeweled* thoughts because of this competition of cognitive resources. However, if instead of another videogame the participant played more *Bejeweled* or a similar game, the opposite is likely to happen. As recency and repetition is a factor in the likelihood of an involuntary thought coming to mind, those who play *Bejeweled* or a similar game would be more likely experience involuntary *Bejeweled* thoughts.

Involuntary videogame thoughts occurring a day after the initial gameplay should also be related to the involuntary thoughts experienced during the tasks. Individuals who reported involuntary imagery of recent songs coming to mind during a task were also more likely to continue experiencing involuntary imagery afterwards (Hyman et al., 2013). This can serve as evidence for the Zeigarnik effect, where unfinished thoughts and activities tend to remain in consciousness longer than those that are completed. It is possible that a similar Zeigarnik effect will occur for involuntary videogame thoughts in this study. Participants who report experiencing more involuntary *Bejeweled* thoughts during the tasks would then experience more Bejeweled thoughts the following day.

Methods

Participants

A sample of 195 participants were recruited from introductory level psychology courses. Of those 195 participants, 91 reported themselves as male, 101 as female, and 3 as other or did not answer. One hundred and forty of the participants categorized themselves as White, 26 as Asian or Pacific Islander, 3 as Hispanic or Latino, 2 as Black, 1 as Native American, and 21 participants categorized themselves as another ethnicity or as multiple of the available options. The average age of the participants was 20.46 (*SD* = 3.33) years old. Overall in terms of gaming behavior, participants played an average of 2.16 (*SD* = 3.86) hours of videogames during a weekday and 2.07 (*SD* = 3.093) hours over a single day on the weekend. On average, participants did not consider themselves to be gamers. On a one to seven scale where participants indicated how much they considered themselves as gamers, from "not a gamer" to "definitely a gamer", the average was 3.19 (*SD* = 2.10). Participants answering 6 or 7 on the gamer scale comprised 17.4%, while 34.8% answered 1.

Of the 195 participants, 112 completed the 24-hour follow-up online survey. Of these, 52 reported themselves as male and 60 as female. Eighty-four of these participants categorized themselves as White, 15 as Asian or Pacific Islander, 3 as Hispanic or Latino, 1 as Black, and 9 as another ethnicity or as multiple of the available options. The average age of the participants that completed the 24-hour follow-up was 20.37 (*SD* = 3.67) years old. For gaming behavior, the participants reported playing an average of 2.70 (*SD* = 4.50) hours during a weekday and 2.55 (*SD* = 3.64) hours over a single day on the weekend. On the one to seven scale where participants reported their gamer self-concept, the average was 3.48 (*SD* = 2.12).

Materials and Procedure

Participants completed the lab component of the experiment individually using a desktop computer with the game *Bejeweled 2* installed. They played the game *Bejeweled 2* for five or thirty minutes, worked on either a verbal word completion task or a visual maze task for five minutes, and then completed a questionnaire about game-related involuntary thoughts experienced during the five-minute task that immediately followed gameplay. Twenty-four hours later, participants completed an online survey consisting of a follow-up questionnaire asking about additional involuntary thoughts and experiences. The immediate questionnaire was given by a paper hardcopy, and the follow-up questionnaire was given electronically as an online survey through the survey host *Qualtrics*.

Lab Session. After giving informed consent, participants followed verbal instructions to launch *Bejeweled 2* and they played the game for five or thirty minutes. Participants played the game at full screen size with sounds at a moderate volume.

Bejeweled 2 (Figure 1) offers four different game modes: classic, action, endless, and puzzle. All four game modes involve switching adjacent gems and clearing matching columns and rows to allow additional gems to fall. Participants played *Bejeweled* in classic mode. In classic mode, the game presents the player with a square interface consisting of a field of gems in a grid orientation. The gems differ in shapes and colors. People play the game by moving gems around with the mouse. The player clicks on a gem and then moves the gem with the mouse up, down, left, or right. The gem will then swap places with the gem adjacent to it in the direction made by the player. For example, if a red gem has a yellow gem to the right of it, clicking the red gem and then dragging it to the right with the mouse will cause the red and yellow gem to switch places. One gem-swap made by the player counts as one move. The goal of the classic game mode is to score points by creating matching rows or columns of three or more of the same kind of gem. When the player matches a row or column, the matching gems disappear, and all the gems above fall down to occupy the newly vacant space. Additional gems also fall from the top of the screen to keep the interface filled with gems. As the player is required to make a matching row or column each move, the game inevitably and eventually ends when the player cannot make any more moves that result in matches.

The gem interface is surrounded by visually displayed game information and options. At the bottom of the game interface is a bar that displays the player's game progression. The bar at the bottom fills to indicate how many points the player has scored. When the bar becomes filled, the player will continue to the next level. On the left of the interface, the game displays the current game score in a numerical value and the current level. On this left side, the player can also click a button to receive a hint from the game. A hint consists of the game pointing to a gem with an arrow to show a possible move the player can take. However, clicking the hint button costs level progression and the bar will empty by a moderate amount each time the hint button is used. The player can also click a button to quit the game and return to the game menu.

After the participants completed playing Bejeweled, they were asked what percent of the time that they were playing *Bejeweled* was their mind wandering. Since *Bejeweled* is a relatively easy game sometimes requiring very little cognitive resources to play, the purpose of this question was to see how much participants focused on the game.

Next, participants completed puzzle tasks using paper packets for five minutes. The puzzle packets were either a series of easy word completion puzzles or simple mazes. The word puzzles were all five-letter words that were missing one letter. The world completion tasks were designed to be easy based on the length of words and the letters that were missing. Writing in the missing letter would complete the word. For example, the answer for “f_ost” would be “frost”, and “house” for “hou_e”. The easy mazes had large spaces between the lines, and consisted of simple pathways. Dead ends in the mazes could be noticed early, and so were not misleading as in more difficult mazes. The difficulty of these tasks was chosen so the participants would experience low cognitive load. Participants could rate both tasks on their difficulty, ranging from one to seven, one being ‘very easy’ and seven being ‘very difficult’. Both tasks were rated as moderately easy. The average difficulty rating for the word completion task was 2.97 (SD = 1.18) and the average difficulty rating for the maze task was 3.25 (SD = .62). The mazes served as a nonverbal, visual task, which would compete with involuntary videogame thoughts. The word completion puzzles served as a verbal task, which would compete less with visual involuntary thoughts (Hyman et al., 2013).

The immediate involuntary videogame thoughts questionnaire asked about involuntary *Bejeweled* thoughts experienced during the five-minute tasks after game play ended. The participants were asked three general questions about the percentage of time that they experienced *Bejeweled* thoughts during the task. Each of these general questions had answer options that ranged from 0% to 100%, with options at ten percent intervals. These three questions asked participants about the percentage of time they experienced involuntary thoughts about *Bejeweled*, *Bejeweled* sounds, and *Bejeweled* visuals. The participants were then asked six additional questions that were more specific about the imagery they may have experienced. Each of these questions focused on specific auditory or visual images. These were answered using a one to five Likert scale ranging from ‘none’ to ‘many’. Three questions were for the participant to rate how many of the auditory imagery coming to mind were sound effects from gems moving, gems exploding, or music from the game. Similarly, three questions were for the participant to rate how many of the visual imagery coming to mind were gems swapping places, gems falling, or gems exploding. These visuals and sound effects occur frequently during gameplay.

The participants then reported their past experience with *Bejeweled* or other games with the same style of gameplay. They answered ‘yes’ or ‘no’ based on if they played such games before. If yes, participants also rated how frequently they played those games with a one to five scale ranging from ‘not at all’ to ‘very frequently’. These questions were to check how familiar participants were with the game, as familiarity may be an important influence in the likelihood of involuntary thoughts.

After the participants completed the questions about involuntary *Bejeweled* thoughts, they completed the Frequency of Involuntary Thoughts Scale (FITS) ($\alpha = .748$) (Hyman et al., 2015). The Frequency of Involuntary Thoughts Scale is a series of eight items about more general involuntary thoughts. The FITS asks about frequency of involuntary thoughts involving music, visual images, memories, relationships, work, money, and other topics. Participants answered each item using a Likert-like one to six scale ranging from ‘never’ to ‘constantly’.

After the Frequency of Involuntary Thoughts Scale, participants completed a Video Game Experience questionnaire. Participants reported their general videogame behavior and preferences. Participants reported if they play videogames and if so, how long they have been playing videogames and for how often. Participants answered how long they have been playing videogames by months or years, and how often by reporting if they played daily, weekly, once a month, or more rarely. Participants also indicated how they started playing videogames: by self-interest, other people, advertisements, or the internet. If participants do not play videogames then they report why not, indicating if due to cost, or lack of interest, time, or skill. Participants rated their videogame skill, and their preferred videogame genres and games. Participants then listed any gaming consoles they own, on what device they play videogames, and their favorite videogames.

Participants then completed a brief, 6-item measure of fantasy proneness ($\alpha = .82$) (Goldberg et al., 2006). This measure focuses on how frequently participants have imaginative and detached experiences. The items asked participants how often they get lost in their daydreams, have fantasies that are overwhelming, find themselves in a trance-like state without trying, feel like their imagination can run wild, or have extremely vivid pictures in their heads. One item also asks how often participants are so preoccupied with their own thoughts that they do not realize that other people are trying to speak with them. Each item was answered from a 1 to 5 Likert scale from 'strongly disagree' to 'strongly agree'. Finally, participants reported their age, gender, and ethnicity as general demographics, followed by their current videogaming behavior. Participants reported the number of hours they played videogames on a typical single weekday and on a typical single day on the weekend. Finally, participants rated to what extent they considered themselves to be a gamer, from one to seven from 'not a gamer' to 'definitely a gamer'.

After the immediate questionnaire, participants were verbally reminded that the study consisted of two parts, the first part being the initial experimental session and the second being an online 24-hour follow-up survey. Participants were instructed how to sign up for the second part of the study.

Follow-up Survey. One day later, participants were emailed reminders about the second part of the study along with instructions. The second part of the study was an online survey hosted on *Qualtrics*, and was scheduled for the participants to take one day after each experimental session.

The 24-hour follow-up questionnaire focused on any *Bejeweled*-related thoughts that came to mind after the initial experimental session. The items on the 24-hour follow-up questionnaire were identical to the items on the immediate questionnaire involuntary *Bejeweled* thought questionnaire with the exception of one item. While the first question of the immediate questionnaire asked participants what percentage of time they experienced involuntary *Bejeweled* thoughts while working on the tasks, the first question of the 24-hour follow-up questionnaire asked participants how frequently they experienced involuntary *Bejeweled* thoughts on a one to five scale from 'not at all' to 'very frequently'. Though these two questionnaires differ, I had originally intended for both questionnaires to be identical, meaning that the first question of the 24-hour questionnaire would have ideally asked about the percentage of time participants experienced involuntary *Bejeweled* thoughts in the previous 24 hours. However, an editing error resulted in this difference between the two questionnaires.

Additional questions asked about the types of activities people were engaged in when they experienced *Bejeweled* thoughts. These questions were to investigate if cognitive load affected the frequency of involuntary thoughts. Participants answered each of these questions by a 'yes' or a 'no' to if they experienced involuntary *Bejeweled* thoughts or not during the activities specified. Four items asked participants about higher cognitive load activities. The first of these higher cognitive load items asked participants if they experienced thoughts about *Bejeweled* when they were engaged in activities that required concentration. The next item asked if participants experienced *Bejeweled* thoughts while engaging in an activity that demanded their attention. The two items that followed focused on social contexts, asking participants if they experienced thoughts about *Bejeweled* when they were interacting with their friends in person or interacting with their friends on social media. Another four items followed, asking participants about low cognitive load activities. The first of these low cognitive load items asked participants if they experienced thoughts about *Bejeweled* when they were bored. The next item asked the same when their minds were wandering. The last two items focused on sleep, asking participants if they experienced thoughts about *Bejeweled* when they were falling asleep or waking up, and when they were asleep and dreaming. One final question asked participants if they imagined swapping objects in real life like gems are swapped in *Bejeweled* gameplay.

The last items of the 24-hour follow-up questionnaire asked participants if they had played a videogame since they played *Bejeweled* in the initial experimental session and if that videogame was *Bejeweled* or a game similar to it. Participants answered either no or yes for these two questions. If participants answered that they did play a videogame in the past 24 hours, they wrote how many hours they did so. A final item asked participants if they would like to share any comments about the game *Bejeweled* or anything about the experiment. This was to allow for any special cases to become known for consideration. Afterwards, participants were awarded appropriate research course credit corresponding to their participation for completing the study.

Results

Involuntary Game Thoughts Measurement. First, I investigated the measurement of the involuntary game thoughts during both the experimental session and in the 24-hour follow-up. In both the immediate and 24-hour questionnaires, nine items focused on the frequency of *Bejeweled* thoughts experienced. In the questionnaire asking about involuntary thoughts immediately after gameplay, three items asked about the percentage of time *Bejeweled* thoughts in general, *Bejeweled* sound thoughts, and *Bejeweled* visual thoughts came to mind during the five-minute task. Three items then asked about the frequency of three specific game sound effects coming to mind, and an additional three items ask about the frequency of three specific game visual effects coming to mind. These six items were answered by frequency on a one-to-five Likert scale. The 24-hour follow-up online survey featured identical items with the exception of the *Bejeweled* thoughts in general coming to mind was answered by frequency on a Likert scale.

Correlations between all items measuring involuntary *Bejeweled* thoughts, immediately after gameplay and 24 hours later, can be seen in Table 1 and 2 respectively. All items are significantly correlated with each other.

I subjected the data relevant to involuntary *Bejeweled* thoughts experienced immediately after gameplay to principal axis factoring, and used a varimax rotation. The overall KMO measure of sampling adequacy was .832. Two factors emerged with eigenvalues greater than 1, and an examination of the scree plot supported a two-factor solution. Of the nine items measuring *Bejeweled* involuntary thoughts, five items loaded onto the first factor, and four items loaded on the second factor. The first factor can be considered involuntary visual thoughts, and is comprised of the items asking participants about the percentage of time *Bejeweled* thoughts in general were experienced, the percentage of time *Bejeweled* thoughts involving game visuals were experienced, and the three items asking about the frequency of specific game visual effects coming to mind. The second factor is involuntary sound thoughts, and is comprised of items asking participants the percentage of time *Bejeweled* thoughts involving game sounds were experienced, and the three items asking about the frequency of specific game sounds effects coming to mind. All of these items ask about the frequency of involuntary *Bejeweled* sound thoughts. This first factor explained 51.32% of the variance and had an eigenvalue of 4.62. The second factor explained 13.60% of the variance and had an eigenvalue of 1.22 Overall, these two factors explained 64.92% of the variance. The factors and their items can be seen in Table 3.

I conducted a similar analysis to the follow-up online survey data. I subjected the data relevant to involuntary *Bejeweled* thoughts experienced 24-hours after gameplay to principal axis factoring, and used a varimax rotation. The overall KMO measure of sampling adequacy was .843. Only one factor emerged with an eigenvalue greater than 1, and an examination of the scree plot supported a one-factor solution. All the nine items measuring the frequency of *Bejeweled* involuntary thoughts in the follow-up survey loaded on this factor. These nine items include the frequency of involuntary thoughts about game visuals and sounds, along with *Bejeweled* in general. The factor explains 54.24% of the variance and has an eigenvalue of 4.881. The factor and their items can be seen in Table 4.

The nine items measuring the frequency of involuntary *Bejeweled* thoughts immediately after gameplay had a Cronbach's alpha of .68, while the nine items measuring the frequency of involuntary *Bejeweled* thoughts 24-hours later had a Cronbach's alpha of .61.

Frequency of Involuntary Thoughts Scale. After the questionnaire measuring the frequency of involuntary *Bejeweled* thoughts immediately after gameplay, participants completed the Frequency of Involuntary Thoughts Scale (FITS). The Frequency of Involuntary Thoughts Scale is made of eight items asking about the frequency of involuntary thoughts on a number of different subjects in general. These eight subjects are music, visual images, memories, thoughts about the future, romantic relationship thoughts, thoughts about other relationships, work thoughts, and thoughts about money. The eight items of the Frequency of Involuntary Thoughts Scale had a Cronbach's alpha of .77.

Fantasy proneness. Participants completed a personality measure of fantasy proneness. This measure involved six items asking about participants' fantasies, daydreams, and imagination. This includes, if their fantasies overwhelming, they experience vivid mental pictures, or if it is easy to become lost in their daydreams. The six items measuring fantasy proneness had a Cronbach's alpha of .78.

Involuntary *Bejeweled* thoughts experienced immediately after gameplay. I examined the impact of exposure time (5 or 30 minutes) and post-game task type (word completion or mazes) on the percentage of time involuntary *Bejeweled* thoughts participants experienced immediately after gameplay. These involved the items in the questionnaire asking participants to report the percentage of time they experienced *Bejeweled* thoughts in general, the percentage of time they experienced *Bejeweled* sounds coming to mind, and the percentage of time they experienced *Bejeweled* visuals coming to mind. I averaged reported percentages from these three items to create an overall measure of percentage of time involuntary *Bejeweled* thoughts were experienced.

I conducted a two-way ANOVA to examine the effect of exposure time and task type on the average percentage of time involuntary *Bejeweled* thoughts were experienced immediately after gameplay (α = .05). The means and standard deviations can be seen in Table 5. There was no effect of exposure time on the average percentage of time involuntary *Bejeweled* thoughts were experienced immediately after gameplay F (1, 191) = .642, p = .424, MSE = 411.876, η^2 = .003. Task type did not have an effect on average percentage of time involuntary *Bejeweled* sound thoughts were experienced immediately after gameplay F (1, 191) = 1.950, p = .164, MSE = 1250.985, η^2 = .010. There was also no interaction F (1, 191) = .231, p = .631, MSE = 148.470, η^2 = .001.

I also examined the impact of exposure time and task type on frequency of involuntary thoughts involving specific game sound and visual effects experienced immediately after gameplay. These involve the items in the questionnaire asking about specific game sound and visual effects. I averaged the reported frequencies from the three items asking about individual *Bejeweled* sound effects coming to mind immediately after gameplay to create a measure of immediate involuntary *Bejeweled* sound thought frequency. I similarly averaged the reported frequencies from the three items asking about individual *Bejeweled* visuals coming to mind immediately after gameplay to create a measure of immediate involuntary *Bejeweled* visuals thought frequency. Each of these items for sounds are both highly and significantly correlated with each other, with the same for items for visuals. Additionally, each of the specific game sound and visual effects are repetitively presented to the player. Based on exposure time, repetition, and familiarity, each of these three sound and visual effects should not differ greatly if at all, and therefore involuntary thought frequency should not differ significantly as well. Thus considering averaged frequencies would be a suitable way to consider an overall frequency of involuntary sound and visual thoughts.

I conducted a two-way ANOVA to examine the effect of exposure time and task type on the average frequency of auditory involuntary *Bejeweled* thoughts experienced immediately after gameplay (α = .05). The means and standard deviations can be seen in Table 6. There was no statistically significant effect of exposure time on the average frequency of involuntary *Bejeweled* sound thoughts experienced immediately after gameplay F (1, 190) = .661, p = .417, MSE = 5.620, η^2 = .003. Task type during the five minutes immediately after gameplay also did not have a statistically significant effect on average frequency of *Bejeweled* sound thoughts F (1, 190) = .637, p = .426, MSE = 5.418, η^2 = .003. There was also no statistically significant interaction F (1, 190) = 2.119, p = .147, MSE = 18.024, η^2 = .011.

I conducted a two-way ANOVA to examine the effect of exposure time and task type on the average frequency of visual involuntary *Bejeweled* thoughts experienced immediately after gameplay (α = .05). The means and standard deviations can be seen in Table 7. There was no statistically significant effect of exposure time on the average frequency of involuntary *Bejeweled* visual thoughts experienced immediately after gameplay F (1, 191) = .992, p = .321, MSE = 1.114, η^2 = .005. Task type during the five minutes immediately after gameplay also did not have a statistically significant effect on average frequency of *Bejeweled* visual thoughts F (1, 191) = .162, p = .687, MSE = .183, η^2 = .001. There was also no statistically significant interaction F (1, 191) = .558, p = .456, MSE = .627, η^2 = .003.

Involuntary *Bejeweled* thoughts experienced 24 hours after gameplay. Exposure time had an effect on involuntary *Bejeweled* thoughts 24-hours later. I averaged the percentages of time that participants reported experiencing *Bejeweled* sounds and visuals coming to mind in the follow-up survey to create a general measure of percentage of time *Bejeweled* thoughts were experienced 24 hours later. The means and standard deviations can be seen in Table 8. A two-way ANOVA was conducted to examine the effect of exposure time and task type on the average percentage of time involuntary *Bejeweled* sound and visual thoughts were experienced 24-hours after gameplay (α = .05). There was an effect of exposure time on average percentage of time involuntary *Bejeweled* thoughts were experienced 24-hours after gameplay F (1, 108) = 5.269, p = .024, MSE = 12554.871, η^2 = .338, though task type during the five minutes immediately after gameplay did not have a statistically significant effect F (1, 108) = .294, p = .589, MSE = 66.864, η^2 = .003. There was no statistically significant interaction F (1, 108) = 1.478, p = .227, MSE =336.031, η^2 = .013. Participants who played *Bejeweled* for 30 minutes reported experiencing auditory and visual involuntary *Bejeweled* thoughts for a greater percentage of time than participants who played for 5 minutes.

Similar to the analyses for specific *Bejeweled* sounds and visuals coming to mind immediately after gameplay, I averaged the frequencies of involuntary *Bejeweled* thoughts involving sound and visual effects experienced 24 hours later. I averaged the frequencies from the three items asking about individual *Bejeweled* sound effects coming to mind to create a measure of the frequency of involuntary *Bejeweled* sound thoughts coming to mind a 24 hours after gameplay. I averaged the frequencies from the three items asking about individual *Bejeweled* visual effects coming to mind to create a measure of the frequency of involuntary *Bejeweled* visual thoughts coming to mind a 24 hours after gameplay.

Exposure time and task type had no statistically significant effect on averaged frequency of involuntary thoughts about *Bejeweled* sound and visual effects 24 hours after gameplay. I conducted a two-way ANOVA to examine the effect of exposure time and task type on averaged frequency of involuntary *Bejeweled* sound thoughts experienced 24 hours after gameplay (α = .05). The means and standard deviations can be seen in Table 9. There was no statistically significant effect of exposure time on averaged frequency of involuntary *Bejeweled* sound thoughts experienced 24 hours after gameplay F (1, 108) = 2.680, p = .104, MSE = 1.690, η^2 =

.024. Task type during the five minutes immediately after gameplay also did not have a statistically significant effect on averaged *Bejeweled* sound thought frequency 24 hours later F (1, 108) = .113, p = .738, *MSE* = .071, η^2 = .001, as well. There was no statistically significant interaction F (1, 108) = .301, p = .584, *MSE* = .190, η^2 = .003.

I also conducted a two-way ANOVA to examine the effect of exposure time and task type on averaged frequency of involuntary *Bejeweled* visual thoughts experienced 24 hours after gameplay (α = .05). The means and standard deviations can be seen in Table 10. There was no statistically significant effect of exposure time on averaged frequency of involuntary *Bejeweled* visual thoughts experienced 24 hours after gameplay F (1, 108) = 2.591, p = .110, *MSE* = 1.761, η^2 = .023. Task type during the five minutes immediately after gameplay did not have a statistically significant effect on averaged frequency of *Bejeweled* visual thoughts experienced 24 hours later F (1, 108) = 1.540, p = .217, *MSE* = 1.047, η^2 = .014. There was no statistically significant interaction F (1, 108) = .306, p = .581, *MSE* = .208, η^2 = .003.

The Zeigarnik effect. To check for a Zeigarnik effect, I explored the relationship between percentage of time involuntary *Bejeweled* thoughts were experienced immediately and 24 hours after gameplay. I averaged all items in the immediate questionnaire that asked about the percentage of time involuntary *Bejeweled* thoughts were experienced immediately after gameplay, and correlated it with the averaged items that asked about percentage of time involuntary time *Bejeweled* thoughts were experienced 24 hours later. The two averaged percentages of time *Bejeweled* thoughts came to mind immediately after gameplay and 24 hours later were positively correlated (r = .426, p <.001). Therefore, participants who experienced involuntary *Bejeweled* thoughts for a higher percentage of time immediately after gameplay also experienced involuntary *Bejeweled* thoughts for a greater percentage of time during the following 24 hours.

Interference from additional gaming experiences. In the follow-up online survey, participants indicated if they played any videogames in the past 24 hours. This was to check if playing another game after the initial *Bejeweled* gaming session would decrease the frequency of subsequent involuntary *Bejeweled* thoughts. Because videogames involve both visual and auditory stimuli and recency is a significant factor in involuntary thought frequency, I hypothesized that the more recent videogame experience would interfere formation of involuntary thoughts involving the less recent, *Bejeweled* experience.

However, playing another videogame after playing *Bejeweled* did not have an effect on averaged percentage of time *Bejeweled* thoughts came to mind 24 hours after gameplay. In the 24-hour follow-up online survey, participants who reported playing a videogame in the past 24 hours (N = 50, M = 11.07, SD = 15.48) did not differ in the percentage of time they experienced involuntary *Bejeweled* thoughts from participants who did not play other games (N = 62, M = 10.32, SD = 15.36); t (110) = .255, p = .799, d = .048. This suggests that more recent videogame experiences did not necessarily prevent involuntary thoughts from previous videogame experiences.

Interference from other activities. The 24-hour follow-up asked participants if they experienced involuntary *Bejeweled* thoughts coming to mind during certain activities. This was to explore the influences of cognitive load on involuntary thought frequency. During higher cognitive load activities, small percentages of participants reported experiencing involuntary game thoughts. During an activity that required concentration, only 13.4% reported experiencing involuntary *Bejeweled* thoughts. Similarly, while participants were engaged in an activity that demanded their attention, only 8.9% experienced involuntary *Bejeweled* thoughts. Few participants reported experiencing involuntary *Bejeweled* thoughts in social contexts as well. While socializing with friends, 15.2% of participants that completed the 24-hour follow-up reported experiencing involuntary *Bejeweled* thoughts. While socializing with friends on social media, 11.6% of participants experienced involuntary *Bejeweled* thoughts.

During activities of low cognitive load, more participants reported experiencing involuntary game thoughts. When the participants were bored, 42.9% of participants who completed the 24-hour follow-up experienced involuntary *Bejeweled* thoughts. When the participants experienced mind wandering, 36.6% of participants experienced involuntary *Bejeweled* thoughts. However, most participants reported not experiencing involuntary game thoughts in contexts related to sleep. While falling asleep or waking up, only 7.2% of participants who completed the 24-hour follow-up reported experiencing involuntary *Bejeweled* thoughts. Only 3.6% of participants reported experiencing involuntary *Bejeweled* thoughts while dreaming. Overall, involuntary game thoughts do not tend to come to mind during higher cognitive load activities or contexts related to sleep, and are more likely to come to mind while in low cognitive load contexts.

Individual differences. The initial questionnaire asked participants about multiple individual differences. These individual differences involved how frequent participants experienced involuntary thoughts in general, their gaming-related behaviors, and their fantasy proneness. Relevant measures were analyzed to determine if there were any relationships between them and involuntary *Bejeweled* thoughts.

Frequency of Involuntary Thoughts Scale and involuntary *Bejeweled* thoughts. I created a total measure of the Frequency of Involuntary Thoughts Scale (FITS) by averaging all eight items. As those who tend to experience a higher frequency of one type of involuntary thought also tend to frequently experience other kinds of involuntary thoughts (Hyman et al., 2015), an overall average of the FITS would serve as a good general measure of how often participants experience involuntary thoughts of multiple types.

I correlated Frequency of Involuntary Thoughts (FITS) items with each other, these correlations can be seen in Table 13. Most FITS items are statistically significantly correlated with each other, with the exception of money and work-related thoughts. I also correlated averaged FITS scores with averaged fantasy proneness scores and measures of involuntary *Bejeweled* thought frequencies. These correlations can be seen in Tables 11 and 12. Averaged scores on the FITS were not correlated with the averaged percentage of time that *Bejeweled* involuntary thoughts came to mind immediately after gameplay ($r = .139$, $p = .053$). However, averaged FITS scores were positively correlated with the averaged percentage of time *Bejeweled* sound and visual thoughts came to mind 24 hours after gameplay ($r = .251$, $p = .007$).

Fantasy proneness. I then correlated all six items together. These correlations can be seen in Table 14. I also created a general measure of fantasy proneness by averaging all six items. Most items within the fantasy proneness scale are very statistically significantly correlated with each other. I also correlated average fantasy proneness scores with average FITS scores, and measures of involuntary *Bejeweled* thought frequencies. Measures of involuntary *Bejeweled* thought frequencies include averaged percentage of time involuntary *Bejeweled* thoughts were experienced and averaged frequencies of involuntary visual and auditory game thoughts, immediately and 24 hours after gameplay. These correlations can be seen in Tables 11 and 12.

Fantasy proneness was not correlated with involuntary *Bejeweled* thought frequency whatsoever, immediately or 24 hours after gameplay. This suggests that fantasy proneness is not related to frequency of involuntary *Bejeweled* thoughts. However, fantasy proneness appears to be related to the general frequency of involuntary thoughts, as averaged fantasy proneness scores are correlated with averaged FITS scores ($r = .440$, $p < .001$).

Gender differences. I also investigated possible gender differences among involuntary *Bejeweled* thought frequencies using t-tests. Means, standard deviations, and t-tests can be seen in Table 15. Gender did not have an effect on the averaged percentage of time involuntary *Bejeweled* thoughts were experienced immediately after gameplay, nor the averaged frequency of involuntary auditory and visual *Bejeweled* thoughts coming to mind immediately after gameplay. Likewise, gender did not have an effect on the averaged percentage of time involuntary *Bejeweled* thoughts were experienced 24-hours after gameplay, nor the averaged frequency of involuntary auditory and visual *Bejeweled* thoughts coming to mind 24-hours after gameplay. Overall, gender alone did not have an effect on involuntary *Bejeweled* thoughts experienced immediately or 24 hours after gameplay.

Gaming behavior. Though there were not necessarily any differences between genders in terms of involuntary *Bejeweled* thoughts, there were differences in terms of reported gaming behavior and gamer self-concept. Men reported spending more hours playing videogames during weekdays ($M = 3.36$, $SD = 4.94$) than women ($M = 1.09$, $SD = 2.03$); $t\ (190) = 4.228$, $p < .001$, $d = .510$. Men also report spending more hours playing videogames during weekends ($M = 2.87$, $SD = 3.68$) than women ($M = 1.36$, $SD = 2.26$); $t\ (190) = 3.471$, $p = .001$, $d = .496$. Hours spent playing videogames on weekdays and weekends were positively correlated ($r = .590$, $p < .001$). There was a significant difference in how men ($M = 1.80$, $SD = .62$) and women ($M = 2.56$, $SD = .75$) participants rated their videogame skills $t\ (187) = -7.867$, $p < .001$, $d = 1.151$, with men rating themselves as more skilled. Men rated themselves higher on the gamer question ($M = 4.32$, *SD* = 2.08) than women (*M*= 2.17, *SD* = 1.53); *t* (190) = 8.212, $p < .001$, *d* = 1.178. Overall, in this study men report playing videogames more frequently, and rate themselves as more skilled at videogames than women.

Gaming behavior and self-concept did not have a statistically significant relationship with involuntary *Bejeweled* thoughts. Number of hours participants played videogames during weekdays were also not correlated with averaged percentage of time involuntary *Bejeweled* thoughts came to mind immediately after gameplay (*r*= .101, *p* = .164) or averaged percentage of time involuntary *Bejeweled* sound and visual thoughts came to mind 24 hours after gameplay (*r* = .033, *p* = .731). Hours of videogames played over the weekend were not correlated with averaged percentage of time involuntary *Bejeweled* thoughts came to mind immediately after gameplay (*r*= .027, *p* = .712) nor averaged percentage of time involuntary *Bejeweled* sound and visual thoughts came to mind 24 hours after gameplay (*r* = .021, *p* = .827). Therefore, the amount that participants play videogames did not affect the frequency of involuntary *Bejeweled* thoughts.

How participants rated themselves as gamers did not have a relationship with involuntary *Bejeweled* thought frequency. Gamer self-concept was not correlated with averaged percentage of time participants experienced involuntary *Bejeweled* thoughts immediately after gameplay (*r*= .09, *p* = .23), nor with averaged percentage of time participants had *Bejeweled* sounds and visuals come to mind 24 hours after gameplay (*r* = .06, *p* = .53). This suggests that perhaps both types of people who are casual or hardcore gamers experience similar levels of involuntary videogame thoughts when they have been similarly exposed to playing videogames.

Discussion

In this study, exposure time affected averaged percentage of time involuntary *Bejeweled* thoughts were experienced 24 hours after gameplay. However, exposure time did not have an effect on averaged percentage of time involuntary *Bejeweled* thoughts were experienced immediately after gameplay. Therefore increased exposure time may not affect involuntary thought frequency immediately after gameplay, but may increase involuntary thought frequency 24 hours later. This supports my original hypothesis where increased exposure time would lead to increased frequency of involuntary thoughts, although this only appeared at a 24-hour delay. However, tasks thought to induce imagery that would affect with involuntary game thoughts coming to mind did not have an effect. Task type did not have any effect on involuntary thought frequency whatsoever, immediately or 24-hours after gameplay. However, cognitive load from activities did effect involuntary thought frequency.

In this study, greater exposure time to a videogame lead to a higher frequency of involuntary game thoughts 24-hours later. With this greater exposure time, participants also experienced a higher amount of repetition of game elements. Just as those who listen to a song six times experienced more involuntary musical thoughts than those who merely listened to a song twice (Byron & Fowles, 2015), those who played a game longer experienced more involuntary game thoughts than those who only played a game for five minutes. This also agrees with other involuntary game thought work. Long sessions of gameplay are associated with involuntary visual videogame imagery (Ortiz de Gortari & Griffiths, 2014, 2015) and hardcore gamers, who are characterized by lots of gaming activity, are more likely to experience involuntary game thoughts than those who are not (Ortiz de Gortari & Griffiths, 2015). Therefore, greater exposure time leads to a higher frequency of involuntary thoughts.

Though in this study, the effect of greater exposure time was only visible 24-hours later and not immediately after gameplay. The reason as to why there was no effect immediately after gameplay may be due to recency. Recent exposure is a major influence on the frequency of involuntary thoughts, such as when in listening to music (Bailes, 2007; Byron & Fowles, 2015; Halpern & Bartlett, 2011; Hyman et al., 2013, 2015; Liikkanen, 2012b; Williamson et al., 2012) and playing videogames (Ortiz de Gortari & Griffiths, 2012, 2014). It may be that regardless of the amount of exposure time, the fact that all participants experienced playing *Bejeweled* recently led to a general experience of involuntary game thoughts.

However, there are many statistical analyses done for this study, of which the great majority of those analyses did not find an effect. Therefore, it is uncertain if exposure time indeed does have an effect on percentage of time involuntary thoughts experienced 24-hours later. Replications of this study may make the effect of exposure time on involuntary thought frequency more certain.

After playing *Bejeweled* for different amounts of time, participants worked on two different types of tasks. In a previous study, participants reported experiencing fewer involuntary musical thoughts after completing a verbal task than participants who completed a nonverbal Sudoku task. (Hyman et al., 2013). As there is limited space in the phonological loop of working memory, it is difficult for both words from a verbal task and words from song lyrics to come to mind. This decreases the frequency of involuntary musical thoughts by interfering with their formation. Images from visual tasks likewise interfere with involuntary thoughts that involve imagery by occupying space in the visuospatial sketchpad. This is how videogames have been used to decrease the frequency of involuntary imagery (Holmes, James, Coode-Bate, Deeprose, 2009; James et al., 2015a; Skorka-Brown, Andrade, Whalley, May, 2015). Overall, inducing imagery from tasks and videogames have this involuntary thought decreasing effect on involuntary imagery of songs, trauma videos, and cravings.

However, the task type did not have an effect on involuntary *Bejeweled* thoughts. One possibility as to why the task types did not have an effect in this study is that they did not differ in the way they affected involuntary thoughts. Tasks that share features with the stimuli causing involuntary thoughts have been previously used to decrease the frequency of those involuntary thoughts (Hyman et al., 2013). Though the tasks in this study were intended to represent a visual task and a verbal task, both tasks were inherently visual. The maze task was a visual puzzle, but the word completion task was a verbal task delivered in a visual medium. This means that participants were reading the words on the paper packets, rather than hearing or listening to words. The reason as to why task type did not seem to have an effect is that both of them might have served as visual tasks, leading to this study comparing the effects of two visual tasks instead of between a visual and a verbal task. Therefore, there might have been a difference in involuntary *Bejeweled* thought frequency between task types if participants worked on a verbal task completely in an auditory medium with no visual information.

Though task type did not have an effect, the cognitive load from subsequent activities did. In the 24-hour follow-up, few participants reported involuntary *Bejeweled* thoughts coming to mind when experiencing higher cognitive load and many participants reported involuntary *Bejeweled* thoughts coming to mind when experiencing low cognitive load. In this study, low cognitive load states included when participants were bored or mind-wandering. Involuntary musical thoughts come to mind while people engage in low-load, automatic activities or mind-wandering (Hyman et al., 2013; Kvavilashvili & Mandler, 2004; Williamson et al., 2012). Involuntary game thoughts also tend to come to mind in low-load contexts (Ortiz de Gortari &

Griffiths, 2012). The participants' experience of involuntary *Bejeweled* thoughts in low cognitive load contexts in this study is consistent with previous studies about involuntary thoughts. When people work on low-load, easy activities, this leaves a large amount of available cognitive resources for involuntary thoughts to occupy. This contrasts with people work on high-load, difficult activities that leaves very little available cognitive resources for involuntary thoughts. Therefore, involuntary thoughts are more likely to come to mind during low-load, easy tasks than during high-load, difficult tasks.

However, in this study most participants did not report experiencing any involuntary *Bejeweled* thoughts coming to mind during or around sleep. This is despite times around sleep involving low amounts of cognitive load. Other studies have found videogame imagery coming to mind when people are falling asleep or waking up, after playing videogames previously during the day (Kusse et al., 2012; Stickgold et al., 2000; Wamsley et al., 2010). Additionally, anecdotal reports from gamers describing involuntary videogame thoughts at times around sleep (Ortiz de Gortari & Griffiths, 2012, 2014). It may be that participants in this study did not play videogames for a long enough time to experience involuntary thoughts during or around sleep. In the previously mentioned studies, participants played *Tetris* for a total of several hours over three days (Kusse et al., 2012; Stickgold et al., 2000) or played *Alpine Racer II* in multiple 45 minute long sessions across three consecutive days (Wamsley et al., 2010). Another reason as to why so few participants reported experiencing videogame dreams might be that the participants completed the 24-hour follow-up online survey later in the day rather than immediately after waking. Stickgold et al. (2000) focused on hypnogogic images with participants in a sleep lab, where participants reported their dreams that they recently experienced. By the time participants in this study completed the 24-hour follow-up, it is possible that participants could not recall what they were thinking about while they were falling asleep, dreaming, or waking up. Therefore, once participants completed the follow-up survey, few participants reported that they experienced *Bejeweled* dreams, despite perhaps experiencing them.

In contrast to the activities, videogames did not seem to affect involuntary *Bejeweled* thoughts. Participants who played additional videogames after playing *Bejeweled* did not experience a difference in involuntary *Bejeweled* thought frequency than those who did not. A videogame, with visual and auditory stimuli, would resemble *Bejeweled* and therefore would be expected to provide interference with involuntary *Bejeweled* thoughts coming to mind, and yet like the tasks did not affect involuntary *Bejeweled* thought frequency. It may be that some feature or detail about these videogame experiences prevented them from becoming an influence on involuntary *Bejeweled* thought frequency. Based on the effects of other activities included in the 24-hour follow-up, it may be that these additional videogame experiences are of low cognitive load. However, as no further information about these additional videogame experiences were collected in the 24-hour follow-up, it is impossible to verify this. Nonetheless, this result suggests that later videogame experiences do not necessarily decrease the frequency of involuntary thoughts involving previous videogame experiences.

Participants in this study who experienced involuntary *Bejeweled* thoughts immediately after gameplay were also likely to experience *Bejeweled* thoughts 24 hours later. Similarly, people who experience involuntary imagery of recently heard songs are more likely to experience involuntary imagery afterwards as well (Hyman et al., 2013). Participants experiencing involuntary game thoughts immediately and 24 hours later can serve as evidence for the Zeigarnik effect, where unfinished thoughts and activities tend to remain in consciousness longer than those that are completed. After playing *Bejeweled*, the game is likely to have remained unfinished in some way due to the way participants were instructed to stop playing regardless where they were in their current game. Thoughts about completing the game then may have come to participants' mind during the after-gameplay task, and then continued to come to mind 24 hours later. It seems that in music and videogames, and perhaps in general, if a person experiences involuntary thoughts about a stimuli after recently experiencing it they are likely to experience further involuntary thoughts about it later.

In future replications of this study, researchers should make adjustments to the after-gameplay tasks by utilizing different mediums that match task type, rather than using all tasks on a visual medium. Future studies should also increase exposure time. First, the length of exposure time in this study is not necessarily representative. A five-minute long gaming session may resemble short, casual gaming sessions such as those possible on mobile phones. However, gamers who do not play in casual, short gaming sessions may play games at hour-long or multiple-hour gaming binges. Second, I would also like to explore if the effects of exposure time as seen in this study are intensified by yet a longer exposure. A replication with a shorter exposure than five-minutes, such as with an even more brief two-minute exposure, may also make the differences between the exposure time conditions more dramatic. Third, replicating this study with exposure time in mind may also give more support to the results of this study. In future similar studies, there may be yet again an effect of longer exposure times increasing involuntary thought frequency 24 hours later. Increasing exposure time is one replication of this study that I would like to explore in addition to changing task medium.

Though this study focused on involuntary videogame thoughts, findings from this study can be applied to other involuntary thought experiences. The results from this study can be used to prevent involuntary thoughts in general. Participants in this study experienced more involuntary game thoughts if they played *Bejeweled* for a longer time. Therefore, people can avoid stimuli with repetitive features or long exposure times to stimuli to prevent involuntary thoughts. In general, people could potentially avoid involuntary thoughts about an activity by avoiding long binges and taking frequent breaks. The results from this study can also be applied to lowering the frequency of unwanted involuntary thoughts. Fewer people reported experiencing involuntary game thoughts during higher cognitive load activities than during low. Thus, to prevent unwanted involuntary thoughts coming to mind, people can engage in activities that require attention or concentration, taking up cognitive space that involuntary thoughts can otherwise occupy.

This study can be applied to commercial uses in order to increase involuntary thought frequency as well. As this study uses the videogame *Bejeweled* in combination with exposure time to induce involuntary thoughts up to 24-hours later, developers of videogames and other products can create informed design to induce a desired frequency of involuntary thoughts. Videogames can feature repetitive elements and encourage long periods of gameplay to maximize involuntary game thoughts. The Zeigarnik effect can also be used, where players' gameplay may be restricted to create personally unfinished thoughts that return to mind later. Overall, I found that exposure time and cognitive load can affect involuntary thought frequency, and how involuntary thoughts may return via the Zeigarnik effect. In future studies, researchers will address task types' common visual medium and further expand on the effect of exposure time. Otherwise, this study was successful in demonstrating that involuntary game thoughts of a wider variety of videogames may be experienced, given sufficient exposure time and repetition, and if the videogame was played recently. Cognitive load can also be used to prevent involuntary thoughts as a useful application in preventing those that are unwanted. Further studies can advance research about prevention by studying interference techniques and their effect through working memory. In all, this study has supported the significance of exposure time and its impact on involuntary thought frequency over time. However, further exploration would provide more information to the current knowledge of involuntary thoughts, which can be applied to multiple means.

Works Cited

Bailes, F. (2007). The prevalence and nature of imagined music in the everyday lives of music students. *Psychology of Music*, 35(4), 555-570.

Beaman, C. P., & Williams, T. I. (2010). Earworms (stuck song syndrome): Towards a natural history of intrusive thoughts. *British Journal of Psychology*, 101, 637-653.

Berntsen, D. (1996). Involuntary autobiographical memories. *Applied Cognitive Psychology*, 10, 435-454.

Berntsen, D. & Rubin, D. C. (2002). Emotionally charged autobiographical memories across the life span: The recall of happy, sad, traumatic, and involuntary memories. *Psychology and Aging*, 17 (4), 636-652.

Berntsen, D., & Jacobsen, A. S. (2008). Involuntary (spontaneous) mental time travel into the past and future. *Consciousness and Cognition*, 17, 1093-1104.

Byron, T. P. & Fowles, L. C. (2015). Repetition and recency increases involuntary musical imagery of previously unfamiliar songs. *Psychology of Music*, 43(3), 375-389.

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The International Personality Item Pool and the future of public-domain personality measures. Journal of Research in Personality, 40, 84-96.

Halpern, A. R. & Bartlett, J. C. (2011). The persistence of musical memories: A descriptive study of earworms. *Music Perception*, 28, 425-431.

Holmes, E. A., James, E. L., Coode-Bate, T., Deeprose, C. (2009). Can playing the computer game “Tetris” reduce the build-up of flashbacks for trauma? A proposal from cognitive science. *PLoS ONE*, 4(1), 1-6.

Hyman, I. E., Burland, N. K., Duskin, H. M., Cook, M. C., Roy, C. M., McGrath, J. C., & Roundhill, R. F. (2013). Going Gaga: Investigating, creating, and manipulating the song stuck in my head. *Applied Cognitive Psychology*, 27, 204-215.

Hyman, I. E., Jr., Cutshaw, K. I., Hall, C. M., Snyders, M. E., Masters, S. A., Au, V. S. K, & Graham, J. M. (2015). Involuntary to intrusive: Using Involuntary musical imagery to explore individual differences and the nature of intrusive thoughts. *Psychomusicology: Music, Mind, and Brain*.

James. E. L., Bonsall, M. B., Hoppitt, L., Tunbridge, E. M., Geddes, J. R., Milton, A. L., & Holmes, E. A. (2015a). Computer game play reduces intrusive memories of experimental trauma via reconsolidation-update mechanisms. *Psychological Science*, 1-15.

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). For whom the mind wanders, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science*, 18(7), 614-621.

Kusse, C., Shaffli-LE Bourdiec, A., Schrouff, J., Matarazzo, L., & Maquet, P. (2012). Experience-dependent induction of hypnagogic images during daytime naps: a combined behavioural and EEG study. *Journal of Sleep Research*, 21, 10-20.

Kvavilashvili, L.,& Mandler, G. (2004). Out of one's mind: A study of involuntary semantic memories. *Cognitive Psychology*, 48, 47-94.

Liikkanen. L. A. (2008). Music in everymind: Commonality of involuntary musical imagery. 408-412.

Liikkanen, L. A. (2009). How the mind is easily hooked on musical imagery. *Proceedings of the 7th Triennial Conference of European Society for the Cognitive Sciences of Music*. 271-275.

Liikkanen, L. A. (2012a). Musical activities predispose to involuntary musical imagery. *Psychology of Music*, 40(2), 236-256.

Mace, J. H. (2005). Priming involuntary autobiographical memories. Memory, 13, 874-884.

Ortiz de Gortari, A. G. & Griffiths, M. D. (2012). An introduction to Game Transfer Phenomena in video game playing. NY: Nova Publisher.

Ortiz de Gortari, A. G. & Griffiths, M. D. (2014). Automatic mental processes, automatic actions and behaviours in Game Transfer Phenomena: An empirical self-report study using online forum data. *International Journal of Mental Health and Addiction*, 12(4), 432-452.

Ortiz de Gortari, A. & Griffiths, M. D. (2015). Game Transfer Phenomena and its associated actors: An exploratory empirical online survey study. *Computers in Human Behavior*, 51, 195-202.

Pearson, J. & Westbrook, F. (2015). Phantom perception: voluntary and involuntary nonretinal vision. *Trends in Cognitive Sciences*, 1-7.

Skorka-Brown, J., Andrade, J., Whalley, B., & May, J. (2015). Playing Tetris decreases drug and other cravings in real world settings. *Addictive Behaviors*, 51, 165-170.

Stickgold, R., Malia, A., Maguire, D., Roddenberry, D., & O'Connor, M. (2000). Replaying the game: Hypnagogic images in normals and amnesics. *Science*, 290, 350-353.

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science*, 12, 257-285.

Wamsley, E. J., Perry., K., Djonlagic, I., Reaven, L. B., and Stickgold, R. (2010). Cognitive replay of visuomotor learning at sleep onset: temporal dynamics and relationship to task performance. *Sleep*, 1, 59-68.

Williamson, V. J., Jilka, S. R., Fry, J., Finkel, S., Müllensiefen, D., & Stewart L. (2012). How do "earworms" start? Classifying the everyday circumstances of involuntary musical imagery. *Psychology of Music*, 40, 259-284.

Figure 1. The player moves gems on the *Bejeweled 2* interface by clicking on a select gem with the mouse, and then clicking the adjacent square they wish for the gem to move. On the left side the player can see the number of points they have earned, navigate back to the main menu, or get a hint of which gems they can move at the cost of some progression to the next level. Progression to the next level occurs then the bar at the bottom of the screen is completely filled. The player fills the bar by matching gems and earning points.

Table 1

Correlations Between Items Measuring Involuntary Bejeweled Thought Frequency Immediately After Gameplay

Item	1	2	3	4	5	6	7	8	9
1 General %	-								
2 Sound %	.598**	-							
3 Gems sound	.468**	.673**	-						
4 Explode sound	.476**	.555**	.499**	-					
5 Music	.186**	.268**	.173*	.202**	-				
6 Visuals %	.689**	.494**	.389**	.363**	.022	-			
7 Gem swapping	.583**	.416**	.461**	.362**	-.002	.711**	-		
8 Gems falling	.509**	.425**	.444*	.362**	.260**	.650**	.636**	-	
9 Explode visual	.514**	.375**	.286**	.525**	-.003	.593**	.544**	.478**	-

** $p < .001$
* $p < .05$

Table 2

Correlations Between Items Measuring Involuntary Bejeweled Thought frequency 24 Hours After Gameplay

Item	1	2	3	4	5	6	7	8	9
1 General freq.	-								
2 Sound %	.596**	-							
3 Gem sound	.551**	.714**	-						
4 Explode sound	.490**	.489**	.440**	-					
5 Music	.459**	.376**	.478**	.232*	-				
6 Visual %	.599**	.717**	.571**	.386**	.284**	-			
7 Gem swapping	.514**	.405**	.465**	.370**	.220*	.581**	-		
8 Gems falling	.419**	.457**	.540**	.370**	.336**	.620**	.521**	-	
9 Explode visual	.424**	.502**	.489**	.600**	.221*	.605**	.526**	.602**	-

** $p < .001$
* $p < .05$

Table 3

Factor Coefficients Relevant to Involuntary Thought Frequency Experienced Immediately After Gameplay

	Factor	
Item	Involuntary Visual Thoughts	Involuntary Sound Thoughts
6 Visual %	**.886**	.137
7 Gem swapping	**.852**	.092
9 Explode visual	**.768**	.083
1 General %	**.716**	.387
8 Gems falling	**.698**	.312
5 Music	-.190	**.782**
2 Sound %	.474	**.693**
3 Gems sound	.442	**.624**
4 Explode sound	.460	**.560**

Table 4

Factor Coefficients Relevant to Involuntary Thought Frequency Experienced 24 Hours After Gameplay

Item	Factor Involuntary Visual Thoughts
1 General freq.	.765
3 Sound %	.809
4 Gems sound	.800
5 Explode sound	.658
6 Music	.515
7 Visual %	.830
8 Gems swapping	.700
9 Gems falling	.741
10 Gems exploding	.759

Table 5

Means (SD) of Averaged Percentages of Time Involuntary Bejeweled Thoughts Were Experienced Immediately After Gameplay

	Exposure time	
Task type	5 minutes	30 minutes
Words	19.90 (18.32)	24.57 (25.36)
Mazes	26.74 (28.95)	27.91 (27.44)

Table 6

Means (SD) of Averaged Frequencies of Involuntary Bejeweled Sound Thoughts Experienced Immediately After Gameplay

	Exposure time	
Task type	5 minutes	30 minutes
Words	2.95 (5.36)	2.00 (1.12)
Mazes	2.00 (1.16)	2.28 (1.10)

Table 7

Means (SD) of Averaged Frequencies of Involuntary Bejeweled Visual Thoughts Experienced Immediately After Gameplay

	Exposure time	
Task type	5 minutes	30 minutes
Words	1.92 (.87)	2.18 (1.19)
Mazes	1.97 (1.11)	2.01 (1.07)

Table 8

Means (SD) of Averaged Percentages of Time Involuntary Bejeweled Thoughts Were Experienced 24-Hours After Gameplay

	Exposure time	
Task type	5 minutes	30 minutes
Words	9.83 (13.98)	12.91 (18.85)
Mazes	4.82 (6.57)	14.83 (17.65)

Table 9

Means (SD) of Averaged Frequencies of Involuntary Bejeweled Sound Thoughts Experienced 24-Hours After Gameplay

	Exposure time	
Task type	5 minutes	30 minutes
Words	1.54 (.79)	1.70 (.94)
Mazes	1.41 (.61)	1.74 (.80)

Table 10

Means (SD) of Averaged Frequencies of Involuntary Bejeweled Visual Thoughts Experienced 24-Hours After Gameplay

	Exposure time	
Task type	5 minutes	30 minutes
Words	1.72 (.96)	1.89 (.87)
Mazes	1.44 (.65)	1.78 (.78)

Table 11

Correlations Between Overall Averaged FITS Scores, Overall Averaged Fantasy Proneness Scores, and Frequencies of Involuntary Bejeweled Thoughts Experienced Immediately After Gameplay

	1	2	3	4	5
1. Averaged FITS scores	-				
2. Averaged Fantasy Proneness scores	.440**	-			
3. Averaged percentage of time *Bejeweled* thoughts came to mind	.139	.048	-		
4. Averaged frequencies of involuntary *Bejeweled* sound thoughts	.092	.140	.357**	-	
5. Averaged frequencies of involuntary *Bejeweled* visual thoughts	.120	.092	.742**	.238**	-

** $p < .001$
* $p < .05$

Table 12

Correlations Between Overall Averaged FITS Scores, Overall Averaged Fantasy Proneness Scores and Frequencies of Involuntary Bejeweled Thoughts Experienced 24 Hours After Gameplay

	1	2	3	4	5
1. Averaged FITS scores	-				
2. Averaged Fantasy Proneness scores	.440**	-			
3. Averaged percentage of time *Bejeweled* sounds and visuals came to mind	.251**	.139	-		
4. Averaged frequencies of involuntary *Bejeweled* sound thoughts	.112	.058	.626**	-	
5. Averaged frequencies of involuntary *Bejeweled* visual thoughts	.178	.182	.691**	.599**	-

** $p < .001$
* $p < .05$

Table 13

Correlations Between Frequency of Involuntary Thoughts Scale Items

Item	1	2	3	4	5	6	7	8
1 Music	-							
2 Visual images	.424**	-						
3 Memories	.158*	.539**	-					
4 Future	.311**	.437**	.478**	-				
5 Romantic	.380**	.385**	.252**	.458**	-			
6 Relationships	.277**	.299**	.297**	.407**	.489**	-		
7 Work	.092	.239**	.224**	.263**	.160*	.253**	-	
8 Money	.099	.159*	.155*	.337**	.250**	.250**	.293**	-

** $p < .001$
* $p < .05$

Table 14

Correlations Between Fantasy Proneness Items

Item	1	2	3	4	5	6
1 Daydreams	-					
2 Overwhelming fantasies	.528**	-				
3 Trance	.476**	.463**	-			
4 Wild imagination	.499**	.437**	.463**	-		
5 Preoccupation	.122	.164*	.190**	.244**	-	
6 Vivid mental pictures	.337**	.345**	.317**	.482**	.085	-

** $p < .001$
* $p < .05$

Table 15

Means (SD) and T-Tests Comparing Gender Differences and Involuntary Bejeweled Thought Frequency

	Gender					
	Male	Female	*t*	*df*	*p*	*d*
Averaged immediate general % of time	25.08 (28.07)	24.75 (22.97)	.089	190	.929	.013
Averaged immediate sound frequency	2.07 (1.16)	2.57 (3.91)	-1.159	189	.248	.171
Averaged immediate visual frequency	2.04 (1.12)	2.00 (1.00)	.263	190	.794	.038
Averaged 24-hour general % of time	11.15 (17.34)	10.23 (13.52)	.751	110	.751	.060
Averaged 24-hour sound frequency	1.57 (.74)	1.62 (.84)	-.342	110	.733	.064
Averaged 24-hour visual frequency	1.83 (.93)	1.61 (.73)	1.379	110	.171	.259